UNIVERSITY OF EDUCATION, WINNEBA

THE USE OF ICT AND ITS CHALLENGES IN THE TEACHING AND LEARNING OF INTEGRATED SCIENCE IN SELECTED SENIOR HIGH SCHOOLS IN TWO DISTRICTS IN THE CENTRAL REGION

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DECLARATION

Student's Declaration

I, JENNIFER ABIBA AWAL, declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my work and has not been admitted, either in part or whole, for another degree elsewhere

SIGNATURE:……

DATE:……

Supervisor's Declaration

I hereby declare that the preparation and presentation of this work were supervised in accordance with the guidelines for the supervision of thesis as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: DR. JAMES AWUNI AZURE

SIGNATURE:…….

DATE:…….

DEDICATION

I dedicate this thesis to God Almighty, The Monarch of the Universe for His love and guidance in the assembling and completion of this work. He has been faithful and I am entirely grateful to Him.

Also, I dedicate this work to my mothers in the Lord, Mrs. Elizabeth Yeboah-Quarshie and Mrs. Leticia Mfum-Mensah for encouraging me and supporting me in prayers and financially as well. I also dedicate this work to my Pastors; Pastor Evans Kingsley Acho and Pastor Francis Ampofo-Essel for the Word and guidance throughout my study.

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ABSTRACT

This study investigated into the extent to which ICT is used in teaching and learning and the challenges teachers face in the integration of ICTs in teaching and learning of Integrated Science. The descriptive survey was used for the study. The study took place in Mfantsiman Girls' Senior High School, Methodist Senior High School, Aggrey Memorial AME Zion Senior High School and Moree Snior High Technical School which are located in the Abura-Asebu-Kwamankese district and Mfantseman Municipality in the Central Region. All integrated science teachers and second year students were purposively selected for the study. The sample comprised of 42 Integrated Science teachers (25 males and 17 females) and 200 students (75 males and 125 females). Questionnaire items and observational schedule were the main instruments used to collect data for the study. The Statistical Package for Social Sciences was used for the analysis. Cronbach Alpha (α) reliability coefficient 0.77 was obtained for the questionnaire items and a Cohen's Kappa coefficient of 0.75 was obtained for the observational schedule. The study revealed that, even though Integrated Science teachers have embraced the integration of ICTs in their teaching, most of the ICT tools available in the schools for teaching were faulty. This inhibited teachers from integrating ICTs in their teaching process. The study also revealed that the time allocated for teaching was too short to integrate ICTs in their teaching. It was noted that most teachers lacked training opportunities and some basic ICT tools are not available for effective teaching and learning of Integrated Science. The study concluded that; even though, most of the teachers had access to some basic ICT tools for teaching they could not use them for their lesson delivery. The study recommended that the National Council for Curriculum and Assessment (NaCCA) of the Ghana Education Service in collaboration with the Ministry of Education should review the Integrated Science curriculum and revise the syllabus to explicitly state what ICT tools should be used and how it should be used in the teaching and learning process.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter deals with the background to the study, statement of the problem, purpose and objective of the study, research questions, significance of the study, delimitations and limitations of the study and organization of the study.

1.1 Background to the Study

Information and communication technology (ICT) plays an important role in people's daily lives all over the world. Information, communication, and technology (ICT) use is a visible symbol in today's world. The rapid development of ICT has resulted in changes in the twenty-first century, as well as influencing the expectations of modern society (Mensah, 2017).

As information and communication technologies (ICT) continue to transform economies, citizens must be highly skilled in their use of the technology. To address this problem, many countries have focused their efforts on incorporating ICT into their educational institutions (Buabeng-Andoh & Yidana, 2015). The rationale for this development is that information and communication technologies (ICT) have the potential to change the education industry (Kaur, 2011) cited in Buabeng-Andoh and Yidana (2015) through enhancing the quality of instruction and changing the teaching and learning processes (Reynolds et al., 2003). Van Reijswoud (2009) argued that the emergence, acceptance, and implementation of various information and communication technologies (ICTs) by society offer clear practical potential for improving teaching and learning quality. Gunton (1993) cited in Natia and Al-hassan (2015) defines ICT as electronic devices or technological equipment used to gather,

process, store, retrieve, and communicate data. ICT encompasses a wide range of computer hardware and software, as well as "network," "video," "audio," "television," "digital camera," and so on, which are all capable of turning information into digital forms for users (Gunton, 1993, cited in Natia & Al-hassan, 2015)

The Ghanaian government advocated for the use of ICT in education and improves educational achievements throughout the previous decade. The Education Strategic Plan (2003-2015; 2010- 2020) of the Ghana Education Service identified the need for ICT in education to help achieve the objectives of the Education Strategic Plan, which are carved into Access, Quality, Gender and Inclusiveness, and Education Management (Natia & Al-hassan, 2015).

Natia and Al-hassan (2015) further added that because of promoting ICT in education, in 2008, the Ministry of Education launched the ICT in Education Policy to meet the ICT needs in education. Adebi-Caesar (2012) asserted that ICT could accelerate the development of higher cognitive skills, deepen learning, and contribute to the acquisition of skills needed for lifelong learning and working in today's labour market if used effectively.

ICT integration in education typically refers to a technologically based teaching and learning process that has a tight relationship to the use of educational tools in classrooms. The way people think, work, and live has completely changed as a result of the innovations and transformation of our society brought about by technology integration today (Grabe, 2007) referenced by (Ghavifekr & Rosdy, 2015). This calls on schools and other educational institutions to think about integrating ICT into their curricula in order to prepare students for life in "a knowledge society" (Ghavifekr,

Afshari & Amla Salleh, 2012) cited in Simin et al (2016).

ICT integration in schools, specifically in the classroom, is crucial since pupils are accustomed to technology and would study better in a technology-based setting. This is due to the fact that technology in education makes a significant contribution to the pedagogical aspects, where the usage of ICT will result in effective learning with the aid and support of ICT elements and components (Jamieson-Procter et al., 2013), quoted by Ghavifekr and Rosdy (2015).

ICT tools, such as interactive simulations and virtual laboratories, provide students with opportunities to visualize complex scientific phenomena. These visual aids help students grasp abstract concepts and improve their understanding of scientific principles (Hosseini et al., 2017). ICT allows teachers to incorporate interactive simulations and virtual experiments into their teaching. These simulations enable students to manipulate variables and observe real-time changes, helping them develop a deeper understanding of scientific phenomena (Smetana & Bell, 2012). Digital technologies enable the creation of three-dimensional (3D) models and animations that visualize complex structures and processes in science. These visual aids can be used to explain intricate biological systems, chemical reactions, or physical phenomena (Dalgarno & Lee, 2010).

The integration of Information and Communication Technology (ICT) into science education can be immensely beneficial, but it also comes with several challenges. These problems are regarded as difficulties (Schoepp, 2005), quoted in Simin et al (2016). These obstacles include: an uneven distribution of computers among students; a lack of maintenance; a teacher's lack of computer expertise; a lack of time; a teacher's lack of interest or knowledge; limited network connectivity; limited

accessibility; a lack of technical support; the teacher's age; the teacher's resistance to change; the teacher's lack of personal access during preparation; and ineffective training (Jenson et al (2002) cited in Adebi-Caesar (2012); Simin et al(2016); Snoeyink and Ertmer (2002) and Jones (2004) cited in Agyei and Voogt (2011).

Regardless of the many initiatives and policies implemented by the Ghanaian government, there are a number of variables that can work against the integration of ICT resources into teaching and learning in senior high schools. (Barfi et al., 2020). Studies show that teachers are unprepared to incorporate ICT into their teaching (Sang et al., 2010). Many research studies have stressed a number of elements to explain why teachers are unprepared to use technology in their schools, encompassing lack of ICT skills, insufficient computer access, and scanty time (Adebe-Caesar, 2012; Barfi, Amenu, & Arkorful, 2020; Natia & Al-hassan, 2015). The available research studies were conducted in few Ghanaian senior high schools giving more gaps to be filled as far as this study is concerned.

1.2 Statement of the Problem

The use of ICT in the classroom is very important for providing opportunities for students to learn in an information age. The Ghanaian government established the ICT for Accelerated Development (ICT4AD) Policy (2003), which established the plans and strategies for using ICTs to achieve the national aim of "transforming Ghana into an information and knowledge-driven ICT literate nation." (Government of Ghana 2008, p.10). Promoting ICT in education is the second cardinal pillar of the ICT4AD policy, which emphasizes "the deployment and use of ICTs in education" (Natia & Al-hassan, 2015). As a result, in 2012, the Ministry of Education, in collaboration with rLG, a Ghanaian ICT business organisation, launched the "teacher

laptop and ICT project," in which teachers were taught ICT and given computers to help with research, teaching, and learning in a number of subject areas.

In Ghana, some schools are better resourced in ICT infrastructure than others. Computers are found in some of Ghana's better-equipped educational institutions, including basic schools and senior high schools in urban areas across the country. Meanwhile, those in the more equipped schools will be taking the same final exam as their counterparts in less equipped schools.

More importantly, these electronic devices are rarely used in the classroom (Adebi-Caesar, 2012). Even when electronic devices are available, teachers may not have the necessary skills to use them effectively. Research has shown that many teachers feel unprepared to integrate technology into their teaching due to a lack of proper training (Hennessy, Harrison, & Wamakote, 2010). Also, some teachers are concerned about managing classrooms where students have access to electronic devices. Issues such as distraction, misuse of devices, and maintaining student engagement can deter teachers from incorporating technology into their lessons (Spires et al., 2008).

Hawkins (2002) posited that while many educational ministries in countries including Ghana, have pledged to computerize schools, only a handful have established comprehensive programmes to completely integrate technology as a pedagogical tool in the classroom.

From the researcher’s preliminary investigation from various schools in Abura-Asebu-Kwamankese district and Mfantseman municipality, it was noted that ICT is not integrated in the teaching and learning of integrated science in many schools in the two districts in the Central Region. ICT tools are insufficient in most of the

schools in these said districts. The available ones are also not used by teachers in their pedagogy. It is also recognised that students in some of these schools have no experience with ICT integration in teaching and learning processes. This can cause a hindrance to the policies enacted by the Ghanaian educational ministry to build students full of the twenty-first century skills.

According to UNESCO (2017), without ICT integration, students are restricted to traditional textbooks and resources, limiting their exposure to dynamic and interactive learning materials. Tondeur et al. (2017) also highlighted that without ICT, students may experience decreased interest and engagement in integrated science topics. ICT offers various teaching strategies such as flipped classrooms, blended learning, and inquiry-based learning. Without ICT, teachers may rely on traditional, lecture-based approaches, which might not effectively engage students or promote deep understanding (Ertmer, 2005).

This raises concerns and the need for additional investigation through study, particularly now that ICT has been designated as a core topic in senior high schools (SHS). (Ministry of Education, 2015) cited in Barfi et al, (2020). It is on this backdrop that, the researcher seeks to investigate the extent of the use of ICT and its challenges in the teaching and learning of Integrated Science in selected Senior High Schools (SHSs) in two districts in the Central Region.

1.3 Purpose of the Study

The purpose of this study was to investigate the extent of use of ICT and its challenges in the teaching of integrated science in selected Senior High Schools in two districts in the Central Region of Ghana.

1.4 Objectives of the Study

The objectives of the study were to:

1. Determine the extent to which teachers use ICT in teaching and learning of integrated science.
2. Assess the availability of ICTs tools or equipment in the selected schools.
3. Examine the challenges integrated science teachers face in the use of ICT in their teaching and learning of integrated science in selected SHSs in the Central Region.

1.5 Research Questions

The study answered the following questions:

1 To what extent do teachers use ICT in teaching Integrated Science?

2 What ICT tools are available to Integrated Science teachers in the selected schools?

3 What challenges do Integrated Science teachers and their students face in their teaching and learning with ICTs?

1.6 Significance of the Study

The study was significant for the following reasons. The participants of the study would understand the need of ICT integration into Integrated Science Education. The study would provide a contribution to existing research in relation to the obstacles preventing ICT integration in the teaching and learning process. Also, the results of this study would be of significance to other teachers, since many of them might be experiencing the same difficulties, as those encountered by the respondents to the research questions. The findings of the study would help to raise awareness among the Directors of Education, Headmasters and teachers in the two districts about the

barriers to ICT integration that exist in most Senior High Schools. This study would help provide a thorough understanding of barriers, which would inform educators, in deciding how to address them, with the hope that they could be minimized if not eliminated from the teaching and learning process.

1.7 Delimitations of the Study

This study considered only selected Senior High Schools in the Central Region. In addition, only a section of the members of these selected schools participated in the study. The study also looked at only ICT out of various multimedia forms of instruction.

1.8 Limitations of the Study

Due to time constraint, the researcher was unable to carry out enough observations. Another limiting factor was finances. False responses from participants of the study may affect the outcome of the study.

1.9 Organisation of the Study

The study is in five chapters. Chapter one provided information on the general overview of the study with introduction, Chapter two reviewed literature on the challenges of ICT integration into Integrated Science teaching and learning. Chapter three described how the research was conducted. Chapter four described the findings and results. Chapter five discussed the summary, conclusions and recommendations.

1.10 Abbreviations and Acronyms

ICT: Information and Communication Technology

ICTs: Information and Communication Technologies

IT: Information Technology

SHS: Senior High School

SHSs: Senior High Schools

SPSS: Statistical Package for Social Sciences

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Overview

This chapter reviews related literature on the theoretical framework of the study, the conceptual framework of the study, education in Ghana, science education in Ghana, integration of ICT into science education, role of ICT in science education, benefits of ICT in science education and Challenges of ICT integration into science education.

2.1 Theoretical Framework

This study is backed by the cognitive development theory of Jean Piaget and the social constructivism theory of Lev Vygotsky. According to Piaget (1954), cited in Entsie (2015), the cognitive development of children toward formal thought could be facilitated through three cognitive processes: assimilation, accommodation and reorganization or equilibration. According to Piaget (1954) cited in Entsie (2015), children assimilate when they perceive new objects and events according to their existing schemata, mental models or cognitive structures. Entsie (2015) pointed out that the mental models of children, formed by their prior knowledge and experience, therefore, control how they incorporate new experiences and new information into their minds.

This may occur when the new experiences of children are aligned with their existing schemata (mental models or internal presentations of the world) or as a result of their failure to change a faulty understanding (Piaget, 1954) cited in Entsie (2015). Sometimes when children's experiences contradict their existing knowledge, internal representations, or schemata, they may change their perceptions of the experiences to fit their internal representations (Entsie, 2015).

However, accommodation results when children reframe or modify their existing schemata or mental representations of the external world to suit their novel experiences for learning to occur (Piaget, 1954) cited in Entsie (2015). Hence, as children workout their existing mental structures, in particular environmental conditions, accommodation-motivating disequilibrium results and the children construct new mental structures to resolve the disequilibrium (Piaget, 1954) cited in Entsie (2015). The state of disequilibrium and contradiction arising between the existing schemata and the more sophisticated mode of thought adopted by the new experience therefore, have to be fixed through equilibrium process (Entsie, 2015).

Entsie (2015) explained that equilibration maintains the balance between always taking in new knowledge, and always assimilating with previously acquired knowledge. Knowledge is therefore, not a mirror of the world but is created or" constructed" from the individual's continuous revision and reorganization of cognitive structures in conjunction with experience (Piaget, 1954) cited in Entsie (2015). So, in the view of Piaget, students are enthusiastically involved in the building of their own knowledge. It is therefore, contended that knowledge is constructed through action and that children must continually reconstruct their own understanding of phenomena through active reflection on objects and events till they finally achieve an adult's perspective (Entsie, 2015). Piaget (1952) cited in Entsie (2015) therefore theorised that the process of intellectual and cognitive development is similar to a biological act, which is adaptation to environmental demands.

Vygotsky (1978) cited in Entsie (2015) states that social learning precedes development. To Vygotsky (1978) cited in Entsie (2015), every function of the child's cultural development appears twice: first on the social level, and later, on the

individuals' level; first between people (interpsychological) and then inside the child (intrapsychological). According to Vygotsky (1978) cited in Entsie (2015), children are proficient of performing at higher intellectual levels when instructed to work in collaboratively better than when asked to work individually.

Vygotsky (1978) cited in Entsie (2015) also believed that less skillful children are able to develop a more complex level of understanding and skill through collaboration, direction or help of an expert or a more capable peer than they could do so independently. Social interaction extends a child's zone of proximal development, which is the difference between a child's understanding and his or her potential to grasp more difficult concepts.

According to Vygotsky, learning occurs in zones (Entsie, 2015). Thus, with Vygotsky, children have the capacity to construct their own knowledge through collaboration, direction or help from an expert or a more capable peer; that is, children are socially engaged in constructing their own knowledge (Entsie, 2015). This is what is termed as "social constructivism". Social constructivism not only acknowledges the exceptionality and complexity of the learner, but also actually inspires, utilizes and rewards the learner as an essential part of the learning process (Wertsch, 1997) cited in Entsie (2015).

Occasionally, when a child's experience contradicts his or her existing knowledge, internal representations, or schemata, they may change his or her perception of the experience to fit his or her internal representations.

According to Entsie (2015), integration of ICT in the teaching and learning processes can be considered a variant of cognitive tool. That is, it permits students to test

hypotheses and more generally “what- if” scenarios and enable learners to ground cognitive understanding of their actions in a situation. According to Milligan and Thomas (2004) referenced by Entsie (2015), ICT integration in this respect is well-matched with the constructivists’ view of education. Light and Mevarech (1992) referenced by Entsie (2015) have informed that, since the early 1980s, there has been a rising interest in the capabilities of ICT integration in teaching serving as a facilitator for students learning process. In the view of Newberry (1999) cited in Entsie (2015), the role of ICT integration in teaching and learning increases a wide range of school outcomes, including academic achievements, cognitive processes, meta-cognitive skills, motivation toward learning, self-esteem and social development. These appear to show that ICT integration in teaching and learning has a positive influence on students’ achievements (Entsie, 2015).

2.2 Education in Ghana

Education is a critical component of human development and economic growth. In Ghana, like many other developing countries, education has undergone significant changes and reforms over the years to improve access, quality, and relevance. Education is a fundamental driver of economic and social development in Ghana, as in many other countries.

Ghana has made significant progress in expanding access to education over the years. Ghana, a West African country with a rich cultural heritage and history, has made significant strides in its education system since gaining independence in 1957. Education is a fundamental part of the country's development agenda, and substantial efforts have been made to improve access, quality, and inclusivity in the Ghanaian educational system (Adei, 2007). Understanding the historical context of education in

Ghana is crucial to appreciate its evolution. Education in Ghana has undergone significant changes over the years (Adu-Gyamfi & Aheto, 2017). Ghana has a rich educational history, dating back to pre-colonial times when traditional education systems played a crucial role in transmitting knowledge and skills. The colonial period introduced Western-style education, and post-independence Ghana has made efforts to blend both systems (Amankwah, 2017). Historically, Ghana inherited an education system from its colonial past, with British influence. According to Adu-Gyamfi and Aheto (2017), British colonial education in Ghana was primarily designed to produce clerks and interpreters, with little focus on African culture and indigenous knowledge. During the colonial era, the British introduced an education system that primarily served their interests, which led to disparities in access and quality.

After gaining independence in 1957, Ghana placed a strong emphasis on education as a means of achieving national development. The government implemented various policies to expand access to education, including free basic education and the establishment of universities (Adu-Gyamfi, 2012). Ghana, after independence, embarked on a journey of educational reform to address these issues (Asante, 2015).

According to UNESCO (2020), Ghana has made progress in increasing access to education, particularly at the primary level. The Ghanaian government has implemented various education policies and reforms over the years. These policies have aimed at addressing issues related to access, quality, and inclusivity (Adu-Gyamfi, 2018). Improving access to education has been a primary goal in Ghana. (Akyeampong et al., 2013). The introduction of the Free Compulsory Universal Basic Education (FCUBE) policy in 1996 marked a significant step towards increasing

access to basic education in Ghana (Ntow, 2009).

Research in Ghana has shown that education plays a vital role in socio-economic development, leading to improved livelihoods, health outcomes, and reduced poverty levels (Ackom, 2016).

Basic education, secondary or high school education, and higher education are the three divisions of the Ghanaian educational system. The typical academic year runs for 45 weeks in junior high school and 40 weeks in primary and senior high schools. Lessons are taught primarily in English (NUFFIC, 2013) cited in (Wikipedia, 2022). According to GES (2014), the educational system is currently split into six years of elementary school and three years of junior high education (referred to collectively as basic education), three years of senior secondary or high education, and traditional four-year university programmes (GES, 2014).

Ages 4 to 15 years; basic education lasts 12 years (GES, 2014). According to NUFFIC (2013) cited in (Wikipedia, 2022), the Ghanaian curriculum is divided into kindergarten, primary school, and junior high school (JHS). JHS lasts three years and concludes with the Basic Education Certificate Examination (BECE), which covers social studies, integrated science, mathematics, design and technology, ICT, French (optional), and religious and moral education (GES, 2014). If they pass the BECE, students have the choice of continuing their education in secondary school and pursuing academic or vocational programs. Student enters senior high school for academic instruction.

The SHS curriculum consists of four core subjects that must be taken and four electives to round out the schedule. English language, mathematics, integrated

science, and social studies make up the core disciplines. The students then select three or four elective studies from among five programs; technical, business, agricultural, arts or science, and business programmes (WAEC, 2012). Three years are spent on these programmes of study. The West African Senior School Certificate Examination (WASSCE), originally known as the Senior Secondary School Certificate (SSSCE) before 2007, is the last test for the SHS (WAEC, 2012).

If a student wants to pursue technical and vocational education (TVET), they have two options: either enroll in secondary school and take elective courses in the field, or take a course in a technical and vocational institute (TVI) (UNESCO-UNEVOC, 2012). Technical and vocational education and training (TVET) have gained importance in Ghana's education system. Efforts to promote TVET aim to address youth unemployment and equip students with practical skills for the job market (Amuzu, 2018). SHS students typically complete a three-year SHS curriculum, while TVI students typically complete a four-year curriculum divided into two cycles of two years that leads to awards from City & Guilds, the Royal Society of Arts, or the West African Examinations Council (COTVET, 2011). Students who want to continue their education can enroll in universities, polytechnics, or training institutes after completing secondary or high school and passing their examinations.

2.3 Science Education in Ghana

Science education plays a crucial role in the development of any nation, and Ghana is no exception. A well-structured and effective science education system is essential for producing a workforce capable of addressing contemporary global challenges. In Ghana, science education has evolved over the years, influenced by various policies, reforms, and educational initiatives. Ghana has a long history of science education

dating back to its colonial period. Early science education efforts were influenced by British educational models. Key milestones include the establishment of the University of Ghana in 1948 and the Kwame Nkrumah University of Science and Technology (KNUST) in 1952, which played crucial roles in shaping science education in the country (Adei, 2007).

Science education involves the training and control of the mind (Sakyi-Hagan & Hanson, 2020). People utilise science to enhance their lives and to adapt to a world that is becoming increasingly technological. This includes pursuing academic and professional programs in science and related sectors (Akpan, 1992) cited in Sakyi-Hagan and Hanson (2020).

Science education in Ghana has evolved significantly over the years. Historically, Ghana's educational system has been influenced by various colonial powers, including the British, who introduced a Western-style education system. This system often prioritized the teaching of European knowledge and values over indigenous knowledge systems (Gyimah-Brempong, 2011). According to Ifamuyiwa and Alebiosu (2008) cited in Sakyi-Hagan and Hanson (2020), science education is crucial for both the growth of a country's scientific and technological capabilities as well as the lives of its citizens. According to Sakyi-Hagan and Hanson (2020), Ifamuyiwa and Alebiosu go on to say that scientific literacy, which can only be acquired through science education, is the key to a nation's existence in terms of science and technology.

According to Sakyi-Hagan and Hanson (2020), Ghana is among the many countries that have developed numerous strategies to pique the interest of their young people in the study of science. These countries have recognized the importance of scientific

education. Ghana's vision of the national Science Technology and Innovation Policy (May 2017) is to support national socio- economic development goals to raise Ghana to a middle income status by the year 2030 through the perpetuation of a science and technology culture at all levels of society, which is motivated by the promotion of innovation and mastery of known and proven tech, according to the Ministry of Environment Science and Technology Innovation (MESTI, 2017) cited in Sakyi-Hagan and Hanson (2020).

One significant development in Ghana's science education was the introduction of the new curriculum known as the "Standard-Based Curriculum" (SBC) in 2019. The SBC aimed to provide a more holistic and practical approach to teaching and learning, including science education (Ministry of Education, Ghana, 2019). The curriculum emphasized the integration of STEM (Science, Technology, Engineering, and Mathematics) subjects and focused on developing critical thinking and problem-solving skills.

Science education in Ghana has undergone significant developments and reforms over the years to improve the quality of education and produce a scientifically literate population. The essence of science education has promoted various initiatives to be launched to improve the training of science teachers, such as the Transforming Teacher Education and Learning (T-TEL) project (T-TEL, 2019), the government's Free SHS program which aims to increase access to secondary education, including science programs (Ghana Ministry of Education, 2017) and STEM (Science, Technology, Engineering, and Mathematics) education have gained prominence in Ghana, with efforts to promote STEM subjects and careers (Anamuah-Mensah, 2015).

In primary and secondary education, Ghana has implemented various policy changes

and initiatives to improve science education. The country has been working on curricular reforms to align science education with global standards. The introduction of the Ghana Education Service (GES) syllabus and textbooks, often supported by international partners, aimed to provide students with a well-rounded science education. One notable program in Ghana's primary and secondary education system is the "Basic Science, Technology, and Mathematics Education" (BSTEM) program. The BSTEM program was designed to enhance the teaching and learning of science, technology, and mathematics subjects. It focuses on teacher training, curriculum development, and the provision of learning materials. Access to science education in Ghana has improved over the years, with government initiatives aimed at increasing enrolment and retention in science-related programs. The introduction of the Free Senior High School (SHS) policy in 2017, for example, has led to increased enrolment in science courses at the secondary level (Addey & Tetteh, 2019).

Ghana has also taken steps to improve science education at the tertiary level. Several universities and institutions in Ghana offer degree programs in science-related fields, including physics, chemistry, biology, and engineering. These institutions have made efforts to enhance the quality of their science programs and research capabilities. Collaboration with international partners and the establishment of research centres have played a significant role in this development. The Ghanaian government has periodically revised the national curriculum to improve science education. The curriculum aims to provide students with a strong foundation in science subjects such as physics, chemistry, and biology (Asabere-Ameyaw et al., 2014).

The importance of Science to the Ghanaian Government and Ghana Education Service made science a compulsory subject to be taken by every Ghanaian right from

Basic Schools to Secondary or High School. Teacher training and professional development have been areas of focus for improving science education in Ghana. Various programs and initiatives, such as in-service training and workshops, have aimed to equip teachers with the necessary skills and knowledge to deliver effective science instruction (Asabere-Ameyaw, et al., 2016). The Ghana Education Strategic Plan (2010-2020) aimed to improve the quality of science education in Ghana by focusing on teacher training, infrastructure development, and curriculum enhancement (Republic of Ghana, 2010).

Science is studied as Natural Science by the pre-schools and Integrated Science by the Junior and Senior Secondary/High Schools. According to Obeng, et al., (2008), Integrated Science is a field of study, which involves the teaching and learning of some of the various fields of science in a holistic manner; such that none of the fields stand alone. Integrated Science combines major areas in biology, chemistry, physics and agricultural Science in unison. The concept of an interdisciplinary approach in Ghanaian education, especially in the context of Integrated Science, has been emphasized in various educational policy documents. The integration of biology, chemistry, physics, and agricultural science into a single subject aims to provide students with a holistic view of science (GES, 2007). Topics in the various fields are carefully selected such that they are interrelated; thus, depending on each other to explain every single concept. Therefore, in the Integrated Science discipline, the various areas have been collectively grouped into five themes or sections (Ministry of Education, 2010). The Integrated Science curriculum has gone through multiple revisions over the years to align with the changing needs of the country and to incorporate advances in scientific knowledge (GES, 2012). The concepts in each theme are related and in general, the themes and sections are also closely related.

These five themes include:

- Diversity of matter
- Cycles
- Systems
- Energy and
- Interactions of matter

2.4 Meaning of Integration of ICT into Science Education

Integrating Information and Communication Technology (ICT) into education in Ghana refers to the incorporation of digital tools, resources, and technologies into the teaching and learning processes within the Ghanaian educational system. According to Dawson (2008), cited in Natia and Al-Hassan (2015), the emergence of information and communication technologies has sparked a revolutionary shift in how information and knowledge are disseminated throughout the world. ICT has made inroads into several areas, including education, where it is improving the effectiveness of teaching, learning, and research (Natia & Al-Hassan, 2015).

The use of computer-based communication that is integrated into the regular educational process in the classroom is referred to as information, communication, and technology (ICT) integration in education. ICT integration in education typically refers to a technologically based teaching and learning process that has a tight relationship to the use of educational tools in classrooms. The way people think, work, and live has completely changed as a result of the innovations and transformation of our society brought about by technology integration today (Grabe, 2007) referenced by (Ghavifekr & Rosdy, 2015). This calls on schools and other educational institutions to think about integrating ICT into their curricula in order to

prepare students for life in "a knowledge society" (Ghavifekr et al., 2012) cited in Simin *et al* (2016). According to Pelgrum and Law (2003), the 1980s saw the emergence of ICT integration, and educational systems realized they needed to equip students to cope with and survive in this new technologically advanced society. In an information society, this meant training pupils for "lifelong learning." Along with this, early proponents of ICT integration in education regarded it as a catalyst for change, encouraging the development of student-centered learning and problem-solving abilities (McGrail 2005, p.6) cited in Adebi- Caesar (2012).

Teachers are viewed as the essential players in implementing ICT in their regular classroom settings and training pupils for the contemporary digital environment. This is a result of ICT's ability to provide an active and dynamic teaching-learning environment, as noted by Arnseth and Hatlevik (2012) cited in Ghavifekr and Rosdy (2015). The topic of ICT integration in schools, specifically in the classroom, is crucial since pupils are accustomed to technology and would study better in a technology-based setting. This is because technology in education makes a significant contribution to the pedagogical aspects, where the usage of ICT will result in effective learning with the aid and support of ICT elements and components (Jamieson-Procter et al., 2013), quoted by Ghavifekr and Rosdy (2015).

There are three rationales for integrating ICT into education, according to Kozma, (2005). The first is the economic rationale, which refers to the part it can play in educating students for future employment and in fostering economic progress. The second is the social rationale, where ICT investment attempts to: boost information exchange, encourage cultural creation, increase civic involvement, make government services more accessible, and finally enhance social cohesion. ICT's potential to

advance educational reform and enhance school management systems is the third and last rationale. Hawkridge (1990) cited in Adebi-Caesar (2012) put up four justifications for using computers in schools. He describes these as social, professional, educational, and catalytic. The social and professional justifications suggest that ICT will be used more frequently across all areas of human endeavour. The pedagogical and catalytical justifications pertain to how technology affects students and educational institutions.

While the goal of ICT integration is to enhance and raise the quality, accessibility, and cost-efficiency of how education is delivered to students, it also pertains to the advantages of networking learning communities to meet the difficulties of present globalization (Albirini, 2006,p.6) referenced in (Adebi-Caesar, 2012). The adoption of ICT is a multi-step process that fully supports teaching, learning, and information resources (Young, 2003), which was noted in (Adebi- Caesar, 2012).

2.5 Role of ICT in Teaching and Learning of Integrated Science

Information and Communication Technology (ICT) has played a significant role in transforming education globally, including Ghana. Ghana has made notable efforts to improve ICT infrastructure in the education sector. Initiatives such as the Ghana Investment Fund for Electronic Communications (GIFEC) have aimed to provide internet connectivity to schools in rural areas (GIFEC, 2017). These efforts have helped bridge the digital divide, providing students and teachers with access to digital resources. ICT tools and resources have contributed to the enhancement of the quality of education in Ghana. Digital textbooks, online learning platforms, and educational software have expanded learning opportunities.

The use of ICT in teaching and learning positively impacted students' performance in

science subjects in Ghanaian schools. ICT provides students and teachers with access to a vast array of educational resources, including online textbooks, multimedia content, and educational websites. This access to a wide range of materials can enrich the learning experience and provide opportunities for self-directed learning (UNESCO, 2013).

According to Krotov (2017), ICT, particularly the internet, is a powerful tool for accessing a vast amount of information. People can use search engines and websites to find information on virtually any topic. Internet access has become increasingly prevalent worldwide, connecting people to global knowledge sources. Digital libraries and online databases offer a wealth of resources, including e-books, academic papers, and research articles. These digital repositories provide easy and convenient access to scholarly information (Moen, 2019).

According to Kaplan and Haenlein (2010), social media platforms provide real-time access to news, updates, and information shared by individuals and organizations. Users can follow accounts and subscribe to pages of interest to receive information directly. Many governments have established online portals and websites to provide citizens with information on public services, policies, and regulations. These portals enhance transparency and access to government information (United Nations, 2018). ICT has facilitated the growth of open-access journals, which make research articles and publications freely available to the public. This democratizes access to scholarly information (Suber, 2012).

ICT tools and platforms can support personalized learning experiences. Adaptive learning software and intelligent tutoring systems can assess individual student's strengths and weaknesses, tailoring lessons to meet their specific needs (Means et al.,

2013). ICT facilitates collaboration among students and educators. Online discussion forums, video conferencing, and collaborative document editing tools enable students to work together on projects and share ideas, fostering a sense of community and enhancing learning outcomes (Garrison & Anderson, 2003).

ICT can make learning more interactive and engaging. Educational games, simulations, and virtual reality experiences can make complex concepts more accessible and enjoyable for students (Steinkuehler & Duncan, 2008). ICT can also improve the quality of teaching through professional development opportunities for educators. Online courses and webinars allow teachers to update their skills and stay current with educational trends (Davis et al., 2013).

ICT systems can collect and analyze data on student performance, enabling educators to make data-driven decisions about curriculum and instructional strategies. This can lead to continuous improvement in teaching and learning (Baker et al., 2010). Online and blended learning options provided through ICT can increase the flexibility and accessibility of education. This is especially important for learners who face geographical barriers or have other commitments (Allen & Seaman, 2017). ICT can support lifelong learning by making education more accessible to adults and individuals who wish to acquire new skills throughout their lives. Online courses and open educational resources (OER) play a crucial role in this regard (European Commission, 2013).

ICT has significantly improved access to educational resources in Ghana. The introduction of computer labs and internet connectivity in schools and universities has expanded the reach of educational content to rural and underserved areas (Dzandu, 2017).

ICT has played a crucial role in enhancing the skills and capacities of teachers in Ghana. Training programs and workshops on ICT integration have been conducted to equip educators with the necessary skills to effectively use technology in the classroom (Boateng et al., 2018). Numerous ICT training programs and workshops have been organized for teachers in Ghana. These programs aim to equip educators with the necessary skills to integrate technology into their teaching methods effectively (Adu-Gyamfi, 2019). Asamoah (2019), also added that ICT has provided teachers in Ghana with opportunities for professional development. Online courses, webinars, and digital resources enable educators to stay updated with the latest teaching techniques and educational trends.

Teachers have access to a plethora of digital teaching resources such as e-books, educational apps, and interactive multimedia content. These resources enhance the quality of instruction and engage students in innovative ways (Kwamena, 2018). Awuah (2018) posited that teachers use ICT tools for lesson planning and assessment. Software and online platforms help educators design lessons, create assessments, and track students' progress more efficiently. ICT facilitates communication and collaboration among teachers. Online platforms and social media groups allow educators to share ideas, resources, and best practices, fostering a sense of community and support (Bawuah et al., 2017). ICT empowers teachers by giving them access to information that can enhance their teaching methods and classroom management. It also provides opportunities for self-directed learning and skill development (Bingab, 2018).

Research suggests that the integration of ICT in education has had a positive impact on learning outcomes in Ghana. Interactive multimedia content and digital tools have

made learning more engaging and effective (Kwabla, 2016). ICT tools, such as educational software and multimedia content, can make learning more interactive and engaging for students. Interactive simulations and digital games, for instance, can help students grasp complex concepts more effectively (Gyamfi et al., 2017). Through the internet, students in Ghana can access a vast amount of educational resources, including e-books, research articles, and online courses. This access to diverse materials enhances their understanding and knowledge base (Kwamena, 2018).

According to Bingab (2018), ICT provides teachers with tools and resources to better support their students. Online platforms for communication and collaboration with colleagues and students can lead to more effective teaching strategies. ICT can streamline the assessment process by enabling automated grading and immediate feedback. This timely feedback allows students to identify areas where they need improvement and take corrective actions (Awuah, 2018). The use of ICT in education equips students with digital literacy skills, which are crucial in today's technology-driven world. These skills, along with critical thinking and problem-solving abilities, contribute to improved learning outcomes (Adu-Gyamfi, 2019).

Liyanagunawardena et al. (2018) explained that ICT enables access to educational content through e-learning platforms. These platforms host courses, lectures, and educational materials, making learning resources available to students globally. Various e-learning platforms and software have been adopted by educational institutions in Ghana. These platforms facilitate online learning, providing students with access to a wide range of educational materials, including videos, lectures, and quizzes (Larweh, 2018). ICT is instrumental in developing Learning Management Systems, which serve as the backbone of e-learning platforms. LMS software allows

institutions to manage and deliver online courses, track student progress, and provide access to learning materials (Kumar & Kumar, 2016). ICT tools are used to create and digitize educational content, such as videos, interactive modules, and assessments. These tools enable instructors to develop engaging and multimedia-rich e-learning materials (Huang & Looi, 2017).

According to Wang (2017), ICT enables the creation of web-based e-learning platforms that can be accessed through internet browsers. These platforms offer a wide range of features, including discussion forums, live chats, and multimedia content. Mobile ICT technologies, including smartphones and tablets, are used to develop e-learning apps. These apps provide learners with the flexibility to access educational content anytime, anywhere (Kapasia et al., 2019). ICT is used to create virtual learning environments that mimic traditional classrooms. VLEs can include features like video conferencing, discussion boards, and collaborative tools (Chiang et al., 2019).

Many e-learning platforms leverage cloud computing technology, allowing for scalable and cost-effective hosting of educational content. This ensures easy access for learners without the need for large infrastructure investments (Kahindo et al., 2018). ICT communities often contribute to the development of open-source e-learning platforms, making it easier for organizations and educators to create and customize their own platforms (Downes, 2016).

The opportunity to learn how to function in the information age is made possible in large part by the use of ICT in the classroom. (Bingimlas, 2009) cited in Bayuo et al., (2018). Students are given information and assistance with learning tasks using ICT. ICT affects students' knowledge, motivation, and skills. Grabe & Grabe (2007) cited

in Bayuo et al., (2018). Gholami et al. (2010), cited in Natia and Al-hassan (2015), make the case that investments in ICTs not only promote economic growth and poverty reduction but also improve students' academic performance when using computers for teaching and learning. Gillespie (2006), referenced by Bayuo et al., (2018), asserts that new technologies can be employed in science education to gather scientific data, engage with resources like photos and videos, and promote communication and teamwork. Wong *et al.* (2006), referenced in Bayuo, Samari and Abukari (2018), make the observation that technology might support in-person teaching and learning in the classroom.

According to 2007 research by the International Institute for Communication and Development, the use of ICT directly and favorably influences 60% of teaching and learning, leading to improved school performance. Many governments in both rich and developing nations have started investing in ICT because they understand how important it is for teaching and learning (Buabeng-Andoh 2012), which was cited in Natia and Al-hassan (2015). Many researchers and theorists assert that the use of ICT can help students to become knowledgeable, reduce the amount of direct instructions given to them, and give teachers an opportunity to help those with learning needs (Iding et al, 2002; Shamatha et al., 2004; Romeo, 2006) cited in Bayuo et al., (2018).

2.6 Benefits of ICT in Science Education

Information and Communication Technology (ICT) has become increasingly integrated into science education, offering a wide range of benefits that enhance the teaching and learning of science subjects. ICT in education has the undisputed capacity to change instructional methods (Dawes, 2001), which was noted in Adebi-Caesar (2012). ICT-based resources (such as simulations, videos, etc.) have the

potential to allow for an alternative transmission, better explanations of various science concepts that otherwise look very abstract, and modernity that is relevant to students, according to studies in the field of ICT integration in science teaching (Georgiou et al., 2007; Donnelly, et al., 2011) cited in Agyei and Agyei (2019).

This seems to emphasize that a typical teacher-centered classroom environment, as frequently observed in the Ghanaian context, could be transformed into an interactive learning environment by integrating ICT into the teaching of science. Students and teachers would acquire various knowledge and skills in ways that inform their study of and implementation of the curriculum (Agyei & Agyei, 2019). Higher level thinking and better problem-solving techniques are encouraged by this method (Ittigson & Zewe, 2003), mentioned in Agyei and Voogt (2011). Its capacity to inspire learning noted by (Korte & Husing, 2007). According to Kozma (2005), ICT may be utilised to enhance both the delivery of and access to education.

Furthermore, Heinecke et al. (1999) made the case, which was cited in Iddrisu (2009), that if one defines student learning as the retention of fundamental knowledge and skills as demonstrated by standard tests, then data point to a favorable correlation between computer-assisted instruction or computer-based learning and standardized tests (Adebi-Caesar, 2012). A cognitive tool is the computer. Its software can expand, deepen, or improve human cognition (Kozma, 1994), which was noted in Kozma (2005). They are made to assist users with task-relevant,cognitive performance elements, leaving the performance open-ended and under the learner's control (Fouche, 1995), as noted in Adebi-Caesar (2012).

ICT tools, such as interactive simulations and virtual laboratories, provide students with opportunities to visualize complex scientific phenomena. These visual aids help

students grasp abstract concepts and improve their understanding of scientific principles (Hosseini et al., 2017). ICT allows educators to incorporate interactive simulations and virtual experiments into their teaching. These simulations enable students to manipulate variables and observe real-time changes, helping them develop a deeper understanding of scientific phenomena (Smetana & Bell, 2012). Digital technologies enable the creation of three-dimensional (3D) models and animations that visualize complex structures and processes in science. These visual aids can be used to explain intricate biological systems, chemical reactions, or physical phenomena (Dalgarno & Lee, 2010).

Augmented Reality (AR) and Virtual Reality (VR) technologies immerse students in virtual environments, allowing them to explore scientific concepts in a more engaging and immersive way. These technologies provide a sense of presence and enable experiential learning (Akçayır & Akçayır, 2017). ICT offers data visualization tools that help students analyze and interpret scientific data effectively. Graphing software, data plotting tools, and interactive charts enable students to explore trends and patterns in scientific data (Tal & Kedmi, 2006). According to Lynch (2017), online platforms and multimedia resources, such as educational videos and interactive tutorials, provide students with visual and auditory representations of scientific concepts. These resources cater to different learning styles and enhance comprehension.

ICT enables students to access a vast array of online resources, including multimedia presentations, e-books, research articles, and educational websites. This access to information empowers students to explore science topics beyond the limitations of traditional textbooks (Reinders et al., 2018). Through the internet, students and

educators can access a wealth of scientific resources, research papers, and educational materials from across the globe, expanding the breadth and depth of science education (Bates, 2015). ICT enables students and educators to access digital libraries and online databases, such as PubMed, JSTOR, and Google Scholar. These platforms offer a vast collection of scientific articles, research papers, and scholarly publications (Kim & Sin, 2015).

ICT supports the dissemination of OER, which are freely available educational materials, including textbooks, videos, and simulations. OER initiatives aim to make high-quality educational resources accessible to all, reducing the cost of textbooks and learning materials (Wiley & Hilton III, 2018). Various online course platforms, like Coursera, edX, and Khan Academy, offer science courses and modules created by experts and institutions worldwide. Students can access these courses to supplement their learning and gain in-depth knowledge in specific scientific fields (Liyanagunawardena et al., 2013). Numerous educational websites and portals, like NASA's educational site or the National Geographic Education website, offer resources, lessons, and interactive content related to science topics. These platforms cater to various grade levels and interests (Savill-Smith & Kent, 2003).

According to Mayer (2017), ICT supports the creation and distribution of multimedia learning resources, including videos, animations, and interactive simulations. These resources provide engaging and visual representations of scientific concepts, enhancing comprehension and retention. ICT facilitates access to peer-reviewed scientific journals and magazines, allowing students and educators to stay up-to-date with the latest research and discoveries in various scientific disciplines (Tenopir et al., 2009).

ICT tools allow for personalized learning experiences through adaptive software and online assessment platforms. These technologies adapt content and pace to match the needs of individual learners, promoting student engagement and achievement (Crompton, 2014). Adaptive learning systems use algorithms and data analytics to assess a student's strengths and weaknesses in real-time. Based on this assessment, the system adapts the content, difficulty level, and pace of learning materials to match the individual learner's abilities (Sampson et al., 2014). ICT platforms often offer personalized learning paths that allow students to choose their learning objectives and progress at their own pace. These systems can provide recommendations for supplementary materials and activities tailored to individual interests (Nouri, 2016).

ICT enables the delivery of online quizzes, tests, and assessments that adapt to a student's performance. Immediate feedback and targeted remediation can be provided to address areas where the student is struggling, promoting self-directed learning (Ferguson & Shum, 2012). Zheng et al., (2020) posited that many educational platforms use machine learning algorithms to recommend content and resources based on a learner's past interactions and preferences. This ensures that learners receive content that aligns with their interests and needs. ICT allows for a variety of learning modalities, including text, video, audio, and interactive simulations. Learners can choose the format that suits their learning style, making the learning process more personalized and effective (Mayer, 2019). Learning analytics tools gather data on learner behavior and performance, enabling educators to identify individual learning patterns and make data-driven decisions to support each student's progress (Siemens & Gasevic, 2012).

ICT facilitates collaborative learning experiences where students can work together

on science projects, share data, and communicate with experts or peers worldwide. Collaborative learning enhances problem-solving skills and fosters a sense of community in science classrooms (Owusu-Acheaw & Larson, 2015). ICT offers a wide range of online collaboration tools, such as discussion forums, wikis, and shared documents, which enable students to collaborate on assignments and projects in real time, regardless of geographic distance (Dillenbourg et al., 2009). Means et al. (2013) assert that video conferencing and webinar platforms like Zoom and Microsoft Teams allow students to participate in virtual meetings, discussions, and presentations. These technologies promote synchronous collaboration and communication among students and educators.

Social media platforms and online communities provide spaces for students to interact, share resources, and discuss science topics. These platforms foster a sense of community and support informal collaborative learning (Junco et al., 2011). Veletsianos et al. (2018) explained in their study that tools like Google Docs and Microsoft Office 365 enable students to collaboratively edit documents, spreadsheets, and presentations. This real-time collaboration simplifies group projects and enhances peer review processes.

Learning management systems (LMS) and educational platforms often include features for group assignments, discussion boards, and collaborative activities. These tools support structured collaborative learning experiences (Beldarrain, 2006). Virtual Reality (VR) and Augmented Reality (AR) technologies can create immersive collaborative learning environments where students can interact with virtual objects and engage in group activities, enhancing teamwork and problem-solving skills (Akçayır & Akçayır, 2017).

ICT can connect science education to real-world applications by enabling students to engage in authentic scientific research, data analysis, and modelling. This hands-on experience increases students' motivation and interest in science (Wang et al., 2019). ICT tools and software, such as data loggers and analysis software (e.g., Excel, SPSS, or Python), allow students to collect and analyze real-world data. This empowers them to conduct experiments, gather data from environmental sensors, or analyze scientific datasets (Blikstein et al., 2014). ICT provides access to simulation and modelling software that allows students to create and explore virtual representations of real-world systems and phenomena. This enables them to experiment with different variables and scenarios, gaining insights into complex processes (Lynch et al., 2007).

ICT platforms host citizen science projects that invite students to actively participate in real scientific research. These projects often involve data collection, classification, or analysis, and students can contribute to ongoing scientific investigations (Raddick et al., 2010). ICT provides access to online research databases and repositories where students can access scientific literature, research papers, and databases of scientific knowledge. This access allows students to explore the latest developments in various scientific fields (Tenopir et al., 2009). ICT offers virtual field trip experiences where students can explore scientific sites, ecosystems, or laboratories virtually. These immersive experiences provide a realistic connection to real-world scientific applications (Squire & Jan, 2007).

ICT offers efficient methods for formative and summative assessment in science education. Online quizzes, interactive assignments, and instant feedback mechanisms support continuous assessment and help educators tailor instruction to student needs (Herrera-Seda & Valcarcel-Carrasquillo, 2016). ICT tools and software, such as data

loggers and analysis software (e.g., Excel, SPSS, or Python), allow students to collect and analyze real-world data. This empowers them to conduct experiments, gather data from environmental sensors, or analyze scientific datasets (Blikstein et al., 2014). ICT provides access to simulation and modeling software that allows students to create and explore virtual representations of real-world systems and phenomena. This enables them to experiment with different variables and scenarios, gaining insights into complex processes (Lynch et al., 2007).

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2.7 Challenges in the Integration of ICT into Science Education

Adebi-Caesar (2012) defined a challenge as anything that impedes the accomplishment of a predetermined goal or hinders progress toward it. The process of integrating ICT into teaching and learning is challenging and may provide several challenges (Simin et al., 2016). The integration of Information and Communication Technology (ICT) into science education can be immensely beneficial, but it also comes with several challenges. These problems are regarded as difficulties (Schoepp,

2005), quoted in Simin et al., (2016). Using ICT tools in the classroom presents several significant obstacles, some of which have been noted in the literature. ICT integration is known to have issues; as a result, problems with ICT integration in teaching and learning processes are most commonly experienced by teachers. The use of ICT in science education is hampered by several issues, according to numerous research. These obstacles include: an uneven distribution of computers among students; a lack of maintenance; a teacher's lack of computer expertise; a lack of time; a teacher's lack of interest or knowledge; limited network connectivity; limited accessibility; a lack of technical support; the teacher's age; the teacher's resistance to change; the teacher's lack of personal access during preparation; and ineffective training (Jenson *et al* (2002) cited in Adebi-Caesar (2012); Simin et al., (2016); Snoeyink and Ertmer (2002) and Jones (2004) cited in Agyei and Voogt (2011).

Not all schools and students have equal access to technology and the internet. This digital divide can create disparities in science education, as students with limited access to ICT may not have the same opportunities as their more privileged peers. One of the primary cost-related challenges in ICT integration is the expenditure required for acquiring and maintaining the necessary infrastructure. This includes the cost of purchasing and updating hardware, such as computers, tablets, and interactive whiteboards, as well as the cost of software licenses and technical support (Cuban, 2001). Ertmer and Ottenbreit-Leftwich (2013) assert that Beyond initial investments, there are ongoing costs associated with ICT integration, including maintenance, repairs, and software updates. Schools must allocate budgets to ensure that technology resources remain functional and up-to-date.

Training educators to effectively use technology in teaching is crucial. Professional

development programs, workshops, and training materials require financial resources. Access to high-quality digital content and resources is essential for effective ICT integration. However, developing or purchasing digital curriculum materials can be expensive (Becker, 2015). The cost of ICT integration can exacerbate disparities in educational opportunities. Schools and districts with limited budgets may struggle to provide equal access to technology resources, resulting in educational inequities (Warschauer, 2006). Christensen et al. (2008) added that ensuring the long-term sustainability of ICT integration initiatives is essential. Schools must develop plans for funding technology resources beyond the initial implementation phase.

The effective integration of ICT into science education requires well-trained educators. Teachers often face challenges in acquiring the necessary skills and knowledge to use technology effectively in the classroom (Ertmer & Ottenbreit-Leftwich, 2013). One of the primary challenges in integrating technology in education is ensuring that teachers have the necessary digital competence and skills. This often necessitates ongoing professional development and training (Ertmer & Ottenbreit-Leftwich, 2013). Teachers may encounter challenges in understanding and implementing technology integration models and frameworks effectively. These models help guide the integration process but can be complex (Mishra & Koehler, 2006). Resistance to change is a common challenge when introducing new technologies in the classroom. Teachers may be apprehensive about adopting unfamiliar tools and methods (Inan & Lowther, 2010).

According to Becker (2000), Teachers often struggle to find the time for professional development and may lack access to necessary resources and support for technology training. The integration of technology effectively requires an understanding of the

intersection of technological, pedagogical, and content knowledge (TPACK). TPACK is a framework that describes the knowledge teachers need to effectively integrate technology into their teaching practices. TPACK address the complex interactions between technology, pedagogy, and content knowledge. (Mishra & Koehler, 2006) Teachers need training in TPACK to make informed decisions about technology use (Koehler & Mishra, 2009). Collaboration and ongoing support from administrators, colleagues, and instructional technology specialists can help address challenges related to technology integration (Tondeur et al., 2012). Teachers may have concerns about technology failures during lessons, leading to disruptions in the learning process. Fear of technology malfunction can hinder their willingness to experiment with new tools.

The integration of ICT often requires a shift from traditional teaching methods to more student-centred, interactive approaches. This shift can be challenging for teachers who are accustomed to traditional lecture-based instruction (Chai et al., 2010). Ensuring that digital content and resources align with curriculum standards and are educationally relevant can be a challenge. The quality and appropriateness of digital materials are critical for effective ICT integration (Becker, 2015).

Assessing student learning outcomes when ICT is integrated into science education can be complex. Teachers must adapt their assessment strategies to accommodate technology-mediated learning experiences (Tamim et al., 2011). Technical challenges, such as internet connectivity problems, hardware malfunctions, and software compatibility issues, can disrupt lessons and create frustration for both teachers and students. Ensuring data privacy and online safety in an ICT-integrated environment is crucial. Schools must establish robust cybersecurity measures and adhere to privacy

regulations.

Ensuring that the digital content used in science education aligns with curriculum standards and learning objectives is crucial. It can be challenging to find high-quality, up-to-date digital resources that are also educationally relevant. One significant challenge in integrating technology into education is the availability of high-quality digital resources. The effectiveness of technology-enhanced learning largely depends on the quality of the digital content and materials (Niess et al., 2010). Digital resources should align with curriculum standards and learning objectives to be educationally relevant. Teachers often face challenges in finding resources that match the content they need to teach (Margaryan et al., 2011). Keeping digital resources up-to-date is essential, especially in fast-evolving fields like science. Teachers may struggle to find resources that reflect the latest scientific discoveries and developments (Kumar et al., 2011).

Teachers often encounter challenges related to access to digital resources, particularly in regions with limited internet connectivity. Open Educational Resources (OER) have emerged as a solution to address these issues (Hilton III, 2016). Ensuring the quality of digital resources may require the establishment of rigorous review processes and quality assurance mechanisms. Challenges arise in implementing such systems effectively (Harley et al., 2016). Designing digital resources that are user-friendly and engaging can be challenging. Resources that do not align with the needs and preferences of teachers and students may not be effectively utilized (Reeves & Herrington, 2010). As technology evolves, digital resources may become obsolete. Teachers need access to updated resources and support to adapt to changes (Molnar & Kletskin, 2016).

Gay (2010) claims that one of the fundamental challenges in adapting ICT tools and content is ensuring that they are culturally relevant. This involves selecting or creating content that reflects the cultural backgrounds and experiences of diverse student populations. Adaptive ICT tools that allow students to customize their learning experiences can be beneficial for culturally and linguistically diverse learners. These tools enable students to select content and resources that align with their individual needs and preferences (Liu, 2009). The principles of UDL emphasize the creation of ICT tools and content that are flexible and accessible to a wide range of learners, including those with diverse cultural and linguistic backgrounds (Rose & Meyer, 2002).

Teachers need training and professional development in cultural competence to effectively adapt ICT tools and content to diverse student populations. This includes understanding the cultural backgrounds and needs of students (Gay, 2002). Involving culturally diverse communities and families in the design and use of ICT tools and content can enhance their relevance and effectiveness (Moss & Jewitt, 2012). Combining ICT integration with culturally responsive pedagogy can create a powerful learning environment. This approach acknowledges students' cultural identities and leverages technology to engage them effectively (Hammond, 2015).

Other research, however, have broken these barriers down into two and three broad categories in different ways. Specifically, there are two types of obstacles: extrinsic and internal barriers (Ertmer, 1999) mentioned in Bayuo, Samari, and Abukari (2018) and material and non-material barriers (Pelgrum, 2001). Balanskat *et al.* (2006) divided these hurdles into three categories: "micro level" (teacher attitude), "meso level" (institutional), and "macro level" (to account for the larger educational system).

A description of these barriers makes distinctions between those that relate to teachers (non-material, "micro level" barriers) and those that relate to institutions (material, "meso level"), but a different description of the intrinsic and extrinsic barriers can be given because either one of them could be both teacher- and institution-related. Ertmer (1999) cited in Adebi-Caesar (2012) referred to extrinsic barriers as first order barriers citing as examples: lack of time, support, resources and training. She referred to intrinsic barriers as second order barriers, citing as examples: attitudes, beliefs, practices and resistance to change.

According to BECTA (2003), referenced in Bayuo, Samari, and Abukari (2018), the success of new technology varies depending on its style of implementation from curriculum to curriculum, location to location, and class to class. In 2003, the British Educational Communications and Technology Agency (BECTA) examined these issues from two (2) main perspectives (Adebi- Caesar, 2012). The first obstacles are those that affect instructors, and the second will look at the challenges that the school itself faces (Adebi-Caesar, 2012).

2.7.1 Teacher Related Barriers

Teachers are crucial in introducing and implementing ICTs in the classroom, according to Malcolm and Godwyll's (2008) analysis of international experience. The way technological innovation is used in education is influenced by the attitudes and beliefs of teachers. There are a number of challenges that instructors face while integrating ICT in their classrooms, according to numerous research (Agyei & Voogt, 2011). Among the other variables in the integration of ICT, it is obvious that the teacher is one important determinant factor (Adebi-Caesar, 2012). However, significant positive correlations exist between teachers' attitudes towards ICTs and

five independent variables namely cultural perceptions, computer competence, computer access and computer training (Albirini & Abdulkafi, 2004) cited in Malcolm and Godwyll (2008). The following are some of the key challenges that have been identified in the literature regarding teachers' use of ICT tools in the classroom.

2.7.1.1 Lack of Confidence

Many teachers who lack ICT skills are not ready to apply them in the classroom or in front of pupils who could know more than them (BECTA, 2004). The pupils' expectations about the teacher's proficiency with ICTs further exacerbate this lack of confidence. This is the case because pupils believe that their teachers are more knowledgeable than they are. With this in mind, a teacher who has even a basic understanding of ICTs won't want to embarrass himself or herself in front of the class (Adebi-Caesar, 2012). Beggs (2000) posits that fear of failure is a possible cause of lack of confidence whereas Balanskat et al (2006) said the limitation in the knowledge base of the teacher in ICTs use makes them feel anxious about using it and thus not confidence to use it in teaching. Therefore, the argument is that growing interest encourages dedication to developing abilities, which raises levels of competence. According to Cox *et al* (1999a), referenced in Adebi-Caesar (2012), instructors who are comfortable with ICT recognize the value of technology in both their professional and personal lives and realize the necessity of using it more often.

2.8.1.2 Lack of Competency

Teachers' ability to incorporate ICT into instructional practice presents another issue directly related to teacher confidence (BECTA, 2004) cited in Simin *et al* (2016). The ability to incorporate ICT into pedagogical practice is the main definition of teacher competency. Teachers' competence in ICT presupposes positive attitudes to ICT,

understanding of the educational potential of ICT, ability to use ICT effectively in the curriculum, ability to manage ICT use in the classroom, ability to evaluate ICT use, ability to ensure differentiation and progression and technical capability (Albirini & Abdulkafi 2004; Beck, 1997) all cited in Malcolm and Godwyll (2008). It is believed that a significant teacher-related barrier to ICT integration is a lack of knowledge or competence (Adebi-Caesar, 2009). Newhouse (2002) cited in Simin *et al* (2016) found that many teachers lacked the knowledge and skills to use computers and were unenthusiastic about the changes and integration of supplementary learning associated with bringing computers into their teaching practices.

Adebi-Caesar (2012) asserts that a teacher's ignorance presents a significant barrier to the use of computers in instructional strategies and practices. According to Roden (2010), referenced in Adebi-Caesar (2012), there will be more ICT use in education if teachers have a high degree of ICT understanding. Research has shown, that this barrier to effective ICT integration in science education is highly recognized among countries because every justification for why it couldn't be done was pointed at this barrier. Some countries reported this as the main barrier (Pelgrum, 2001; Al-Oteawi, 2002; Albirini, 2006) cited in Simin *et al* (2016) while others cited it as a serious obstacle or a constraining factor preventing successful ICT integration (Al-Alwani, 2005; Almohaissin, 2006; Empirica,2006) all cited in Simin, Thanusha, Logeswary and Anreetha, (2016).

2.7.1.3 Lack of Effective Training

A substantial body of evidence in the literature backs the idea that teachers need to obtain efficient, timely, and ongoing training to support technology in their instruction. (Wilson et al., 2003; Yildirim, 2000; Yildirim & Kiraz, 1999; Lemke,

1999; Northrup & Little, 1997) all cited in Malcolm and Godwyll (2008). According to BECTA (2004) cited in Simin *et al*. (2016), the issue of training is certainly complex because it is important to consider several components to ensure training effectiveness. A similar study conducted by Cox et al (1999) cited in Adebi-Caesar (2012) argues that Pedagogical elements need to be included in teacher ICT training. This study found that teachers who received basic ICT training without taking into account the pedagogical aspects of ICT were still unable to use ICT in the classroom. Correspondingly, recent research by Gomes (2005) cited in Simin et al., (2016) addressing the use of new technologies in classroom practice concluded that a lack of training in digital literacy, a lack of pedagogic and didactic training in how to use ICT in the classroom, and a lack of training concerning technology use in certain subject areas were barriers.

Cox et al (1999) cited in Adebi-Caesar (2012) assert that if teachers are to be convinced of the value of using ICT in their teaching, their training should focus on pedagogical issues. According to the study, this is because it was discovered that teachers did not know how to use ICT in their classrooms successfully even after attending professional development courses in the field. This occurred as a result of an over-focus during training on learning technical ICT capabilities rather than abilities to integrate ICT into the curriculum. The evidence from in-service training has indicated that the training programmes offerings, all too frequently fall short of meeting the instructors' actual needs. (Tella & Adeyinka, 2007; Crook, 1994:) all cited in Malcolm and Godwyll (2008). The provision of appropriate in-service training to the teachers, training that will show them how to use the new tools in their everyday teaching practice, is said to be a crucial component in the effective integration of computer use in the school curriculum (Malcolm & Godwyll, 2008).

2.8 Institutional Barriers

The environment or conditions present at various institutions or schools may also be a factor that prevents the integration of ICT into the learning and teaching process, claims Adebi-Caesar (2012). Depending on the location of the school and the class or category of the school, these requirements may change (Adebi-Caesar, 2012). Many recent research studies on the condition of ICT adoption in schools, as noted by Malcolm and Godwyll (2008), also demonstrate that many institutions are struggling to incorporate technology into the current setting. The following is an explanation of a few institution-level difficulties.

2.8.1 Limited Access to Resource

According to Adebi-Caesar (2012), It is crucial to recognise that ICT can have technical issues and contingency planning is required to guarantee that backup plans are in place. If the infrastructure and application platform are unreliable, the output may be impacted, which may hurt student motivation. Teachers cannot be expected to overcome the barriers preventing them from adopting ICT without both competent technical support in the classroom and whole-school resources (Lewis, 2003), quoted in (Simin, Thanusha, Logeswary, & Anreetha, 2016). In Sicilia's (2005) study cited in Simin et al (2016), technical problems were found to be a major barrier for teachers. These technical obstacles included things like waiting for websites to load, having trouble connecting to the Internet, printers that wouldn't print, broken computers, and having to use outdated computers for teachers. Waite (2004) cited in Malcolm and Godwyll (2008) reveals the lack of ICT infrastructure as one of the factors for the non-usage of those tools.

Korte and Hüsing (2007) cited in Simin *et al* (2016) argued that ICT support or

maintenance contracts in schools help teachers to use ICT in teaching without losing time fixing software and hardware problems. The Becta (2004) cited in Simin *et al* (2016) report stated "if there is a lack of technical support available in a school, then it is likely that technical maintenance will not be carried out regularly, resulting in a higher risk of technical breakdowns".

2.8.2 Limited Time

Adebi-Caesar (2012) explained that the time ICT suites are available may not suit the schemes of work planned by the teachers. According to several recent surveys, many instructors are competent and confident in utilising computers in the classroom, yet they still don't use technology much since they don't have the time (Simin, Thanusha, Logeswary, & Anreetha, 2016). BECTA (2004) cited in Simin *et al* (2016) found that Lack of time is a problem for teachers in many facets of their profession because it impairs their capacity to finish activities; some of the participating teachers particularly mentioned that ICT-related chores take up more time. These comprise the time required to research options on the Internet, plan lessons, experiment with and practise utilising the technology, resolve technical issues, and acquire proper training. According to Malcolm and Godwyll (2008), teachers frequently face resistance from other teachers, school officials, and parents to changes in classroom practises, yet they nevertheless manage to find the additional time and energy needed to integrate ICTs in schools.

2.2 Conceptual Framework

A conceptual framework is an analytical tool with several variations and contexts (Wikipedia, 2023). It can be applied in different categories of work where an overall picture is needed. It is used to make conceptual distinctions and organize ideas

(Wikipedia, 2023). This study was conceptualized on the variables used in the objectives. The study focused on Senior High School Education and integrated science teachers and students as the main factors that are influenced by the integration of ICT in teaching and learning processes.

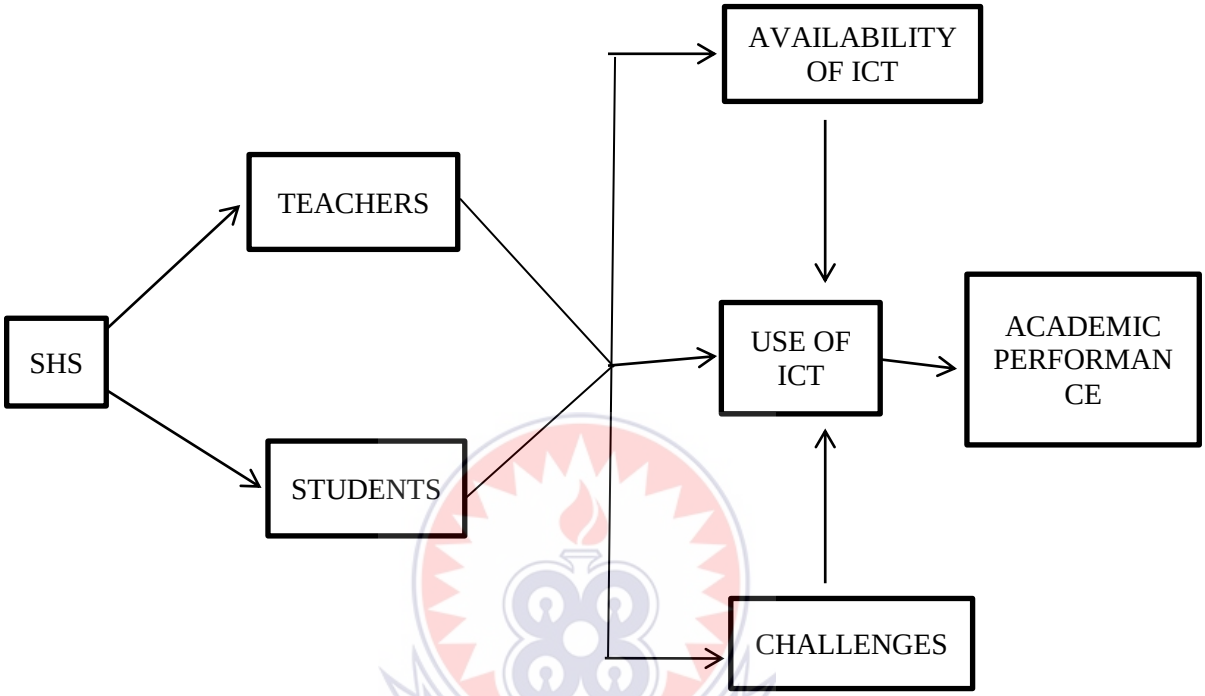

Figure 1: Conceptual framework of the study

Source: Researcher (2023)

From Figure 1, in senior high schools, teachers and students have a role to play in the use of ICT. When there is availability of ICTs, they can use them. When there is a challenge, it can affect the use of ICT. When they use ICT well there will be a positive academic performance. ICTs can make learning more interactive and engaging. Educational games, simulations, and virtual reality experiences can make complex concepts more accessible and enjoyable for students (Steinkuehler & Duncan, 2008).

Teachers play a vital role in integrating ICT into teaching by acting as facilitators of

learning rather than just providers of information. They guide students in using ICT tools to explore, create, and analyze information (Pelgrum & Law, 2003). ICT enables blended learning approaches where traditional face-to-face instruction is combined with online activities and resources. This allows for personalized learning experiences and flexibility in accessing content (Garrison & Kanuka, 2004). Teachers use ICT to facilitate collaborative projects where students work together using digital tools such as shared documents, video conferencing, and online collaboration platforms (Johnson, Smith, Levine, & Haywood, 2003).

Students actively engage with ICT tools as active participants in the learning process. They use technology to explore concepts, solve problems, and create multimedia presentations (Jonassen, 2000). ICT integration promotes digital literacy skills among students, including the ability to evaluate information sources, use digital tools responsibly, and communicate effectively in online environments (Warschauer & Matuchniak, 2010).

Without ICTs, teachers may rely on traditional, lecture-based approaches, which might not effectively engage students or promote deep understanding. As there is no understanding, teaching and learning becomes ineffective which then renders a declining academic performance among students.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter presents a discussion on the research procedure that was followed in the study. The discussion focused on the Research Design, Population, Sample and Sampling Procedure. It also talked about the Research Instrument, the Data collection procedure and method of Analyses that was used. It considered also ethical issues.

3.1 Research Design

Considering the nature of the research problem and the purpose of this study, the most appropriate research methodology that was used is the survey design. A survey was used because it provides an opportunity for researchers to ask questions about people's opinions, beliefs, characteristics and behaviour. It also helps the researcher to investigate into the associations between respondents' characteristics such as age, education, social class, race, and their current attitudes toward some issues. Survey research typically does not make causal inferences but, rather, describes the distributions of variables in a specified group (Ary et al., 2010).

3.2 Population

A population is defined as all members of any well-defined class of people, events, or objects. (Ary et al., 2010). According to Castillo (2009) cited in Entsie (2015), there are two types of populations: the target population and the accessible population. The target population refers to the large group to which the researcher wishes to generalize the results of the study. Whilst the accessible population is the population of subjects accessible to the researcher for drawing a sample (Ary et al., 2010). The target population for this study includes all Integrated Science teachers and students in

senior high schools in the Central Region. The accessible population for this study included all Integrated Science teachers and students in four selected Senior High Schools in the Central Region of Ghana.

The study was carried out in Mfantsiman Girls' Senior High School, Methodist Senior High School, Aggrey Memorial Senior High School and Moree Community Senior High School. These schools are located in two districts in the Central Region. Mfantsiman Girls' Senior High School and Methodist Senior High School are both from the Mfantseman district whereas Aggrey Memorial Senior High School and Moree Community Senior High School are also located at the Abura-Asebu-Kwamankese district. All these schools are located in urban communities. According to the Central Regional Statistics Coordinator, a community with a population of less than five thousand members is a rural community and a community with a population of more than five thousand members, is an urban community. In the Central Region, all the public Senior High Schools are located in the urban communities.

3.3 Sample and Sampling Procedure

A sample is a portion of a population. The small group that is observed is called a sample. The sample was selected from the four Senior High Schools - Mfantsiman Girls' Senior High School, Methodist Senior High School, Aggrey Memorial Senior High School and Moree Community Senior High School by the use of the stratified random sampling. The simple random sampling was also used in the sampling procedure to select 200 second year students from these four schools; 50 students were selected from each school without regard to their representation in the overall population.

However, the purposive sampling technique was used to sample all the Integrated

Science teachers from the accessible population. This enabled the researcher to choose participants who are sure to respond appropriately to the research questions. Also, the simple random method, thus, the lottery method was used to select three Integrated Science teachers from each school for observation. Their lessons were observed. In all 200 students and 42 teachers participated in the study.

3.4 Research Instruments

The instruments used to collect data for this study were the observational schedule and questionnaire items. Observational schedule was used by the researcher to determine the extent to which a particular behaviour is present during teachers' lesson delivery whilst the questionnaire items were used for both teachers and students.

The questionnaire with a total of 26 items came in two forms; one for the teachers and the other for the students. The teacher's questionnaire was in four sections. Section A of the questionnaire which contained 5 items was used to collect demographic data on the teachers. Section B which had 2 items collected data on the availability of ICT tools in schools for teachers and those owned by teachers. Section C with 8 items collected data on how teachers used ICTs with ease in teaching. Section D had 11 items collected data on the challenges science teachers face in ICT integration in their teaching. Also, the students' questionnaire with a total of 11 items had three sections; section A contained 3 items which was used to collect data on their demographic information. Section A had 2 items which was used to collect data on the ICT tools available to students for learning and those they have access to for learning. Section C consisted of 6 items which were used to collect data on the challenges of ICT integration in teaching and learning integrated science.

The observational schedule provided data on the extent to which integrated science

teachers use ICTs in their instructional processes. A checklist was used to collect this data. The checklist was made of 10 behaviours on the ICT tools available and how they integrated them in their teaching that was observed.

3.5 Validity of Instruments

A research instrument is valid when it measures what it is supposed to measure. The validity of both instruments was determined. The validity of the observational schedule was assessed by two observers, the researcher and a colleague teacher who was trained by the researcher. Two observers were used to prevent bias. A checklist was constructed by the researcher and the other two observers, these behaviours were carefully defined and clarified. The research supervisor also acknowledged the checklist before they were used to carry out the study. To determine the validity of the questionnaire, three colleague Integrated Science teachers together with the researcher's supervisor were made to review the items to assess whether they were appropriate to measure what they were supposed to measure.

3.6 Reliability of Instruments

According to Ary, Jacobs, Sorensen and Razavieh (2010), the reliability of a measuring instrument is the degree of consistency with which it measures whatever it is measuring. A research instrument is reliable when it produces consistency in measurements. Cronbach's Alpha reliability testing is used to test the internal consistency of an instrument and its items (Ghavifekr & Rosdy, 2015). Hops *et al* (1995) cited in Bryington et al (2002) defined interobserver agreement as a measure of consistency and therefore, as representing a form of reliability. Interobserver agreement is an estimate of objectivity that specifies the degree to which the data reflect the behaviour being observed rather than the behaviour of the observer (Alessi,

1988 cited in Bryington et al., 2002).

The reliability of the observational schedule was measured by the extent to which the two observers' records agreed with each other. A pilot test was carried at Ghana National College and 0.75 Cohen's Kappa coefficient of agreement was obtained using the Statistical Package for Social Scientists (SPSS), this indicated that the observational schedule was good and therefore, reliable and also in good shape for the study.

The questionnaire items were pilot-tested at Ghana National College in the Central Region because they did not take part in the main study. Ghana National College Integrated Science teachers and students were used because they have the same characteristics of members who were used for the actual study. The purpose of the pilot test was to provide an opportunity for the researcher to assess the appropriateness of the data-collection instruments and other procedures and to make changes if necessary.

Also, questionnaire items' internal consistency was checked by building some redundancy into the instrument—items on the same topic were rephrased and repeated in the questionnaire. The more consistent the responses, the higher the reliability. An alpha value of 0.77 was obtained from the questionnaire for teachers and 0.695 for that of the students.

3.7 Data Collection Procedure

The researcher visited each of these four schools selected for her study on four different occasions for study. The first visit was to seek permission from the school authorities and an appropriate date was scheduled for each data collection. The second

visit was when the researcher was introduced to the Integrated Science Departments of the schools and allowed to select participants and provide them with more information on the study; questionnaire items were given to participants and given three days each to complete. The third visit was to collect completed questionnaire items from participants. The remaining visit was an arranged observational schedule with the three teachers sampled for the study each for a particular day. Responses from the students' questionnaire were to determine the extent to which teachers use ICT in their lesson delivery.

3.8 Data Analysis Procedure

The researcher used descriptive statistical tools (Statistical Package for Social Scientists) for the analysis of the data. Statistical tools like frequency distribution, charts and percentages were also used to present the results. The analysed data were interpreted in relation to the research questions. The observation data was analysed quantitatively. The behaviours that were observed were defined and created into a checklist. These behaviours were observed during lessons. The results were quantified as; one for a present behaviour and zero for an absent behaviour. Descriptive statistical tools were used and the analysed data were interpreted in relation to research question one.

3.9 Ethical Issues

Permission was sought from the Heads and Stakeholders of the institutions where the study was carried. Participants of the study were duly informed about the nature of the study, what it seeks to achieve and how data collected about them would be handled. Respondents were assured of anonymity and confidentiality of information provided.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.0 Overview

This chapter presents the data that was collected during the study, its analysis and discussions. This chapter is made of three categories, teacher's questionnaire data analysis, student's questionnaire data analysis and the observational schedule's data analysis.

Two hundred (200) students responded to student questionnaire. Forty-two (42) teachers responded to the teacher's questionnaire.

The observational was done during teachers' lesson periods to ascertain the ICT tools available to them for teaching, how they integrate ICTs in their teaching and the challenges they could face in the use of ICTs in their teaching.

A check list of 10 items was used for this schedule where a behaviour that occurred during the lesson was marked present and those that didn't take place were marked as absent.

4.1 Demographic Characteristics of the Teachers

Table 1 shows the demographic characteristics of the teachers concerning age, gender, teaching experience and ICT experience based on a sample of 42 individuals. Twenty-seven of the respondents came from Mfantseman municipality and 15 came from Abura- Asebu-Kwamankese district.

Table 1: Demographic characteristics of teachers

Factors	Category	Frequency	Percentage %
Age	Under 25 yrs	5	11.90
	25-40 yrs	27	64.30
	41-60 yrs	10	23.80
Gender	Male	25	59.50
	Female	17	40.50
Teaching experience	Less than 1 year	7	16.70
	1 – 10 yrs	23	54.70
	11 years and above	12	28.60
ICT experience	Less than 1 year	2	4.80
	1 – 5 years	18	42.90
	6 – 10+ years	22	52.30

From Table 1, 11.90% of the teachers were under 25 years of age, 64.30% were between 25-40 years whilst 23.80% of them were between the ages of 41-60. For gender, 59.50% of them were males and 40.50% were females.

Also, for teaching experience, 16.70% of the teachers have less than one year of experience, 54.70% of them have 1 to 10 years and 28.60% of the teachers have 11 years and above experience in teaching. For ICT experience, 4.80% of the teachers have less than one year of experience in ICT, 42.90% of them have 1 to 5 years of experience and 52.30% of them have 6 to 10+ years of experience in ICT. Teachers who are experienced with ICT are more likely to feel comfortable experimenting with different technological tools and incorporating them into their science lessons; so, from the results above, 52.30% of the teachers were expected to integrate ICTs into their teaching.

The result indicates that the age of teachers can significantly impact their integration of Information and Communication Technology (ICT) in education. Teachers under 25 years, being digital natives, those who grew up with technology, are generally more comfortable and adept at using technology in their teaching. This is in line with

Prensky's (2001) study on digital natives, digital immigrants who highlighted that, young teachers are more likely to experiment with new ICT tools and incorporate them seamlessly into their lessons. Age can also influence attitudes towards technology. Older teachers may be more resistant to change or may have a mindset that favours traditional teaching methods. This complements studies by Ertmer et al. (2012) on teachers' beliefs and uses of technology to support 21st-century teaching and learning and Mishra and Koehler (2006) on technological pedagogical content knowledge suggest that teachers' beliefs about the value of technology play a crucial role in its integration.

Also, younger teachers often receive more recent and comprehensive training in ICT during their education. This is in support of a study by Schrum and Levin (2013) who noted that younger teachers are more likely to attend professional development workshops focused on technology integration This exposure enhances their confidence and skills in using ICT tools effectively. Age can also influence the pedagogical strategies teachers employ. This aligns with research by Hilton et al. (2016) who highlighted that younger teachers may lean towards student-centered, interactive approaches facilitated by technology, such as flipped classrooms or collaborative online platforms On the other hand, older teachers may rely more on traditional lecture-based methods.

4.2 Demographic Characteristics of Students

Table 2 displays the age and gender distribution of the students. Two hundred students were considered.

Table 2: Demographic findings on students

Variable/Factor	Category	Frequency	Percentage %
Gender	Male	75	37.50
	Female	125	62.50
Total		200	100
Age	Under 13yrs	1	0.50
	13-16yrs	47	23.50
	17-19+yrs	152	76.00
Total		200	100

Table 2 shows that 75(37.5%) and 125(62.5%) of the respondents were males and females respectively; this indicates that for gender, the majority of respondents were females. The age distribution of the respondents indicates that 1 (0.5%) are under 13 years, 47(23.5%) are 13 to 16 years and 152(76.0%) are 17 to 19+ years; this indicates that most of the respondents were of 17 to 19+ years.

4.3 Research Question 1: To what extent do teachers use ICT in teaching Integrated Science?

To answer this research question, a teachers' questionnaire was used to determine teachers' skills, interests, views, duration of ICT use and information on how ICT tools are accessible to them, and the results are presented in Table 3 and Table 4. Also, to validate the results, an observation checklist was used to verify the extent to which teachers use ICT in teaching integrated science.

Table 3: Duration of ICT usage by teachers in years

Number of years	Frequency	Percentage%
Less than a year	2	4.80
1 – 5 years	18	42.90
6 – 10 years	14	33.30
11 years and above	8	19.0

Table 3 indicates that 4.8% of the teachers have used computers for less than a year, 42.9% have used computers for 1-5 years, 33.3% have used computers for 6-10 years, and 19% have used computers for 11 years and above. It can be deduced from this information that the majority of the teachers have been using computers for quite a number of years. Hence, most teachers are experienced in the usage of computers.

From the results obtained, it can be seen from Table 3 that a significant portion of teachers have considerable experience in using computers. This experience can significantly impact their ability to integrate technology effectively into science instruction. This is in agreement to previous studies carried out by Baylor and Ritchie (2018) investigated the factors that facilitate meaningful integration of technology to support inquiry-based learning in the classroom. They found out that integrating ICT in science instruction by experienced teachers often leads to active learning and collaboration. They design activities that encourage students to explore, experiment, and collaborate using digital platforms, fostering a deeper understanding of scientific principles. Also, Mishra and Koehler (2006) carried out a study on the technological pedagogical content knowledge. They found out that through the use of technology, experienced teachers create opportunities for students to engage in critical thinking and problem-solving. Digital tools such as concept mapping software, online research databases, and multimedia presentations enable students to analyse, evaluate, and synthesize information in the context of science.

Table 4 shows the accessibility and usage of ICT by teachers. Respondents were asked to state whether each statement is true or false.

Table 4: ICTs accessibility and usage by teachers

ITEMS	True	False
We do not have access to computers in our school	9 (21.40%)	33 (78.60%)
We have access to internet in the classrooms and other areas	35(83.30%)	7 (16.70%)
We do not have access to the internet in the science or ICT laboratory	34(81.0%)	8 (19.0%)
The internet connection is not strong in the classroom	38(90.50%)	4 (9.50%)
The internet connection is strong in the science or ICT laboratory	13(31.0%)	29 (69.0%)
I do not use laptops, smartphones, Ipads or tablets when teaching	11(26.20%)	31(73.80%)
I use projectors for PowerPoint presentations in my lesson delivery	4(9.50%)	38(90.50%)
There are IT experts in my school	40(95.20%)	2(4.80%)

It can be seen from the data obtained that as many as 33(78.6%) of the respondents agreed that they have access to computers in their schools, 9(21.4%) disagreed. This is positive for effective use of ICTs in teaching and learning of Integrated Science. 35(83.3%) of the respondents claimed they had internet in their classrooms and other areas whiles 7(16.7%) disagreed. 34(81.0%) agreed that they do not have access to the internet in the science or ICT lab while 8(19.0%) disagreed. This indicated a potential limitation in the use of online resources during teaching and learning.

Also, 38(90.5%) responded that the internet connection is not strong in the classrooms while 4(9.5%) disagreed. 13(31.0%) agreed that the internet connection is strong in the science or ICT laboratories but 29(69%) disagreed; this showed a negative for effective use of ICTs in teaching and learning. Again, 31(73.8%) responded that they use laptops, smartphones, Ipads or tablets in their teaching but 11(26.2%) disagreed. 38(90.50%) disagreed that they use projectors for PowerPoint presentations while 4(9.5%) agreed. While 2(4.8%) agreed that there are IT experts in their schools, 40(95.2%).

The results from Table 4 shows that majority of respondents agreed that they have access to computers in their schools, and a significant number also have internet access in their classrooms. However, there seems to be a limitation in internet access specifically in science or ICT labs. This aligns with a research study on the ICT impact report, the study indicated that while schools may have basic technology infrastructure, specialized areas like science labs might lack robust internet connectivity, limiting the use of online resources and collaborative learning platforms (Balanskat et al, 2006). Also, the data reveals that internet connection strength is perceived to be weak in classrooms and even weaker in science or ICT labs. This echoes findings from OECD (2015) study on students, computers and learning, which highlighted the importance of reliable internet access for effective integration of technology in education Weak internet connections can hinder teachers' ability to utilize online tools, conduct research, and engage students in interactive learning experiences.

The majority of respondents use laptops, smartphones, iPads, or tablets in their teaching, which is in line with the trend of integrating mobile devices into education for enhanced learning experiences (Pachler et al., 2010) in their study on mobile learning. However, the limited use of projectors for PowerPoint presentations suggests a gap and limitation to Kumar and Tjandra (2018) study on enhancing learning with visuals, they posited that utilizing visual aids effectively can enhance students' understanding and engagement during lessons. Also, the data indicates a low percentage of schools having IT experts. This aligns with Bauer and Kenton (2005) research on technology integration in schools. The study indicated that many schools lack dedicated IT support staff, which can impact the maintenance, troubleshooting, and integration of technology in teaching and learning processes.

Table 5 shows the observational schedule data on ICT tools available to teachers and how they are integrated in their lessons.

Table 5: Observation on teacher's integration of ICTs in their lessons

Behaviours	Available	Not available
Teacher has a tablet for teaching	3 (25%)	9 (75%)
Teacher has a smart phone for teaching	12 (100%)	0 (0%)
Teacher has a laptop for teaching	10 (83.3%)	2 (16.7%)
Projector is available for this lesson	5 (41.7%)	7 (58.3%)
Teacher had prepared notes, videos or pictures on laptop for projection	10 (83.3%)	2 (16.7%)
Teacher projected lesson from the laptop for students	3 (25%)	9 (75%)
Internet is needed for this lesson	8 (66.7%)	4 (33.3%)
Internet is used for this lesson	4 (33.3%)	8 (66.7%)
Smart phone is used for this lesson	3 (25%)	9 (75%)
Tablet is used for this lesson	2 (16.7%)	10 (83.3%)

The data shows that 3 (25%) of the teachers had tablet for teaching but 9 (75%) of them did not; while 2 (16.7%) used tablet in teaching, 10 (83.3%) did not use tablet in teaching. Also, 12 (100%) of the teachers brought smartphones to teach. However, only 3 (25%) of them used smartphones to teach while 9 (75%) did not. 10 (83.3%) had laptops with prepared notes, pictures or videos for teaching but 2(16.7%) did not have. Also, 10 (83.3%) of the teachers had laptops for teaching but 2(16.7%) did not. However, while 3 (25%) of the teachers used the laptops and projectors in teaching, 9 (75%) did not. Finally, 8 (66.7%) of the teachers needed to use the internet, while 4 (33.3%) did not need the internet to teach. Only 4 (33.3%) used the internet while 8 (66.7%) did not.

The data obtained in Table 5 shows the low percentage of teachers using tablets and

smartphones for teaching despite having access to them is consistent with research by Moersch (2010) on a practical guide to implementing Web 2.0 in K-12 classrooms, who noted that teachers often face challenges in effectively integrating mobile devices into instruction due to lack of training and support. The data also shows that a minority of teachers used laptops and projectors in teaching, indicating a potential gap in leveraging multimedia resources for enhanced learning experiences. This is consistent with research by Mishra and Koehler (2006) on technological pedagogical content knowledge, which highlighted the need for teachers to develop technological Pedagogical Content Knowledge (TPACK) for effective integration of technology into teaching practices.

While a significant number of teachers had laptops with teaching materials and needed internet access, the utilization rates were lower. This echoes findings from Ertmer and Ottenbreit-Leftwich (2013) in their study on removing obstacles in order to facilitate understanding and application of technological pedagogical content knowledge (TPACK), who emphasized the importance of teacher training and pedagogical support in harnessing the full potential of technology for teaching. Also, the disparity between teachers needing internet access and those actually using it for teaching reflects a common challenge identified in Koehler and Mishra (2008) handbook of technological pedagogical content knowledge (TPACK) for educators, that teachers may encounter barriers such as limited connectivity, lack of digital resources, or insufficient training in utilizing online tools effectively.

4.4 Research Question 2: What ICT tools are available to Integrated Science teachers in the selected schools?

To answer this research question, students' questionnaire was used to collect data on

ICT tools available to students in the schools for learning and the various places they can get access to these ICT tools in their schools. Also, teachers' questionnaire was to collect data on ICT tools owned by teachers and those that are available in their schools for teaching. Participants were made indicate whether an item is available or not available.

Table 6 shows the responses from students on various ICT tools that are available in their schools for learning. Students were provided with a list of ICT tools to select those that are available in their schools for learning Integrated Science.

Table 6: The availability of ICT tools to students in school

ICT tools	Available	Not available
Internet	102(51.0%)	98(49.0%)
Projector	130(65.0%)	70(35.0%)
Laptop	108(54.0%)	92(46.0%)
Desktop computer	161(80.50%)	39(19.50%)
Tablet or iPad	7(3.50%)	193(96.50%)
Smart phone	13(6.50%)	187(93.50%)
Calculator	155(77.50%)	45(22.50%)
Printer	131(65.50%)	69(34.50%)
Photocopier machine	108(54.0%)	92(46.0%)
Smart board	0(0.0%)	200(100%)

The results indicate that 98(49%) of the students do not have internet in their schools while 102 (51%) had internet. 70 (35%) do not have projectors but 130 (65%) had. 92 (46%) do not have laptop but 108 (54%) had laptops in their schools. While 161 (80.5%) had desktop computers in their schools, 39 (19.5%) do not have. 7 (3.5%) had tablets or iPads in their schools for learning but 193 (96.5%) do not have. 13 (6.5%) had smart smartphones for learning but 187 (93.5%) do not have. 155 (77.5%)

had calculators while 45 (22.5%) do not have. 131 (65.5%) had printers but 69 (34.5%) do not have. 108 (54%) had photocopier machine but 92 (46%) do not have. The results also show that 200 (100%) of students do not have access to smart board in their schools.

From the results obtained, Table 6 revealed that 49% of students lack internet access in their schools aligns with broader global disparities in digital connectivity in education. This supports UNESCO (2020) work on education, from disruption to recover found that around 60% of the world's population still lacks internet access, with significant implications for educational opportunities. The availability of hardware such as projectors, laptops, desktop computers, tablets, and smartphones varies widely. While some schools seem well-equipped, others lack basic devices like laptops and tablets. This aligns with research by UNESCO (2020) on futures of education; learning to become, which underscored the need for governments and institutions to invest in educational technology infrastructure for effective teaching and learning. The availability of printers and photocopiers is crucial for facilitating document sharing, assignments, and administrative tasks. Schools lacking these resources may face challenges in delivering educational materials efficiently. This is in support of research by Anderson et al. (2018) on technology and education, discussed the impact of resource availability on educational outcomes, highlighting the role of technology in enhancing learning experiences. Also, the low presence of tablets, smartphones, and smart boards reflects a gap in leveraging mobile technology for learning. However, studies like those by Lai and Chen (2017) on investigating the learning effectiveness of augmented reality applications in K-12 education highlighted the potential of mobile devices in enhancing student engagement and learning outcomes. Overall, these findings underscore issues of equity and access in

educational technology. Students in schools with limited technological resources may face challenges in keeping pace with digital learning trends and acquiring essential digital literacy skills. Addressing these disparities requires concerted efforts from policymakers, educators, and stakeholders, as highlighted in the work of Alabi et al. (2021) on digital inclusion in education.

Table 7 shows the places where the ICT tools are available to students in school for learning. Respondents were required to select the most appropriate from many options.

Table 7: Places of access to ICT tools by students

Places	Available	Not available
Classroom	74 (37%)	126 (63%)
Library	54 (27%)	146 (73%)
Science lab	87 (43.5%)	113 (56.5%)
Assembly hall	68 (34%)	132 (66%)
Dining hall	10 (5%)	190 (95%)

The results indicate that 74 (37%) of the students agreed to have access to ICT tools in their classrooms while 126 (63%) disagreed. 54 (27%) had access to ICT tools in the library but 146 (73%) do not. 87 (43.5%) had access to ICT tools in the science laboratories but 113 (56.6%) do not. 68 (34%) had access to ICT tools in the assembly hall but 132 (66%) do not. 10 (5%) had access to ICT tools in the dining hall but 190 (95%) do not. These results indicate that there is a need to increase the availability of ICT tools in various places within the schools to ensure that all students have equal access to these resources.

From Table 7, the data presented reveal a digital divide where some students have

access to ICT tools while others do not. This divide can exacerbate existing inequalities in education. This aligned to a research by Becker (2000) on pedagogical motivations for student computer use that lead to student engagement who suggested that students with access to ICT tools tend to demonstrate higher academic achievement compared to those without such access. Therefore, increasing the availability of ICT tools across various school areas can potentially lead to improved learning outcomes. A report by the World Bank (2016) on digital dividends emphasized the importance of addressing this gap to ensure equitable access to educational resources for all students.

Table 8 presents the data obtained on the ICT tools teachers own.

Table 8: ICT tools that are owned by teachers

ICT tools	Available	Not available
Projector	2(4.8%)	40(95.2%)
Laptop	36(85.7%)	6(14.3%)
Desktop computer	9(21.4%)	39(78.6%)
Tablet or iPad	12(28.6%)	30(71.4%)
Smart phone	34(81%)	8(19%)
Calculator	11(26.2%)	31(73.8%)
Printer	4(9.5%)	38(90.5%)
Modem or MiFi	13(31%)	29(69%)

The results show that 40 (95.2%) of the teachers do not have projectors but 2 (4.8%) had projectors. 6 (14.3%) of the teachers do not have laptops while 36(85.7%) had laptops. 9 (21.4%) had desktop computers while 39 (78.6%) do not have. 12 (28.6%) had tablet or iPad but 30 (71.4%) do not. 8 (19%) do not have smartphones but 34 (81%) had. 31 (90.5%) do not have calculators but 11(26.2%) had calculators. 4 (9.5%) had printers but 38 (90.5) do not have. 13 (31%) had modem or MiFi but 29 (69%) do not.

Table 9 shows the ICT available in schools for teachers to teach Integrated Science. Respondents selected the most appropriate from a number of options.

Table 9: ICT tools available to teachers in school for teaching

ICT tools	Available	Not available
Internet	32(76.20%)	10(23.80%)
Projector	24(57.10%)	18(42.90%)
Laptop	20(47.60%)	22(52.40%)
Desktop computer	25(59.50%)	17(40.50%)
Printer	27(64.30%)	15(35.70%)
Photocopier machine	26(61.90%)	16(38.10%)
Smartboard	0(0%)	42(100%)

The results indicate that 10 (23.8%) of the teachers do not have internet in their schools while 32 (76.2%) had internet. 18 (42.9%) do not have projectors but 24 (57.1%) had. 22 (52.4%) do not have laptop but 20 (47.6%) had laptops in their schools. While 25 (59.5%) had desktop computers in their schools, 17 (40.5%) do not. 27 (64.3%) had printers but 15 (35.7%) do not have. 26 (61.9%) had photocopier machine but 16 (38.1%) do not have. The results also show that 42 (100%) of the teachers do not have to smart board in their schools. This shows that there is the need for an increase of some ICT tools in schools for teachers for effective teaching and learning of Integrated Science.

From Table 8 and Table 9, the data highlighted a significant gap in educational technology access among teachers. The low percentages of teachers with projectors, desktop computers, tablets, printers, and modems/MiFi devices indicate a lack of essential tools for effective teaching and learning. On the other hand, a relatively higher percentage of teachers have access to laptops, smartphones, and calculators,

which are more commonly, used personal devices. This is in support of several research studies in educational technology access often emphasizes the importance of equitable access to technology for both students and teachers.

A study by Kimmons and Hall (2020) on technology integration in schools, found that teachers' access to technology significantly influences their ability to integrate technology into their teaching practices. For example, teachers with limited access to digital tools may struggle to create interactive lessons, incorporate multimedia resources, or facilitate online collaboration, all of which are crucial components of modern education. Moreover, the digital divide, which refers to disparities in access to technology based on socioeconomic factors, exacerbates these challenges. DiMaggio et al., (2004) on from unequal access to differentiated use also pointed that teachers working in schools with limited resources are more likely to face barriers in accessing and utilizing educational technology effectively.

4.5 Research Question 3: What challenges do Integrated Science teachers and their students face in their teaching and learning with ICTs?

To answer this question, students and teachers responded to a number of questions. Students' questionnaire required that students state "True or false" to each statement. Teachers' questionnaire with a Likert scale to determine whether teachers strongly agree, agrees, undecided, disagree or strongly disagree to each statement.

Table 10 presents the challenges that students face in using ICT tools for learning.

Table 10: Responses by students to challenges they face in the use of ICT for learning

ITEMS	RESPONSES	
	TRUE	**FALSE**
There are no prescribed locations for using ICTs in our school	30 (15%)	170 (85%)
We are prevented from using ICTs at the prescribed locations in our school	151 (75.5%)	49 (24.5%)
Most of the ICT tools in our school are faulty	122 (61%)	78 (39%)
The internet connection is not strong at the prescribed locations in our school	123 (61.5%)	77 (38.5%)
Our teachers do not use any ICT tools when teaching	64 (32%)	136(68%)
There are IT experts who help our teachers to use ICTs in their teaching in our school	72 (36%)	128 (64%)

It can be seen that, 30 (15%) agreed that there are no prescribed place to use ICT in their schools but 170 (85%) disagreed. 151 (75.5%) of the students agreed that they are not allowed to use ICT for learning in the schools while 49 (24.5%) disagreed. 122 (36%) agreed that the ICT tools available are faulty but 78 (39%) disagreed. While 123 (61.5%) of the students agreed that the internet connection is not strong in their schools, 77 (38.5%) disagreed. Also, 136 (68%) agreed that their teachers use ICT tools in teaching but 64 (32%) disagreed. 128 (64%) disagreed that there are IT experts in their schools but 72 (36%) agreed.

From Table 10, it can be deduced that there are guidelines or designated areas for utilizing ICT resources this corresponds to a study by Teo (2011) on factors influencing teachers' intention to use technology, noted that schools are increasingly integrating ICT into various aspects of teaching and learning, and this often involves setting up

specific spaces or labs for ICT use. Such structured environments can enhance students' access to and engagement with technology. A significant portion of students (75.5%) agreed that they are not allowed to use ICT for learning in schools. This contradicts the trend toward technology integration advocated in modern education frameworks study by OECD (2015) on students, computers and learning. They pointed that the restriction on ICT usage could stem from various factors such as limited resources, outdated policies, or concerns about misuse.

A notable percentage (36%) agreed that the ICT tools available in their schools are faulty hinders effective use of technology in teaching and learning. This echoes findings from a study by Ertmer (2010) on teacher pedagogical beliefs, which highlighted challenges related to technical issues and inadequate maintenance of ICT infrastructure in educational settings. A significant percentage (68%) acknowledged that their teachers use ICT tools in teaching. This aligns with the growing emphasis on digital pedagogy and the benefits of incorporating technology to enhance instructional practices highlighted by Mishra and Koehler (2006) in their study on technological pedagogical content knowledge. Also, absence of IT experts in some schools can have a negative impact on the maintenance on ICT tools this agrees to Friedman and Kagan (2017) study on addressing the shortage of IT expertise in K-12 education found that shortage of expertise can impact the maintenance, troubleshooting, and innovative use of ICT resources.

Table 11 shows the responses of integrated science teachers on the challenges they face in using ICT in their teaching. The responses are categorized into five levels: Strongly Agree, Agree, and Undecided, Disagree, and Strongly Disagree.

Table 11: Challenges Integrated Science teachers face in the use of ICT for teaching

ITEMS	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
I do not have enough time to use ICTs in my teaching	9 (21.4%)	11 (26.2%)	6 (14.3%)	13 (31.0%)	3 (7.1%)
I am too old to learn how to integrate ICTs in my teaching	2 (4.8%)	5 (11.9%)	3 (7.1%)	14 (33.3%)	18 (42.9%)
I do not have the necessary skills to integrate ICTs in my teaching	3 (7.1%)	7 (16.7%)	6 (14.3%)	17 (40.5%)	9 (21.4%)
There is frequent power failure in my school, hence, ICT tools cannot be used	0 (0%)	5 (11.9%)	8 (19%)	24 (57.1%)	5 (11.9%)
Expertise teachers are not ready to teach others in using ICT	6 (14.3%)	11 (26.2%)	6 (14.3%)	18 (42.9%)	1 (2.4%)
There is no reliable technical support in using ICTS in my teaching	3 (7.1%)	12 (28.6%)	17 (40.5%)	9 (21.4%)	1 (2.4%)
I can use ICTs but cannot integrate them in my teaching	1 (2.4%)	3 (7.1%)	8 (19%)	26 (61.9%)	4 (9.5%)
I could be embarrassed when things go wrong	1 (2.4%)	9 (21.4%)	11 (26.2%)	18 (42.9%)	3 (7.1%)
There are not enough ICT training opportunities by the GES for teachers	6 (14.3%)	12 (28.60%)	13 (31.0%)	8 (19%)	3 (7.1%)
I am not encouraged by other teachers to use ICT in my teaching	1 (2.4%)	10 (23.8%)	6 (14.3%)	22 (52.4%)	3 (7.1%)
We are not motivated by the Headteacher to use ICT in our teaching	4 (9.5%)	12 (28.6%)	4 (9.5%)	11 (26.2%)	11 (26.2%)

From the table, the following can be deduced:

1. Time constraint: 9 (21.4%) of the teachers strongly agreed, 11 (26.2%) agreed and 6 (14.3%) were undecided that they do not have enough time to use ICTs in their teaching but 13 (31%) disagreed and 3 (7.1%) strongly disagreed. This suggests that they face time constraints that prevent them from incorporating ICT in their teaching.
2. Age and skill level: 18 (42.9%) of the teachers strongly disagreed and 14 (33.3%) disagreed that they are too old to learn how to integrate ICTs in their teaching, 3 (7.1%) were indecisive, while 2 (4.8%) strongly agreed, 5 (11.9%) agreed. Also, 17 (40.5%) disagreed and 9 (21.4%) strongly disagreed that they do not have the necessary skills to integrate ICTs in their teaching, however, 3 (7.1%) strongly disagreed, 7 (16.7%) agreed and 6 (14.3%) were indecisive. This suggests that age and lack of skills may not be the primary challenge faced by the teachers.
3. Power supply: 24 (57.1%) disagreed that frequent power failure in their school prevents them from using ICT tools, 5 (11.9%) strongly disagreed, 8 (19%) were indecisive but 5 (11.9%) agreed. This suggests that the availability of reliable power supply is not a significant challenge for teachers.
4. Technical support and IT expertise: 17 (40.5%) were undecided about no reliable technical support in using ICT in their teaching, while 12 (28.6%) agreed to this statement, 3 (7.1%) strongly agreed, 9 (21.4%) disagreed and 1 (2.4%) strongly disagreed. This suggests that technical support may be a challenge for some teachers. Also, 18 (42.9%) disagreed that expertise teachers were not ready to teach others in using ICTs, 11 (26.2%) agreed, 6 (14.3%) strongly agreed, 6 (14.3%) were indecisive and 1 (2.4%) strongly

disagreed. This suggests that help from expertise teachers is not an issue in the schools.

5. ICT Integration: 26 (61.9%) disagreed that they cannot integrate ICT in their teaching, 4 (9.5%) strongly disagreed, 8 (19%) were indecisive, 3 (7.1%) strongly agreed and 1 (2.4%) strongly agreed.
6. Embarrassment: 18 (42.9%) disagreed that they could be embarrassed when things go wrong with ICTs in their teaching, while 11 (26.2%) were undecided, 9 (21.4%) agreed, 3 (7.1%) strongly disagreed and 1 (2.4%) strongly agreed. This suggests that teachers may not be too concerned about being embarrassed when using ICTs in their teaching.
7. Training and motivation: 22 (52.4%) agreed that they are encouraged by other teachers to use ICT in their teaching, 10 (23.8%) disagreed, 6 (14.3%) were indecisive, 3 (7.1%) strongly agreed and 1 (2.4%) strongly disagreed. Though, 12 (28.6%) agreed that they are not motivated by the head teacher to use ICT in their teaching, 11 (26.2%) disagreed, 11 (26.2%) strongly disagreed, 4 (9.5%) strongly agreed and 4 (9.5%) were indecisive. Also, 12 (28.6%) of the teachers agreed that there are not enough ICT training opportunities by the GES for teachers, 6 (14.3%) strongly agreed, 13 (31%) were indecisive, whiles 8 (19%) disagreed, 3 (7.1%) strongly disagreed. This suggests that training and motivation may be significant challenges faced by the teachers in the integration ICTs in their teaching.

From Table 11, the results shows that a significant portion of teachers (47.6%) agreed or strongly agreed that they do not have enough time to use ICT in their teaching. This aligns with findings from a study by Teo (2009) on modelling technology acceptance in education that cited time constraints as a common barrier to technology

integration in education. He pointed that teachers often face heavy workloads and may struggle to find the time to explore and incorporate new technologies effectively. Interestingly, a majority of teachers (76.2%) disagreed or strongly disagreed that age or lack of skills hinders their ability to integrate ICT. This contradicts a study by Russell et al., (2011) on examining teacher technology use. They claimed that older teachers may struggle more with technology adoption. Most teachers (69%) disagreed or strongly disagreed that power failures or lack of technical support hinder their use of ICT. This finding contrasts with the study by Zhao et al. (2002) on conditions for classroom technology innovations that highlighted infrastructure challenges, such as unreliable power and lack of IT support, as major barriers to technology integration.

A majority of teachers (76.2%) felt encouraged by other teachers to use ICT in their teaching, while a smaller percentage (47.6%) felt motivated by their head teacher. This emphasizes the study by Ertmer and Ottenbreit-Leftwich (2010) on teacher technology change that highlighted on the importance of peer support and suggests that a supportive school culture can positively influence technology integration efforts. Also, a significant portion of teachers (42.9%) agreed or strongly agreed that there are not enough ICT training opportunities provided by the Ghana Education Service (GES). This echoes findings from the study by Tondeur et al. (2016) on a comprehensive investigation of teachers' technology acceptance that emphasize the importance of ongoing professional development and training for teachers to effectively integrate technology into their pedagogy.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter is made up of the summary of the findings of the study, the conclusions that were drawn and the suggested recommendations and areas for further studies.

5.1 Summary of the Study

The study is more related to examine the challenges Integrated Science teachers face in the integration of ICTs in their teaching and learning. Furthermore, it examines what ICT tools are available to teachers for their lesson delivery and determined the extent to which Integrated Science teachers integrate ICTs in their lesson delivery.

In relation to the challenges Integrated Science teachers face during their lesson delivery, the study came out with the following findings as the main factors: lack of time to use ICTs in teaching, lack of technical support, lack of motivation to use ICTs, lack of ICT integration training opportunities, unavailability of basic ICT tools, ICTs not accessible to use by students, faulty ICT tools dominant in school and poor internet connection for researches. The least factors include: teacher's age, teacher's IT skills, possibility of embarrassment, lack of assistance from IT expertise, use of ICTs in teaching, no encouragement from other teachers to use ICTs, frequent power failure and poor access to ICT tools.

5.2 Findings

SHS Integrated Science Teachers use of ICTs in the Teaching and Learning of Integrated Science

In examining whether teachers use ICTs to teach, it was noticed that even though teachers are willing to use ICTs, scanty time for teaching do not permit them to use

ICT. This is because they had to move these tools from class to class and had to set up all over again. Another important issue was that ICT tools needed for teaching were not sufficient in every school. Motivation from head teachers and trainings for ICT use was very low in all the schools that took part in the study. The study also revealed that even though some teachers get to use the internet for teaching, prepare notes for teaching, the extent to which teachers use them to teach Integrated Science is very low.

ICT tools are not available and accessible to teachers and students for teaching and learning

It was revealed in the study that most of the ICT tools in the schools are faulty and cannot be used. Internet connection was responded to be poor in the classrooms and laboratories where ICTs can be used. Students also confirmed that though they can get access to ICTs to learn some Integrated Science concepts for better understanding, they are restricted or prevented from getting access to them. Also, the issue of insufficient ICT tools like projectors and others slows down teacher's rate of using ICT in their teaching.

Teachers' perception on ICT usage in their teaching and learning

Majority of the teachers were in support of using ICTs in teaching and learning of Integrated Science. However, it was surprising to identify that quite a number of them were concerned of the possibility to be embarrassed if anything goes wrong when they use ICTs to teach. Others also reported that they are too old to use ICTs and they have accepted that ICTs are for the young teachers. Some of them also claimed to the fact that they need other teachers to encourage them to use ICTs without "fear or favour".

5.3 Conclusions

The study revealed that while basic ICT infrastructure is available in most schools, access to them and integration of technology in instructional practices remain areas of improvement for effective integration of ICT in science education. Also, the availability of ICT tools in various places within the schools is not consistent, which could lead to unequal access for students.

These findings highlight the need for schools to invest in providing adequate and equitable access to ICT tools and resources for all students.

It can also be concluded that; even though, most of the teachers had some basic ICT tools for teaching they could not use them for their lesson delivery. It was also observed the projectors were not enough for teachers in all schools, though teachers come to teach in the hope of getting them to project their notes and so there is the need for sufficient projectors in the schools.

The results of the study further showed that, the aged teachers need some sort of encouragement, consistent trainings and motivations to boost their confidence level to use ICTs. In addition, the study revealed that none of the teachers or students have seen or used smart boards before.

5.4 Recommendations

It is recommended that schools with limited ICT tools should design their time table in such a way that the least available resources like projectors can be equally used by all the Integrated Science teachers in their teaching processes; thus, Integrated Science should not be clashing so that both teachers and students will be part of the technology age. In other ways, these limited ICT tools should have a special scheduled routine of usage by teachers so that it can be equally used by all of them

this can prevent competition and promote fairness to all teachers and students.

Also, it is recommended that schools that lack some ICT tools can collaborate with schools that are more endowed with ICT tools and are closer, to go into such schools to use these ICT tools. This will ensure that no student will be deficit in this Information Technology age in the Senior High Schools Also, this will enhance effective teaching and learning process since IT is the basic stage of equipping the students with the necessary skills and knowledge for national development.

Again, the National Council for Curriculum and Assessment (NaCCA) of the Ghana Education Service in collaboration with the Ministry of Education should review the Integrated Science curriculum and revise the syllabus to explicitly state what ICT tools must be used and how it should be used in the teaching and learning process. They should also make the use of ICT compulsory for all Integrated Science teachers with intense supervision to eliminate the reluctance of teachers to use ICTs in their instructional processes.

It is also recommended that ICT integration workshops and seminars should be provided exclusively for the aged teachers because it will give them the opportunity to air their problems confidently in these seminars to be addressed individually once they see that they are all at the same level. This could also cause most of them to be motivated as they notice that some of them are ahead and picking up with the trainings. This is very important because these teachers are still in the educational system and will have to push these students to meet up with the technology age such that none of them will be left behind.

Finally, modern ICT laboratories should be built for our Senior High Schools to accommodate enough students at a time looking at their population size for effective

and efficient teaching and learning environment. Also, the provision of modern ICT tools in these laboratories will cause Ghanaian students to catch up with the global Information Technology such that no one is left out.

5.5 Suggestions for Further Studies

The following are the suggestions for further studies:

i. It is suggested that this should be replicated in other districts in the Central Region because only four out of twenty districts in the region have been done and could not be used for generalization

ii. It is also suggested that this study should be done in all the Senior High Schools in Ghana since few of the have been undergone this study.

iii. It is suggested that the study should be replicated in other subject areas in the Senior High Schools.

iv. It is suggested that this study should be done in the basic and tertiary institutions of Ghana.

REFERENCES

Ackom, E. K. (2016). The role of education in socio-economic development: A case study of Ghana. *Journal of Education and Practice*, 7(5), 101-110.

Addey, J., & Tetteh, E. (2019). Free senior high school policy and access to education in Ghana: A study of the students with disabilities in selected public senior high schools in the Greater Accra Region. *International Journal of Special Education*, 34(2), 337-352.

Adebi-Caesar, T. E. (2012). *Assessment of ICT situation in senior high schools.* Kwame Nkrumah University of Science and Technology: Unpublished thesis submitted to institute of distance learning, in partial fulfilment for the degree of Commonwealth Executive Master of Business Administration.

Adei, S. (2007). Educational reforms in Ghana: Past and present. *Journal of Educational Administration*, 45(6), 674-693.

Adu-Gyamfi, S. (2012). Educational policy and planning in Ghana. *International Journal of Humanities and Social Science*, 2(22), 176-181.

Adu-Gyamfi, S. (2018). Educational policies and the quality of basic education in ghana: An analysis of some key issues and challenges. *SAGE Open*, 8(3), 2158244018799479.

Adu-Gyamfi, S. (2019). The impact of ict training on basic school teachers' attitudes and beliefs toward ict use in the Sunyani Municipality, Ghana. *Journal of Education and Learning*, 8(2), 103-113.

Adu-Gyamfi, S. (2019). The role of ICT in improving students' performance in mathematics at the basic education level in Ghana: A case study of basic schools in the Kwabre East Municipality. *Journal of Education and Practice*, 10(10), 63-71.

Adu-Gyamfi, S., & Aheto, M. K. (2017). *Colonialism and education: The case of the Gold Coast (Ghana).* In African Histories and Modernities, 119-134. Palgrave Macmillan, Cham.

Agyei, D. D., & Voogt, J. (2011). ICT use in the teaching pf mathematics:Implications for professional development of pre-service teachers in Ghana. *Education and Information Technology*, 423-439.

Agyei, D. E., & Agyei, D. D. (2019). Feasibility of ICT use in teaching physics at the senior high schools in Ghana. *International Journal of Education, Learning and Development*, 26-42.

Akçayır, M., & Akçayır, G. (2017). Advantages and challenges associated with augmented reality for education: A systematic review of the literature. *Educational Research Review*, 20, 1-11.

Akyeampong, K., Djangmah, J. S., Seidu, A., & Hunt, F. (2013). Access to basic education in Ghana: Politics, policies, and progress. *International Journal of Educational Development*, 33(3), 277-286.

Alabi, S., et al. (2021). Digital inclusion in education*: Challenges and opportunities*.

Allen, I. E., & Seaman, J. (2017). Digital Learning Compass*: Distance education enrollment report 2017*. Babson Survey Group.

Amankwah, E. O. (2017). *Historical development of education in Ghana*. In Handbook of Education Systems in Africa 1-16. Springer.

Amuzu, A. K. (2018). *Technical and vocational education and training in Ghana: Implication for sustainable development.* In Handbook of Technical and Vocational Education and Training Research 1-18. Springer.

Anamuah-Mensah, J. (2015). Strengthening science, technology, and mathematics education in Ghana: *A comprehensive approach.* Ghana Education Service.

Anderson, J., et al. (2018). Technology and education: *Effects of hardware and software on student achievement.*

Ary, D., Jacobs, L. C., Sorensen, C., & Razavieh, A. (2010). *Introduction to Research Education.* Canada: Wadsworth, Cengage Learning.

Asabere-Ameyaw, A., Asabere-Ameyaw, A., & Boateng, F. O. (2016). Teacher professional development in Ghana: Perceptions and experiences of science Teachers. *International Journal of Education and Research*, 4(4), 171-186.

Asabere-Ameyaw, A., Mavuru, L., & Kwansa, J. (2014). Problems and prospects of science education in Ghana: *An overview*. Problems of Education in the 21st Century, 63, 13-24.

Asamoah, D. A. (2019). Assessing the impact of ICT on teaching and learning in the New Juaben Municipality of Ghana: A case study of the eastern regional library. *Journal of Education and Practice,* 10(4), 39-45.

Asamoah, D. A. (2019). The influence of ICT on teaching and learning in Ghanaian Schools: A case study of the New Juaben Municipality in the Eastern Region of Ghana. *Journal of Education and Practice*, 10(2), 129-134.

Asante, S. K. B. (2015). *The historical development of education in Ghana.* In The Palgrave Handbook of Education Law for Schools, 245-265.

Awuah, K. G. (2018). Assessment of the use of ICT in the teaching and learning of mathematics in basic schools in the Ashanti Mampong Municipality. *International Journal of Computer Applications in Education*, 2(2), 80-96.

Baker, R. S., D'Mello, S. K., Rodrigo, M. M. T., & Graesser, A. C. (2010). Better to be frustrated than bored: The incidence, persistence, and impact of learners'

cognitive–affective states during interactions with three different computer-based learning environments. *International Journal of Human-Computer Studies,* 68(4), 223-241.

Balanskat, A., Blamire, R. & Kefala, S. (2006). *A review of studies of ICT impact on schools in Europe*. European Schoolnet: European Communities.

Balanskat, A., Blamire, R., & Kefala, S. (2006). The ICT impact report: *A review of studies of ICT impact on schools in Europe.*

Barfi, K. A., Amenu, A., & Arkorful, V. (2020). Assessing the integration of ICT resources in teaching and learning in selected senior secondary schools in Cape Coast Metropolis. *Library Philosophy and Practice (e-journal),* 41,11.

Bates, A. W. (2015). *Teaching in a digital age*: *Guidelines for designing teaching and Learning*. BCcampus.

Bauer, J., & Kenton, J. (2005). Toward technology integration in the schools: Why it isn't happening. *Journal of Technology and Teacher Education*, 13(4), 519-546.

Bawuah, B. (2017). The use of ICT by teachers in teaching and learning: A case study of Sekondi-Takoradi Metropolis. *International Journal of Information and Communication Technology Research,* 7(1), 60-65.

Baylor, A. L., & Ritchie, D. (2018). *What factors facilitate meaningful integration of technology to support inquiry-based learning in the classroom*. Computers & Education, 126, 89-103.

Bayuo, J., Samari, J., & Abukari, M. A. (2018). Computer technology use and its challenges in science education at rural and urban senior high schools in the Upper East Region of Ghana. *Journal Of Education Review*, 13-23.

Becker, H. J. (2000). *Pedagogical motivations for student computer use that lead to student engagement*. Educational Technology, 40(5), 5-17.

Becker, H. J. (2000). *Pedagogical motivations for student computer use that lead to student engagement*. Educational Technology, Research and Development, 48(3), 45-72.

Becker, H. J. (2015). Innovative educational technology: *Are researchers and developers asking the right questions.* Contemporary Issues in Technology and Teacher Education, 15*(*2), 126-141.

BECTA (2004). *A review of the research literature on barriers to the uptake of ICT by teachers.* Retrieved on May 18, 2022 from https://partners.becta.org.uk/page_documents/research/barriers.pdf

Beggs, T. A. (2000). *Influences and barriers to the adoption of Instructional Technology*. Retrieved on May 18, 2022 from https://www.mtsu.edu/itconf/

proceed00/beggs.html

Beldarrain, Y. (2006). Distance education trends*: Integrating new technologies to foster student interaction and collaboration.* Distance Education, 27(2), 139-153.

Bingab, N. B. (2018). Empowering teachers with information and communication technology tools for effective teaching and learning: The case of two basic schools in the Wa Municipality. *International Journal of Education and Research,* 6(3), 137-148.

Bingab, N. B. (2018). The role of information and communication technology in improving basic school students' academic performance: A case study of the Wa Municipality. *International Journal of Education and Research,* 6(3), 149-160.

Blikstein, P., Worsley, M., Piech, C., Sahami, M., Cooper, S., & Koller, D. (2014). Programming pluralism: Using learning analytics to detect patterns in the learning of computer programming. *Journal of the Learning Sciences*, 23(4), 561-599.

Boateng, R., Dankwa, K. O., & Twum, P. (2018). Integrating ICT into teaching and learning: The case of ICT trained teachers in Ghana. *Journal of Education and Practice,* 9(19), 28-35.

Bryington, A. A., Palmer, D. J. & Watkins, M. W. (2002). *The estimation of interobserver agreement in behavioral assessment.* The Behavior Analyst Today, 3(3), 323-328.

Buabeng-Andoh, C., & Yidana, I. (2015). Teachers' ICT usage in second-cycle institutions in Ghana: A qualitative study. *International Journal of Education and Development using Information and Communication Technology (IJEDICT),* 104-112.

Chai, C. S., Koh, J. H. L., & Tsai, C. C. (2010). *Facilitating preservice teachers' development of technological, pedagogical, and content knowledge (TPACK).* Educational Technology & Society, 13(4), 63-73.

Chiang, T. H. C. (2019). *An innovative approach to enhancing English language learning through a virtual reality-based gamification platform*. Interactive Learning Environments, 27(7), 965-981.

Christensen, C. M., Horn, M. B., & Johnson, C. W. (2008). *Disrupting class: How disruptive innovation will change the way the world learns*. McGraw-Hill.

Council for Technical and Vocational Education and Training, COTVET (2011). *Prejudice and prestige: Vocational education and training in Ghana* retrieved from en.m.wikipedia.org on 5 August 2023

Crompton, H. (2014). *A historical overview of mobile learning: Toward learner-*

centered education. In Handbook of Mobile Learning, 3-14. Routledge.

Cuban, L. (2001). *Oversold and Underused: Computers in the Classroom*. Harvard University Press.

Dalgarno, B., & Lee, M. J. W. (2010). What are the learning affordances of 3-D virtual environments. *British Journal of Educational Technology*, 41(1), 10-32.

Davis, N., Preston, C., & Sahin, I. (2013). *Innovative professional development programs for teachers: Models and cases*. IGI Global.

Dillenbourg, P., Järvelä, S., & Fischer, F. (2009). *The evolution of research on computer-supported collaborative learning*. In Technology-Enhanced Learning, 3-19. Springer.

Downes, S. (2016). *Learning platforms as technologies of personal learning.* In Handbook of Research on Learning Outcomes and Opportunities in the Digital Age, 1-20. IGI Global.

Dzandu, M. D. (2017). The role of information and communication technology (ICT) in education in Ghana - A case study of the University of Education, Winneba. *Research Journal is Journal of Education*, 5(3), 1-14.

Entsie, G. (2015). *The impact of integrating information and communication technology into the teaching and learning of biology in Ghanian Senior High School*. Retrieved from https://ir.uew.edu.gh/xmlui/handle/123456789/ 668

Ertmer, P. A. (2005). *Teacher Pedagogical Beliefs: The Final Frontier in Our Quest for Technology Integration.* Educational Technology Research and Development, 53(4), 25–39.

Ertmer, P. A. (2010). *Teacher pedagogical beliefs: The final frontier in our quest for technology integration.* Educational Technology Research and Development, 58(2), 231-243.

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2013). *Removing obstacles to the pedagogical changes required by Jonassen's vision of authentic technology-enabled learning.* Computers & Education, 64, 175-182.

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, 42(3), 255-284.

Ertmer, P. A., Ottenbreit-Leftwich, A. T., & Tondeur, J. (2012). *Teachers' beliefs and uses of technology to support 21st-century teaching and learning*. International Handbook of Research on Teachers' Beliefs, 403-418.

European Commission. (2013). Opening up education: *A support framework for higher education institutions.* Publications Office of the European Union.

Ferguson, R., & Shum, S. B. (2012). *Social learning analytics: Five approaches*. In Proceedings of the 2nd International Conference on Learning Analytics and Knowledge (LAK '12), 23-33.

Friedman, A., & Kagan, M. (2017). *Addressing the shortage of IT expertise in K-12 education.* Education Week.

Garrison, D. R., & Anderson, T. (2003). E-learning in the 21st century: *A framework for research and practice*. Routledge.

Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *The Internet and Higher Education, 7*(2), 95-105.

Gay, G. (2010). *Culturally responsive teaching: Theory, research, and practice (2nd ed.).* Teachers College Press.

Gay, G. (2002). Preparing for culturally responsive teaching. *Journal of Teacher Education, 53*(2), 106-116.

Ghana Education Service (2014). *Basic education curriculum*. Retrieved from https://www.ges.gov.gh on 5 August 2023

Ghana Education Service. (2007). *National science education policy*. Accra: GES.

Ghana Education Service. (2012). *Ghana Education Service syllabus for integrated science*. Accra: GES.

Ghavifekr, S., & Rosdy, W. W. (2015). Teaching and learning with technology: effectiveness of ICT in schools. *International Journal of Research in Education and Science*, 175-191.

Gyamfi, S. A. (2017). The Impact of ICT on students' academic performance at university level: A case study of the University of Ghana. *Journal of Education and Practice,* 8(6), 105-112.

Gyimah-Brempong, K. (2011). Science and technology education in Ghana. *Science Education International,* 22(1), 18-26.

Hammond, Z. (2015). *Culturally responsive teaching and the brain: Promoting authentic engagement and rigor among culturally and linguistically diverse students*. Corwin Press.

Harley, D., Henke, J., Lawrence, S., McMartin, F., Maher, M., Gawlik, M., & Hruska, C. (2016). *Peer review and scholarly publication of digital materials: A white paper from the center for the study of digital libraries.* Computers and the Humanities, 50(3), 343-370.

Hennessy, S., Harrison, D., & Wamakote, L. (2010). Teacher factors influencing classroom use of ICT in Sub-Saharan Africa. *Itupale Online Journal of African Studies, 2*(1), 39-54.

Herrera-Seda, C., & Valcarcel-Carrasquillo, P. E. (2016). Assessment strategies in an ICT-rich learning environment: Experiences from a physics classroom. Education and Information Technologies, 21(1), 87-101.

Hilton, III, J. (2016). Open educational resources and college textbook choices: A review of research on efficacy and perceptions. *Educational Technology Research and Development,* 64(4), 573-590.

Hilton, J., Graham, C., Rich, P., & Wiley, D. (2016). Using online technologies to extend a classroom to learners at a distance. *Distance Education*, 37(2), 167-185.

Hosseini, M., Lee, J. J., & Wible, D. (2017). The effect of computer simulations on high school chemistry students' understanding of acids and bases. *Journal of Science Education and Technology,* 26(2), 146-157.

Huang, W., & Looi, C. K. (2017). Developing e-learning materials: *Some insights from an analysis of the national digital literacy programme in Singapore*. In Learning, Design, and Technology, 209-224. Springer.

Inan, F. A., & Lowther, D. L. (2010). Factors affecting technology integration in K-12 classrooms: A path model. *Educational Technology Research and Development,* 58(2), 137-154.

Jegede, P., Dibu-Ojerindo, O & Llory, M. (2007). Relations between ICT competence and attitude Nigerian tertiary institution lectures. *Education Research and Review*, 2(7), 172-175

Johnson, M., et al. (2019). *Smart boards in education: Enhancing learning experience*

Johnson, D. W., Smith, K. A., Levine, A., & Haywood, K. M. (2003). The cooperative learning center. *Clearing House, 76*(3), 149-153.

Junco, R., Heiberger, G., & Loken, E. (2011). The effect of twitter on college student engagement and grades. *Journal of Computer Assisted Learning*, 27(2), 119-132.

Kahindo, J. M. (2018). Cloud-based e-learning platform for secondary schools in Tanzania. *In Proceedings of the International Conference on Computing and Wireless Communication Systems,* 139-146. Springer.

Kapasia, N. (2019). E-Learning Mobile Application: Design and development for the indian engineering students. *Advances in Computer Vision*, 223-233. Springer.

Kaplan, A. M., & Haenlein, M. (2010). *Users of the world, Unite! The challenges and opportunities of social media.* Business Horizons, 53(1), 59-68.

Kim, M. K., & Sin, S. C. J. (2015). Interactive features of e-books and learning effectiveness. *Computers & Education*, 82, 216-228.

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education*, 9(1), 60-70.

Koehler, M. J., & Mishra, P. (2008). Introducing TPCK. *In AACTE committee on innovation and technology (Eds.)*, Handbook of technological pedagogical content knowledge (TPCK) for educators (pp. 3-29). Routledge.

Korte W. B. & Husing, T. (2007). *Benchmarking access and use of ICT in european schools 2006: Results from head teacher and a classroom teacher surveys in 27 European Countries*. eLearning Papers, 2(1), 1-6.

Kozma R. (2005). National policies that connect ICT-based education reform to economic and social development. *Human Technology*, 1(2), 117-156

Krotov, V. (2017). *Internet access and usage in developing countries*. In Global Encyclopedia of Public Administration, Public Policy, and Governance 1-6. Springer.

Kumar, A., & Tjandra, N. C. (2018). *Enhancing learning with visuals: The case of PowerPoint in Science teaching*. In Handbook of Research on Instructional Systems and Educational Technology (pp. 236-252). IGI Global.

Kumar, A., & Kumar, P. (2016). *Development and implementation of e-learning platform for engineering education.* In Emerging Trends in Science, Engineering, and Technology, 89-98. Springer.

Kumar, V., Schreiber, A., & Händel, M. (2011). Challenges in designing and using mobile interfaces for resource constrained users. *International Journal of Human-Computer Studies*, 69(11), 685-702.

Kwabla, A. (2016). The role of ICT in achieving the sustainable development goal of quality education in Ghana. Research and Reviews: *Journal of Educational Studies*, 2(4), 1-10.

Kwamena, F. (2018). Teachers' use of information and communication technology in basic schools in the Ga West Municipality, Ghana. *International Journal of Educational Technology in Higher Education*, 15(1), 24.

Kwamena, F. (2018). The use of information and communication technology (ICT) in teaching and learning mathematics in selected basic schools in the Ga West Municipality, Ghana. *Journal of Education and Practice*, 9(3), 78-85.

Lai, C. H., & Chen, C. W. (2017). *Investigating the learning effectiveness of augmented reality applications in K-12 education: A systematic review.* Computers & Education, 125, 55-67.

Larweh, B. T. (2018). E-learning in Ghana: Past, present and future. *International Journal of Education and Research*, 6(10), 127-140.

Liu, M. (2009). Cultural factors and learning in technology-enhanced learning environments: 4 cases. *Journal of Research on Technology in Education,* 41(1), 1-21.

Liyanagunawardena, T. R., Adams, A. A., & Williams, S. A. (2013). MOOCs: A systematic study of the published literature 2008-2012. *The International Review of Research in Open and Distributed Learning,* 14(3), 202-227.

Liyanagunawardena, T. R., Williams, S. A., & Adams, A. A. (2018). The impact and reach of MOOCs: A developing countries' perspective. *eLearning Papers,* 53, 5-13.

Lynch, R. (2017). The role of multimedia in science education: A survey of teachers' and students' perceptions. *Interdisciplinary Journal of E-Learning and Learning Objects,* 13(1), 1-15.

Lynch, S., Kuipers, J., Pyke, C., & Szesze, M. (2007). Examining the effects of a highly interactive computer simulation on diverse middle school students' science knowledge, vocabulary, and concept generation. *Journal of Research in Science Teaching*, 44(7), 983-1009.

Malcolm, E., & Godwyll, F. (2008). *Diffusion of information communication technology in selected Ghanaian schools.* Ohio University: Unpublished Doctoral Dissertation.

Margaryan, A., Littlejohn, A., & Vojt, G. (2011). Are digital natives a myth or reality: University students' use of digital technologies. *Computers & Education*, 56(2), 429-440.

Mayer, R. E. (2017). Using multimedia for e-learning. *Journal of Computer Assisted Learning*, 33(5), 403-423.

Mayer, R. E. (2019). *Multimedia learning*. Cambridge University Press.

Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2013). *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies*. US Department of Education.

Mensah, F. S. (2017). Ghanaian mathematics teachers' use of ICT in instructional delivery. *Global Journal of Human-Social Science, XVII(VIII), 31*. Retrieved OCTOBER WEDNESDAY, 2021, from https://www.researchgate.net/publication/321384034

Ministry of Education, Ghana. (2019). *Pre-tertiary education curriculum framework.* Accra, Ghana.

Ministry of Education, Ghana (2017). *The free senior high school policy*. Implementation Progress Report.

Ministry of Education. (2015). *Ministry of Education Youth and Sports.* Accra: Government of Ghana White Paper.

Ministry of Education. (2010). *Teaching syllabus for integrated science (senior high school).* Accra, Ghana: Curriculum Research and Development Division.

Mishra, P., & Koehler, M. J. (2006). *Technological pedagogical content knowledge: A framework for teacher knowledge*. Teachers College Record, 108(6), 1017-1054.

Moen, W. E. (2019). *Digital Libraries*. In Encyclopedia of Information Science and Technology (4th ed.), 181-191. IGI Global.

Molnar, A., & Kletskin, I. (2016). *Technology-driven educational reform in post-soviet Kyrgyzstan.* In Handbook of Research on Education and Technology in a Changing Society, 20-35. IGI Global.

Moss, G., & Jewitt, C. (2012). *Designing for multimodal learning: The role of genre and discourse*. In the routledge handbook of multimodal analysis, 289-302. Routledge.

Natia, J. A., & Al-hassan, S. (2015). Promoting teaching and learning in Ghanaian basic schools through ICT. *International Journal of Education and Development using Information and Communication Technology*, 113-125.

Niess, M. L., van Zee, E. H., & Gillow-Wiles, H. (2010). Knowledge growth in teaching mathematics/science with spreadsheets: Moving PCK to TPACK through online professional development. *Journal of Digital Learning in Teacher Education*, 26(2), 54-63.

Nouri, J. (2016). The flipped classroom: For active, effective, and increased learning—especially for low achievers. *International Journal of Educational Technology in Higher Education,* 13(1), 33-45.

Ntow, S. S. (2009). Basic education and human resource development in Ghana. *In M. Carnoy & T. Loyalka (Eds.), The Status of Education in Ghana,* 57-90. World Bank.

NUFFIC (2013). Country module: Ghana (PDF). Netherlands organization for international cooperation in higher education. *Archived from the original (PDF)*. Retrieved from en.m.wikipedia.org/wiki/Education_in_Ghana on 5 August 2023.

Obeng , A. K., Monnie, A., & Ekuban , S. (2008). *Integrated science for senior high schools.* Accra: Approacher's Series.

Opoku, M. P. (2016). ICT Education in Ghana: An evaluation of challenges associated with the teaching and learning of ICT in basic schools in Atwima Nwabiagya District in Ashanti Region. *European Journal of Alternative Education Studies*, 7-27.

Organisation for Economic Co-operation and Development. (2015*). Students, computers and learning: Making the connection.*

Owusu-Acheaw, M., & Larson, A. G. (2015). Use of social media and its impact on academic performance of tertiary institutions students*:* A study of students of Koforidua Polytechnic, Ghana. *Journal of Education and Practice, 6*(6), 94-101.

Pachler, N., Bachmair, B., & Cook, J. (2010). Mobile learning: Structures, agency, practices. Springer Science & Business Media.

Pelgrum, W. & Law, N. (2003). *ICT in Education around the world: Trends, Problems and Prospects*. Paris: UNESCO, International Institute for Educational planning.

Pelgrum, W. R. (2001). Obstacles to the integration of ICT in education: Results from a worldwide educational assessment, *Computers and Education*, 37(2), 163-178.

Pelgrum, W. J., & Law, N. (2003). *ICT in education around the world: Trends, problems and prospects*. UNESCO.

Prensky, M. (2001). Digital natives, digital immigrants. *On the horizon*, 9(5), 1-6.

Raddick, M. J., Bracey, G., Gay, P. L., Lintott, C. J., Murray, P., Schawinski, K., & Vandenberg, J. (2010). Galaxy Zoo: Exploring the motivations of citizen science volunteers. *Astronomy Education Review*, 9(1), 010103.

Reeves, T. C., & Herrington, J. (2010). *Authentic activities and online learning.* Routledge.

Reinders, H., Watt, E., & Canning, N. (2018). From access to success: The impact of digital resources on student learning. *The International Review of Research in Open and Distributed Learning*, 19(1).

Republic of Ghana. (2010). *Ghana Education Strategic Plan (2010-2020): Investing in Education for National Development.* Ministry of Education, Ghana.

Reynolds, D., Treharne, D., & Tripp, H. (2003). ICT-the hopes and the reality. *British Journal of Educational Technology*, 34, 151-167.

Rose, D. H., & Meyer, A. (2002). *Teaching every student in the digital age: Universal design for learning*. Association for Supervision and Curriculum Development.

Russell, M., Bebell, D., & Higgins, J. (2011). Examining teacher technology use: Implications for preservice and inservice teacher preparation. Journal of Teacher Education, 62(4), 392-404.

Sakyi-Hagan, N. A., & Hanson, R. (2020). *Interactive instructional approaches to teaching Integrated Science and their effect on students' performance: A study in a Ghanaian University context*. Retrieved May 18, 2022, from ul.ac.za/aportal/application/download/.

Sampson, D. G., Karagiannidis, C., Kinshuk, & Ifenthaler, D. (2014). Adaptive and adaptable learning: Editorial to the special issue. *Educational Technology & Society*, 17(4), 1-2.

Savill-Smith, C., & Kent, P. (2003). The use of handheld computers to support mobile learners. *Journal of the Royal Society Interface*, 1(3), 243-251.

Schrum, L., & Levin, B. B. (2013). *Leading 21st-century schools: Harnessing technology for engagement and achievement*. SAGE Publications.

Siemens, G., & Gasevic, D. (2012). Guest editorial—learning and knowledge analytics. *Educational Technology & Society*, 15(3), 1-2.

Simin, G., Thanusha, K., Logeswary, R., & Anreetha, A. (2016). Teaching and learning with ICT tools: Issues and challenges from teachers' perceptions. *Malaysian Online Journal of Educational Technology*, 38-57.

Smetana, L. K., & Bell, R. L. (2012). Computer simulations to support science instruction and learning: A critical review of the literature. *International Journal of Science Education*, 34(9), 1337-1370.

Spires, H. A., Lee, J. K., Turner, K. A., & Johnson, J. (2008). Having our say: Middle grade student perspectives on school, technology, and academic engagement**.** *Journal of Research on Technology in Education, 40*(4), 497-515.

Squire, K., & Jan, M. (2007). Mad city mystery: Developing scientific argumentation skills with a place-based augmented reality game on handheld computers. *Journal of Science Education and Technology*, 16(1), 5-29.

Steinkuehler, C., & Duncan, S. (2008). Scientific habits of mind in virtual worlds. *Journal of Science Education and Technology*, 17(6), 530-543.

Suber, P. (2012). *Open Access*. MIT Press.

Tal, T., & Kedmi, Y. (2006). Exploring dynamic modeling tools for enhancing student learning of complex biological systems. *Journal of Science Education and Technology*, 15(1), 45-58.

Tamim, R. M., Bernard, R. M., Borokhovski, E., Abrami, P. C., & Schmid, R. F. (2011). What forty years of research says about the impact of technology on learning: A second-order meta-analysis and validation study. *Review of Educational Research,* 81(1), 4-28.

Tenopir, C., King, D. W., Edwards, S., & Wu, L. (2009). Electronic journals and changes in scholarly article seeking and reading patterns. *Aslib Proceedings,* 61(1), 5-32.

Teo, T. (2011). *Factors influencing teachers' intention to use technology: Model development and test*. Computers & Education, 57(4), 2432-2440.

Teo, T. (2009). *Modelling technology acceptance in education: A study of pre-service teachers*. Computers & Education, 52(2), 302-312.

Tondeur, J., van Braak, J., Sang, G., Voogt, J., Fisser, P., & Ottenbreit-Leftwich, A. (2017). The role of ICT in higher education: A focused literature review. *International Journal of Educational Technology in Higher Education*, 14(1), 58.

Tondeur, J., Siddiq, F., Scherer, R., & Baran, E. (2016). *A comprehensive investigation of teachers' technology acceptance: Testing the TPACK model*. Computers & Education, 108, 113-125.

Tondeur, J., van Braak, J., Sang, G., Voogt, J., Fisser, P., & Ottenbreit-Leftwich, A. (2012). *Preparing pre-service teachers to integrate technology in education: A synthesis of qualitative evidence*. Computers & Education, 59(1), 134-144.

T-TEL. (2019). Transforming Teacher Education and Learning: *Annual Report 2019*.

UNESCO. (2013). *ICT in education toolkit for policymakers, planners, and practitioners.* United Nations Educational, Scientific and Cultural Organization.

UNESCO. (2017). *Education for sustainable development goals: Learning objectives*. UNESCO.

UNESCO (2020). *Education: From disruption to recovery*. https://en.unesco.org/covid19/educationresponse

UNESCO (2020). *Futures of education: Learning to become*.

UNESCO (2020). *Global education monitoring report 2020: Inclusion and education: All means all*. Paris: UNESCO.

UNESCO-UNEVOC (2012). *Vocational education in Ghana*. Retrieved from unevoc-unesco.org on 5 August 2023

United Nations. (2018). *E-government survey 2018*: *Gearing e-government to support transformation towards sustainable and resilient societies*. United Nations Publications.

Van Reijswoud, V. (2009). Appropriate ICT as a tool to increase effectiveness in ICT4D. *The Electronic Journal of Information*, 38, 1–18.

Veletsianos, G., Kimmons, R., Larsen, R., Dousay, T. A., & Lowenthal, P. R. (2018). Digital inequalities in teacher presence in networked publics: The emergence of equity-oriented uses of social media among educators. *Journal of Educational Technology & Society*, 21(4), 264-277.

Wang, C. (2017). Development of e-learning platform in higher education. *In Technology and Engineering Applications of Simulink* 279-287. Springer.

Wang, L., Ertmer, P. A., & Newby, T. J. (2004). Increasing preservice teachers' self-efficacy beliefs for technology integration. *Journal of Research on Technology in Education*, 36(3), 231-250.

Wang, M., Liu, W., & Cheng, Y. (2019). The effect of online scientific inquiry journaling on students' motivation, science process skills, and science achievement. *Research in Science Education*, 49(2), 375-398.

Warschauer, M. (2006). *Laptops and literacy: Learning in the wireless classroom*. Teachers College Press.

West African Examination Council, WAEC (2012). WASSCE – Subjects for examination Retrieved from http://www.ghanawaec.org/EXAMS/WASSCE-aspx on 5 August 2023

Wikipedia. (2023). *Conceptual framework*. Retrieved from WIKIPEDIA: en.m.wikipedia.org/wiki/Conceptual_framework

Wiley, D., & Hilton III, J. L. (2018). Defining OER-enabled pedagogy. *The International Review of Research in Open and Distributed Learning, 19*(4).

World Bank. (2016). *Digital dividends: World development report 2016*. World Bank Publications.

Zhao, Y., Pugh, K., Sheldon, S., & Byers, J. L. (2002). *Conditions for classroom technology innovations*. Teachers College Record, 104(3), 482-515.

Zheng, Y., Li, L., Li, Y., & Yang, Y. (2020). Personalized recommendation in education: A survey. *IEEE Transactions on Emerging Topics in Computational Intelligence*, 4(2), 180-197.

APPENDICES

APPENDIX A

INTRODUCTORY LETTER

UNIVERSITY OF EDUCATION, WINNEBA
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DEPARTMENT OF INTERGRATED SCIENCE EDUCATION
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Our ref. No.: ISED/PG.1/Vol.1/36
Your ref. No.:

6th October, 2022

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

LETTER OF INTRODUCTION
MISS AWAL, JENNIFER ABIBA

We write to introduce, Miss Awal is a MPhil. student of the Department of Integrated Science Education, University of Education, Winneba, who is conducting a research titled:

THE USE OF ICT AND ITS CHALLENGES IN THE TEACHING AND LEARNING OF INTEGRATED SCIENCE IN SELECTED SENIOR HIGH SCHOOLS IN TWO DISTRICTS IN THE CENTRAL REGION.

We would be very grateful if you could give the assistance required.

Thank you.

Yours faithfully,

MS. ALEXANDRA N. DOWUONA
CHIEF ADMINISTRATIVE ASSISTANT
For: HEAD OF DEPARTMENT

APPENDIX B

TEACHER'S QUESTIONNAIRE

I am Jennifer Abiba Awal, a final year student of the University of Education, Winneba Graduate School. I am conducting a survey designed to investigate into the use of ICT and its challenges inthe teaching of Integrated Science. Kindly assist me in your response to this questionnaire.

It may be demanded that I ask you some personal questions but your privacy and confidentiality is assured regarding any information you provide here. Please, this information is solely for research purposes and your anonymity is assured. This would take about five (5) minutes of yourtime. Thank you.

SECTION A

PERSONAL DATA (DEMOGRAPHY)

Please place a tick **[√]** in the appropriate box.

Gender

Male [ ]
Female [ ]

Age

Under 25yrs [ ]
25 – 40yrs [ ]
41 – 60yrs [ ]

Highest Educational Level

HND [ ]
Post Diploma [ ]
Degree [ ]
Masters [ ]

What is the name of your School?

……..

Duration of teaching

Less than 1 year	[ ]
1 – 10 years	[ ]
11 years and above	[ ]

SECTION B

What ICT tools are available to science teachers?

Please place a tick [√] to all that apply**.**

(1) Which of these tools do you personally own as a teacher?

Laptop	[ ]
Desktop computer	[ ]
Tablet or ipad	[ ]
Smart phone	[ ]
Projector	[ ]
Calculator	[ ]
Printer	[ ]
Modem or Mifi	[ ]

(2) What ICT tools are available in your school for teaching?

Internet	[ ]
Projector	[ ]
Laptop	[ ]
Desktop computer	[ ]
Printer	[ ]
Photocopier machine	[ ]
Smart board	[ ]

SECTION C

To what extent do science teachers use ICT in teaching?

Please place a tick [√] to the appropriate response

How long have you been using computers?

Less than 1 year [ ]
1 – 5 years [ ]
6 – 10+ years [ ]

Please place a tick [√] in the appropriate box**.**

ITEMS	RESPONSES	
	TRUE	FALSE
We do not have access to computers in our school		
We have access to internet in our classrooms		
We do not have access to the internet in the science or ICT laboratory		
The internet connection is not strong in the classrooms		
The internet connection is strong in the science or ICT laboratory		
I do not use laptops, smartphones, ipads or tablets when teaching		
I use projectors for PowerPoint presentations		
There are IT experts in my school		

SECTION D

What challenges do Science teachers face in the use of ICTs in their teaching?

Please place a tick [√] to the appropriate response.

ITEMS	RESPONSES				
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
I do not have enough time to use ICTs in my teaching					
I am too old to learn how to integrate ICTs in my teaching					
I do not have the necessary skills to integrate ICTs in my teaching					
There is frequent power failure in my school, hence, ICT tools cannot be used					
Expertise teachers are not ready to teachothers in using ICTs					
There is no reliable technical support inusing ICTS in my teaching					
I can use ICTs but cannot integrate them in my teaching					
I could be embarrassed when things go wrong					
There are not enough ICT training opportunities by the GES for teachers					
I am not encouraged by other teachers touse ICT in my teaching					
We are not motivated by the Head teacher to use ICTs in our teaching					

APPENDIX C

STUDENT'S QUESTIONNAIRE

I am Jennifer Abiba Awal, a final year student of the University of Education, Winneba Graduate School. I am conducting a survey designed to investigate into the use of ICT and its challenges inthe teaching of Integrated Science.

Kindly assist me in your response to this questionnaire. It may be demanded that I ask you somepersonal questions but your privacy and confidentiality is assured regarding any information youprovide here.

Please, this information is solely for research purposes and your anonymity is assured. Thiswould take about five (5) minutes of your time. Thank you.

SECTION A

PERSONAL DATA (DEMOGRAPHY)

Please place a tick **[√]** in the appropriate box.

Gender

Male [ ]
Female [ ]

Age

Under 13yrs [ ]
13 – 16yrs [ ]
17 – 19+yrs [ ]

What is the name of your School?

……

SECTION B

What ICT tools are available to students for learning?

Please place a tick [√] to all that apply**.**

(A) What ICT tools are available in your school for learning?

Internet	[ ]
Projector	[ ]
Laptop	[ ]
Desktop computer	[ ]
Tablet or ipad	[ ]
Smart phone	[ ]
Calculator	[ ]
Printer	[ ]
Photocopier machine	[ ]
Smart board	[ ]

(B) Where can you get access to ICTs in your school?

Classroom	[ ]
Library	[ ]
Science laboratory	[ ]
Assembly hall	[ ]
Dining hall	[ ]

SECTION C

What are the challenges of the integration of ICTs in teaching and learning of IntegratedScience?

Please place a tick [√] in the appropriate box**.**

ITEMS	RESPONSES	
	TRUE	FALSE
There are no prescribed locations in for using ICTs in our school		
We are prevented from using ICTs at the prescribed locations in our school		
Most of the ICT tools in our school are faulty		
The internet connection is not strong at the prescribed locations in our school		
Our teachers do not use any ICT tools when teaching		
There are IT experts who help our teachers to use ICTs in their teaching in our school		

APPENDIX D

CHECK LIST

This checklist consists of behaviours which are expected to occur in this lesson. Kindly tick as appropriate to the behaviours that occurred only. Thank you.

- ☐ Teacher has a tablet for teaching
- ☐ Teacher has a smart phone for teaching
- ☐ Teacher has a laptop for teaching
- ☐ Projector is available for this lesson
- ☐ Teacher had prepared notes, videos or pictures on laptop for projection
- ☐ Teacher projected lesson from the laptop for students
- ☐ Internet is needed for this lesson
- ☐ Internet is used for this lesson
- ☐ Smart phone is used for this lesson
- ☐ Tablet is used for this lesson