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FEASIBILITY OF ICT USE IN TEACHING PHYSICS AT THE SENIOR HIGH SCHOOLS IN GHANA

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ABSTRACT: *The study employed a descriptive research design to explore the feasibility of information and communication technology (ICT) use in the teaching of physics in Ghanaian high school classrooms. A questionnaire was used to collect data from 70 practicing physics teachers from 23 Senior High Schools (SHSs) in Ghana. The study showed that the practicing physics teachers were not using ICT in their current teaching practices owing to barriers such as lack of ICT resource and lack of knowledge and skill that are ICT-oriented. However, the practicing teacher of the study showed positive attitudes and beliefs toward the use of ICT for physics instruction and expressed their willingness to participate in training programmes to foster their teaching practices with ICT. The study therefore advocates that the use of ICT as an instructional tool for physics teaching in Ghanaian high school is feasible but requires that substantive assistance be given to teachers in order to equip them with ICT-related pedagogical knowledge and skills to facilitate their teaching practices.*

KEYWORDS: information and communication technology, high school physics, barriers of ICT use, opportunities of ICT use.

INTRODUCTION

In most Ghanaian high school physics classrooms, the teaching of the day places much emphasis on the accumulation of information rather than an effective method of inquiry (Byzee, Trowbridge & Powell, 2008). As a consequence, students are subjected to become passive receptacles of the information provided in the classroom (Agyei, 2013). This has resulted in problems such as poor performance and lack of interest in physics and seems to have also added to the perceived difficulty in the subject by students. A number of researchers (e.g., Antwi, Anderson & Sakyi-Hagan, 2015; Azure, 2015; Changeiywo, Wambugu & Wachanga, 2011; Gunasingham, 2009; Smither, 2006) have identified uninteresting teaching method as one of the reasons for the poor performance reported in physics at the SHSs (Buabeng & Ntow, 2010). This seems to suggest that there is a gap in the way and manner in which physics as a science subject is being taught at the high school level. Perhaps, the traditional teaching method being adopted in the physics classrooms is not the most appropriate approach for teaching physics after all and as it does not make use of advanced technologies (Tambade & Wagh, 2011). The teaching of physics is therefore a facing dilemma not

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only for teachers but also for students especially in a system where the appropriate resources and equipment needed for good facilitation and enhancement of teaching and learning processes are limited. A way forward in tackling these concerns would perhaps be to develop and equip both pre-service and in-service physics teachers on more effective instructional methods for the teaching of physics. This could serve as a platform by which the use of an educational and instructional tool like information and communication technology (ICT) and its implication on teaching and learning processes are brought to the attention of these teachers. Such an agenda however would be more effective and useful if the real difficulties teachers face in teaching various content areas of physics at the senior high schools are examined to explore their perceived affordances of ICT for promoting interactive teaching at the SHSs. The overall purpose of the present study was therefore to explore how feasible the use of ICT as an instructional tool could be in physics classrooms at the senior high school level of education in Ghana. Consequently, the study sought to provide an understanding of the context of physics teachers at the SHSs regarding ICT integration in physics lessons. The following research questions were addressed:

1. What are the practices of ICT use among SHS physics teachers in Ghana?
2. What are the factors that inhibit the use of ICT in teaching physics at the SHSs in Ghana?
3. What are the needs of physics teachers in teaching physics with ICT at the SHSs in Ghana?
4. What are the opportunities to explore for effective use of ICT in the teaching of physics at the SHSs in Ghana?

Educational change with ICT

Change in general is not easy though, traditions and familiar routines and practices in schooling are easy to maintain and follow (Speck, 1996). Educational change is therefore not an easy task to achieve as it depends on so many factors. According to Donnelly, McGarr, and O'Reilly (2011), these factors could be classified as internal or external by looking at who the change affects, what drives the change process and what is needed to effect the change. Internal factors highlight the importance of the teacher's role in the change process in that "what they do and what they think" as emphasized by Fullan (1991) are key ingredients to the success of educational change. External factors however could be zoomed in on the issue of curriculum development where teachers do not show or exhibit ownership in curriculum development because they feel left out in the process and thus, do not readily take part in it (Donnelly, et al., 2011). This is very much evidenced in the Ghanaian context. We see from the Ghanaian perspective that the scope of factors that influence the change process in education is complicated and the complexity is even extended to a high dimension with ICT integration in the picture. If such a change with ICT is to be effected in the Senior High Schools for teaching physics in Ghana as a way of addressing the poor performance observed in subject at that level of education (Ghana Academy of Arts and sciences: Occasional lecture, 2016), such complexities in the change process cannot be avoided as teachers who have a greater role to play in the change process are usually limited in identifying the most appropriate ICT resources required to teach physics and also seem to be lacking in their knowledge and understanding of what the affordances of ICT offer to the learner (Webb & Cox, 2003). Hence, there is a need to get a better understanding of what ICT affords in the physics classroom, possible barriers there is to its use and some of the attitudes and beliefs that teachers have towards ICT use.

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We discuss herein each of these elements briefly using extant literature in the area of ICT integration into physics education.

Potential of ICT use in teaching physics

Information and communication technology are well noted to be the key to addressing the various concerns that have been expressed in literature (Buabeng, Ossei-Anto, & Ampiah, 2014; Wanbugu & Changeiywo, 2008) in relation to physics as a science subject at the Senior High level not only in Ghana but also in other countries abroad as it has much to offer. Studies in the area of ICT integration in science teaching have highlighted that ICT-based resources (e.g., simulations, videos, etc.) have potentials that allow for an alternative transmission; better explanations of various concepts in science that otherwise look very abstract; and modernity which is relevant to students (Georgiou, Dimitropoulos & Manitsaris, 2007; Donnelly, et al., 2011). This seems to emphasise that by incorporating ICT into the teaching of physics and science in general, a typical teacher-centered classroom environment as often seen in the Ghanaian context, could be transformed into an interactive learning environment where students and teachers acquire different knowledge and skills in ways that informs their study and implementation of the curriculum. ICT can thus be said to have the capacity for improving physics education or the teaching of physics. This supports Bransford, Brown and Cocking's (2002) view that the impact of ICT on the teaching of physics for positive results is highly dependent on how teachers use ICT in their classrooms. Based on this notion, one of the objectives of the study was to assess physics teacher's use of ICT in their teaching practices in an attempt to get an understanding of the extent to which ICT is being adopted for instruction at the SHS's in Ghana.

Barriers to ICT integration into Physics Teaching

ICT innovations are noted to face the same problems with other types of innovation. If teachers decide to use ICT in their teaching, these problems are sure to surface. Prestage (1996) identified lack of time as a major barrier to teachers' use of ICT in the classroom. Other studies (Dawes, 1999; Mumtaz, 2000; Hadley & Sheingold,1993) highlighted barriers such as teachers' styles of computing, teachers' resistance to change (with computer use), lack of human resources, inadequate ICT resources and the low level of teachers' competency in ICT use as the major hindrances to ICT integration. All these barriers can be grouped into either first -order barrier or second other barrier (Ertmer,1999). For example, Donnelly et al. (2011) classified inadequate ICT resources and the low level of teachers' competency in ICT use as first-order barrier. Ertmer (1999) however, indicated that these barriers could be eliminated through the provision of financial assistances. Lack of specific knowledge and skills has also been found to be a major barrier to teachers as most of them shy away from using technology because of the gaps in their knowledge and skills where ICT is concerned (Hew & Brush, 2007). These barriers also apply to ICT use in physics education; as without the appropriate ICT-related knowledge and skills, physics teachers cannot be encouraged to take up ICT in their instruction. Also, without the needed resources, even if they have the skill, they cannot put it into practice. As numerous as these barriers appear, it is still not clear which of these barriers apply in the Ghanaian context with respect to the teaching of physics. Thus, there is need to explore the perception of physics teachers on what they consider as a barrier to their use of ICT in their classrooms.

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Teachers' Attitudes and Beliefs Towards ICT Use

According to Mumtaz (2000), teachers' attitudes can either encourage or prevent teachers from using ICT. This seems to imply that a positive attitude could be an opportunity to explore for effective integration of ICT into teaching and consequently reflects Moseley and Higgins's (1999) assertion that a positive attitude towards ICT on the part of a teacher tends to motivate teachers to use ICT in teaching. On the other hand, a teacher's attitude if negative could serve as a barrier to the integrating process. Donnelly et al. (2011) posited that educational change through ICT integration in schools lies in the consideration of teachers' beliefs and how these beliefs are brought into action through practice. This seems to suggest that beliefs, if well studied could be key to elucidating the caliber of teachers that exist in schools and how they react to the introduction of new ICTs into their schools. This could be useful in informing educational stakeholders on measures to espouse for effective use of ICT-based resources by teachers. Thus, the attitudes and beliefs teachers have about the use of ICT in teaching physics cannot be underestimated as these factors have the potential to influence the success of any ICT initiative and implementation process. The study therefore investigated teachers' attitudes and belief in order to identify the opportunities to explore for effective use of ICT in the teaching of physics at the SHSs.

METHODS

Research design

The study employed a survey method to investigate and describe the feasibility of ICT use as an instructional tool for teaching physics at the SHS level of education in Ghana. By this method, a systematic information about the current status of ICT integration into the teaching of physics, beliefs, attitudes and opportunities of physics teachers to explore effective use of ICT were ascertained.

Participants

A total of 70 practicing physics teachers (59 males and 11 females) were used for this study. The participants were selected from 23 Senior High Schools in Ghana ranging from government, mission, private and international schools. These schools were selected on the basis that they had a reasonable number of physics teachers as well as ICT infrastructure, hence the sampling technique used was purposive as the participants were selected from schools based on the authors' internal knowledge of the said characteristics of the population. The years of teaching experiences among the participants raged from one to twenty-one years.

Research Instrument

A questionnaire was used to collect data for this study. The questionnaire was in two parts: the first part was used to collect demographic data which included gender, school, teaching subject and years of experience in teaching while the second part was subdivided into six sections that were designed to gather information on: 1) current use of ICT in physics classrooms; 2) teachers' attitudes towards ICT; 3) perceived barriers to ICT; 4) teachers' beliefs on teaching approaches and ICT; 5) teachers professional needs with ICT as well as their willingness to participate in ICT training programmes.

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The first section contained 11 items designed to determine the extent to which various ICT applications were used by the teachers in the physics classroom. Participants were asked to indicated the extent to which they used each of the ICT applications as follows: (1) Never; (2) Hardly; (3) Sometimes; (4) Often; (5) Always. A mean score less than 3 represented rare use of ICT application whereas a mean score greater than 3 represented frequent use of ICT application.

The second section was designed to contain items about teachers' attitudes towards computer (TAC). These items were developed based on existing computer attitudes scales by Christensen and Knezek (2000). The TAC questionnaire is a 95–199 item Likert Differential instrument for measuring teachers' attitudes towards computers up to about 20 sub-scales (Agyei & Voogt, 2010). These measurement instruments are confirmed to be reliable by previous research (Knezek & Christensen, 1998). To be specific, fifty items of the TAC questionnaire were slightly modified and used to explore the attitudes of the practicing teachers in the study. Out of the fifty modified items, twenty-four were selected as high loadings on the extracted factors after an exploratory factor analysis was done (see Table 1 for the internal consistency reliabilities for the TAC subscales and the factor loadings for the selected items as reported by the participants).

Table 1: Internal consistency reliabilities for six subscales of the TAC Questionnaire

Subscale	Cronbach's alpha	Items (N=70)	Factor loadings
Benefits	0.79	The relationship between theory and practice is strengthened (e.g. through simulations).	0.70
		Enhances students learning (effectiveness).	0.65
		Students can access courses, assignments, course outlines etc. regardless of location and time (flexibility in education).	0.66
		Improvement of feedback to students.	0.57
		Learning becomes fun.	0.63
Enjoyment	0.70	I feel comfortable working with a computer.	0.61
		I enjoy lessons on a computer.	0.51
Professional enhancement	0.81	If there is a computer in my future classroom, it would help me to be a better teacher.	0.56
		If there was a computer in my classroom, it would help me to be a better teacher.	0.62
		I believe that the more often teachers use computers, the more students will enjoy school.	0.75
Lack of Anxiety	0.75	I think that it takes a long time to finish a task when I use a computer.	0.68
		Using a computer is very frustrating.	0.79
		Computers are difficult to use.	0.54
		I will do as little work with computers as possible.	0.57
Instructional productivity	0.83	Computers could enhance remedial instruction.	0.68
		Computers can be used successfully with courses which demand creative activities.	0.57

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		Computers can help accommodate different teaching styles.	0.52
		Incorporate new ways of organizing students	0.50
		Computers can help teachers provide more individualized feedback to students.	0.65
		Computers help to incorporate new teaching methods.	0.50
		Lesson delivery is improved and enhanced (efficiency).	0.53
Interaction	0.70	E-mail is an effective means of disseminating class information and assignments.	0.73
		I prefer e-mail to traditional class handout as an information.	0.63
		Improvement of communication and interaction between instructors and students, and among students.	0.66

As shown in Table 1, the items were grouped under six subscales namely: *Benefits* (i.e., perceived affordances of using computers in class), *Enjoyment* (i.e., the pleasure someone experiences when using computers), *Professional Enhancement*, Anxiety (i.e., fear to use computers), *Instructional productivity* (i.e., effect of computer use on teaching practices adopted in the classroom) and *Interaction* (use of possible applications of the computer for information dissemination), were used. A five-point Likert scale (1 = strongly disagree, 5= strongly agree) was used for all subscales. A score of 1 (i.e., the lowest possible score) was interpreted to mean a very strong negative attitude while a score of 5 (i.e., highest possible score) was interpreted as a very strong positive attitude. It is important to mention that items of the Anxiety scale were rescaled so that a high score of computer anxiety could be taken as "Lack of Anxiety".

The third section contained items that were used to assess factors affecting teachers' implementation of ICT-based innovations in the classroom. This section of the questionnaire contained 21 items that investigated possible reasons for teachers' use (as well as inability to make use) of the ICT in teaching. The items were developed based on instruments developed by Surry and Ensminger (2004). The fourth section was developed to assess teachers' beliefs in using different instructional strategies. This aspect contained 12 items on a five-point Likert scale (1 = strongly disagree, 5= strongly agree). An average of 3 and above indicated a positive favourable opinion while below 3 indicated a negative opinion of teachers' responses with respect to their beliefs. The fifth section of the questionnaire was purposed to: 1) identify the teachers' professional needs with ICT and 2) determine the teachers' willingness to participate in ICT training programmes.

All these five sections of the second part of the questionnaire were intended to help the authors to adequately address the research questions.

Data collection and data analysis procedures

The questionnaire was distributed to the practicing teachers in their various high schools during school time with the help of the principals and department heads. To analyze the data factor analyses, independent t-test and descriptive statistics (i.e., means (M) and standard deviation (SD) and frequency distribution) were used.

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RESULTS

Physics Teachers' Use of ICT

To determine the existing practices of ICT use in the physics classroom, the teachers indicated the extent to which they used certain ICT applications in their instruction. Table 2 shows the descriptive statistics of the results. The result in this regard showed that the teachers hardly use ICT applications in teaching physics. ICT applications that promote interactive teaching such as computer simulations (*M*=2.49, *SD*=1.201), presentation with simple animation functions (*M*=2.60, *SD*=1.001) and application of multimedia (*M*=2.74, *SD*=1.090) are currently not being adopted for the teaching of physics in schools. The most popular ICT application reported was the word processing application (*M*=3.23, *SD*=1.140) which seemed often employed for personal use and perhaps for assessment purposes. The results seem to indicate that, physics teachers in the study are novices with the use of ICT for instructional purposes. Consequently, some ICT applications for teaching physics were not known to some teachers.

Table 2: Teachers use of ICT applications in the teaching of physics (N=70)

ICT Application	Never %	Hardly %	Sometimes %	Often %	Always %	Mean (M)	SD
Word processing packages	7.5	20.9	25.4	32.8	13.4	3.23	1.140
Data software	20.0	28.6	32.9	14.3	4.3	2.54	1.101
Presentation Software	15.5	28.2	28.2	21.1	7.0	2.79	1.150
Graphical Application	18.8	29.0	34.8	13.0	4.3	2.53	1.090
Application of multimedia	12.9	25.7	40.0	17.1	4.3	2.74	1.030
Computer simulations	24.3	30.0	25.7	12.9	5.7	2.49	1.201
Presentation with simple animation functions	17.1	24.3	41.4	15.7	1.4	2.60	1.001
Useful curriculum resources in physics on internet for teaching	12.7	31.0	35.2	19.7	1.4	2.66	0.998
E-mail	18.3	23.9	33.8	21.1	2.8	2.66	1.101
Taking photos and using them for teaching	12.7	28.2	28.2	23.9	7.0	2.83	1.141
Use of spreadsheet for student administration	20.6	26.5	27.9	14.7	10.3	2.67	1.240

1= Never, 2=Hardly, 3=Sometimes, 4=Often, 5=Always

Barriers to ICT

The study also sought to identify what physics teachers perceived as barriers to their implementation of technology enhanced physics teaching in their respective schools (i.e., research question 2). Table 3 represents the results of their perceived barriers.

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Table 3: Factors affecting teachers' use of ICT in teaching physics (N=70)

Factors	Mean	SD
Lack of Rewards and Incentives	2.77	1.027
Poor School Culture	3.58	0.593
Dissatisfied with status quo	3.58	0.623
Lack of Resources	3.99	0.836
Lack of Commitment	3.26	0.912
Lack of Time	3.74	0.984
Lack of Participation	3.64	0.986
Lack of Knowledge and Skills	3.89	0.960

The results pin point to the fact that *Lack of resources (M* =3.99, *SD*=0.836) and *Lack of knowledge and skills* (*M*=3.89, *SD*=0.96) are perceived as the major barriers which inhibit teachers' use of ICT in their current teaching practices. Lack of time (*M*=3.74, *SD*=0.984) was also revealed as the third major barrier to teachers' use of ICT. However, *Lack of rewards and incentives* (*M* =2.77, *SD*=1.03) was not considered as a barrier to teachers' use of ICT in the classroom suggesting that its absence or presence does not influence teachers' decision to use or not to use ICT in teaching physics. The participants' reported overall mean (*M*=3.55, SD=0.74) depicts that with the exception of *Lack of rewards and incentives*, all the other factors indicated in Table 3, one way or the other inhibit the teachers' use of ICT in teaching physics.

Opportunities to Explore for Effective Use of ICT

In spite of the observed barriers, the study further sought to identify the opportunities to explore for effective use of ICT in the teaching of physics at the SHSs. To achieve this, three factors were explored. These included teachers' attitude toward computers; teachers' beliefs on teaching approaches and ICT; and teachers' willingness to participate in ICT training programmes. Responses to these questions are indicated in Table 4, Table 5 and Table 6 respectively. Table 4 shows the teachers' attitudes towards the use of ICT as reported in their TAC scores. Table 5 and Table 6 highlight the responses on teachers' beliefs and willingness to participate in ICT training programmes respectively.

The overall attitude (*M*=4.05, *SD* =0.614) suggests that in general, the teachers reported high positive attitudes for all the TAC subscales as shown in Table 4. This result will obviously augur well for the development of ICT training programmes for teachers in the context of this study; the high positive attitudes reported could serve as an opportunity that could be maximized to promote the teachers' effective use of ICT in the teaching of physics at the SHS's. This is further confirmed by the teachers' reported low anxiety *(i.e. Lack of Anxiety (M=4.06, SD=0.663))* with the use of computers. The highest reported attitudinal subscale was *Enjoyment (M=4.22, SD=0.500)* (i.e., the pleasure someone experiences when using computers) and the least, *Interaction (M=3.73, SD=0.690)* (use of possible applications of the computer for information dissemination).

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Table 4: Attitudes of Physics teachers based on TAC scores(N=70)

Subscales	Mean	SD
Benefits	4.13	0.550
Enjoyment	4.22	0.500
Professional Enhancement	4.16	0.716
Lack of Anxiety	4.06	0.663
Instructional Productivity	4.01	0.564
Interaction	3.73	0.690
Overall Attitude	4.05	0.614

Further analyses were also done to ascertain differences (mean difference = -0.23, p = 0.326) in attitudes based on TAC scores for the male *(M=4.05, SD=0.454)* and female *(M=4.28, SD=0.296)* physics teachers and the result was not significant for overall computer attitudes between the two groups as well as for all the TAC subscales.

The mean score for teachers' beliefs on teaching approaches and ICT as shown in Table 5, ranges from 4.06 to 4.32 which in all, represent positive responses from respondents.

Table 5: Physics teachers' beliefs on teaching approaches and ICT

Beliefs	Mean	SD
I believe the use of the activity-based pedagogical approach supports student learning.	4.31	0.689
I believe that the use of video techniques facilitates physics related concepts formation.	4.32	0.789
I believe that the use of computer simulations promotes conceptual learning	4.29	0.617
I believe that the use of microcomputer-based laboratories (MBL) provides students with the opportunity to undertake their own investigations during physics practical sessions.	4.06	0.720
I believe that the use of teamwork among students promote collaborating learning.	4.32	0.671
I believe that the use of "interactive demonstration" helps to encourage teachers to be facilitators of students' learning.	4.23	0.614

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The results seem to suggest that, the teachers believed that ICT when used in physics instruction can have a positive impact on students' learning as well as promote inquiry method of teaching. Once again, the results seem to reiterate the notion that teachers are not ignorant of the affordances that ICT provides for the learner or teacher. This was evident in results Table 2; which hinted that the teachers had a fair idea of the what ICT innovations that employs technological tools like videos, computer simulations and MBL among others, allow for effective and interactive teaching of physics. Perhaps this could also serve as an opportunity to explore apart from the positive attitude highlighted earlier; thus, the findings here situate teachers' beliefs, when positive serve an essential ingredient for successful ICT integration into the teaching of physics.

Teachers' needs with ICT

With regards to the extent to which teachers were willing to part take in ICT training programmes, they were expected to indicate one of the options: Yes, *No*, or *undecided. The results are shown in Table* 6. An extremely high number (94.2%) of the teachers gave a positive response (i.e., indicated "*yes*") — which is an indication of their willingness to participate in ICT training programmes.

Table 6: Physics teachers' willingness to participate in ICT Training programmes (N=70)

Responses	Frequency	Percentages (%)
No	3	4.3
Undecided	1	1.4
Yes	66	94.2
Total	70	100.0

Teachers needs in relation to the teaching of physics with ICT were reported in two folds: 1) ICT training needs and 2) ICT intervention needs for specific physics content. The teachers in the study identified specific content of ICT professional development programme needs shown in Figure 1.

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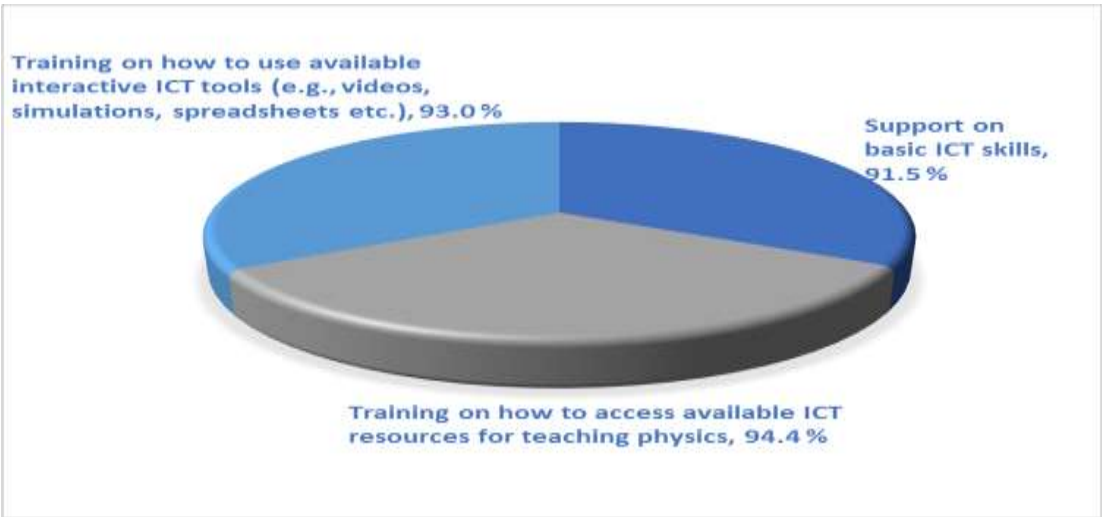

Figure 1: Physics teachers' perceived training needs for physics instruction using ICT

From Figure 1, it can be observed that the teachers responded positively concerning their ICT training needs in three areas. Thus, the results suggest that the teachers believed that they needed training not just on basic ICT skills (91.5%) as most ICT professional development programmes do, but also, on how to access available ICT resources for teaching physics (94.4%) and how to use available interactive ICT tools (93.0%). This seems to suggest that the teachers lack knowledge and skills to integrate ICT in teaching physics at the SHS's. This confirms the findings that lack of knowledge and skills was one of the major factors that inhibits physics teachers use of ICT in teaching physics.

The teachers also indicated the perceived major topic(s) in the physics syllabus for SHS's in Ghana that need some kind of ICT intervention in instruction.

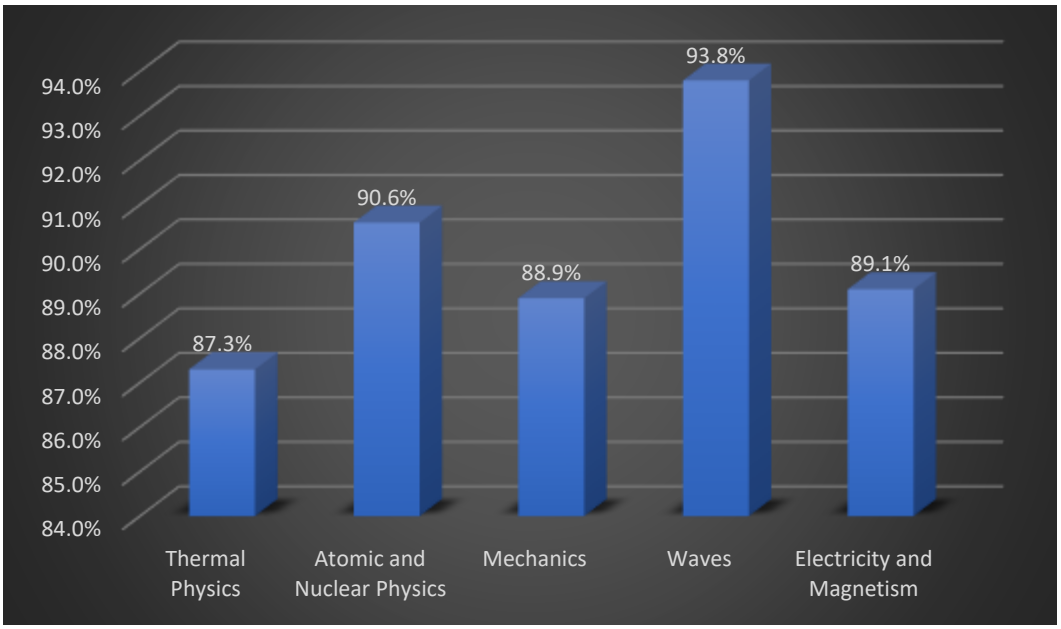

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Figure 2: Physics teachers' positive responses on content in physics that needs ICT intervention in instruction.

The results shown in Figure 2 indicate that the physics teachers perceived all the topic options (i.e., Electricity and Magnetism, Waves, Mechanics, Atomic and Nuclear Physics, and Thermal Physics) to require some kind of ICT intervention in instruction. Waves was ranked the highest (93.8%), followed by Atomic and Nuclear Physics (90.6%), then followed by the others. These statistics are very significant and thus, seem to suggest that the current methods in instruction being adopted for the teaching of these physics' topics are not only insufficient but also, ineffective for the facilitation of the conceptual understanding learners need as far as physics as a science subject is concerned. Interestingly, the results seem to highlight that physics teachers at the SHS's are not ignorant of the potentials of ICT in physics education and thus, appreciate what ICT affords the physics teacher as well as the learner.

DISCUSSION

The present study was conducted to explore the feasibility of the use of ICT as an instructional tool for teaching physics at the senior high school level of education in Ghana. The analysis made was based on 70 respondents (physics teachers) and revealed that the teachers hardly use ICT applications in their current teaching practices in physics classrooms. It appears that factors such as lack of resources, lack of knowledge and skills, and lack of time, which the teachers perceived as major barriers to their use of ICT in teaching physics were the main reasons why the teachers were not using ICT in their teaching practices. This aligns with finding of studies in literature (Donnelly, et al., 2011; Ertmer,1999; Hayes, 2007; Hew & Brush, 2007; Mumtaz, 2000) that identify these factors as the major hindrances to teachers' uptake of ICT at the school level.

According to Mumtaz (2000), there are several factors that influence teachers' use of ICT in teaching. These include among others, teachers' beliefs, attitudes and skills in using ICT. He further explained that these factors can either encourage or prevent teachers from using ICT. This seems to suggest that if teachers have positive attitude in using ICT, they will use it in teaching, on the other hand, if their attitudes toward ICT are negative, they will not use ICT in their teaching practices likewise beliefs and skills. Interestingly, in the context of this study, teachers showed relatively high positive attitudes towards computers and also, had relatively high positive beliefs on teaching approaches and ICT. Their positive beliefs for example, seemed to have emanated from the value these teachers place on ICT to help them achieve their instructional goals. This seems to suggest that the more value teachers place on instructional and technological tools, the more likely they are to use them (Ertmer & Ottenbreit-Leftwich, 2010). Going by Mumtaz's explanation, the positive attitudes and beliefs as revealed herein can be seen as an opportunity to explore in order to encourage teachers to take up ICT in their teaching. Seemingly, this confirms Moseley and Higgins' (1999) assertion that a positive attitude towards ICT on the part of a teacher has a tendency to motivate the teachers to use ICT in teaching.

Another key finding of the study was that the physics teachers were willing to participate in ICT training programmes. Their willingness was also reflected in their positive attitudes and beliefs as discussed earlier and hence, could be a prospect to consider in coming up with strategies to

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eliminate the factors identified by teachers as barriers (e.g., lack of knowledge and skills) to their use of ICT in instruction.

Findings also highlighted that the teachers in this context had a fair idea of what teaching practices that are ICT-driven offer learners, teachers and the schools as a whole (Kozma, 2003). This brings to bear an important detail that physics teachers in Ghana are very much aware of the potentials of ICT in transforming the teaching and learning strategies currently being adopted for the teaching of physics at the SHS's into a more interactive and effective teaching and learning approaches that enhance students' learning outcomes. This was emphasized in their perceived needs— training on how to: access available ICT resources for teaching physics, use available interactive ICT tools and to incorporate ICT in teaching. In addressing these needs, the teachers also expressed their views on what content in physics are to be considered with ICT. These according to the teachers, should include topics such as Electricity and Magnetism, Waves, Mechanics, Atomic and Nuclear Physics, and Thermal Physics.

Based on the outcomes of this study, we highlight the following propositions for effective integration of ICT into physics teaching for better learning outcomes:

- Emphasis on the provision of modern technological resources such as microcomputer-based laboratories (MBL), internet, computer and projection devices for instructional purposes in physics classrooms will increase teachers' access to ICT and thus contribute to their uptake of ICT in schools.
- Developing teachers' competencies on the use ICT applications that promote interactive teaching of physics and also meet the specific physics content needs should be an integral part of the design and implementation of any professional development arrangement for physics teachers. This will assist teachers to develop in-depth understanding into how technology can be used to effectively transform teaching and learning of physics.
- Although the study was conducted among in-service teachers, it is implied for pre-service teachers in that, teacher education institutions in the context of the study need to include pedagogical courses that are related to ICT integration in their curriculum for physics education. This could be an opportunity for enhancing the prospective teachers' capabilities and experience to integrate ICT in their future physics classes and also make them appreciate the potential of ICT for making the teaching of physics interesting, interactive and also fun.

CONCLUSION

The study has shown that the practicing physics teachers were not using ICT in their teaching practices at the SHSs. However, they showed positive attitude towards computer, more positive beliefs on what ICT enables in the physics classroom when used for instructional purposes, and were willing to participate in ICT integration training programmes when presented with the opportunity. Based on these findings, it is clear that teachers' attitudes and beliefs though are essential ingredients for a teacher to want to use ICT in physics instructions, they are not the only elements needed; there are more factors that can influence teachers' use of ICT in the physics classroom. Apparently, other equally important factors such as adequate and readily available resources as well as teachers' knowledge and skills about both the activity structures that are appropriate for teaching specific physics content and the manners in which particular technologies

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can be explored as part of a lesson are also key factors that influence teachers' use of ICT in teaching physics. This study therefore suggests that the prospect of using ICT as a technological tool for the teaching of physics at the SHSs in Ghana is feasible, however, the implementing agents like the practicing teachers of such initiatives require some substantive assistance in terms of resources and training in order to develop new pedagogical knowledge and skills that are ICT-oriented.

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