UNIVERSITY OF EDUCATION, WINNEBA

FACTORS THAT INFLUENCE ICT INTEGRATION IN THE TEACHING AND LEARNING OF INTEGRATED SCIENCE AT THE SENIOR HIGH SCHOOL

PAINTSIL ESSEL

2015

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(8130130010)

A THESIS IN THE DEPARTMENT OF SCIENCE EDUCATION, FACULTY OF SCIENCE EDUCATION SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF PHILOSOPHY IN SCIENCE

MAY, 2015

DECLARATION

STUDENT'S DECLARATION

I, ESSEL PAINTSIL declare that this thesis with the exception of references contained in published works which have been identified and acknowledged, is entirely my own original work, and that it has neither in part nor whole been submitted for another degree elsewhere.

Candidate's Signature: …… Date: ……

CERTIFICATION

We hereby certify that the preparation and presentation of this thesis was supervised in accordance with the guidelines on supervision of thesis laid down by the research and graduate school, University of Education, Winneba.

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PROF. JOHN K. EMINAH

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ACKNOWLEDGEMENTS

My first sincere thanks go to Almighty Jehovah for His grace and mercies that have brought me this far despite all the obstacles in my life. Secondly, I wish to acknowledge the immeasurable assistance, motivation and guidance I received from my supervisors Prof. John K. Eminah and Dr. I. K. Anderson before and during my studies especially in the supervision of my thesis.

My appreciation also goes to all the lecturers in the Department of Science Education University of Education, Winneba especially Dr. Ernest Ngman-Wara for the support and advice. I am also thankful to all those who have helped in diverse ways, including friends and colleagues who shared ideas with me, made useful suggestions and helped me with information to make this work a success.

Finally I am grateful to my family for their love, advice, support and encouragement at various stages in my life so far. God will reward your efforts richly.

DEDICATION

I dedicate this work to the memory of my late father Benjamin Kwaku Gyasi Paintsil who sadly enough couldn't stay to see me complete this programme. Forever in my heart Daddy.

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ABSTRACT

This study was designed to investigate ICT integration and its use in the teaching and learning of integrated science in selected senior high schools in the Agona East district within the Central Region. A descriptive survey design approach was employed in the study involving four schools. The target population for the study comprised all senior high schools in the Central Region of Ghana. The accessible population however consisted of senior high schools in the Agona East District of the Central Region. One district science coordinator, one hundred and twenty students and sixty science teachers in four senior high schools in the Agona East District formed the research subjects for the study. Data was collected using questionnaires, interview and informal observation as instruments. The teachers' and students' questionnaires had reliability indices of 0.87 and 0.91 respectively. Descriptive statistics was used to analyze the data. The results gathered from the four schools involved in the study revealed that though a few of the schools have made progress and had some resources to promote ICT use in science teaching and learning most of them were not well equipped with ICT resources. Teachers indicated that the unavailability of ICT resources, lack of training and inadequate support from the stakeholders of education in Ghana were some of the challenges impeding ICT integration in science teaching and learning. The study recommended that the training needs of science teachers must be addressed immediately. Additionally, investments should be made by the districts directorate of education towards equipping schools with ICT resources by addressing the individual needs of schools at the senior high school level to promote ICT integration in pedagogy. The teacher is an important component in ensuring a successful integration of ICT in the teaching and learning of integrated science therefore based on the findings of the study, it was suggested that a study on the ICT training needs of science teachers in the research area should be conducted.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter contains the background to the study, statement of problem, the purpose of the study, research objectives and research questions. The significance of the study, delimitations and limitations of the study are also presented. The chapter ends with the operational definition of terms, abbreviations and acronyms used in the study and the organisation of the research.

1.1 Background to the Study

Science education holds the key to every country's developmental process to train and nurture the needed human resource base to build the foundation for growth in every facet of its endeavour. The ultimate realization of this goal to provide the requisite human resource to improve the socio-economic standard of a country in the 21st century makes the inclusion of information and communication technology in pedagogy a deliberate quest to keep pace with the rest of the world. Every aspect of human activities has encountered the inevitable nature of ICT and its associated merits that could be harnessed if the right procedures are employed to harvest the potential it fully brings.

Nolan (2004) stated that it is believed that the use of ICT to enhance teaching and learning is unlikely to be explored in meaningful ways in school classrooms unless there is effective modelling of technology integration during the teacher education experience. Based on this assertion educational systems around the world have come under immense pressure to use the new information and communication technologies

(ICTs) to teach students the knowledge and skills needed in this modern era of globalization.

Yidana and Asiedu- Addo (2001) noted that despite the huge potential of information technology (IT) in the efficient delivery of education in Africa, it is sad to observe that we neither have the requisite resources nor technical expertise to tap the resource. Sharma (2003) also noted that developing countries like Ghana have a significantly lower level of diffusion and use of ICT than the developed countries. The question now is to what extent has the use of ICT in pedagogy been integrated into the educational system in Ghana. Anamuah-Mensah and Eminah, (2005) underscored their support for science and technology development noting that the state of the science resource centres which happen to be one of the major drive to integrate ICT into teaching and learning needed a face lift. This meant that the 110 science resource centres (SRCs) in Ghana should be rehabilitated and re-equipped by expanding facilities and providing facilities for practical activities. Additionally, to ensure sustainability of the SRCs, teachers training needs in ICT should be addressed and an effective management system put in place.

With the proliferation of internet connectivity and mass production of ICT tools one would expect that the use of ICT in teaching and learning of integrated science would increase. However, it is an undeniable fact that the effective integration of information and communication technology into the educational system is a complex multifaceted process that involves not just technology (initial capital to buy gadgets) but also adequate and proper structuring of the science curriculum and pedagogy, institutional readiness (availability and suitability of infrastructure), teacher competence, long term financing, provision of technical support and regular in-service training among others. These variables of institutionalizing ICT integration into teaching and learning of

science is manifested at different levels in the senior high schools in the research area. To the knowledge of the researcher no study has been conducted in the research area with respect to pertinent issues on the integration of ICT into the teaching and learning of integrated science. Although such a study is likely to be expensive and time consuming it is nevertheless a credible means of unearthing the different factors and barriers in ICT integration and its application in the senior high schools in Ghana, specifically in the research area.

1.2 Statement of the Problem

Webber (2003) has noted that the impact of technology is one of the most critical issues in education. Over the years, especially at the turn of the new millennium, the educational system in many countries has been revised to cater for information and communication components to facilitate teaching and learning to yield appreciable levels of success. All subject areas have encountered the new order, especially the teaching and learning of science. There have been a great deviation from the chalk and talk method towards the use of modern technologies in the teaching and learning of science at the senior high school level. The teacher who is a key component of the teaching and learning milieu remains relevant to ensure ICT is successfully integrated into the schools to aid teaching and learning. Becta (2004) noted that teachers' attitude toward the use of technology is their understanding of how these technologies will benefit their teaching and their students' learning.

About twenty years ago, the Ministry of Education (MOE) initiated procedures to institutionalize ICT use in science teaching and learning, by establishing science resource centres in selected senior high schools in the country. The establishment of the resource centres was one of the objectives of the 1987 educational reforms which was aimed at promoting the teaching and learning of science and to provide

opportunities for teachers to enrich their science lessons. Students were also to be aided to access the full benefits of practical lessons and experiments. This led to the provision of equipment and materials in selected schools to serve as host schools to other schools within certain geographical areas as satellite schools with equal opportunity of utilizing the resource centres for academic work. Gyamera (2006) reported that facilities at the science resource centres were to be used to enable science teachers organize a variety of practical activities using equipment that were not available in the conventional science laboratories. As a teacher I have a personal experience based on observation for the past four years starting September 2011 in my school of work which happens to be a resource centre. Over the years there have been no coordinators to manage the resource centre. As a result most of the equipment have broken down without replacements. Additionally, the host school used the facilities meant for the centre for other purposes. For instance normal lessons and societal meeting were held at the premises of the resource centre. School leaders and departmental heads have not done enough on their part to make the resource centres operate effectively. Additionally, the governments through the district educational directorate have encouraged the use of ICT in pedagogy by undertaking a massive distribution of laptops to teachers and schools. The schools have also been assisted to build new ICT laboratories or the refurbishment of old laboratories to advance ICT use in teaching and learning. Subsequently, colleges of education have been mandated to include ICT educational programs in the teacher training process to build teachers competence and knowledge in ICT use in order to encourage the teacher to use ICT in the teaching and learning process. For this reason this study was conducted to determine the extent to which ICT has been integrated into integrated science instructional activities in senior high schools within the study area and to offer

suggestions on how ICT opportunities can be reviewed, resources managed and the needed personnel trained to maximize the benefits of ICT use in integrated science lessons. Though traditional learning situations cannot be completely wiped out it can be greatly enhanced by creating variety in the mode of knowledge and skills dissemination through the use of ICT resources. The effective integration and incorporation of ICT into teaching and learning is key to the realization of academic success of science students at the senior high school level in Ghana. It is in light of this that this study investigated the state of ICT in pedagogy at the senior high school level by analyzing the factors that interacted to impact ICT application in the teaching and learning of integrated science in selected senior high schools in the Agona East District.

1.3 Purpose of the Study

Persky (1990) asserted that using technology is not easy and that learning how to effectively use technology in the context of the classroom does not happen overnight. The purpose of this research work was to determine how various factors like infrastructure and ICT tools, technical support and ICT soft wares, teacher competence in ICT use, school leadership and management and how finance influence ICT integration in the teaching and learning of integrated science at the selected senior high schools.

1.4 Research Objectives

The study was guided by the following objectives: To determine:

1. The state of ICT in the teaching and learning of integrated science in the selected senior high schools.

2. The extent to which current educational provisions in the schools adequately enable integrated science teachers integrate ICT into their teaching.
3. How knowledgeable are teachers and students about ICT integration in the selected senior high schools.
4. The barriers to the integration of ICT applications in the teaching and learning of integrated science in the selected senior high school.
5. How the problems hindering ICT integration into integrated science teaching and learning in the senior high schools could be solved.

1.5 Research Questions

The following research questions were addressed in the study.

1. What is the state of ICT in the teaching and learning of integrated science in the selected senior high schools?
2. To what extent do current educational provisions in the schools adequately enable integrated science teachers to integrate ICT into their teaching?
3. How knowledgeable are teachers and students about the integration of ICT in the selected senior high schools?
4. What are the barriers to the integration of ICT application in the teaching and learning of integrated science in the selected senior high schools?
5. How can the problems hindering ICT integration into integrated science teaching and learning in the senior high schools be solved?

1.6 Significance of the Study

The teaching and learning of science require a much more innovative approach to sustain students' interest and break the phobia associated with the study of science. In view of this the use of ICT born from the knowledge of science is an enviable tool

that can be relied on to simplify science concepts to students at the secondary school level to make the subject more interesting and equip learners to meet the demands of today's digital working environment. (Siaw, 2000). Though traditional face to face teaching methods has its merits, it falls short of the skills needed in today's fast paced environment. Nonetheless, the realization of the full potential of the educational benefit of information and communication technology is not automatic. This is because ICT can be used in numerous ways which may not be meaningful and relevant to help address the demands of society.

Annan (2006) stated that human development is a process of enlarging peoples' choice. Though many research works has been carried out by other researchers in similar areas, it is hoped that the findings of this research would highlight the current status of ICT integration in teaching and learning of integrated science at the senior high schools. Subsequently, it is hoped that this work would offer appropriate planning required facilitating ICT integration in the senior high schools to aid its effective use in teaching and learning of science particularly integrated science.

1.7 Delimitations

Due to the purpose of this study it would have been very appropriate to include all second cycle schools in Ghana in the research work. However, with respect to the nature and organization of this research, time constraints and financial difficulty the research work was restricted to four selected Senior High Schools in the Central Region of Ghana within the Agona district.

1.8 Limitations

This work based on the integration of ICT in the teaching and learning of integrated science would be limited. This is because the findings of the study cannot be generalized because of the small sample size.

1.9 Operational Definition of Terms

ICT - it is defined as the study of the use of technological tools as a subject in school. It is also a range of applications, communication and technologies which aid information retrieval and research communication and administration.

Integration – it is the combination of different sets of factors to work collectively to achieve a common objective.

ICT integration – it is the process of restructuring educational systems to encompass different technological innovations comprising heterogeneous set of elements and tools to deliver information and communication efficiently.

Learning - it is the process of acquiring new or modifying and reinforcing existing knowledge, behaviour, skills and values which may lead to a potential change in synthesizing the depth of knowledge, attitude or behaviour relative to a type and range of experiences.

Teaching- it is the impartation of knowledge, development of skills and attitudes by making specific interventions to meet the special needs of people in various ways ranging from structured to individualized activities.

1.10 Abbreviations and Acronyms

ICT	-	Information and Communication Technology
ICTs	-	Information and Communication Technologies
SRCs	-	Science Resource Centres
CSIR	-	Council for Science and Industrial Research
ILO	-	International Labour Organization
GES	-	Ghana Education Service
MOE	-	Ministry of Education
JICA	-	Japanese International Cooperation Agency
WSIS	-	World Summit on the Information Society
UNESCO	-	United Nation Educational, Scientific and Cultural Organization
ICT4AD	-	Information and Communication Technology for Accelerated Development
PTA	-	Parent Teacher Association

1.11 Organisation of the Research

This research study is organized into five chapters. The beginning chapter contains the background to the study, statement of the problem, the purpose of the study, research objectives and research questions. The significance of the study, delimitation, limitation, operational definition of terms, abbreviations and acronyms and the organization of the research concludes this chapter.

The chapter two of this study contains primary reviewed literature that relates to the study. The chapter three of this study into the ICT integration in the teaching and learning of integrated science in selected senior high schools contains the methodology employed in this research work. The chapter four contains the results

and discussion while the chapter five covers the summary of the findings, conclusions, recommendations and suggestions for further studies.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

Chapter two of the study on ICT integration in the teaching and learning of integrated science at the senior high school level comprises introduction, history of ICT integration efforts in Ghana, teacher competence in ICT use, leadership issues in ICT integration, teachers' access to ICTs, structural adaptation of ICT integration, benefits of ICT integration in education, barriers to ICT integration, theoretical framework and conceptual framework.

2.1 Introduction

In the 1980s the use of computer became popular when personal computers became available to consumers. Pelgrum and Law (2003) noted that the term ICT emerged signaling the introduction of e-mail and electronic messaging with computer technology. ICT includes computers, the internet and electronic tools like radio, television, projectors, photocopiers, scanners and many more. ICT an acronym that stands for Information and Communication Technology can be defined as the means of processing information with the use of computer systems. UNESCO Institute for Statistical Glossary defines ICT as 'a diverse set of technological tools and resources used to transmit, store, create, share, or exchange information.

Integration is defined as the combination or formation of constituent parts into a whole (Oxford Study Dictionary, 2012). Earle (2002) noted that ICT integration is a concept of wholeness, when all elements of the system are connected together to become a whole. In furtherance, Flanagan and Jacobsen (2003) also noted that

technology integration is meant to be cross-curricular rather than a separate course or topic in itself.

Stanb and Wetherbe (1998) outlined that interactive media is one of the most promising technologies of the time and has potential to revolutionize the way we work, learn and communicate. It is overwhelmingly true that all stakeholders and partners in education are convinced with the merits associated with the application of ICT in teaching and learning especially in science related subjects. Mayer (2003) noted that multimedia delivery in science teaching and learning include computer-controlled integration of texts, graphics, drawings still and moving images, animation and audio. The use of multimodal means appeal to all the senses of students increasing the receptive channels for information reception thus enhancing students' skills and knowledge base with respect to science concepts. However, the realization of this goal is not in merely promulgating laws and acknowledging ICT use but inculcating ICT use meaningfully into the educational system. Tomei (2005) stated that restructuring the teaching and learning process requires the adoption of technologies into existing educational environments in order to provide learners with knowledge to promote meaningful and to enhance productive learning. Tinio (2003) also noted that the effective integration of ICT into the educational system is a complex multifaceted process. It involves not just technology and initial capital, because getting technology is the easiest part but also aligning it with curriculum change, institutional readiness, teacher competence and long term financing among others is critical to ensure successful integration of ICT in teaching and learning.

2.2 History of ICT Integration in Ghana

Lave and Wenger (1991) noted that knowledge is strongly connected with a social situation or context. The world as it stands now has become a global village due to the efficiency of communication and information sharing. The school system which hinges on information and communication in the acquisition and transmission of skills and knowledge inevitably operates under this new culture of science and technology. The pervasive nature of ICT in different societies around the world has revolutionarized the total existence of humanity and thus education. Ghana as a country has its own though comparatively inadequate ICT resources but has put in some efforts to fully incorporate ICT as a pre-requisite for national development by building a strong scientific and technology literate society.

The first and major investments into science and technology to make Ghana self-sufficient began with the first president of the country when he resorted to the industrialisation of the country thus the need to equip the citizenry with technological skills to push that agenda. This led to the establishment of Kwame Nkrumah University of Science and Technology and other science based centres like Council for Scientific and Industrial Research (CSIR), Noguchi Memorial Institute and Ghana Atomic Energy Commission over the years. All these efforts were made with the intent to promote science through the establishment of astute science based institutions geared toward creating a holistic science environment. However, the establishment of this institution alone could not bring the needed goals because people needed to train outside the country to gain in-depth knowledge in the area of science and technology. This necessitated the move to structure academic systems to align with the requisite methodology. The governments that came after Dr. Kwame Nkrumah put in efforts to improve the status of the country with regards to technology

but little was realized because they mainly operated as military regimes. In furtherance, the drive to fully integrate information and communication technology into the socio-economic structure of Ghana and the academic circles in schools in Ghana continued vigorously receiving several political and cabinet barking in the many policies and educational reviews in the country and on many other political agendum of various governments over the last two decades. However, the culture of science and technology is yet to be an integral component of the Ghanaian society. This could be attributed to different factors stemming out of various degrees of inefficiencies in the driving force needed to catapult a rich ICT society.

Some of the comprehensive programs committed to rapid deployment and utilization spearheaded by the Ministry of Education (MOE) serving as the main engine operating through the Ghana Education Service (GES) led to initiatives that cover pre-tertiary and tertiary levels of education with mainly establishing laboratories and the provision of computers. One of the active process was captured in Ghana ICT for Accelerated Development (ICT4AD 2001). It is a policy in which the framework started in 2001 and the strategic educational plan drawn in 2003 with various enactment stages in 2006 and 2008. The overall vision of this policy was to 'articulate the relevance, responsibility and effectiveness of utilizing information and communication technologies (ICTs) in the educational sector with a view of addressing current sector challenges and equipping Ghanaians learners, students, teachers and communities in meeting the national and global demands of the 21st century'. Additionally, there was a drive to make the Ghanaian society ICT compliance as a vision for Ghana in the information age. The establishment of the National ICT Science Resource Center financed by the Japanese International Cooperation Agency (JICA) and Phillip Harris of UK translated into the

establishment of district science centres throughout the country as a way of bringing science and technology through the use of ICT to the door step of the Ghanaian students to transform the fortunes of Ghana through the use of information and communication technology as part of the global village. In 2008 the ICT drive in Ghana was reinforced by a revised policy that through the deployment of ICT in education, the culture and practice of traditional memory-based learning would be transformed to education that stimulates thinking and creativity necessary to meet the challenges of the 21st century.

The benefits of this policy led to a massive distribution of government sponsored laptops manufactured locally across the country. This was aimed at readily making available ICT tools to teachers to impact positively on their teaching and learning. To the best of the knowledge of the researcher these are some of the major efforts channeled towards ICT integration in Ghana in which the school is no exception. However, comparing ICT compliance of Ghana to other countries there is the need for Ghana to improve its ICT policies significantly to impart positively in all sectors of the country especially in the area of education.

2.3 Structural Adaptation to ICT Integration

ICT integration and its use has become one of the essential requirements in educational systems around the world for the attainment of goals in the area of developments, economic, finance, governance and many others for the current generation. One of the basic means by which the drive to incorporate ICT in education is the adequate provision of infrastructure. The characteristics of a school greatly affect the integration of ICT at the classroom level. This is because successful integration of ICT is closely related to adequate provision of infrastructure to accommodate the omnipresent and fast sweeping tool in the classroom environment to

improve pedagogy. This implies that new and user friendly structures should be built to create conducive environments to house ICT tools, widen access and facilitate its efficient use in teaching and learning especially in the area of science. Fullan (2001) noted that the educational improvement or innovation efforts should consider to a large extent the power of site or place. The school structure can also be viewed in the light of the hierarchy of leadership and how they impact on the integration of ICT in teaching and learning of integrated science at the senior high school level. Schiller (2002) noted that studies have shown that school leadership plays an increasingly important role in leading change providing vision and objectives, as well as professional development and initiatives in using ICT to bring about pedagogical changes. Though, the physical infrastructure advancement of a school key the leadership design of a school is paramount. It is the most effective implementation process for ICT integration in the teaching and learning process. In effect if all the other factors like teacher motivation, finance, technical support, capacity building and others that contribute to a successful ICT integration are in place they would only correlate effectively to aid ICT use with a pro-active leadership capacity. Leadership is therefore very critical for the short term, medium term and long term sustainability of ICT compliance of a school. When the capacity of leadership is ineffective and less supportive to deepen ICT integration then the compliance level of an academic institution in the area ICT would be low but a transformational leadership in tune with modern trends in academics would accelerate ICT integration for teaching and learning especially in the area of science.

2.4 Teachers' Access to ICTs

Yildrim (2007) found out that access to technological resources is one of the effective ways to teachers' pedagogical use of ICT in teaching. The effective adoption of ICT in the teaching and learning of integrated science at the senior high school is largely dependent on availability and access to educational resources including hardware, software and technical support. One of the uses of ICT is the ability to access information. Effective integration and use of ICT depends primarily on access of the resource by teachers and students for use. This implies that the ability to access internet services is paramount to improving ICT use in lessons. The internet enables teachers and learners to access several and different educational and information resources from different parts of the world within a short time. However, the internet penetration in Ghana is low especially in the rural and deprived areas of the country. But with the influx of telecommunication companies there is an increase in internet services across the country. However, the senior high schools seem to have no or limited access which could be attributed to its relative high cost. Additionally, the high cost of maintenance and running of ICT centres and laboratories leaves most of the gadgets in a poor state thus learners are denied access to utilize these tools for their academic benefits. Alternatively, some teachers and some students are denied access because most of the laboratories equipped with ICT have been taken by some senior teachers and head of departments as their private class and office due to the fact that these places are fitted with modern gadgets thus the settings are conducive compared to the normal classroom environment. In the light of this though most teachers have their personal gadgets they feel reluctant to use them for classroom work. Therefore, a myriad of factors hinder the teachers and student access in include

ICT in teaching and learning thus becoming a barrier in technology integration across several senior high schools in Ghana.

2.5 Teacher Competence in ICT Use

Pelgrum (2001) stated that the success of educational innovations depends largely on the skills and knowledge of the teachers. Nolan (2008) indicated that the use of ICT and multimedia enhance teaching and learning but cannot be explored in meaningful ways in the classrooms unless there is effective modeling of technology integration during the teacher education experience. In view of this one of the essential components needed to aid in a successful integration of ICT into pedagogy is the teachers' knowledge and competence in the use of ICT to facilitate teaching and learning especially in science lessons. The teacher is believed to be one of the strong depending factors to successfully initiate and continue ICT use in education. If teachers are competent technology they are likely to include ICT in their teaching. Therefore it is incumbent on teachers and educational stakeholders to develop their competence in ICT in line with educational goals. This is because the teacher is the fulcrum around which all other factors would revolve to ensure that the teaching and learning process is successful. Though many teachers are qualified in their subject areas to teach effectively, until recently ICT education was not an integral part of the educational system thereby hindering their ability to incorporate ICT fully into their teaching and learning process.

Becta (2004) noted that teachers' attitudes toward the use of technology is their understanding of how these technology will benefit their teaching and student learning. Normally teachers understanding of how technology would help borders on years of teaching experience.

Teachers with many years of teaching experience rely on their years of teaching and familiarity to achieve academic success in their learners to the neglect of ICT use thus neglecting the benefits that can be derived from ICT use in teaching. Secondly, teachers with few years of teaching experience tend to focus more on understanding curriculum related issues and general acclimatization of school system which impart negatively on the use of ICT in their teaching. Schoepp (2005) also found out that although teachers felt that there was more than enough technology available they did not believe that they were being supported, guided or rewarded in the integration of technology into their teaching. This requires that the capacity and competence level is boosted by building institutional capacity and regular training programmes.

A benchmark created by UNESCO which stipulates the skills needed by a teacher to teach effectively using ICT can be employed. The UNESCO ICT Competency Framework for Teachers enumerates the contents that when followed by teachers would help learners to be collaborative, develop problem solving skills and become creative learners. However, due to the absence of in-service training, technical support and motivation, teachers with low self-efficacy in ICT use are not able to improve on their competence level thereby diminishing the successful integration of ICT into teaching and learning of integrated science. Lee (2001) explained that there is a direct relationship between continuous professional development in ICT provided to tutors and their motivation and commitment.

2.6 Leadership Issues in ICT Integration

New technologies have generated the needed impact and have made significant progress in the improvement of conditions in teaching and learning. Leadership is critical for establishing and maintaining learning environments that creates the fertile grounds to acquire and implement sustainable ICT facilities and structure to instill the

culture of ICT in all facets of the schools system especially in teaching and learning. Leadership controls the financial and the social conditions in the schools therefore leadership disposition plays an integral role in determining how all the various factors correlate to ensure a successful integration and use of ICT to generate the needed benefits in the domains of education. Wong and Li (2008) conducted a study on factors that influenced transformational integration of ICT in eight schools in Hong Kong and Singapore. The study revealed that leadership promotion of collaboration and experimentation and teacher dedication to students' learning influenced effective ICT transformation. This implies that an extensive leadership attribute creates opportunities to collaborate and converge all the relevant factors toward a successful ICT integration effort. Subsequently, leadership is required to provide the necessary organizational improvement to establish and maintain an ICT friendly environment. This is when high performance expectation is demanded from teachers through staff development and instilling the need for ICT use in teachers by making it a part of the daily routine. According to research some of the attributes of leaders that supports ICT integration include

- Creativity
- Team player
- Courageous
- Collaborative
- Excited about innovations
- Not resistant to change

It can be concluded that when leadership has the requisite characteristics they are better able to manage all the resources at their disposal including the human component to achieve the desired results.

2.7 Barriers to ICT Integration

The barriers to ICT integration in education in the teaching and learning of integrated science according to the literature reviewed, relate to:

- The teacher- skill level, attitude, motivation and pedagogic beliefs.
- The school culture – leadership, planning and staff development.
- Resources –finance, hardware and software, time and access to training.

Although it is accepted that ICT integration has a significant role in education, there are barriers to be overcome in its successful implementation into teaching and learning in the classroom especially in the study of integrated science. Most education leaders, according to studies conducted by the Office of Technology Assessment in the U.S., believe that the under-utilization of computer technology in the classroom is a result of at least four factors:

- Inadequate teacher training:
- A lack of vision of technology's potential for improving teaching and learning.
- A lack of time to experiment.
- Inadequate technical support.

In 1991, Pelgrum and Plomp conducted a worldwide study of computers in education in which they identified over 20 conditions that impeded the use of IT in education. Further studies reported by the Congressional Office of Technology and Ginsberg and McCormack (1998) also found many of the same factors to be present. A year later a survey of school principals in British Columbia identified almost identical factors.
The factors common to these studies that are perceived as impediments which hinder effective integration of ICT into teaching and learning includes:

- Access to computers and scheduling computer time.

- Availability of appropriate software.
- Time required for planning, preparing and providing assistance.
- Skill and confidence required to implement computers in teaching.
- Lack of incentives and self-motivation.
- Negative (or lack of positive reinforcement) attitudes of administrators.
- Inadequate teacher education and training.

Beside all the listed factors that serve as barriers to the realization of the full potential in ICT integration and its use specifically in the area of teaching and learning is the health related issues that may be associated with the use of technology tools. It is an undeniable fact that ICT usage poses a certain degree of challenges and difficulties to persons with regards to health defects that may arise due to prolonged use of ICT tools. Available information indicates that eye strains leading to severe headache that results from looking at the monitor for a long time, repetitive strain injury in the wrist and hands that results from the use of the mouse and typing and back and neck ache that results from bad posture limits people from using ICT tools or persons originally suffering from such effects are not able to apply themselves adequately to harness the full benefits that can be derived from ICT use. It therefore can be concluded that effective integration and use of ICT in education depends on access to computers, time to learn the technology, perception that adoption of ICT would present major challenges and the health related hazards are some of the major obstacles which administrators and stakeholders in education must confront and address to ensure that effective integration of ICT into education become a reality.

2.8 Benefits of ICT Integration in Science Education

Valdez (2004) observed that technology offers many opportunities to improve learning and that it has the potential to provide people in their own homes and work settings with access to knowledge and learning resources until recently only in very large universities.

Research have showed that several benefits could be derived from the effective use of ICT in all facets of human interaction especially in the field of education. When used appropriately ICT can help strengthen the importance of education to increasingly network society, raising quality and standards of education by making teaching and learning an active process connected to real life (Zaman, Shamin & Clement, 2011). Information and communication technology though has some demerits, the merits associated to its use in education can enhance the delivery of goal oriented education at all levels. ICT use in teaching and learning has the tendency of increasing considerably the performance of students thus the adequate use of ICT resources in education steer students toward the achievement of better results. ICT use in science lessons eliminate social disparities among students since it gives all students equal opportunities by assuming more responsibility requiring less teacher participation. The use of ICT stimulates teacher's interest by significantly enhancing lesson delivery making access and gathering of information effective thus creating new and exciting ways of teaching. ICT can support innovative education and enhance flexibility in teaching and learning by expanding access to education regardless of geographical location.

Ota (1995) noted that the following benefits could be derived from integrating technology into education:

- Promote active learning.

- Promote critical thinking.
- Provide flexibility for students with special needs.
- Help students to build cultural bridges.
- Enhance communication skills.
- Promote cooperation learning and increase teacher-students interaction.
- Supply information through multi-sensory channels (support students with various learning styles).
- Offer diversity and self-paced learning and individual growth.
- Motivate and inspire students by making learning exciting and relevant.

It is an undeniable fact that the effective use of ICT in education though could have a certain degree of limitations when properly managed teachers and students stand at an advantage to harness the enormous benefits associated with the integration of ICT into teaching and learning especially in the field of integrated science.

In conclusion, the benefits associated to ICT integration in teaching and learning can be summarized or grouped into social and vocational benefits. Many studies have outlined the social benefits that can accrue from the use of technology in the classroom (Schrum & Berenfeld, 1996). The following social benefits can be derived when teachers and students have access to widely distributed electronic resources.

- Resources are shared such that students and teachers can collaborate.
- Collegial, social and professional development activities can be supported among educators.
- Students in deprived areas have the same access to information as those in affluent areas.
- Physically challenged people can participate.
- The educational process is available to all.

The world operates as an information society. Over the last twenty years, electronic technology has dramatically become part of every area of society and every aspect of our lives. The very nature of work has changed with an increasing demand for workers who could master the new technologies and use them to conduct business that formerly did not require computers at all (Strommen, 1992). It is clear that in the future effective leaders and citizens will be expected to understand and use computers and communications technology. Obviously, a school's policy in relation to computer technology will play a major role in the preparation of these future leaders and citizens to be fully equipped and adequately prepared to effectively occupy the various sectors and levels of work.

2.9 Theoretical Framework

Theoretical framework is a theory to explain, predict, challenge and sometimes extend existing knowledge within the limits of the critical bounding assumptions. It forms the basis to hold and support a research study. Based on knowledge, environmental stressors and personality traits which are key to the integration of ICT in the teaching and learning of integrated science at the senior high school level, the theoretical framework for this research is hinged on the constructivist theory. The constructivist theory is appropriate in explaining and supporting the concept on ICT integration in teaching and learning of integrated science. Knowledge and meaning of concepts are generated by humans from interacting with their environment and experience thus deepening the understanding of concepts by accommodating and assimilating new experiences. Constructivism is based on the active participation and the construction of different teaching strategies and interactive engagements in the context of different pedagogical modes to build knowledge and acquire skills.

Valdez (2004) pointed out that if the potential of technology is to be optimized, educators and community members need to develop a comprehensive learning and technology plan long before technology equipment starts arriving. The integration and use of ICT in pedagogy promote active learning and allow learners to construct knowledge and skills out of their own experiences. This forms the bases for constructivist theory which clearly defines the theory underpinning this research study to determine the status of ICT integration in the teaching and learning of integrated science at the senior high school.

2.10 Conceptual Framework

Miles and Huberman (1994) stated that a conceptual framework explains either graphically or in narrative form (both are much preferred), the main things to be studied- the key factors, constructs or variables – and presumed relationship among them. The use of conceptual framework in research work makes the stated objectives clear by relying on inductive and deductive reasoning to differentiate between the dependent and independent variables. It highlights the various factors that influence each other on how outcomes based on the researchers' position would be achieved.

The conceptual framework is shown in figure 1

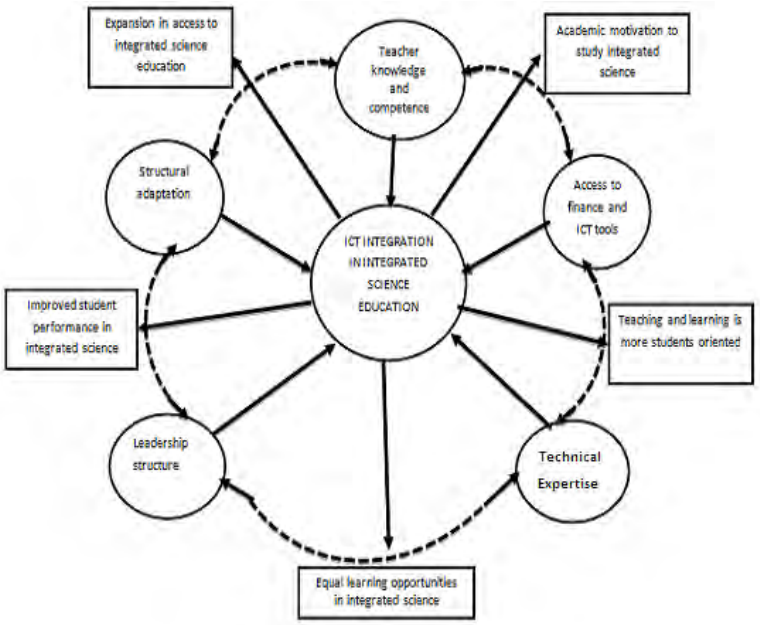

Figure 1: **Conceptual Framework of ICT Central Role in Academic Success**

ICT integration though a very beneficial and an important academic process when not properly managed could be highly ineffective. This requires that there should be an effective and efficient application of different factors to ensure that the derived outcomes are harnessed. These factors converge and interact with each other and do not operate in isolation to impact positively or hinder a successful ICT integration process. This is highlighted in Figure 2.1 which is the conceptual framework for this research work. As showed in Figure 1, ICT integration in science education is at the center indicating that when ICT is made central to the teaching and learning of science at the senior high school it has the tendency to provide the following benefits indicated by the arrows moving from the circle at the center toward the factors in the squares. These benefits as indicated include

- Equal learning opportunities in science
- Improved student performance and results
- Academic motivation to study science

- Expansion in access to science education
- Teaching and learning is more student oriented

However, for the benefits associated with ICT use in the teaching and learning of science to be fully gained it require that certain conditions are fulfilled. These are indicated in the diagram as

- Structural adaptation
- Leadership structure
- Access to resources and finance
- Teacher knowledge and competence
- Technical expertise

These conditions cannot influence ICT integration positively unless there is a combination of these conditions. This is shown in the diagram by the conditions in the circle with arrows pointing to the center. This means that when these conditions should are addressed in ICT integration in teaching and learning then the benefits of ICT use can be assessed. The dotted arrows linking the conditions also shows that there should be a combination of the conditions before the required benefits are fully derived.

CHAPTER THREE

METHODOLOGY

3.0 Overview

The chapter describes the procedures adopted in conducting the study. Research methodology is essentially a systematic and focused procedure of gathering data for the purpose of extracting information that will in turn answer or solve the research problems or questions (Leedy, 1989). The researcher has to decide from the beginning, whether he will use the quantitative or qualitative methods of collecting data. Mixed methods studies could be done also. Both qualitative and quantitative research methods have been used in carrying out this research. This chapter provides details related to the methodology of the study. It presented the research design, research area, population, sample size and sampling technique, research instrument. The content validity, reliability of the main instrument, instrument scoring, data collection procedures and data analysis are also presented.

3.1 Research Design

A descriptive survey design approach was used for this study. Bryman (2008) defined research design as a framework for data collection and analysis. Research approach is a scheme, outline or plan that is used to generate answers to research problems (Kombo & Delno, 2006). It is also a detailed documentation of plan for the collection, measurement, and analysis of data. Research approach is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose. It constitutes the blue print for the collection, measurement, and analysis of data (Saunders, Lewis & Thornhill, 2007). The research design used to structure the research, show how all the major parts of the research

project, the samples or groups, measures, treatments, and methods of assignment work together to address the central research questions.

Descriptive research studies design aids a researcher to obtain precise information in order to draw valid generalizations and conclusions from the discovered facts. They are not only restricted to fact finding but very often, they result in the formulation of important principle of knowledge and solution to problems. Descriptive studies are more than just a collection of data. They also involve measurement, classification, analysis, comparison and interpretation of issues. The descriptive survey is one of the means through which opinions, attitudes, suggestions for improvement of educational practice and instruction as well as other significant data can be obtained. Therefore, for the purposes of this work the descriptive survey approach was used to study the various components in the research in a logical way.

3.2 Research Area

The research area covered four selected senior high schools found within the Agona East District in the central region of Ghana with the capital being Cape Coast. The capital of the central region was the first capital of the nation during the Gold Coast. This places the region in a particular disposition with a rich history with respect to education. It is a region with the highest concentration of first class senior high schools in the country haven produced most of the human resource base across the country in all facets of the Ghanaian economy. Additionally, the region has the older's senior high school in Ghana. It is also the only region in Ghana with two fully fledged public universities. With such a rich profile in academics it makes the central region a worthy area and an exciting challenge to ascertain ICT integration into the teaching and learning especially in the area of integrated science at the senior high school level.

3.3 Population

Kusi (2012) defined population as a group of individuals or people with the same characteristics and in whom the research is interested. He further asserts that a population is a group of individuals that the researcher generalizes his or her findings to. The target population comprises senior high school students within the Central Region. However, the accessible population included four senior high schools. 181 subjects were used that comprised 120 students, 60 teachers from the selected senior high schools and 1 district coordinator of science.

3.4 Sample and Sampling Technique

Both qualitative and quantitative research methods have been used in carrying out this research. It was impractical to collect data on the whole population of senior high school students studying integrated science in central region considering the population size and the time available to the researcher. For manageability and time constraints the sample size for this study was 181.

The sampling techniques available to researchers can be categorized into probability and non-probability (Creswell, 2005). Convenient sampling technique was employed to select the four senior high schools used in the study. Convenient sampling was used because of the proximity of the schools to the researcher which would facilitate the collection of data in a short time. In simple random sampling all the research subjects have an unbiased chance of being selected and since all the students at the senior high school level study integrated science the simple random sampling technique was used to select one hundred and twenty (120) students thirty (30) from each of the selected senior high schools. Purposive sampling technique is used based on the objective of the study and the characteristics of the population. As a result purposive sampling was employed to select sixty (60) teachers fifteen (15) from each of the selected senior

high schools and one (1) district science coordinator within the research area in the Agona east district.

3.5 Research Instruments

This study was conducted sequentially using qualitative face-to-face interviews and observation to gain in-depth knowledge on the research topic and quantitative self-administered questionnaire. Interview provide in-depth information pertaining to participants' experiences and viewpoints of a particular topic (Plano- Clark, 2007). The emphasis with respect to the interview is to look at peoples words to see if any patterns emerges. A structured interview schedule with five questions was used. As part of the multiple tool- approach observations were also carried out in the four senior high schools to compliment the data in this study. An observational check list with eight items was used. The questionnaires were the main instrument used to collect data from the sample. A questionnaire is a research instrument defined by De Vaus (2002) as "all techniques of data collection in which each person is asked to respond to the same set of questions in a predetermined order". Wegner (2001) contends that the design of the questionnaire is critical to ensure that the correct research questions are addressed and that accurate and appropriate data are collected. Two questionnaires were used for the study. A questionnaire with 19 and 21 items were used to gather data from student and teacher respondents respectively. The first 2 and 3 items in each questionnaire centred on the background of student and teacher respondents. Besides there were 16 and 17 closed ended items based on the research questions respectively. The last item in each questionnaire was an open ended question used to collect responses from students and teachers used for the study.

3.6 Content Validity

In considering content validity, experts in this research such as supervisors and lecturers with specialization in test and measurements were consulted. Validity was established by giving the pilot questionnaires to them to read through and offer constructive criticisms. This is because validation is based on expert advice (Best and Khan, 1993). Colleagues who are also knowledgeable in the field of research offered constructive criticisms which helped to improve item quality.

3.7 Reliability of the Main Instrument

According Joppe (2000) reliability is the extent to which results were consistent over time and were accurate representation of the total population under study. When the responses could be reproduced under a similar methodology then the research instrument was reliable. To ensure reliability of the instrument for the study and to generate overall consistency of measure a Cronbach alpha coefficient above 0.700 should be measured. Ten students and ten teachers with the same characteristics as the population were tested with the instruments on pilot basis. The teachers' and students' questionnaires were coded and measured using Cronbach's alpha (α) coefficient of reliability. The following $\alpha = 0.87$ and $\alpha = 0.91$ were obtained respectively for the teachers' and students' questionnaires. These teachers and students were however, excluded from the main research study.

3.8 Instrument Scoring

The scoring was in association of the 5-point Likert scale that indicated the level of agreement or disagreement of participants to question items in the questionnaire. The rating were Strongly Agree = 5; Agree = 4; Undecided = 3; Disagree = 2; Strongly Disagree = 1. (Riggs & Enochs, 1990). The responses to items were mutual added so

that respondents with the most favourable responses had the highest scores and the least favourable responses had lowest summative scores. The mean of all participant summated scores stand for the measures of favourable and unfavourable response (Gliem & Gliem, 2003).

3.9 Data Collection Procedures

The questionnaires were distributed to respondents and they were given time to complete them. The researcher explained the purpose of the questionnaire to the respondents. All the seemingly difficult and technical terms were explained and respondents were made to understand that there are no rights or wrong answers thus they should complete questionnaires as sincerely as possible.

Interview data was collected through face to face interaction with participants and the verbal responses recorded by writing.

Subsequently, observational data was collected by using a simple check list.

3.10 Data Analysis

The research study had quantitative data from the questionnaire and qualitative data from interviews and observations. The quantitative data gathered from the questionnaire were converted into frequency counts and percentages and the results put into tables. Microsoft office excels and the statistical packages for social science (SPSS) tools were used to analyze the data.

Qualitative data gathered from the observations was based on frequency counts using an observational checklist. Additionally, data gathered from the structured interviews were analysed qualitatively by describing sequentially the concurrent responses from the research respondents and the results grouped into categories.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter is centred on data presentation, analysis and discussion of findings that were generated through the data collected. The study was primarily focused on teachers and students in selected senior high schools within the research area. Out of the one hundred and eighty questionnaires administered, all were returned. This represents 100% of the total number of questionnaires that were sent out. None of the questionnaires was rejected. The results from the findings were analysed in accordance with the research questions by organizing and presenting the data using descriptive statistics and tables.

4.1 Background and Demographic Characteristics of the Research Subjects

Table 1: Gender of student

Sex	Frequency Counts	Percentage (%)
Male	72	60
Female	48	40
Total	**120**	**100**

Table 1 shows the gender distribution of students used for the study. 60% were males and 40% were females. It can be concluded that there were more male students involved in the research from the selected senior high schools as compared to females.

Respondents were asked to provide information about their ages. The ages of the students are summarized in table 2.

Table 2: Ages of the students

Age Group	Frequency Count	Percentage (%)
Below 15years	11	9
16-18 years	77	64
Above 18years	32	27
Total	**120**	**100**

Table 2 indicated that majority of students (64%) were between the ages of 16-18 years. About 9% were below the age range of 15 years, while 18 years and above were represented by 27%.

The demographic data on teachers for the research study is presented in Table 3

Table 3: Sex Distribution of teachers

Sex	Teachers	Percentage (%)
Male	37	62
Female	23	38
Total	**60**	**100**

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Table 3 indicated that 62% of the teachers were males whiles 38% were females. Again, it was evident that majority of teachers who formed part of this study were males as highlighted.

Data was also collected on teachers' age groups. The ages are summarized in Table 4.

Table 4: Background data on the ages of the teacher respondents

Age	Frequency	Percentages (%)
Below 30 years	9	15
30-35 years	32	54
36-40 years	14	23
41 years and above	5	8
Total	**60**	**100**

Table 4 indicated that about 15% of the teachers were below the age of 30 years, 54% of them were aged between 30 to 35 years whereas 23% and 8% of teachers were between ages of 35-40 years and above 40 years respectively. Table 4 suggested that majority of integrated science teachers (92% - ages below 41 years) have encountered computer resources in their pre-service and post service professional development programs. This is because ICT educational policy started within the Ghana educational system in 2003.

Data was collected on teachers' years of teaching. Table 5 outline the results of the years teachers have been teaching integrated science.

Table 5: Years of teaching experience of science teachers

Years of Teaching	Frequency	Percentages (%)
Below 5 years	12	20
Between 5-10 years	23	38
Between 11-15 years	16	27
Above 15 years	9	15
Total	**60**	**100**

Table 5 shown that 20% of science teachers had taught for less than 5 years, 38% had taught between 6-10 years, 27%, between 11-15 years and 15% had been teaching science for over 15 years. Table 5 indicated that majority (80%) of science teachers had taught science for substantial number of years (6-15 years), hence might had gained lots of experiences in teaching integrated science at Senior High School level. Soglo (2000) stated that patterns of teachers' years of teaching is an indication of teachers maturity and life experiences which enhance their objective judgment and decision making about events and situations. Therefore, science teachers used in the study might have acquired some requisite teaching experiences - capacity and skills -

to adopt and adapt to ICT use in their teaching and learning activities to improve upon students' performances in integrated science.

4.2 Presentation of Data Results in Answering Research Questions

Research Question 1

What is the state of ICT in the teaching and learning of integrated science in the selected senior high schools?

This research question sought to find out the state of ICT in the selected senior high schools. The teachers and students responded to questionnaire items to ascertain the current level of ICT application in their schools. These included whether they are capable of booting and shutting down computers. Again, it was to find out whether ICT tools and other related ICT resources were available in the schools. In addition, the question sought to find out whether teachers and students have adequate access to these ICT resources to improve on teaching and learning of integrated science and other school activities (extra-curricular activities).

Table 6: Frequency of students capable of booting and shutting down computers

Response	Frequency	Percentage (%)
Yes	116	97
No	4	3
Total	**120**	**100**

Table 6 shows that 97% of the respondents indicated that they had knowledge in basic in booting and shutting down computers whiles 3% claimed they had no basic knowledge about computers. The overwhelming claim by students in the knowledge of the use of computers could be attributed to the growth and spread of telecommunication centres, secretarial services, business centres and the presence of computers in homes and schools; especially those owned by teachers.

Data on the availability of ICT resources in the selected senior high schools for the study is presented in table 7.

Table 7: Students' opinion on availability of ICT resources in their schools

Response	Frequency	Percentage (%)
Yes	25	21
No	95	79
Total	**120**	**100**

Table 7 indicated that about 21% of the students stated that their schools had ICT resources while the remaining 79% indicated that they have no ICT resources in their schools.

Concerning students' ability to access ICT tools and resources in their schools the results of students' responses is presented in table 8.

Table 8: Students' who had access to ICT resources at schools

Response	Frequency	Percentage (%)
Yes	32	27
No	88	73
Total	**120**	**100**

Table 8 shows that 27% of students indicated that they had access to ICT resources whiles majority (73%) of students do not have access to ICT resources. This could confirm the lack of ICT resources or absence of a functioning ICT laboratory at the Senior High Schools. However, a few of the students who had access to computers and some ICT tools (resources) could be attributed to informal interaction with teachers' computers or peers' computers in homes.

From the study a greater number of students were of the view that their schools do not have adequate computers and accessories for students' to use for academic purpose.

Students opinions on the state of ICT is presented in table 9 below

Table 9: Students' opinion on the state of ICT in their schools

S/N	Item Statement	SA	AG	UD	DA	SD
i.	My school has adequate computer and accessories for the use of students	13 (11%)	21 (17%)	2 (2%)	30 (25%)	54 (45%)
ii.	Students don't have access to computers in carrying out their studies in my school	29 (24%)	55 (46%)	7 (6%)	13 (11%)	16 (13%)
iii.	My school is fully equipped with computers, ICT tools and resources	9 (7%)	14 (12%)	3 (2%)	49 (41%)	45 (38%)
iv.	I have access to internet services in my school	4 (3%)	7 (6%)	1 (1%)	59 (49%)	49 (41%)
v.	Students don't have adequate assignment and work practices involving the use of computers.	45 (38%)	65 (54%)	0 (0%)	4 (3%)	6 (5%)

Students N = 120. Frequency (percent count); SA = strongly agree; AG= agree; UD = undecided, DA= disagree; SD =strongly disagree

According to students the computer facilities present were inadequate to serve large student population for any meaningful work. Students' responses to the items as presented in Table 9 had shown that 11% of students strongly agreed and 17% agreed that their '*schools has adequate computers and accessories for students' usage'*, 2% were undecided while 25% disagreed and 45% strongly disagreed to the assertion. This implied that about 60% of schools are ill-equipped with computers and accessories (ICT tools) to enhance students learning of science.

Again, Table 9 showed that students have limited access to computers to enhance learning. It suggested that 24% of students strongly agreed and 46% agreed that '*Students don't have access to computers in carrying out their studies in their schools',* 6% of students were undecided while 11% disagreed and 13% strongly disagreed to the statement. This further suggests that about 60% are cleared in their mind that they do not have access to ICT tools usage. With regards to the school being fully equipped with ICT tools and resources as shown in Table 9 indicated that

7% of the students strongly agreed and 12% agreed that '*their schools are fully equipped with computers, ICT tools and resources'*, 2% were undecided whiles 41% disagreed and 38% strongly disagreed to the assertion.

Table 9 further indicated that appreciable number of students pointed out that their schools lacked access to internet connectivity. Table 9 showed that 3% of students strongly agreed and 6% agreed that *their schools have access to internet connectivity /services*, 1% were undecided, whiles 49% disagreed and 41 % strongly disagreed to the statement. This implies that, despite the high country-wide internet penetration, little or no investments had been made by stakeholders and authorities of these Senior High Schools to enable students access internet services. In addition, Table 9 showed that with regards to assignments involving computer use 38% of students strongly agreed and 54% agreed that '*Students don't have adequate assignment and work practices involving the use of computers'* in schools. However, 3% of students disagreed and 5% strongly disagreed to the assertion. This by implication means that about 8% of Students had adequate assignments and work practices involving the use of computers. Could one suggests that beside absence of ICT tools, time constraints too, could define some reasons why a greater number of students were not given assignments and practices that involved the use of computers in schools.

Teachers' responses to the availability of ICT in their schools were analysed and presented in Table 10.

Table 10: Teachers' opinion on availability of adequate ICT resources in schools

Response	Frequency	Percentage (%)
Yes	21	35
No	39	65
Total	**60**	**100**

The results in Table 10 and Figure 10 had shown that 35% of the teachers had indicated that there were ICT resources in their school whiles 65% claimed they had no ICT resources in their schools. Considering the results, it goes to confirm the students' assertion that Senior High Schools have not provided them with adequate ICT resources to improve on teaching and learning of science.

In relation to teachers' access to computers and other ICT accessories. The analysed results is presented in table 11

Table 11: Teachers with access to ICT resources for teaching and learning

Response	Frequency	Percentage (%)
Yes	41	68
No	19	32
Total	60	100

Despite the assertion in Table 10 that schools do not have adequate ICT resources, Table 11 and Figure 11 had shown that 68% of teachers stated they had access to ICT resources while 32% of teachers indicated that they did not have access. However, it could be deduced that many teachers have access to their own ICT resources to aid in teaching and learning.

The availability of ICT tools and resources in Senior High Schools are inevitably major factors to describe the state of ICT usage and its influence in promoting teaching and learning, especially in science curriculum. Teachers' responses are summarized in table 12 below

Table 12: Results of questionnaire items on the state of ICT-teachers' views

S/N	Statement	SA	AG	UD	DA	SD
i.	The current curriculum and educational system is not ICT driven.	18 (30%)	22 (37%)	2 (3%)	11 (18%)	8 (12%)
ii.	ICT integration is not important because of the partial success of traditional method of teaching.	27 (45%)	19 (32%)	1 (1%)	9 (15%)	4 (7%)
iii.	Recent educational reforms promote ICT integration.	6 (10%)	12 (20%)	3 (5%)	17 (28%)	22 (37%)
iv.	There is adequate internet infrastructure to aid teaching and learning.	4 (7%)	5 (8%)	0 (0%)	23 (38%)	28 (47%)
v.	Assignments and work given to students involve the use of computers.	6 (10%)	9 (15%)	7 (12%)	13 (22%)	25 (41%)

Teachers N=60. Frequency (percent count); SA = strongly agree; AG= agree; UD = undecided; DA= disagree; SD =strongly disagree

Table 12 had shown that 30% of teachers strongly agreed and 37% agreed that *'The current curriculum and educational system is not ICT driven'*, 3% of teachers were undecided, 18% disagreed, and 12% strongly disagreed to the assertion. Thus, 67% were likely to indicate that emphasis on ICT use in curriculum and the promotion ICT use in classroom were not priority in accordance to their view of the current curricula. Again, Table 12 had shown that 45% of teachers strongly agreed and 32% agreed that *'ICT integration is not important because of the partial success of traditional method of teaching'*. However, 1% of teachers were undecided whiles 15% disagreed and 7% strongly disagreed to the assertion. Thus, 77% of teachers were likely to rely on the traditional way of teaching since it had produced some successes in the past in their experience as against ICT integration which majority cannot get access (Table 10). This attitude of Teachers is vital in the integration of ICT in teachings and learning. Therefore, when teachers did not embrace change, as a factor that affects the use of ICT in teaching, they would decline in effort to implement ICT in classrooms.

In the views of the teachers with regards to whether recent educational reforms have influence the integration of Information and Communication Technology tools into teaching and learning, 10% of teachers strongly agreed and 20% agreed to the statement that *'Recent educational reforms promote ICT integration'* whereas 5% were undecided. Nonetheless, 28% of teachers disagreed and 37% strongly disagreed with the statement. This implies that 68% do not feel the impact of Education Reforms policies on ICT integration in schools. Teachers could have this opinion because they had little knowledge in recent education reforms policy documents or due to the widened gap between written policies and what is translated into concrete evidence.

Internet connectivity is one of the key components in ensuring that ICT is fully integrated into Senior High School system. It enables teachers and students to acquire relevant information that aid teaching and learning. However, Table 12 showed that 47% of teachers strongly disagreed and 38% disagreed that *'there is adequate internet infrastructure to aid teaching and learning*'. Nonetheless, 8% of teachers agreed and 7% strongly agreed. Thus, about 85% of teachers had the opinion that there is inadequate internet infrastructure to aid teaching and learning.

Assignments and work given to students involve the use of computers

Students' assignments are means of extending teaching and learning from the classroom to the home or social environments to help deepen or internalise student's comprehension of lessons taught. Table 12 had shown that 10% teachers strongly agreed and 15% agreed that *'assignments and work given to students involve the use of computers*. Conversely, 22% of teachers strongly disagreed and 41% disagreed to uphold the statement whiles 12% of teachers were undecided.

Research Question 2

To what extent do current educational provisions in the schools adequately enable integrated science teachers to integrate ICT into their teaching?

Educational provisions in schools are vital to ensure that ICT and its' resources are integrated into teaching and learning to improve on teachers' performances, knowledge dissemination and students' reception and comprehension in integrated science. Also, educational provisions in senior high schools should include physical and administrative structures to harness ICT integration within the curricula. Again, educational provisions should lay the essential related background resources that influence decision making to address critical issues in ICT integration in education. Thus, they are factors that strengthen or weaken external school factors that promote ICT integration in teaching and learning.

With regards to this study some relevant factors viewed by the researcher as important educational provisions needed in Senior High Schools were assessed using observation check list in the four schools used for the study. These were aimed at ascertaining the basic educational provisions present in these schools to promote ICT integration into teaching and learning of integrated science. Spodark (2003) noted that the factors which served as enabling environment to cater for universal students' were access, reliable network, multiple opportunities for training, consultation and faculty ethos which values experimentation and toleration of falters. Hence the items were framed to find out:

- If the senior high schools have ICT policy
- If the schools have alternative source of electrical power
- If the school is a science resource centre
- If the school has air-conditioned ICT laboratories

- If the school has a Wi-Fi internet facility
- If the schools have software and hardware technicians
- If teachers are given incentives to motivate the use of ICT in teaching and learning.

Subsequently two observations were also made in each of the four schools to find out if ICTs were integrated into the teaching and learning of integrated science.

The observations made in all the four schools used for the study are indicated in the Tables 13, 14, 15 and 16.

Table 13: Integrating ICT into teaching and some educational provisions for ICT integration in school A

Integrating ICT into teaching	**Present**	**Absent**
1. i. First observation	√	
ii. Second observation		√
Educational Provisions	**Present**	**Absent**
2. Is the school having an educational ICT policy framework?		√
3. The school has air-conditioned ICT laboratory.		√
4. The school has a Wi-Fi internet service.	√	
5. There are incentives and motivational packages to compensate teachers on extra work and time spent with the use of ICT.		√
6. The school has a science resource centre.	√	
7. The school has ICT software and hardware technicians.		√
8. The school has alternative electricity power supply.	√	

Senior High School 'A' is an urban setting school with its ICT integration status shown in Table 13. Out of the two lessons observed to ascertain whether ICT is integrated into the teaching of integrated science only one lesson in the first observation the teacher included ICT into the instructional process. In the second lesson observed the teacher did not include ICTs during the instructional process. It is also observed from Table 13 that Senior High School 'A' had a science resource

centre, alternative electricity power and Wi-Fi internet service. But it did not have educational ICT policy framework, air-conditioned ICT laboratory or ICT software and hardware technician. Also, it had no incentives and motivational packages to compensate teachers who effectively use ICT resources for academic activities.

The observations made in the school B is presented in table 14.

Table 14: Integrating ICT into teaching and some educational provisions for ICT integration in School B

Integrating ICT into teaching	**Present**	**Absent**
1. i. First observation		√
ii. Second observation		√
Educational Provisions	**Present**	**Absent**
2. Is the school having an educational ICT policy framework?		√
3. The school has air-conditioned ICT laboratory.		√
4. The school has a Wi-Fi internet service.		√
5. There are incentives and motivational packages to compensate teachers on extra work and time spent with the use of ICT.		√
6. The school has a science resource centre.		√
7. The school has ICT software and hardware technicians.		√
8. The school has alternative electricity power supply.	√	

Table 14 presented the ICT integration status of Senior High School 'B' which is in rural setting. From the table the two observations made to assess whether ICTs is integrated into integrated science lessons showed that none of the lessons delivered included the use of ICTs. Table 14 also reveals that Senior High School 'B' had no educational ICT policy framework, no air-conditioned ICT laboratory or Wi-Fi internet service. Again, it had no software and hardware technicians, no science resource centre or incentives and motivational packages to compensate teachers who effectively use ICT in teaching and learning. However, it had alternative electricity power supply resources. Hence Senior High School 'B' had virtually not made provision for any ICT integration in teaching and learning of integrated science.

Therefore, teachers who are enthused to use ICT resources for academic activities with their students had to do so with their own resources. This was a disincentive to general ICT integration in Senior High School 'B'.

The observations made using the observation checklist in school C are presented in table 15

Table 15: Integrating ICT into teaching and some educational provisions for ICT integration in School C

Integrating ICT into Teaching	**Present**	**Absent**
1. i. First observation		√
ii. Second observation		√
Educational Provisions	**Present**	**Absent**
2. Is the school having an educational ICT policy framework?		√
3. The school has air-conditioned ICT laboratory.		√
4. The school has a Wi-Fi internet service.		√
5. There are incentives and motivational packages to compensate teachers on extra work and time spent with the use of ICT.		√
6. The school has a science resource centre.		√
7. The school has ICT software and hardware technicians.		√
8. The school has alternative electricity power supply.	√	

Observations made from Senior High School 'C' which is also in a rural setting did not show any difference in ICT status as compared to Senior High School 'B'. It is indicated in Table 15 that Senior High School 'C' did not have any of the items listed in the checklist and with regards to the lessons observed the teachers did not include ICTs in their instructions except that the school had an alternative electricity power supply to provide light for students' academic activities.

A study of the fourth school, Senior High School 'D' which is in a sub-urban settings did not show any remarkable differences from the ICT statuses of Senior High School 'B' and that of Senior High School '**C**'. The ICT status of Senior High School 'D' is shown in table 16.

Table 16: Integrating ICT into teaching and some educational provisions for ICT integration in School D

Integrating ICT into teaching	**Present**	**Absent**
1. i. First observation		√
ii. Second observation		√
Educational Provisions	**Present**	**Absent**
2. Is the school having an educational ICT policy framework?		√
3. The school has air-conditioned ICT laboratory.	√	
4. The school has a Wi-Fi internet service.		√
5. There are incentives and motivational packages to compensate teachers on extra work and time spent with the use of ICT.		√
6. The school has a science resource centre.		√
7. The school has ICT software and hardware technicians.		√
8. The school has alternative electricity power supply.	√	

Observations made from Senior High School 'D' as indicated in Table 16 shown that ICTs were not included in the teaching of integrated science at the time of observation.

The school had air-conditioned ICT laboratory and alternative electricity power supply. However, the school 'D' did not have educational ICT policy framework, Wi-Fi internet service or incentives and motivational packages for teachers who indulged in using ICT to promote teaching and learning integrated science. Again, it did not have a science resource centre or ICT software and hardware technicians to manage the air-conditioned ICT laboratory in the school.

Considering the general observation using the checklist data, the results indicated that the current educational provisions in the four Senior High Schools used for the study are highly inadequate to promote ICT integration in these schools. It further signifies that these schools lacked the required driving force - educational ICT policies - that could speed up ICT integration efforts. In effect the location of schools had serious

repercussions on ICT integration status of Senior High Schools, hence the promotion of ICT integration in integrated science academic activities.

Research Question 3

How knowledgeable are teachers and students about the integration of ICT in the selected senior high schools?

The ability to manipulate ICT hardware and software to achieve a desired outcome is indicative of one's knowledge in ICT tools. In the same vein the ability to use ICT tools to achieve a stated academic objective reflects one's ability to combine a variety of instructional procedures and ICT tools or resource. The research question sought to find out the knowledge base of teachers and students in the use of Information and Communication Technology (ICT) in education at the Senior High School. The results from respondents as analysed are presented in Table 17.

Table 17: Results of students' knowledge about the use of ICT tools/resources

S/N	Statement	SA	AG	UD	DA	SD
i.	ICT use does not make learning more interactive and enjoyable.	0 (0%)	4 (3%)	0 (0%)	50 (42%)	66 (55%)
ii.	ICT use in teaching improves ways of recording marks and reports.	40 (33%)	42 (35%)	6 (5%)	18 (15%)	14 (12%)
iii.	The use of ICT enhances collaboration among teachers and students.	29 (24%)	39 (33%)	19 (15%)	19 (16%)	14 (12%)
iv.	The use of ICT in schools does not promote student centered learning.	6 (5%)	17 (14%)	0 (0%)	59 (49%)	38 (32%)

Students N=120. Frequency (percent count); SA = strongly agree; AG= agree; UD = undecided; DA= disagree; SD =strongly disagree

Table 17 indicated that about 42% of students disagreed and 55% strongly disagreed to the statement that the use of ICT does not make learning more interactive enjoyable whiles 3% of students did agree with the assertion. Therefore, greater number of students believed that the use ICT makes learning more interactive

and enjoyable which to large extent reflects their knowledge in ICT tools as capable of enhancing pedagogy.

Again, the Table indicated that 33% of students strongly agreed, with 35% agreed, and 15% disagreed with 12% strongly disagreed to the assertion that the use of ICT improves ways of recording marks and reports. Thus, about 68% of students have comprehensive knowledge that, ICT could be used to record marks of students and prepare their reports.

Additionally, the Table showed that 24% of students strongly agreed, 33% agreed, 15% remained undecided, 16% disagreed and 12% strongly disagreed that the use of ICT in teaching and learning enhance collaboration among teachers and students. Thus, it might mean that about 28%, if not 43%, of students have not had that meaningful benefit of teacher-student-ICT lesson interactions to enhance their academic performance. Hence one could state that about 57% of students know the value of ICT in creating friendly academic rapport between teachers and students.

Furthermore, Table 17 showed that 5% of students strongly agreed and 14% agreed as against 49% of students who disagreed and 32% strongly disagreed that the use of ICT in education does not promote student centered learning. Therefore, one could affirm that about 81% of students understand that the use of ICT in education promote student-centered learning.

However, teachers' opinions on the use of ICT in academic work was analysed and presented in Table 18.

Table 18: Results of teachers' knowledge of the use of ICT in academic work

S/N	Statement	SA	AG	UD	DA	SD
i.	The use of ICT stimulates and motivates teachers and students.	20 (33%)	28 (47%)	0 (0%)	12 (20%)	0 (0%)
ii.	The use of ICT impede ways of accountability and reporting	0 (0%)	4 (7%)	0 (0%)	38 (63%)	18 (30%)
iii.	ICT uses develop student learning skills which is essential for work.	12 (20%)	48 (80%)	0 (0%)	0 (0%)	0 (0%)
iv.	The use of ICT does not reduce teachers load and increase student participation.	5 (8%)	16 (27%)	0 (0%)	25 (42%)	14 (23%)
v.	Educational materials can be prepared and distributed using ICT.	14 (23%)	24 (40%)	0 (0%)	13 (22%)	9 (15%)

Teachers N=60. Frequency (percent count); SA = strongly agree; AG= agree; UD = undecided; DA= disagree; SD =strongly disagree

The results represented in Table 18 showed that there is a general agreement among teachers that the use of ICT by educators promote teaching and learning at the Senior High School. About 33% of teachers strongly agreed while 47% agreed that the use of ICT stimulates and motivates teachers and students in their academic work. However, 20% of teachers disagreed to the statement. It can be deduced that about 80% of teachers who did not agree do not have ICT friendly environment to efficiently and sufficiently engage their students in academic activities.

Again, Table 18 showed that about, 63% of teachers disagreed and 30% strongly disagreed that the use of ICT in education impedes ways of accountability and reporting. The results showed that about 93% of teachers know how important ICT resources are used in storage, retrieval and processing and transmitting information by way of reporting. In addition, Table 18 showed that about 20% of teachers strongly agreed and 80% agreed to the statement that ICT use in

education develop student learning skills essential for work. It could be inferred that teachers had insight to current job skills requirement in relation to the use of ICT related resources, hence the necessity of ICT tools/ resources in students' academic activities.

Also, teachers' opinions on the statement, "the use of ICT does not reduce teachers' load and increase student's participation", obtained the following responses: about 8% of teachers strongly agreed and 27% agreed while 42% disagreed and 23% strongly disagreed. Hence, about 65% of teachers are of the view that ICT usage in class activities/lessons reduces teachers' workloads and increase student's active participation Lastly, Table 18 highlighted that 23% of teachers strongly agreed and 40% agreed to the assertion that, educational materials can be prepared and distributed using ICT. Nonetheless, 22% of teachers disagreed and 15% strongly disagreed to the statement.

In summary from Tables 17 and 18, students and teachers alike had indicated high sense of knowledge on ICT tools' position in education and that these resources when harnessed into academic activities will greatly improve on teaching and learning.

Research Question 4

What are the barriers to the integration of ICT applications in the teaching and learning of integrated science in the selected senior high school?

This research question sought to find out from respondents barriers that hinder the integration of ICT into teaching and learning of integrated science at Senior High Schools. The results of the data analysed is presented in Table 19.

Table 19: Students' opinion on barriers to integration of ICT in science lessons

S/N	Statement	SA	AG	UD	DA	SD
i.	Lack of electricity affects ICT use in teaching and learning.	49 (41%)	62 (52%)	0 (0%)	5 (4%)	4 (3%)
ii.	Lack of competent and qualified ICT personnel does not affect ICT use.	5 (4%)	16 (13%)	13 (11%)	51 (43%)	35 (29%)
iii.	The government's inability to avail ICT resources affects ICT use.	45 (38%)	58 (48%)	0 (0%)	7 (6%)	10 (8%)
iv.	High cost of investments and inadequate ICT infrastructure does not affect ICT use.	2 (2%)	7 (6%)	0 (0%)	53 (44%)	58 (48%)

Students N=120. Frequency (percent count); SA = strongly agree; AG= agree; UD = undecided; DA= disagree; SD =strongly disagree

According to Table 19 about 41% of students strongly agreed and 52% agreed that the lack of electricity was a challenge in the integration of Information and Communication Technology into teaching and learning, especially integrated science at Senior High Schools. However, 4% of students disagreed and 3% strongly disagreed with the assertion. This 7% of students might be in schools that have had alternative source of electricity, had not experienced frequent power outages or were not conversant with the utility of ICT tools and resources.

Again, in relation to the statement that, '*Lack of competent and qualified ICT personnel does not affect ICT use*', about 43% of students disagreed and 29% strongly disagreed to the assertion. However, 4% strongly agreed and 13 % agreed that the lack of ICT personnel does not affect ICT integration at the Senior High School whiles 11% of students were undecided. Additionally, Table 19 indicated that about 38% of students strongly agreed and 48% agreed that 'the government's inability to avail ICT resources affects ICT use'. This by implication meant 86% of students indicated that the unavailability ICT resources impede the integration of ICT in teaching and learning; especially learning integrated science at Senior High Schools. However, about 6% of students disagreed and 8% strongly disagreed that the

government's inability to provide ICT resources affects ICT integration. It can be deduced that the later (14%) are of the view that government could not be blamed for lack of ICT integration in Senior High Schools. Furthermore, Table 19 had shown that about 44% disagreed and 48% strongly disagreed to the statement that, 'High cost of investments and inadequate ICT infrastructure does not affect ICT use'. Nonetheless 2% strongly agreed and 6% agreed to the statement. Hence, high cost of investments and inadequate ICT infrastructure affect negatively the use of ICT in Senior High Schools.

Analysed data on teachers' opinions on the barriers to ICT integration is presented in table 20.

Table 20: Teachers opinions on barriers to ICT integration in science lessons

SN	Statement	SA	AG	UD	DA	SD
i.	The school is not structurally adapted to facilitate ICT integration.	30 (50%)	18 (30%)	0 (0%)	7 (12%)	5 (8%)
ii.	School administration is a barrier to ICT integration.	25 (42%)	26 (43%)	0 (0%)	9 (15%)	0 (0%)
iii.	Teacher education does not prepare teachers adequately to include ICT in teaching.	21 (35%)	14 (23%)	3 (5%)	12 (20%)	10 (17%)
iv.	Adequate in-service training are organised for teachers to enhance their ICT skills.	0 (0%)	4 (7%)	0 (0%)	20 (33%)	36 (60%)
v.	Finance does not prevent the use of ICT in education.	0 (0%)	6 (10%)	0 (0%)	42 (70%)	12 (20%)

Teachers N=60. Frequency (percent count); SA = strongly agree; AG= agree; UD = undecided; DA= disagree; SD =strongly disagree

The results in Table 20 represent responses of teachers based on items of the questionnaire that sought to determine the challenges in ICT integration. Regarding the statement that *'The school is not structurally adapted to facilitate ICT integration*', 50% of teachers strongly agreed and 30 % agreed to the statement.

Again, 12% of teachers disagreed and 8% strongly disagreed to the statement. It could be suggested some schools have an advantage of physical infrastructure for ICT usage; therefore the issue of building cannot hinder ICT integration in teaching and learning. However, majority (80%) of schools require infrastructure investments to facilitate ICT integration in teaching and learning.

In addition, about 42% of teachers strongly agreed and 43% agreed to the statement that, *'School administration is a barrier to ICT integration'* in teaching and learning. However, 15% disagreed and 0% strongly disagreed to the assertion. Therefore, 85% of teachers underpinned school administration as a major factor that hinders ICT integration in teaching and learning. Some Senior High Schools have made gains in ICT integration. This could be attributed to school leadership styles that motivate teachers and provide platforms for ICT integration in teaching and learning.

Again, table 20 indicated 35% of teachers strongly agreed, 23% agreed whiles 5% were undecided on the statement that 'Teacher education does not prepare teachers adequately to include ICT in teaching'. Nonetheless, 20% disagreed and 17% strongly disagreed to the statement. It can be concluded that 58% of teachers were not given adequate training in their various training institutions to integrate ICT in pedagogy in science. Hence, more could be done to ensure that teacher education in Ghana builds and imparts the requisite skills needed by teachers to integrate ICT in teaching and learning. Furthermore, on whether 'adequate in-service training are organised for teachers to enhance their ICT skills', 33% of teachers disagreed and 60% strongly disagreed while 7% agreed to the assertion. It could be inferred from the responses that stakeholders in education were not according enough priority to ICT integration by supporting teachers' capacity building through in-service and educational training.

Lastly, Table 20 showed that when teachers were asked whether 'finance does not prevent the use of ICT in education', 70% of them disagreed, 20% strongly disagreed and 6% agreed to the statement. Therefore, it is overwhelmingly (90%) clear that teachers had shown that financing ICT integration in education is a major hindrance to ICT usage in Senior High Schools. Notwithstanding, some teachers were of the view that finances should not hinder ICT integration perhaps due the huge benefits associated with ICT use in education; that is, in teaching and learning.

Research Question 5

How can the problems hindering ICT Integration into integrated science teaching and learning in the senior high schools be solved?

The research question 5 explored views of students, teachers and a district coordinator of science on how to manage problems that hindered the integration of ICT in teaching and learning of integrated science at senior high schools. The free response open-ended items that were used in teachers' and students' questionnaire yielded responses presented in Table 21 and Table 22 respectively. In the case of the district science coordinator interviewed, the responses are presented in Table 23.

Table 21: Students opinions on how to manage problems hindering ICT integration in SHS

Responses
1. Students should be allowed to bring or use their own computers in the school.
2. Students should be allowed to bring mobile phones to school since it is convenient and easy to use.
3. The government should provide money to all the schools to help in ICT use.
4. It should be made compulsory for the teachers to use ICT in teaching.
5. School authorities should use part of the school fees to buy the needed ICT materials to support ICT integration in the schools.

The students were of the view that to solve or manage the problems hindering ICT integration in teaching and learning of integration science, they could be allowed to bring their own personal computers such as laptops, smartphone, iPad and tablets to ease schools' burden on hardware provisions and maintenance. They also felt that government could provide schools with needed funding or the schools could use part of students' fees to promote and improve on schools' ICT resources and facilities. Again students had the opinion that when it was made compulsory for teachers to use ICT in teaching it will improve on ICT integration in Senior High Schools.

Table 22: Teachers' opinions on how to manage problems hindering ICT integration in SHS

Responses
1. Teachers should be supported by the provision of government laptops to aid their teaching.
2. Training should be given to the teachers on regular basis to help them to use ICT.
3. The volume of the syllabus should be reduced to give teachers time to be able to use ICT in teaching and learning.
4. Teachers should be financially motivated to integrate ICT into teaching and learning.
5. The leadership of the schools should support and enforce ICT use for teaching and learning in the schools.

Table 22 indicated that teachers were of the views that in order to manage or solve the challenges hindering ICT integration, government should provide teachers with laptops as well as organise regular in-service training to improve on their skills of using ICT resources to deliver on curricula activities in science. They further, wished that teachers should be given financial incentives that promote ICT integration in schools. As a result of time and resource constrains the curricula content should be reduced to facilitate ICT integration in lesson delivery. Teachers also felt that school management could support and enforce the use of ICT resources in teachers and students' academic activities.

However, a science coordinator who was interviewed gave the following responses as shown in Table 23.

Table 23: District science coordinator's opinion on how to manage problems hindering ICT integration

Responses
1. Politicization of ICT integration efforts through the sharing of government laptops should not be encouraged.
2. Teachers should be given regular training in ICT to boost their confidence in its use.
3. Parents should be made to contribute by paying bills for ICT in the school.
4. The schools should be made to use a certain quota of internally generated funds to support ICT
5. Government should enter into private partnership with telecom companies to promote ICT integration in the schools.

The science educationist interviewed was of the opinion that government should give laptops to teachers. Again, government could jointly partner with the various telecommunication companies to network schools to provide internet services to promote ICT integration in schools. However, they also felt that teachers could be given regular training on ICT and its related tools and resources usage in schools. They further allude that schools could support ICT integration from their internally generated funds as well as asking parents to support ICT by paying electricity bills incurred by schools' ICT laboratories.

4.3 Results of Interview

In order to obtain broad and diversified views of student, teachers and the district science coordinator on the factors that influence ICT integration in the teaching and learning of integrated science interviews were used as one of the data gathering instrument to check consistency and confirm the responses of respondents.

Considering the interview schedule item 1, on the state of ICT in the senior high schools all respondents were of the opinion that schools were not equipped with the

needed ICT tools and had no adequate infrastructure or access to internet resources to facilitate ICT integration.

A summary of these assertion are captured in the following

Student responses

1. *Students don't have access to computers at school.*
2. *The schools do not have fully equipped ICT laboratories.*
3. *The schools do not have internet facilities.*

Teacher responses

1. *The schools do not have internet services or Wi-Fi to be used for research.*
2. *The schools do not have adequate infrastructure to support ICT use*
3. *Computer and ICT tools in the schools are inadequate compared to the number of teachers and students.*

Science coordinator responses

1. *The schools lack internet facilities.*
2. *The schools need buildings for classroom and dormitory thus lack adequate space to support ICT.*
3. *The schools do not have enough ICT gadgets to be used by teachers and students for academic work.*

Subsequently, teachers, students and the science coordinator indicated that lack of funding, steady electricity supply and lack of government support in hardware facilities were some barriers hindering ICT integration.

A summary of these assertions is captured in the following

Student responses

1. *Lack of electricity affects ICT use in teaching and learning.*
2. *Governments inability to supply ICT resources affects ICT use.*
3. *High cost of computers affects ICT use in teaching and learning.*

Teacher responses

1. *School administration serves as a barrier to ICT use in teaching and learning.*
2. *Lack of steady electricity supply affects ICT use in education.*
3. *The high cost of ICT resources and tools hinder ICT use in the teaching and learning process.*

Science coordinator responses

1. *Inadequate in-service training for teachers serves as barrier to ICT use in teaching and learning.*
2. *The high financial demand associated to ICT is a barrier to ICT use in education.*
3. *The high cost of electricity hinders ICT use in education.*

Additionally, the interview response to research question on how knowledgeable teachers and students were in the integration of ICT into lessons showed that as a result of lack of in-service training, lack of ICT technicians and lack of effective ICT integration in the training of teachers, teachers and students have basic knowledge in ICT but the knowledge and skills required to use the resource in the classroom for educational purpose was considerably insufficient. Respondents asserted to having the following basic knowledge in ICT and computer use.

This assertion is captured in the following

Student responses

1. *ICT use makes teaching and learning enjoyable.*
2. *The use of computers improves understanding.*
3. *Computer use encourages collaboration.*

Teacher responses

1. *Lesson notes, scheme of work and teaching notes can be prepared using computers.*
2. *Computer use in teaching and learning motivate and stimulate student's interest.*
3. *ICT use reduce teachers work load.*

Science coordinator responses

1. *Computer use make teaching and learning exciting.*
2. *ICT use reduce teachers work load.*
3. *ICT tools bridge the gap between the teachers and students.*

With regards to research question four which centered on educational provisions in the schools. All the respondents indicated that current educational provisions in the schools do not support ICT integration in teaching and learning of integrated science at the senior high school.

This assertion is captured in the following

Student responses

1. *The school does not have ICT teachers and technicians.*
2. *The school does not have fully equipped ICT laboratory.*
3. *The school does not have alternative power supply.*

Teacher responses

1. *The schools do not have ICT policy.*
2. *The syllabus does not include ICT modules.*
3. *Teachers do not receive incentives for the extra work in preparing and using ICT in teaching.*

Science coordinator responses

1. *The design of the syllabus does not encourage ICT use in teaching and learning.*
2. *There are no hardware and software technicians at the schools.*
3. *There are no motivational packages to motivate teachers.*

With respect to interview responds to research question 5, respondents indicated that government should increase its efforts toward ICT integration at the Senior High Schools. Additionally, Senior High Schools managements should be instrumental in ensuring efficient ICT integration in Senior High Schools.

A summary of these assertions is captured in the following

Student responses

1. *Students should be allowed to use mobile phones in school.*
2. *School authorities should ensure that all the tools needed are provided*
3. *Parents should be made to provide the computers needed by their wards in school.*

Teacher responses

1. *Financial motivation should be given to teachers to support their efforts in using ICT in teaching.*
2. *Government should ensure equity in the distribution of laptops to teachers.*

3. *Authorities should make ICT integration a key component of their developmental agenda.*

Science coordinator responses

1. *Parents should be made to contribute by paying bills for ICT.*
2. *The schools should be made to use a certain quota of internally generated funds to support ICT.*
3. *Government should enter into partnership with telecom companies to promote ICT integration in the schools.*

4.4 Discussion

The purpose of the study was to assess ICT integration in teaching and learning of integrated science in Senior High Schools.

Structured interviews and informal observation technique were employed to compliment the data gathered by the questionnaires. Considering the state of ICT in teaching and learning of integrated science in selected senior high schools it was observed that the state of ICT was not encouraging. The issues identified were common to all four schools used in the study. Ghana Education Service (GES) and other stake holders in education encourages that ICT resources were used in all teaching and learning activities, especially in integrated science at Senior High Schools level. However, the observations made in the schools contradict the demands of the academic system.

Hope (1997) stated that for technology to be exploited in an environment, it must first exist. Also Brace and Roberts (1996) emphasized that schools need access to technology of all types which included networked computer and audio-visual equipment. Teachers and students responses to questionnaire items on the state of ICT

in Senior High Schools showed that computers and other ICT tools were not available. The few resources present were also inadequate. The large number of students and teachers compared to the small number of available ICT resources limited teachers and students access to ICT resources. Teachers and students also had no internet facilities; therefore, work practices and assignments did not involve the use of ICT related resources. It was further observed that most of the ICT materials were out of use and had not been repaired or replaced. Additionally, some heads of departments use the ICT tools and facilities for their personal benefits. A notable example was in school A which had a resource centre. It was observed that most of the gadgets have been locked up to create space for normal classroom lessons and other social gathering to be held at the centre.

The second research question in this study was on the barriers to the integration of ICT application in the teaching and learning of integrated science in the senior high schools. Several research works show that several barriers impede ICT integration in education. There were varieties of barriers analysed in this study's questionnaires. The barriers included lack of electricity supply, lack of government support and high cost of ICT tools, inadequate finance, inadequate infrastructural facilities and unenthusiastic school management were barriers to ICT integration in teaching and learning of integrated science. A greater percent of the both teachers and students affirmed the above barriers to ICT integration. However, interview responses from teachers pointed out that leadership style and lack of in-service training were some major barriers hindering ICT application into teaching and learning.

Lai and Pratt (2004) noted that for effective utilization of technological resources by teachers, there is the need for a strong leadership to drive a well-designed technology

plan in schools. This is because leadership shapes the culture of the school. The percentage difference showed in Table 14 confirms that leadership is a barrier to integrating ICT applications in education; that is 42% of teachers stated strongly agreed and 43% agreed- constituting 85% of teachers affirming the assertion.

Roberts (1996) stated that the lack of training creates barriers to faculty's use of technology. Hands-on experience through workshops and orientations offers teachers' the opportunity to build their cognitive and technical skills in the use of ICT resources. The percentage distribution in Table 14 confirms the statement. About 93% confirms that the training need of teachers in ICT is important to ensure the integration of ICT into teaching and learning of integrated science at the Senior High Schools.

The third research question in this study on ICT integration in teaching and learning of integrated science in selected senior high schools centred on how knowledgeable teachers and students were concerning integration of ICT in schools' lessons. Pelgrum (2001) stated that the success of educational innovations depends largely on the skills and knowledge of the teachers. The analysis from Table 15 and Table 16 respectively depicted that both students and teachers had basic knowledge on ICT uses. However, responses from teacher and students to the interview schedule items showed that they had no adequate knowledge in the levels of ICT use, the levels in ICT application and the components of ICT.

Subsequently, students and teachers responses in the use of ICT to promote student-centered learning, motivates teachers and make learning more interactive showed that teachers and students had basic knowledge in ICT. This is confirmed by Becta (2004)

who noted that teachers' attitudes toward the use of technology is their understanding of how these technology will benefit their teaching and their student learning.

With respect to the fourth research question, 'are current educational provisions in the schools adequate to enable integrated science teachers to integrate ICT in their teaching?

Observations made in the four schools on the educational provisions as showed in Tables 17, 18, 19 and 20 depicted that educational provision in the schools were not favorable to support ICT integration in teaching. Earle (2002) noted that ICT integration is a concept of wholeness, when all elements of the system are connected together to become a whole.

The fifth research question which sought to find out how the problems hindering ICT integration into integrated science teaching and learning in the senior high schools can be solved revealed that government was central in ensuring that senior high schools' capacity to integrate ICT into teaching and learning was improved through training of teachers and provision of needed finances. Additionally, it came to light that the heads of senior high schools had major roles to play thus they could provide motivation for teachers, create the enabling environment and use internally generated funds to support ICT initiatives in the senior high schools. Subsequently, students noted that one of the ways of ensuring that ICT were used in teaching and learning was by allowing students to use mobile phones that were currently not allowed at the senior high schools. Mobile phone are one of the components of ICT resources, thus it made students' claim valid but the inability to monitor students use of the phone and the tendency to use the mobile phone in ventures that were detrimental to educational goals made its use unacceptable.

In conclusion this study revealed that teachers and students had basic knowledge in the use of ICTs in education. However, they were not likely to harness the full benefits associated with its uses because teachers had no knowledge of ICT components, levels of ICT application and the levels of ICT use. Yidana and Asiedu-Addo (2001) noted that despite the huge potential of information technology (IT) in the efficient delivery of education in Africa, it is sad to observe that we neither have the requisite resources nor technical expertise to tap the resource. However, ICT integration in teaching and learning of integrated science in the senior high schools is greatly impeded by the unavailability of ICT resources, personnel; technical support; institutional barriers and the ICT unfriendly nature of current education provisions to promote ICT integration.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION, RECOMMENDATIONS AND SUGGESTIONS FOR FUTHER STUDIES

5.0 Overview

This chapter summarizes the details obtained in the study. The chapter is grouped into three parts. The first part summarizes the findings, the second part outlines the conclusions drawn from the research and the third part makes recommendations on measures to address the relevant factors to ensure successful integration of ICT at the senior high schools in the teaching and learning of integrated science.

5.1 Summary of Findings

The research was conducted to determine ICT integration in the teaching and learning of integrated science in selected senior high schools. The study was guided by five research questions. The first research question centered on the state of ICT in the senior high schools. In considering the state of ICT the availability of facilities and ICT tools are very important. Some of these tools and facilities include

- Generators for electrical power
- Computers, photocopier, Printers, Speakers, Scanners
- ICT technicians for hardware and software installation
- Projectors and White screens for large scale class/audience lesson delivery
- ICT laboratories with Internet facilities, modems and Mobile phones
- Television and Radio sets for projection of video and audio lessons

Judging from the data collected from the four senior high schools used in the study it revealed that though some schools had made moderate progress with respect to ICT resources and infrastructure it is comparatively inadequate compared to ICT use in some developed countries. This is because a greater number of other forms of ICT tools were absent. However, in the schools that made moderate gains with respect to ICT use the following were observed

- The resources were not enough because the students' population are too large
- The resources were old and had broken down
- Laboratories were not fully equipped
- The computers and ICT tools present were old models and the broken down parts are not available on the market
- Absence of qualified staff to manage and ensure sustainability of ICT tools.

In a nutshell the above observations indicates that the state of ICT integration into teaching and learning specifically with integrated science is poor and therefore urgent attention is needed to improve the level of ICT use at the senior high schools in the research area.

The second research question in the study centered on barriers to the integration of ICT into teaching and learning of integrated science at the senior high schools. To ensure successful integration of ICT into teaching and learning at the senior high schools requires that several barriers that can hinder ICT use in pedagogy are eliminated. ICT integration in education is not easy therefore requires a multifaceted approach to ensure that the full benefits associated to ICT use are harnessed. Due to the multi complex nature of the resource there are myriads of challenges that impede its use in education. Barriers in ICT integration could be grouped under the following:

- Personal barriers
- Technical barriers
- Institutional barrier

Personal barriers to ICT integration culminates largely from the competence level of teachers in the use of ICT tools due to inadequate professional development in the area of technology use. The problem is further compounded due to the absence of in-service training to improve the capacity and knowledge base of teachers in ICT use. Secondly, technical barriers stems up from the lack of ICT experts in the schools to manage the software applications, repair and maintain the hardware components of ICT tools. The institutional barriers fall on leadership styles, physical structures in the schools and to a very large extent finance.

Some of the barriers highlighted by this study included the following

- High cost associated with investing into technology use
- Government's inability to avail resources to the schools
- Administrative barriers
- Teacher incompetence on ICT use and the lack of in-service training to enhance teachers' ICT skills
- Structural deficiencies in the senior high schools to facilitate ICT adoption

The third research question investigated the knowledge of teachers and students in ICT integration. This was geared toward answering the following questions:

- Do teachers know what it means to integrate ICT into their teaching?
- Do teachers have the practical skills to include ICT in their teaching?
- How competent do the teachers perceive themselves with respect to ICT application in their lessons.

- Are teachers utilizing ICT applications in their schools and at what level?

The study revealed that though teachers and students had basic knowledge in ICT they lacked the competency and the practical skills to utilize ICT applications effectively to aid in their teaching and learning of integrated science. This reduces the role ICT plays in strengthening current educational systems aimed at networking society to raise the standard of education in general by making teaching and learning an active process connected to real life.

Haddad and Draxler (2008) noted that there are five levels of ICT use and five levels of ICT application. The five levels of ICT use are: Presentation, Demonstration, Drill and practice, Interaction and Collaboration. The five levels of ICT applications included: Data logging, Analysis and interpretation, Graph and models, Multimedia software for simulation and animation and Information seeking.

From the study it can be concluded that teachers were completely ignorant about the levels of ICT use and the levels in ICT application. Therefore by default teachers operated mostly at the lower levels of ICT use and application which is presentation and data logging respectively. This reduces their scope on how to apply ICT tools in their teaching. Teachers' capacity in terms of knowledge and technical skills in ICT should therefore be expanded to equip them to teach effectively and efficiently using ICT tools and materials.

The fourth research question centred on whether current education provisions are adequate to influence ICT integration in the selected schools. The observations made indicated that though there were some efforts, resources and ICT materials present in the schools and other supporting conditions were absent. ICT integration require a holistic approach. This requires that the different factors and structures needed in the various institution should be coordinated and geared toward the achievement of ICT

compliance. Sadly enough the coherent approach needed in the schools were not present thus hampering ICT integration into teaching and learning.

The fifth research question centered on how the problems hindering ICT integration into integrated science teaching and learning in the senior high schools can be solved. The opinions gathered from the teachers, students and science educationist indicated that the problems hindering ICT integration can be solved in the teaching and learning of integrated science when some of the following factors are addressed:

- Students should be allowed to bring mobile phones to school since it is convenient and easy to use.
- The management of the senior high schools should support and enforce ICT use in the teaching and learning of integrated science.
- The ICT integration efforts should not be politically based.
- The parents of students at the senior high schools should be made stakeholders in the ICT integration process.

5.2 Conclusions

The following conclusions are drawn based on the findings of this study.

- The state of ICT use in the teaching and learning process in the selected senior high school level within the research area is considerably low. This paints a gloomy picture which does not augur well for the current educational objective to harness the full potentials associated with the use of ICT resources for science education.
- Several factors serve as barriers in ICT use in teaching and learning in the senior high schools within the research area. But the major inhibiting challenges extend beyond the capacity of the teachers. Stakeholders of science education must pool their resources to reduce the challenges to the barest

minimum so as to complement the teachers' efforts in using ICT tools for teaching and learning.

- Teacher competence and knowledge in ICT influence the teacher's decision to use ICT in the teaching and learning process. The inadequate knowledge of the teacher in the area of ICT both in the software and hardware components do not promote the use of ICT in teaching and learning.
- Current educational provisions do not support ICT integration efforts in the senior high schools within the study area. One of such important provisions is the syllabus. The volume of the syllabus compared to teaching periods does not allow teachers to practice and use ICT tools for their instructions.

5.3 Recommendations

The following recommendations are made based on the findings of the study

1 Infrastructural deficiencies in the senior high schools within the research area should be addressed by the district directorate of education and the district assembly.

2 The training needs of integrated science teachers in ICT at the senior high schools within the research area should be addressed through school based in-service training.

3 Parents of students at the senior high schools within the study area should be encouraged to assist in the integration efforts through the PTA.

4 Future revision of the syllabus must include ICT models to enforce the use of ICT in integrated science teaching and learning.

5.4 Implications for Classroom Teaching

The application of ICTs in teaching and learning have the tendency to increase students participation, motivate students, increase their attention span, deepen their comprehension of lessons taught and reduce teachers work load during instructions. However, the current conditions in the classroom showed that the use of ICT tools in the teaching and learning of integrated science is not conducive to facilitate ICT integration. Therefore, in the 21st century in which educational systems around the world have revolutionalized with the use of technology the same cannot be said about the senior high schools in the research area. This implies that the traditional chalk and talk method in teaching is continuously used thus integrated science lessons are teacher centred instead of student centered and the enormous benefits associated to ICT use in education is not harnessed.

5.5 Suggestions for Further Studies

Based upon the findings of this study the following suggestions for further research are made

1. A study on the ICT training needs of integrated science teachers in the senior high schools should be undertaken.
2. A survey of the level of ICT integration between schools in the urban setting and schools within the rural settings should be undertaken.

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APPENDIX A

STUDENT QUESTIONNAIRE

This is a questionnaire designed to gather information about students' opinions on the use of ICT in the teaching and learning of integrated science at the senior high school level.

Your assistance in filling out this questionnaire is very much welcome. Be assured that your responses and identity would be kept secret.

Fill the following as applicable

Name of school ……..……..

Class ……

Course of Study ……

Nationality ……

Guidelines

This questionnaire is constructed into a set of 19 items. You are required to tick in the appropriate bracket to show your best response.

1. Sex of student

   Male [ ]

   Female [ ]

2. Age of student

   Below 15 years [ ]

   Between 16-18 years [ ]

   18 years and above [ ]

3. Indicate if you are computer literate.

   Yes [ ]

   No [ ]

4. My school has ICT facilities.

   Yes [ ]

   No [ ]

5. Students have access to ICT tools in my school.

   Yes [ ]

   No [ ]

6. ICT use in teaching improves ways of recording marks and reports.

   Strongly agree [ ]

   Agree [ ]

   Undecided [ ]

   Disagree [ ]

   Strongly disagree [ ]

7. My school has adequate computers and accessories for students to use.

   Strongly agree [ ]

   Agree [ ]

   Undecided [ ]

   Disagree [ ]

   Strongly disagree [ ]

8. Students do not have access to computers in carrying out their studies in my school.

   Strongly agree [ ]

   Agree [ ]

Undecided [ ]

Disagree [ ]

Strongly disagree [ ]

9. My school is fully equipped with ICT tools and resources.

   Strongly agree [ ]

   Agree [ ]

   Undecided [ ]

   Disagree [ ]

   Strongly disagree [ ]

10. Lack of electricity affects ICT use in teaching and learning.

    Strongly agree [ ]

    Agree [ ]

    Undecided [ ]

    Disagree [ ]

    Strongly disagree [ ]

11. I have access to internet services in my school.

    Strongly agree [ ]

    Agree [ ]

    Undecided [ ]

    Disagree [ ]

    Strongly disagree [ ]

12. Students do not have adequate assignments and work practices involving the use of computers.

    Strongly agree [ ]

    Agree [ ]

Undecided [ ]

Disagree [ ]

Strongly disagree [ ]

13. ICT use does not make learning more interactive and enjoyable.

Strongly agree [ ]

Agree [ ]

Undecided [ ]

Disagree [ ]

Strongly disagree [ ]

14. Lack of qualified and competent ICT personnel does not affect ICT use in my school.

Strongly agree [ ]

Agree [ ]

Undecided [ ]

Disagree [ ]

Strongly disagree [ ]

15. The use of ICT enhance collaboration among teachers and students within the school community.

Strongly agree [ ]

Agree [ ]

Undecided [ ]

Disagree [ ]

Strongly disagree [ ]

16. The Government inability to provide resources to aid ICT in my school affects its use in teaching and learning.

    Strongly agree [ ]

    Agree [ ]

    Undecided [ ]

    Disagree [ ]

    Strongly disagree [ ]

17. The use of ICT in my school does not promote student-centered learning.

    Strongly agree [ ]

    Agree [ ]

    Undecided [ ]

    Disagree [ ]

    Strongly disagree [ ]

18. High cost of investments and inadequate ICT infrastructure does not affect ICT use.

    Strongly agree [ ]

    Agree [ ]

    Undecided [ ]

    Disagree [ ]

    Strongly disagree [ ]

19. How can the problems hindering ICT integration into teaching and learning of integrated science in the senior high schools be solved. Please give at least three suggestions;

a) ……

……

……

b) ……

……

……

c) ……

……

……

APPENDIX B

TEACHER QUESTIONNAIRE

This questionnaire is designed to elicit responses and gather information on the status of ICT integration in the teaching and learning of integrated science at the senior high school level.

Your assistance in filling out this questionnaire is very much appreciated. Please be very much assured that your anonymity is guaranteed and every response and suggestions would be kept strictly confidential.

Demographic Details

Please fill and tick in a box as applicable

Name of school …….

Subject taught

Chemistry [ ]

Biology [ ]

Physics [ ]

Agricultural science [ ]

Integrated science [ ]

Others [ ] please write in the space shown. ……

Academic level

Diploma [ ]

Degree [ ]

Master's Degree [ ]

Doctorate degree [ ]

Guidelines

The questionnaire has 21 items. Please tick in the appropriate bracket to show your level of agreement or disagreement with the statements.

1. Sex

   Male [ ]

   Female [ ]

2. Age group

   Below 30 years [ ]

   Between 30- 35 years [ ]

   Between 36 – 40 years [ ]

   41 years and above [ ]

3. Years of teaching

   Below 5 years [ ]

   Between 5 – 10 years [ ]

   Between 11 – 15 years [ ]

   15 years and above [ ]

4. Our school has enough ICT materials available for both teachers and students to use.

   Yes [ ]

   No [ ]

5. Teachers have efficient and regular access to ICT facilities to help in their work.

   Yes [ ]

   No [ ]

6. The school is not structurally adapted and positioned to facilitate the integration of ICT into teaching and learning.

   Strongly agree [ ]

   Agree [ ]

   Undecided [ ]

   Disagree [ ]

   Strongly disagree [ ]

7. The school administration serves as a barrier for the integration of ICT in teaching and learning.

   Strongly agree [ ]

   Agree [ ]

   Undecided [ ]

   Disagree [ ]

   Strongly disagree [ ]

8. The use of ICT in my school stimulates creativity, increase motivation and collaboration for teaching and learning.

   Strongly agree [ ]

   Agree [ ]

   Undecided [ ]

   Disagree [ ]

   Strongly disagree [ ]

9. The teacher education process in Ghana does not adequately build and train teachers to include ICT into their lessons.

   Strongly agree [ ]

   Agree [ ]

Undecided [ ]

Disagree [ ]

Strongly disagree [ ]

10. Using ICT tools in teaching and learning impedes ways of accountability and reporting.

Strongly agree [ ]

Agree [ ]

Undecided [ ]

Disagree [ ]

Strongly disagree [ ]

11. ICT use in pedagogy develops the students' learning skills considered essential in the modern working environment.

Strongly agree [ ]

Agree [ ]

Undecided [ ]

Disagree [ ]

Strongly disagree [ ]

12. Adequate in-service training are organized by my school or the government for teachers to enhance their ICT application.

Strongly agree [ ]

Agree [ ]

Undecided [ ]

Disagree [ ]

Strongly disagree [ ]

13. The use of ICT in teaching does not reduce teachers work load.

    Strongly agree [ ]

    Agree [ ]

    Undecided [ ]

    Disagree [ ]

    Strongly disagree [ ]

14. Finance does not prevent the use of ICT in teaching and learning.

    Strongly agree [ ]

    Agree [ ]

    Undecided [ ]

    Disagree [ ]

    Strongly disagree [ ]

15. Educational materials can be prepared and distributed through the use of ICT resources.

    Strongly agree [ ]

    Agree [ ]

    Undecided [ ]

    Disagree [ ]

    Strongly disagree [ ]

16. There is adequate telecommunication infrastructure and internet service to support teaching and learning.

    Strongly agree [ ]

    Agree [ ]

    Undecided [ ]

Disagree [ ]

Strongly disagree [ ]

17. The current school curriculum and educational system is not information and communication technology- driven.

    Strongly agree [ ]

    Agree [ ]

    Undecided [ ]

    Disagree [ ]

    Strongly disagree [ ]

18. Considering the partial success of traditional teaching methods in the past, ICT inclusion in the teaching and learning process is not important.

    Strongly agree [ ]

    Agree [ ]

    Undecided [ ]

    Disagree [ ]

    Strongly disagree [ ]

19. The recent educational reforms in Ghana positively influenced the integration and use of ICT in teaching and learning integrated science.

    Strongly agree [ ]

    Agree [ ]

    Undecided [ ]

    Disagree [ ]

    Strongly disagree [ ]

20. Assignment and work practices given to students involve the use of computers.

    Strongly agree [ ]

    Agree [ ]

    Undecided [ ]

    Disagree [ ]

    Strongly disagree [ ]

21. How can the problems hindering ICT integration into teaching and learning of integrated science in the senior high schools be solved. Please give at least three suggestions;

    a) ……

    ……

    ……

    b) ……

    ……

    ……

    c) ……

    ……

    ……

APPENDIX C

INTERVIEW GUIDE

This interview was conducted as part of the research into ICT integration in the teaching and learning of integrated science in selected senior high schools for student and teacher research subjects and selected science educationists.

In your own opinion:

1. What is the state of ICT in the teaching and learning of integrated science in the senior high school?
2. What are the barriers to the integration of ICT application in the teaching and learning of integrate science in the senior high school?
3. How knowledgeable are the teachers and students about the integration of ICT into their lessons?
4. Are the current educational provisions in the schools adequate to enable integrated science teachers integrate ICT into their teaching?
5. How can the problems hindering ICT integration into integrated science teaching and learning in the senior high schools be solved?

OBSERVATION SCHEDULE

OBSERVATION **REMARKS**

INTEGRATING ICT INTO TEACHING	**PRESENT**	**ABSENT**
1. i. First observation		
ii. Second observation		
EDUCATIONAL PROVISIONS FOR ICT	**PRESENT**	**ABSENT**
2. Educational policy for ICT		
3. Air-conditioned ICT laboratory		
4. Wi-Fi and internet services		
5. Incentives for ICT use		
6. Science resource centre		
7. ICT software and hardware technician		
8. Alternative electricity power supply		