UNIVERSITY OF EDUCATION, WINNEBA

SCIENCE TEACHERS' KNOWLEDGE AND INTEGRATION OF ICT TOOLS IN TEACHING INTEGRATED SCIENCE

ABDULAI ISSAH

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DECLARATION

Student`s Declaration

I, Abdulai Issah, declare that this thesis, with exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own work, and that it has not been submitted either In any form elsewhere for another degree in this university or elsewhere.

Signature……

Date……

Supervisors` Declaration

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

Dr. Rosemary Naana Kumi-Manu (Principal Supervisor)

Signature……

Date……

Prof. Clement Ali (Co-Supervisor)

Signature……

Date……

DEDICATION

To God Almighty for His guidance and protection

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ABSTRACT

The study explored the barriers to ICT integration in the teaching of Integrated Science in the Wa Municipality. The study was conducted using the sequential explanatory mixed method design with a sample size of sixty-nine (69) JHS Integrated Science teachers. Data were collected using structured questionnaires and semi-structured interview guides. The instruments were first pilot tested in the Wa West District with twenty (20) teachers to ensure validity and reliability of the items. Tables, frequencies, percentages, mean and standard deviations were used to analyzed the questionnaire data using Statistical Product for Service Solutions (SPSS) version 21. The interview data were transcribed and analyzed. The study found out that integrated science teachers have content knowledge in ICT. The study also found out that the teachers believe ICT integration can improve the quality of teaching and learning with students actively participating during lessons. Even though teachers have content knowledge in ICT, they scarcely use the computer and its accessories to prepare and present lessons in class. The study found out that teachers were faced with many challenges in their efforts to integrate ICT into their teaching such as: inadequacy of ICT tools (computers, projectors, printers) in schools, power fluctuations, inadequate of computer specialists to fix computer problems, inadequate workshops to up-date teachers, poor access to the internet. The study recommended that GES and for that matter Wa Municipal Education Directorate should regularly organize workshops, seminars and in-service trainings on ICT integration for teachers to up-date their knowledge and skills on new technologies. Also, the ministry of Education and donor partners in education in the Wa Municipal Education Directorate should not only assist schools by supplying them with the necessary ICT logistics such as computers, projectors, printers, scanners and others with appropriate software installed but also, provide generators, solar panels, internet connectivity and technical support.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

According to Boahen and Atuahene (2021), the educational potential of information and communication technology (ICT) can be pragmatic in diversity of ways. ICT is influencing education by changing the way of teaching and learning. Schools are making efforts to benefit from the potential power of ICT by integrating it into teaching and learning activities. We live in a time where development is moving fast because of access to ICT. Throughout the world there is awareness of the fundamental role of ICT in the field of education. The use of technology in our world is prevalent and significantly impacts the lives of students in the classrooms. Thus, technology has become a big part of the human life and lifestyle as observed by some scholars (Hansen, 2019; Harmer, 2015). ICT refers to information that is acquired through digital communication and digital tool (Ahlback, 2018). In the context of this study, ICT refers to any electronic equipment that can be used to enhanced teaching and learning: systems that enable easy communication between the teacher and the students beyond the physical barrier (either by space, time or both) of the classroom.

The nature of the 21st century students who are often referred to as digital natives contribute to the changing face of education. In the era of globalization underlying the current wave of monumental change, modern technological paradigm has changed the way people learn, communicate, work and carry out their daily activities. Students of today have become technologically savvy and pro-active users of ICTs. They are seen as „active producers of knowledge" as they become responsible for their learning (Ratheeswari, 2018). Thus, integrated science educators need to plan to address uncertainties by discovering and adapting new ways and process to enhance teaching

and learning integrated science. The popularity and accessibility of modern technology in the 21st century is no longer an issue and the education system of the 21st century requires teachers to integrate ICT into classroom in order to modify their traditional pedagogy with modern ICT tools. We often hear the assertion that we live in the midst of the post-digital era and that the contemporary art is based on new media, so, predictably, the computer has become a basic tool for the artist. The tools and techniques available for integrated science have expanded tremendously with the advent of new hardware and software, and the integration of technological devices into the classroom environment provides unique opportunities to improve teaching and learning.

It is an undisputable fact that ICT play a crucial role in the advancement of every country. "The importance of technology to modern concepts such as e-commerce, teleconferencing, e-governance, and telecommunication have all risen as a result of the application of technology in almost every aspect of human activity" (Boni, 2018, p. 23). Countries all over the world, including Ghana have identified the pivotal role ICT plays in all aspects of human endeavor of which education forms a part.

Opoku, Badu, and Alupo, (2016) noted that the rate at which ICT is developing and its impact on socio-economic activities cannot be overemphasized. The use of ICT in the classroom provides learners with plenty of opportunities to promote their learning and enables them to develop the necessary skills to successfully communicate in this information age which is advancing at a rapid pace.

The United Nation‟s 2030 agenda for sustainable development is mandated to implement ICT towards enhancing national development by all the UN member countries. It is obvious that the UN recognizes the importance of ICT as a vehicle for

nation building as it is visible under goal 17 of the UN international policy framework. The UN aims to augment international cooperation and access to Science, Technology, and Mathematics (STM) through effective integration of ICT. The agenda intends to promote the development, dissemination, transfer and above all the infusion of technologies concerning the sound environment that is also favorable for developing countries (UN, 2016). This means that the UN agenda for 2030 intends to entirely operationalize the technology bank science, technology and innovation capacity building mechanism for the least developed countries by 2030. "This is to enhance the use of enabling technology, in particular information and communications technology" (UN, 2016, p. 31). Ghana, though a developing country, recognizes the importance of Information and Communication Technology to her socio-economic development and in the light of this, the Ghana ICT for Accelerated Development (ICT4AD) policy was formulated with an overall objective to "engineer an ICT-led socio-economic development process with the potential to transform Ghana into a middle income, information-rich, knowledge-based and technology driven economy and society" (Republic of Ghana, 2003, p. 8). The ICT4AD policy which laid the foundation for the famous 2007 educational reform advocates for the integration of ICT in all levels of education to facilitate effective learning and management through the provision of computer labs, internet and network connectivity, the supply of school laptops to teachers and learners, and the capacity development of teachers. The Integrated Science Curriculum proposes ICT use as a pedagogical tool.

The current trends in education require a paradigm shift from the mere supply of ICT tools in education into a comprehensive use of the ICT in education. Mwila (2018) in a study found that integration of ICT in teaching and learning is confronted with

several factors. These include inadequacy of resources, limited experiences from the perspective of teachers and inadequate of technical abilities and skill. The ideology that ICT use can for a fact improve teaching and learning has compelled the Government of Ghana to draft guidelines geared towards the integration of ICT in education. An effective approach to the integration of ICT into teaching and learning is to view the whole process as an interaction between teachers and which technological knowledge needs to be applied in their classrooms.

The availability of ICT facilities in schools will not automatically guarantee their effective use in the teaching and learning processes (Ahiatrogah & Barfi, 2016). There is therefore the need for heads of institutions to supervise the progress of ICT implementation and measure the evaluation results to the ICT plan. However, the observation conducted by the researcher in some schools in Ghana appears to suggest that much is not being done to ensure successful integration of ICT in the teaching and learning of Integrated Science. Inadequate of ICT integration, capacity building workshops and training programmes for teachers, the use of inappropriate equipment and inadequate of infrastructure are among the challenges associated with the integration of ICT in some schools. In most of these studies, it has been revealed that teacher‟s positive attitudes towards the use of ICT were equally associated with their level of computer experiences (Buabeng-Andoh & Yidana, 2015).

Gyamfi (2017) study revealed that teachers who have positive attitudes and are highly enthusiastic about interactive teaching aids or tools for teaching are motivated to use ICT for lesson delivery. In Ghana, the use of ICT in education is fraught with several challenges. Boni (2018) found out that Ghanaian schools which had computer laboratories, the ones accessible to both students and teachers easily got damaged due

to inoperative air-conditioners in the computer laboratories, power fluctuations, obsolete computers and malware attacks. The study also found out that none of the computer laboratories in the 10 schools were connected to a server and only four computers out of 20 computers in one of the schools were connected to the internet. The implementation of ICT tools in pedagogical settings becomes more pervasive and continues to proliferate worldwide. In Western and Asian countries, nearly all schools are equipped with modern ICT infrastructure and promulgated policy for teacher professional development on ICT for the sake of developing digital literacy which contributes in improving the teaching and learning process. On the contrary, many African countries are in the early phase of ICT integration and Ghana is no exception.

Despite the massive investments of the Ghanaian government in ICT integration in the educational system by supplying Roagams Link Ghana (RLG) notebook computers to various Junior High Schools (JHS) and Senior High Schools (SHS) in 2013 and also TM1 laptops to enhance a national ICT policy, many obstacles prevent teachers from incorporating ICT tools into their teaching.

1.2 Statement of the Problem

The use of ICT in schools is taken very serious by governments and educational systems around the world, but it appears this is not the case in Wa Municipality. Even though standalone computers have been in some schools for more than a decade now, the usage of these computers to enhance teaching and learning is relatively new for many schools and teachers in Wa Municipality. This is an indication that the integration of ICT in education has not achieved its intended purpose especially with the teaching and learning of science which the Wa Municipality is not different.

Notwithstanding the political will shown by the Government of Ghana through the presidential computerization programme

Hajara and Bukari (2017) advocated that, teachers who do not consider themselves to be well skilled in using ICT feel anxious about using it in front of a class of students who perhaps know more than them. Effective integration will depend to a large extent on the level of training and support given to teachers**.** Ahiatrogah and Barfi (2016) revealed that most basic school Science teachers still find it difficult to learn, adapt and integrate ICT tools during teaching and learning with the excuse that they do not have access to basic ICT tools and infrastructure. This is the case in Wa Municipality of the Upper West Region based on the data collected. The question therefore remains that could this so-called luck of access to ICT tools and infrastructure be one of the many perceived barriers to the integration of ICT in the teaching of Integrated Science in the JHS in Wa Municipality.

A lot of research has been carried out on barriers to ICT integration in teaching and learning worldwide (Kennah, 2016; Buza & Mula, 2017) and in Ghana (Ofosu-Appiah, 2017). Some of these studies in Ghana centered on the relevance of ICT in teaching and learning, and the perceptions of students and teachers on the integration of ICT in teaching and learning. These researchers have, however observed that technology has not been sufficiently incorporated into schoolwork and is yet to be properly articulated with other classroom teaching activities. They revealed that teachers generally cannot really claim to be computer literates, let alone have the ability to use technology as a tool to teach. Some of these studies also revealed that the majority of teachers who are to teach students do not only lack the training, but also access and accessibility to the appropriate technology and other classroom

resources. For instance, Agyei (2012) cited that both in-service and pre-service teachers in Ghana have limited or no knowledge about ICT integrative skills, little or no use of ICT for instruction and therefore use the lecture approach mainly as the dominant classroom instruction technique.

Although Ghavifekr (2014) investigated the phenomenon of ICT integration in teaching and learning and the barriers to its application, they were not conducted in the present study setting though. This creates cultural and contextual gaps that need to be filled by this study. Also, Ghavifekr (2014) studies on the phenomenon employed purely quantitative methodology, thereby ignoring a mixed-methods approach. This implies that there is a methodological gap on the subject matter. Therefore, this study employed the concurrent mixed method triangulation design to investigate the barriers to ICT integration in the teaching of Integrated Science in JHS in Wa Municipality.

1.3 Purpose of the Study

The purpose of the study was to explore science teachers‟ knowledge and integration of ICT tools in the teaching of Integrated Science in Wa Municipality.

1.4 Research Objectives

The study sought to:

1. Determine the availability of ICT tools and infrastructure needed for successful integration in teaching JHS Integrated Science in Wa Municipality.
2. Explore the ICT content knowledge of JHS teachers in integrating ICT in teaching Integrated Science in Wa municipality.
3. Examine the extent to which JHS Integrated Science teachers practice/use ICT integration into teaching Integrated Science in the Wa Municipality.

4. Explore the barriers to the successful integration of ICT in teaching JHS Integrated Science in Wa municipality.

1.5 Research Questions

The following questions were formulated to guide the study:

1. What are the available ICT tools and infrastructure needed for successful integration in teaching JHS Integrated Science in the Wa municipality?
2. What ICT content knowledge do JHS integrated Science teachers possess to integrate ICT into teaching Integrated Science in the Wa municipality?
3. To what extent do JHS Integrated Science teachers practice/use ICT integration into teaching Integrated Science in the Wa municipality?
4. What are the barriers that hinders the successful integration of ICT in teaching Integrated Science in Wa municipality?

1.6 Significance of the Study

Little has been done to ascertain teachers‟ status in ICT integration and the barriers in integrating ICT in the teaching of JHS Integrated Science in Ghana since the ICT in education policy came into being. Rather, the focus has been on secondary and tertiary levels. By exploring into the barriers to integrating ICT in the Wa municipality, this study will contribute to the discourse on educational technology by investigating hindrances of ICT tools on teaching and learning. The findings of this study will be useful to policy makers and educational planners in fashioning out future ICT in education strategies. Finally, areas that this study is unable to explore will give rise for further research in Ghana as the country continues to push forward the agenda of transforming traditional teaching and learning methods with ICT.

1.7 Scope of the Study

The study covered two dimensional areas, thus theoretical or thematic scope and institutional as well as geographical scope. Geographically, the study covered the Wa Municipality and public basic schools in the municipality. The study intended to gather data from science teachers across the municipality. Notably, the pertinent issues that were looked at included the level of teacher‟s knowledge and usage of ICT tools in teaching and learning, the various ICT tools used in teaching and learning integrated science, the challenges faced using ICT tools in teaching and learning of integrated science. The study covered literature on various ICT tools and infrastructure use in schools, level of teacher‟s knowledge and usage of ICT tools in teaching and learning science and the challenges underlying their usage. It considered learning theories that will provide conceptual frameworks of interpretation for the act of learning and as such engaged the Technological Pedagogical Content Knowledge (TPACK) and Technology Acceptance Model (TAM) learning theories.

1.8 Definition of Terms

a) Computer Training – The process of enlightening an individual on how to use the computers.

b) ICT –Information Communication Technology, ICT refers to any product that will store, retrieve, manipulate, transmit and analyze information electronically in digital form including the internet, broadcasting technologies and mobile phones.

c) ICT – Consistent with Sarkar (2012), “Information and Communication Technologies consist of the hardware, software, networks, and media for collection, storage, processing, transmission and presentation of information (voice, data, text, images), as well as related services” (Sarkar 2012, p. 32). In another definition,

Marcelle (2000) stated that ICTs "are a complex and heterogeneous set of goods, applications and services used for producing, distributing, processing and transforming information" (para. 1). All in all, ICTs embrace diverse set of tools used to store, process, and diffuse information and knowledge. ICT resources include television, radio, telephone, satellites, computers, and internet. Such technological devices have infiltrated all aspects of life including education.

d) Information Communication Technology Integration – Refers to use of any product that will store, retrieve, manipulate, transmit and analyze information electronically to introduce, reinforce, supplement and extend learning or acquisition of skills.

1.9 Organization of the Study

In line with the in-house style of the School of Graduate Studies of the University of Education, Winneba, this thesis was presented in five chapters. Chapter one comprises background to the study, problem statement, research objectives, research questions and scope of the study. It also includes significance of the study and organization of study. Chapter two reviews literature pertinent to the study. Chapter three, which is the methodology, describes research design, population, sample size, sampling techniques, instrumentation, validity and reliability of the instrument, data collection procedures, data analysis and ethical considerations. Chapter four concentrates on results and discussion. Chapter five gives the summary of findings, conclusion and recommendations based on the results of the study. This chapter also makes suggestions on relevant areas for further studies.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Introduction

This chapter of the study devotes itself to presenting the existing literatures in the arena of ICT integration in teaching and learning. Topics or areas reviewed include concept of technology integration into teaching and learning, teachers‟ perceptions about use of ICT in teaching and learning, type of digital technology resources available in the integrated science classroom, level of ICT integration among integrated science teachers, frequency of teachers‟ attendance to ICT integration capacity building workshops, challenges of Information Communication Technology integration into teaching and learning.

2.1 Theoretical Framework

According to Creswell and Creswell (2017) a theory is a scientifically acceptable set of principles offered to explain a phenomenon. A theory provides frameworks for interpreting environmental observation and serves as a bridge between research and education. Theories provide us with direction and guidance as we try to understand how things work. According to Swanson (2013) theories are formulated to explain, predict, and understand phenomena and, in many cases, to challenge and extend existing knowledge within the limits of critical bounding assumptions. The theoretical framework is the structure that can hold or support a theory of a research study. The theoretical framework introduces and describes the theory that explains why the research problem under study exists. The theoretical framework connects the researcher to existing knowledge. In practice factors that guide human actions to change or influence technology acceptance behavior may be varied and cannot be

assumed to be static. As a result, it was difficult adopting a single existing overarching theory as a framework to guide the conduct of this study.

Therefore, the theories that guided the study was the Technology Acceptance Model (TAM) propounded by Fred Davis in 1989 and the Technological Pedagogical Content Knowledge (TPACK) developed by Mishra and Koehler (2006). TAM is derived from the Theory of Reasoned Action (TRA) model which was developed by Fishbein and Ajzen in 1975 to explain a broader range of behaviors based on situation specific combinations of personal beliefs and attitudes, and the effects of beliefs of others close to the individual (Szajna, 1996). An extensive body of subsequent research has confirmed the usefulness of Technology Acceptance Model and various extensions and revisions as a tool for investigating and predicting user information technology acceptance (Geffen, Straub, & Boudreu, 2000). It is the most widely applied model of users' acceptance and usage of technology (Venkatesh, 2000). The model has strong behavioral elements, which assumes that when someone forms an intention to act, he will be free to act without limitation (Bagozzi, Davis & Warshaw, 1992). The model suggests that when users are presented with a new technology, a number of factors influence their decision about how and when they will use it, notably: Perceived usefulness (PU), this was defined by Fred Davis as the degree to which a person believes that using a particular system would enhance his or her job performance, and Perceived ease-of-use (PEOU), Davis defined this as the degree to which a person believes that using a particular system would be free from effort (Davis, 1989).

Bagozzi et al. (1992) opine that, since modern technologies such as personal computers are sophisticated and an iota of doubt exists in the minds of policy makers in connection with the successful adoption of them, people form attitudes and ideas towards trying to learn to use the new technology leading to initiating efforts directed at using them. Attitudes towards usage and intentions to use may be ill-formed or may occur only after preliminary strivings to learn to use the technology. Thus, actual usage may not be a direct or immediate consequence of such attitudes and intentions. The case of integrated science teachers in the Wa Municipal is not different per this assertion and the observation of the researcher as a teacher in the area. The researcher will therefore want to test this theory on integrated science teachers in the Wa Municipality since they have formed attitudes towards the use of ICT in classrooms to find out the possible determinants for their attitudes.

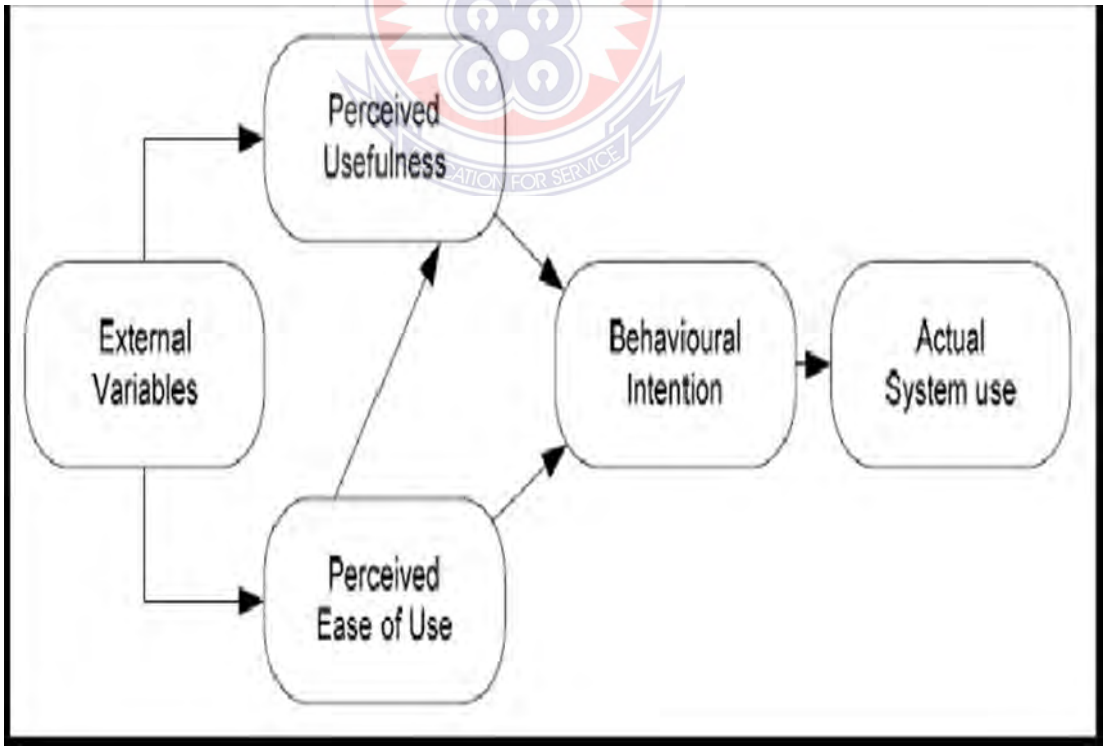

Figure 2.1: Technology Acceptance Model (TAM) Venkatesh and Davis, 1996.

Source: Lai (2017)

Also, the other theoretical framework informing this study is the theory of Technological Pedagogical Content Knowledge (TPACK) developed by Mishra and Koehler (2006). It is a theory that emerged to describe the set of intelligence that teachers must possess to effectively teach their students using ICTs. The TPACK framework explains the use of ICT for teaching and learning from a knowledge context. It classifies three basic forms of knowledge that must be available in any ICT integrated class: Technological Knowledge (TK), Pedagogical Knowledge (PK) and Content Knowledge (CK). The TPACK model has introduced a new structure that guides the use of ICTs for teaching and learning purposes and how it fits into the structure of the classroom to enable quality educational practices when using ICT. The use of ICT for teaching around a particular topic desire creating sensitivity to the dynamic, value-based connection between these segments of learning arranged in special settings. Instructors, grade-level, school-particular elements, socioeconomics, culture, and different elements guarantee that each circumstance is exclusive, and no single blend of substance, innovation, and instructional method will apply for each educator, each course, or each perspective of educating. The TPACK model puts forward two basic arguments;

1. Mindful interweaving of technology, instructional method and content knowledge is required by the educator to guarantee a beneficial utilization of ICTs in teaching and learning.
2. There is no single mechanical arrangement that applies for each instructor, each course, or each perspective of educating. (Mishra & Koehler, 2006).

According to Gorder (2008) the most important factor to integrate ICT effectively in the classroom is the teachers‟ ability and efficiency to organize technology-embedded learning activities based on learners‟ needs. It concerns teachers' understanding on

know-hows for drawing upon their technological knowledge, pedagogical knowledge and content knowledge to design ICT-embedded lessons to meet the needs of the pupils. The technological pedagogical content knowledge (TPACK) conceptualized by Mishra & Koehler, 2006 seem extremely appropriate for stimulating teachers‟ reflections on their ICT integration classroom. TPACK framework provides a theoretical and a conceptual lens of depicting teachers‟ competency in designing and conducting technology-enhanced instruction, assessment of teachers‟ technology integration, knowledge and experiences (Lin et al., 2013) and measure pre-service and in-service teachers‟ readiness to teach effectively with technology (Koehler et al., 2013).

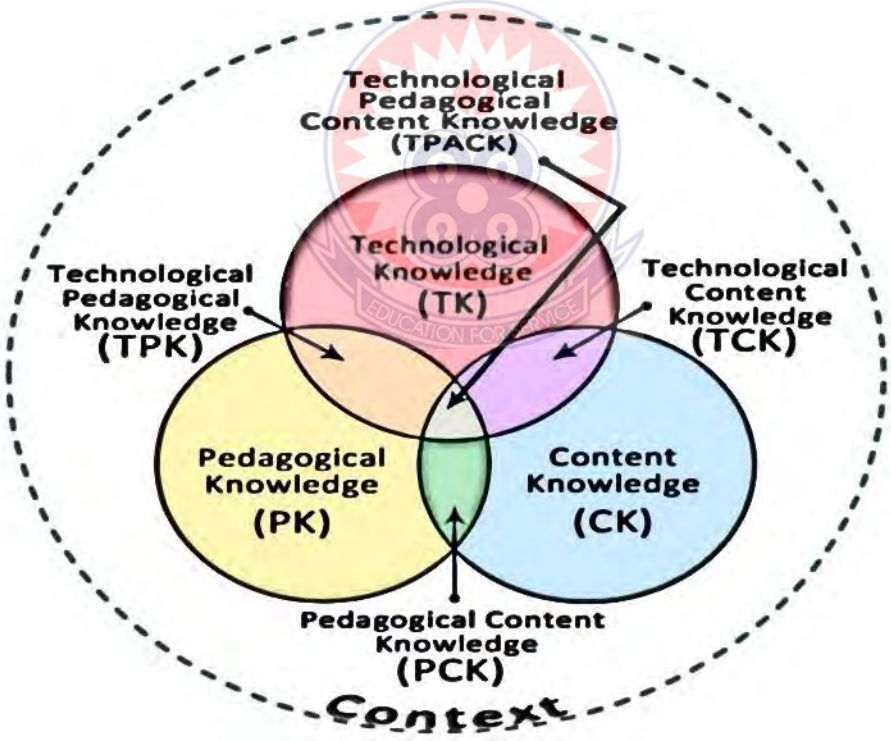

Figure 2.2 Technological Pedagogical Content Knowledge [TPACK] (Mishra & Koehler, 2006)

2.2 Conceptual Framework

The researcher after reading the works of other researchers, objectives of his study and taking into consideration the Technology Acceptance Model (TAM) and the Technological Pedagogical Content Knowledge (TPACK) theory designed a conceptual framework for his work.

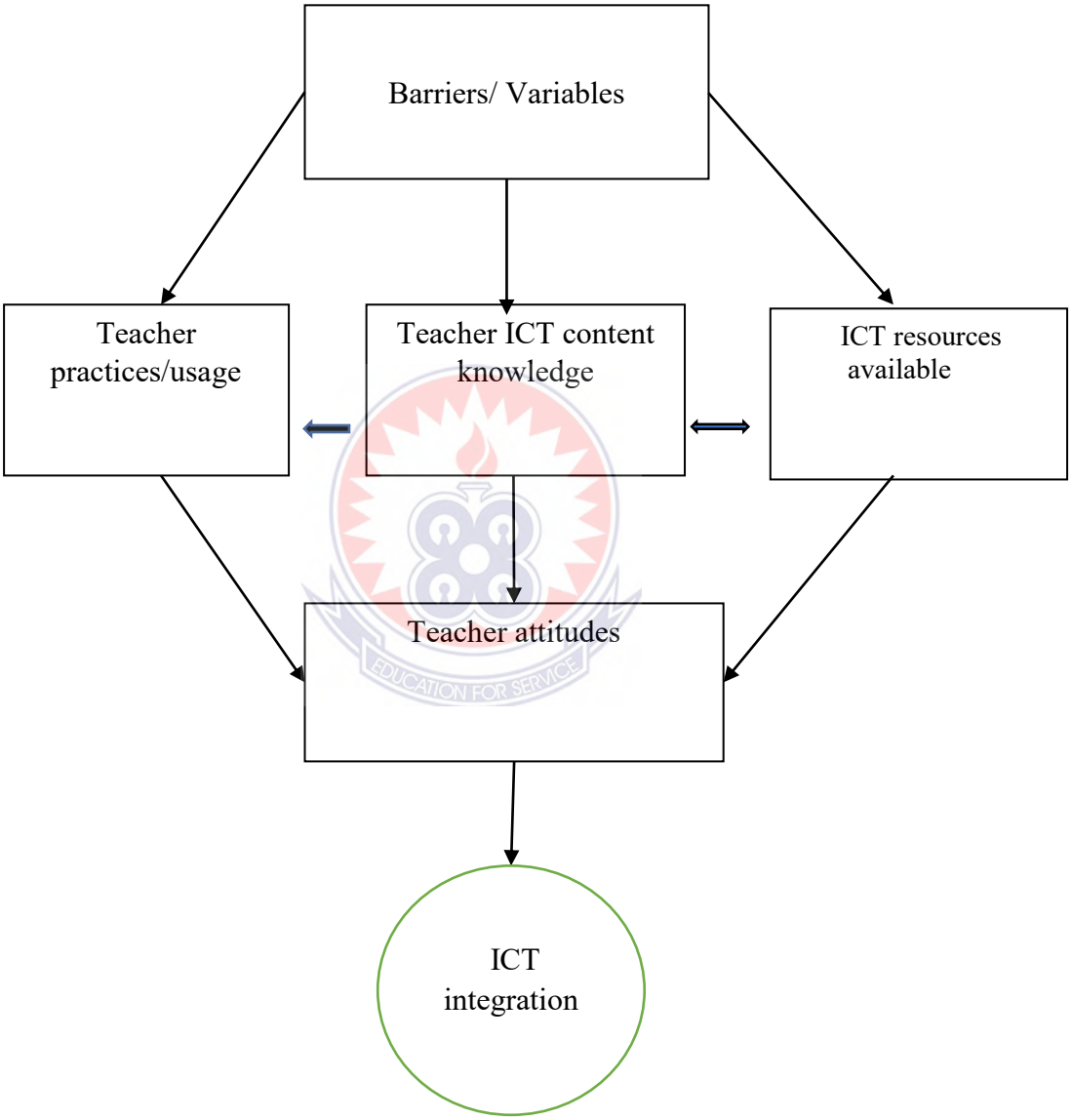

Figure 2.3: Modified TPACK Framework

(Source: Researcher"s construct, 2021).

This diagram provides an explanation to the barriers of ICT integration into teaching of integrated science. The framework suggests that when teachers are to integrate ICT into teaching, a number of variables influence their acceptance such as: their practices or usage, their ICT content knowledge, availability of human and material resources, among others.

Practices or usage here refer to how teachers (integrated science inclusive) practice ICT integration. These practices are influenced by how useful or easy teachers think the technology will be to them in their teaching. Therefore, if teachers have the requisite knowledge in ICT and also knows how to integrate it in their lessons coupled with the available facilities, they will by all means have good attitude towards it hence leading to its integration. However, if they lack the requisite knowledge, facilities and how it should be integrated, they will have negative attitude towards it thereby failing to integrate it. Teachers ICT content knowledge also refers to the level of teachers` ICT expertise in the subject matter to effectively integrate it into teaching in the classroom. This is determined by the kind of pre-service as well as in-service training that they receive to efficiently integrate ICT into teaching. The level of ICT content knowledge, adequate facilities and usage might be a driving force in determining the kind of attitude teachers will have and as to whether they will practice it or not thus leading to the integration process. The higher the content knowledge of a teacher and facilities available, the more likely he/she might be willing to practice it and hence develop positive attitude towards ICT therefore leading to the integration process. However, if a teacher has little or no knowledge in ICT content knowledge coupled with inadequate facilities, he/she might have negative attitude towards it and will not practice it probably for fear of been found wanting by his students hence failing to

integrate it. Again, in the diagram is resource availability. This refers to the various ICT facilities like computers, internet, projectors, tutorials that are at the disposal of the teacher. The more available these facilities are at the disposal of the teacher coupled with his/her ICT content knowledge, the more he/she might develop a positive attitude towards ICT integration and will always practice it thereby leading to the integration process. And the less available these facilities are at teacher‟s disposal the more likely they might not integrate ICT in their lessons.

In effect, these variables or determinants of ICT integration come together to make teachers form attitudes towards ICT use and integration.

2.3 Concept of Technology Integration in Education

According to Gunter and Gunter (2015) technology integration is a means of enhancing learning through the use of hardware and software components of computer technology together with each subject-related area of curriculum to enhance learning. Technology integration is considered superior to the traditional teaching of ICT as a subject (otherwise called ICT in education) because research has proven that technology facilitates learning, improves students‟ ability to retain information/knowledge and increases their motivation to learn independently (Meenakshi, 2013). The rewards from computers and other related technologies are best realized when they are integrated into subject contents and placed at the point of instruction. This helps to ensure realistic learning, which involves instructional activities that demonstrate real-life connections by associating the concept being taught with real-life experiences or events (Gunter & Gunter, 2015). Just as what content is included in the curriculum is planned, technology also needs to be deliberately planned and integrated into the curriculum for best results.

Vitanova, V., Atanasova-Pachemska, T., Iliev, D., & Pachemska, S (2015) showed that basic ICT Competency was low among 25% of the teachers, basic knowledge and skills to operate a computer was found among 17% of the teachers, and 58% of teachers were proficient in ICT competence. According to Vanderlinde, R., Aesaert, K., & van Braak, J. (2015) in Belgium, all the three categorized types of ICT use in schools (basic ICT use, ICT as a learning tool and ICT as an information tool were influenced by the teacher-level of ICT competencies measured by their levels of knowledge and skills. ICT inadequacy of teachers was one of the barriers identified by Ozdemir (2017) for integration of ICT in Turkish schools.

Countries have been investing considerably in terms of money, expertise, resources and research to integrate technology in education as smoothly as possible so that the classroom environment is made more conducive for enhanced teaching and learning. For countries to compete with each other in the global information-based and knowledge-based economy, they need a workforce that is skilled in the use of technology to gain the necessary competitive edge over one another. Low ICT competency was detected as a factor affecting teacher education in Thailand (Akarawang et al., 2015). Technological and pedagogical competencies were identified as two subsets of ICT competencies of teachers in the results reported by Almerich et al. (2016) from Indonesia. However, until now, there are no computer laboratories or adequate ICT resources in primary schools. A direct result of this situation is frustration among ICT teachers and a sense of disabuse in the nation. Inadequate of funding and inadequate planning have been postulated as two major obstacles to the implementation of the SITP project. Funding has always been a perennial hurdle in any project. Variations among five schools in ICT-related teacher competencies and actual use of ICT in teaching were observed in a Turkish case study

by Aydin et al. (2016) and misjudgments of the massiveness and scale of the project by policy makers, the project was likely to suffer a setback. The government has now revived the project by adopting what it calls the phased-implementation approach. Under this formula, around 50 computer laboratories would be set up each year in 50 primary schools instead of equipping all 284 primary schools at one time. This approach has been advanced as being more realistic and feasible. Undoubtedly, the amalgamation of achievable and realistic targets with firm commitment from authorities will move the technology integration project a step closer towards success.

Using mobile smart phones of educational purposes have fast become an accepted technology due to its convenience of using anywhere anytime. In Cyprus, a study by Ozdamli & Uzunboylu (2015) teachers had positive perceptions about teaching using mobile technologies, even with inadequate skills for the technology. The study found that both teachers and students were keen to use mobile phones for teaching and learning purposes. The following recommendations were made: The need for proper infrastructural support such as for proper hardware, software and, networks and Internet access, in order to provide the required logistical support to schools.

According to the opinion of some Spanish primary and secondary school teachers surveyed by Badia et al. (2013) educational use of ICT was influenced by its utility in the given educational context, teacher support for its use by students, availability and access of ICT in classroom, technological expertise of teacher and access to ICT outside classrooms. The improvement and expansion of professional development programs on the hands-on instructional use of technology in classroom. These programs need to be continuous and relevant to the needs of the teacher. Considerable authority should be given to schools in deciding the nature, scope, and frequency of

the programs. The development of a district-wide technology plan focusing on the integration of technology in education to provide an enhanced learning environment. The investment of more effort by the district to inform teachers about software focusing on communication, application, and exploratory activities instead of tutorial activities. The provision of more technical support to teachers, both in how to handle the technology for administrative works and how to make pedagogical use of it in the classroom. The equipment of classrooms with computers is so important that teachers and students can have easy access when they need them.

According to Wilson-Strydom, M., & Thomson, J (2017), most (93%) of the South African teachers had computers for teaching and 79% of teachers had a computer laboratory at school. Internet access was available to 63% of teachers, meaning ICT could be used as a mediational tool. The teachers who had implemented ICT-integrated lessons about once per month (58%) or less than once per month (57%) had 11 to 20 computers. The remaining 33% of teachers never used ICT-integrated lessons even if they had more than 21 computers. Thus, access alone does not lead to ICT integration. Similarly, access to internet favored increased ICT integration, but not always a pre-condition. Extent of ICT integration ranged from less than one month through to about once per month and more than once per month. Limitations of number of computers (67%), time to complete the lesson, inadequate skills of learners and time scheduling problems were identified as the barriers to ICT integration. Use of ICT for teaching has resulted in many changes in teaching.

The creation of an information network in and among schools with access to the Internet. The creation of new technology-rich learning communities of teachers and students that (1) foster more active learning, (2) provide access to information, (3)

enable teacher-student communication and collaboration irrespective of time, geography, age and ability, (4) transform the classroom into a global learning environment by providing links to the rest of the world, and (5) link homes, schools and society so that learning not only occurs in schools but anywhere and at any time during the life of an individual. Opportunities for the professional development of in-service and pre-service teachers, parents, community members, and local boards of education in upgrading their technological skills. Also, the allocation of adequate funding for the establishment of a state-wide informational and educational network and for staff development programs targeted to increase skills and competencies of school staff in its use of educational technologies. The development of a set of educational technology standards for the creation of a flexible technology-based learning environment that promotes and maintains full participation, open communication, and equal access. This ensures that users of technology such as teachers, students, administrators, and the community will be able to access it, and communicate with each other without having to worry about the changes in and differences among the technological platforms constituting the learning environments.

This can be achieved by fostering a partnership among government, business, and educational institutions, such as schools and universities. This partnership involves all stakeholders concerned and would create a forum whereby they can collaborate constructively in the technology integration process. A proper scheme for allocating funds needs to be established. This scheme must not only include one-time funding but continuous and recurring financial support. Though the state of Michigan already had a number of technological capabilities and infrastructure, like a data network connected to the National Science Foundation NET (NSFNET), the National Research Network, and the Internet, the goal of the concept paper was to extend and

improve these existing facilities to grant access to a wider community of learners in schools and community. This plan, despite dating back ten years, still offers strong propositions which apply to any country in the world.

According to Wilson-Strydom et al. (2005) most (93%) of the South African teachers had computers for teaching and 79% of teachers had a computer laboratory at school. Internet access was available to 63% of teachers., meaning ICT could be used as a mediational tool. The teachers who had implemented ICT-integrated lessons about once per month (58%) or less than once per month (57%) had 11 to 20 computers. In an Israeli study, Avidov-Ungar and Nagar (2015) used both quantitative and qualitative methods to investigate on to examine how the ICT instructors perceive the encouraging and inhibiting factors of the change implementation. The results showed that the sense of empowerment of ICT instructors improved by enhancing their Program Information Communication Technology Knowledge (PICTK) and Technological Pedagogical and Content Knowledge (TPACK). This sense of empowerment facilitated creation of own viewpoints by the instructor regarding the implementation process and the outcome of the National Information and Communication Technology (ICT) Program in Israel. Therefore, it is useful to encourage ICT instructors to expand their PICTK and TPACK knowledge on the developing ICT program. The encouraging factors of ICT implementation were overall guidance of the implementation process, training and technological–pedagogical guidance, technological infrastructure and financial reward in the order of decreasing frequency of instructors. Inadequate or absence or poor quality of the above factors were reported as inhibiting factors.

Based on a review, Basak and Govender (2015) found that inadequate of teacher confidence was associated with a fear of failure, anxiety about ICT knowledge and inadequate of self confidence in ICT. They also reported that teacher confidence was also linked to inadequate of technological competence of the teacher in terms of knowledge and skills, negative attitude and resistance to change; inadequate of effective training; inadequate of time, inadequate of accessibility and inadequate of technical support. All these negative factors contributed to difficulties of ICT integration process into their classes. All the findings discussed above identified similar factors promoting or inhibiting ICT in education. The common factors applicable to both developed and developing countries are inadequate of knowledge and skills of teachers, inadequate of training, poor incentives, unrealistic policies and non-support from the departments, inadequate involvement of all stakeholders, poor school leadership and time factor. Inadequate of proper network, inadequate of political stability, brain drain, power supply problems, poor transportation, technological illiteracy, inadequate of pedagogical skills and poor connectivity are specific to developing countries.

Harris and Hofer (2017) discovered that K-12 schools and districts in the US have increasingly been adopting TPACK framework for professional development of teachers. Context and professional culture were important in this respect. Seven schools/districts participated in the study. TPACK served as a connector, an initiative at the grassroot level, a system of checks and balances, an instructional planning tool, a technological focus, a compass and a collaborative process.

In a case study, TPACK was used by Evans, Nino, Deater-Deckard, and Chang (2015) to describe the process of implementing „The Candy Factory" an iPad-specific learning game that focuses on pre-algebraic concepts, especially fraction knowledge successfully. The findings may be useful for schools and school districts, which are considering adoption of game-based learning and other types of mathematical learning games in classrooms for improved engagement and performance. All these studies demonstrate the usefulness of TPACK as framework to evaluate the teachers" efforts to integrate ICT into education, especially Science subjects, in schools. This study will also use this framework for evaluation of the factors which lead to success/failure of ICT use in Bhutanese middle secondary school Science Education.

The government of Ghana in 2003 produced a policy document dubbed, The Ghana ICT for Accelerated Development Policy (ICT4AD) which has part of its mission to: „transform the educational system to provide the requisite educational, and training services and environment capable of producing the right types of skills and human resources required for developing and driving Ghana"s information and knowledge-based economy and society and that the government is committed to a comprehensive programme of rapid deployment, utilization and exploitation of ICTs within the educational systems from primary school upwards" (GoG, 2003). The policy is directed at using ICT to facilitate education and learning within the educational system and to promote e-learning and life-long learning as well. Consequently, it is recognized that the policy document must be hinged around three pillars, each of which should receive slightly different policy intervention emphasis and strategy to assure effectiveness, namely:

a) ICT as learning and operating tool

b) ICT as integrated into the teaching and learning

c) ICT as a career option for students

Some of the twenty-one strategies that the government intends to use to achieve the objectives of the policy include:

1. To introduce computers into all primary, secondary, vocational and technical schools.
2. To transform Ghana into an information and knowledge-driven ICT literate nation.
3. To modernize Ghana`s educational system using ICT to improve and expand access to educational, training and research resources and facilities.
4. To promote electronic distance education and training and virtual learning systems to implement and support face -to- face campus-based education and training systems.
5. To put in place special schemes to enable students, teachers and educational institutions to purchase computers through attractive financial packages.
6. To promote internet access at all educational institutions including the basic, secondary and tertiary.

The government of Ghana through these has placed a strong emphasis on the role that, ICT plays towards the nation`s economic growth.

Boahen and Atuahene (2021). opine that, the country`s medium term development plan captured in the Ghana Poverty Reduction Strategy Paper (GPRS 1 & 2) and the Education Strategic Plan 2003-2015 all suggest the use of ICT as a means of reaching out to the poor in Ghana. The government of Ghana has made a lot of policy

interventions through the Ghana Education Service (GES) by introducing ICT as a subject at all levels of education. This was reinforced by making it examinable at the Basic Education level, the Colleges of Education and the Universities. The policy was aimed at ensuring that every Ghanaian student has adequate knowledge and usage of ICT devices. Additionally, the government of Ghana since 2008, through RLG- a telecommunication company, started distributing laptops to teachers and pupils dubbed one laptop per child project.

Curriculum integration depicts using technology not for its own sake but for the delivery of curriculum content and it portrays a better picture of the practice as one that interweaves education and technological skills. As a somewhat complex process, technology integration requires distinct knowledge about technology, distinct knowledge about the content of curriculum coupled with appropriate pedagogical skills. Most pre-service and in-service training courses designed for educational professionals emphasize proficiency in various technological tools without training on how to incorporate them into the teaching of individualized subject contents. Mastering the integration of technology into the curriculum is not an easy endeavor, hence the need for concerted efforts to assist teachers master the skill (Gunter & Gunter, 2015). According to Bariham (2020) ICT which helps to improve on the quality of instruction. CBI support learners develop critical thinking, creativity and collaboration skills needed to function effectively in this 21st Century.

The Government of Ghana rolled out the ICT in Education Policy (2015) to transform education. ICT in school setting offers a wide variety of services. In the school management level, ICT is used in student data management, teacher data managements such as attendance and weekly lesson plans are all enhanced with the

use of ICT tools. Other than follow up of students‟ achievements, the information gained from the computer enables management to follow up on each and every teacher‟s work. Also, rather than facilitating teaching and learning in the schools, the head teacher can evaluate the input of the teachers and output of the students with the help of ICT tools. School management information system enhances planning, organizing, and monitoring, and is used as a tool for improving the effectiveness of the educational system in school.

Although teachers said they used ICT to prepare lessons and other teaching materials and adapt their teaching strategies (Bhagat et al., 2017), they were not done to sufficient extent. Use of ICT for organization and management of the school when some teachers said that they were ICT teachers and helped the school management in designing websites and software applications for student evaluations and formulating strategies of ICT use in the school curricula, sharing knowledge and information with other teachers and in-school training of other teachers in ICT. This therefore goes to buttress his thoughts that the impact of ICTs in education can be attributed to greater accessibility of ICTs, and the increase in internet speed and availability of broadband. However, positive attitude towards ICT by change agents is of paramount significance as it will facilitate the willingness to change. Without the will power, no meaningful change can take sound effect despite the presence of ICT facilities, internet speed and man power on the ground.

Overall, the above review shows that ICT knowledge and skills of teachers are generally inadequate and vary depending upon many contextual factors. This is true even in the case of developed countries with advance education systems and technologies. This problem can be addressed only through appropriate methods to

improve their ICT knowledge and skills. Bhutan may be backward in this respect, but the extent to which this factor affects ICT implementation and progress in secondary level education needs to be researched. This work addressed this felt need. Along with the knowledge and skills, perceptions and attitude of teachers towards ICT has a strong influence on how well ICT is implemented in their classes, even if other favorable factors exist.

2.4 Role of ICT in Science Education

The impact of Information and Communication Technology (ICT) on modern societies cannot be over emphasized. The spread, adoption and use of information technology has transformed many societies in the world (Ahiatrogah & Barfi, 2016). A study by Amedeker (2020) reveal that the use of ICT in teaching has nurtured Science students who are committed and are able to engage themselves actively in their own learning can develop new ideas by collaborating with other students all over the world. However, there seems to be a literature gap as far as integration of ICT is concerned in Ghana. Additionally, the government of Ghana and its allies have been trying to provide teachers as well as students with free laptops aimed at improving teaching and learning (Ahiatrogah & Barfi 2016; Buabeng-Andoh, 2017). However, the expected pace of ICT integration in our schools have not been fast enough because many teachers still find it difficult to apply basic ICT skills in their lessons.

Dzakpasu and Adom (2017) conducted a study which found out that ICT had a favorable impact on the lesson delivered by science lecturers and students and learning outcomes were positive in many areas of study. These areas included research, ease of dissemination of information and assessment procedures. The study contended that in order to improve ICT integration in the lesson delivery of lecturers

as well as academic performances of students, educational policies should be changed to pave way for modern technological advancement which would groom and provide students with requisite skills to fit into the job market. Additionally, training should be periodically organized for instructors to improve their skills to deliver effectively. However, for students to acquire the requisite skills, teachers have a greater responsibility, therefore, the need for an investigation into factors that influence teacher‟s adoption of ICT integration is important. In Botswana, Dintoe (2018) discussed how faculty found it very difficult to apply their experiences in the use of ICT for purposes of teaching and learning. The study revealed that though technology was available and accessible, faculty expected to adopt technology at the University of Botswana found it hard to use technology in teaching and learning. The findings from the study posited that majority of faculty members used teacher-centered approaches as compared to the much-desired student-centered approach.

Also, the ICTs resources availability in schools can contribute significantly to increase teachers‟ willingness to incorporate Computer Based Instruction (CBI) in classroom. Kennah (2016) opines that the appropriate integration of ICT in education has been greatly affected by lesson duration, availability of the digital resources, students‟ perceptions of the technology use, a physical class structure, teacher´s content knowledge, class diversity, socio-economic background of teachers and students, leadership and school management approach, and community perception about CBI. Competent teachers, friendly learning environments, reliable assessment systems, and relevant ICT programmes for learning all required financial resources. As more children proceed further in education, financial needs will increase. Yet more funding leads to superior learning outcomes if only it is applied effectively and at the

right time, with an intentional focus on students learning outcomes (World Bank Report, 2018).

Technology is often used as a set of available tools enabling people to accomplish their tasks in an efficient way. The same applies to ICT, which by its nature can be understood as a large array of hardware and software. Some commonly used ICT tool are tool applications: word processing, graphics packages, scanner, digital camera, video, presentation application, databases, spreadsheets. In science learning, students can use different tool applications and also learn what needs are met by these applications and when and how to use their different features. For example, the following tool applications can be used in science learning: word processing, publications and presentation software, spreadsheets, databases, multimedia, web browsers and e-mail. Word processing software can be used, for example, for organizing ideas, writing home works and project works.

Spreadsheets can be used for analyzing data and modeling. To select the right tool application, it is important to understand what types of thinking and learning experiences and also the right ICT to support. A teacher can use tool application in several ways. He or she can present assignments, tests, and other resources for science teaching and learning. Video or LCD projector can be used as a tool in several ways for presentations and it can be connected to MBL-tool or a microscope. Tool applications may however also be a potential drawback to this development as it can easily reinforce a didactic style of teaching in which students are the passive receivers and teacher generated ideas and information, albeit, rather more richly illustrated with images. One new interesting tool Science teachers have started to use is an interactive whiteboard (white board, SMART board). Whiteboards operate analogously to

chalkboards in that they allow markings to temporarily adhere to the surface of the board. The touch-sensitive display connects computer and digital projector and then computer applications can be controlled directly from the display, write notes in digital ink and save work to share later. Most white boards also have specially designed software that includes a range of useful tools (Wolrd Bank Report, 2018).

2.4.1 Computer Based Instruction (CBI)

Computer Based Instruction (CBI) refers to tools, techniques, resources, and content used in instruction to improve students‟ learning outcomes. The functional use of CBI has been categorized into teacher-centered instruction in which the teacher takes control of the design, development, delivery, and assessment of instruction and student-centered learning, in which the students are actively involved in useful activities that result in authentic learning. CBI is one of the latest instructional innovations in education from the point of view of both the learner and the teacher that can be used to improve the quality of integrated science instruction. It is an interactive instructional approach that combines the use of a computer programme to deliver teaching, monitor the kind of learning that takes place, assess students learning, and provide timely feedback to improve learners' performance (EdSurge, 2016).

2.5 Teachers ICT Content Knowledge in Teaching and Learning

International research suggests that ICT as a tool for promoting learning is not generally well embedded in teachers‟ practices (Cubukcuoglu, 2015). Teachers are the most critical determinant of students learning in schools. Teacher training and professional development programmes are critical variables for the implementation of ICT integration. Several studies have reported that whether inexperienced or

experienced, ICT capacity building programmes equip teachers' preparedness with sufficient knowledge and skills for the pedagogical use of ICT during learning and teaching (Gakime, 2016).

Voogt and Tondeur (2015) extrapolate that the application of ICT in learning is situational. For effective integration of ICT in instruction to take place, instructors should be willing to learn, practice and acquire skills and knowledge about the learners, schools, infrastructure, and tools at their disposal, and the environments they find themselves in. In-service Teacher Professional Development demands significant time and resources in which developing nations invest millions a year to build and sharpen teachers‟ skills and competencies. However, most teacher professional development programmes go unevaluated and much of it may be ineffective. Globally, a survey by OECD involving 34 schools discovered that almost 88% reported having attended a Professional Development Programme during the year. Of those, 71% attended at least one workshop; 44% attended an education conference and 37% attended in a teacher network (Global Education Monitoring Report, 2018). Many teachers lack the skills to collect, analyze, interpret and use data to improve their instructions. A study in five OECD countries on teacher pedagogical knowledge revealed that assessment, in addition to research and data use was the least emphasized part of pre-service teacher education (Global Education Monitoring Report, 2018).

Clarke (2017) noted that teachers do not use technology to conduct social experiments because such competencies are inadequate. To support effective teaching and learning in schools, teachers need to deliver quality instructions effectively and efficiently. But many education systems pay little attention to what teachers know or what they do in

the classroom. Focusing on teachers‟ skills and motivation can pay off (World Bank Report, 2018).

According to Mustafina (2016) young tutors are perceived as having much more desire to be trained in modern technology than older tutors because the ICT revolution turned out to be prominent during the nineties. Teachers born after this period have more interest in using ICT than those who were born earlier. Likewise, religion and inadequate of awareness also affect the incorporation of modern technology in classroom instructions. A myriad of researches has investigated the relationships among such variables as age, gender and various technology constructs across diverse work settings; medicine, industry, commerce, education. Findings from these studies have not been conclusive; while some studies have found significant relationships among age, gender and technology, others have reported no significant relationships.

2.6 ICT Resources Available in the Science Classroom

Today, Information and Communication Technology (ICT) has, however, assumed a very important role in education and society at large. ICT use in education has constantly been reviewed in countless researches with most recommendations from such researches encouraging its use as well as further researches into specific areas of education (Ahiatrogah & Barfi, 2016).

ICT resources are tools that can be used to support teaching and learning. In this study, the types of tools that support the teaching and learning of ICT in various schools was considered. The use of ICT resources in teaching encourages students to learn. According to Ghavifek et al. (2016) ICT resources in education mean teaching and learning using ICT tools. Educational ICT tools or resources are divided into three categories namely: input resources, output devices and others. Input sources

include such things as personal computers (PCs), tablets, applications software, student response systems, visualizer or document camera. Output resources/devices refer to such devices as projector, interactive boards, monitors, display, and television. Others include digital camera, digital recorders, switchers and other technologies. The use of ICT tools can lead to improved student learning and better teaching methods with better resources. The resources include laboratories in schools, internet, limited computer facilities for teachers, no central databases are used and no learning management systems are available for purposes of electronic learning.

Teachers are the key change agents of any educational establishment. Teachers‟ knowledge of ICT for teaching and learning cannot be undervalued when they are not ready to use them. According to Ahiatrogah and Barfi (2016) for teachers to be able to use ICT, there is the need for the right attitude to be cultivated towards ICT as a tool for teaching and learning. They further stressed that teachers‟ attitude is their opinion of acceptance or rejection of ICT as a tool for teaching and learning. For teachers to have the right attitude there should be a forum for teachers to develop their ICT skills, knowledge and ability.

Pergrum (2016) indicates that inadequate access to resources, including home access to computers and classrooms is another complex challenge that prevents teachers from integrating ICT into lesson delivery. The inadequate computers in classrooms has led most of the students to become unfamiliar with using them and to have poor behavioral attitudes toward using computers in their teaching methods. Study conducted by Pergrum (2016) proves that inadequate infrastructure facilities is one of the many causes of poor ICT integration in schools. He further lamented that

unavailability of resources for teaching with technology discourages teachers from using ICT in their teaching.

2.7 Integrated Science Teachers` Practices/Usage of ICT Tools

The literature on the uptake and use of ICT in education worldwide shows that, in spite of governments having invested large sums of money in equipment, resources and teacher training with the purpose of improving teaching and learning in the schools, the integration of ICT in education in many countries has been limited (Valenzuela, 2002).

An earlier study carried out by the International Association for the Evaluation of Educational Achievement IAEEA (1991) which investigated the process of ICT implementation in 26 countries, concluded that, only a small number of teachers (Integrated Science inclusive) were using computers as an integral part of their teaching. In order to measure teachers‟ level of ICT use in Chile, questionnaire data were analyzed from the Computers in Education Questionnaire (Valenzuela, 2002). Two questions in the questionnaire were considered for the analysis: one which requested teachers to select, from a list of eleven ICT applications (word-processing, spreadsheets, multimedia encyclopedias, etc.) the type of ICT they had used in their teaching during the first semester in the year 2002; and another one, which asked teachers to provide the frequency (0 = never, 1 = once a semester, 2 = twice/three times a semester, 3 = monthly, 4 = twice/three times a month, 5 = weekly, 6 = twice/three times a week, 7 = daily) of use in teaching for each software type according to an eight-point frequency scale. The majority of teachers in the sample (n=74) used between1 to 5 types of ICT with a frequency mean of 4.45 (about twice/three times a month) and a mean number of 2.15 ICT types, which is quite

limited considering that teachers may decide to use ICT only for a short period of time in a semester or during the year (as several teachers indicated in the interviews).

Similarly, a survey of teachers in eight representative schools in Ghana (Boakye & Banini, 2008) reported that 71% of the teachers never used the computer for teaching in class and never took their students to the computer lab while 49% used ICT for lesson preparation. The main conclusion was most of the teachers seemed unprepared to integrate ICT in their practice.

2.8 Frequency of Teachers' Attendance at ICT Integration Capacity Building Workshops

A predetermined process is important for integrating ICTs in the classroom, school management, library, and any educational setting. Integration of ICTs enhances the quality of education by helping teachers to do their job and by helping student to learn more effectively. In these contexts, teachers shifting role in the 21st century involves an essential mission, which is to be the frontiers for applying technological innovations to the teaching and learning process.

At this point, necessary skills and level of future teachers" researchers are key factors in implementing new ICTs, (Goktas et al., 2009). Consequently, schools of teacher education play a crucial rule in preparing further teachers to become proficient in the integration of ICTs into Curriculum. They need to help prospective teachers understand how ICTs can be used to teach content in rich and meaningful ways (Keating & Evans, 2001; Roblyer & Edwards, 2000). On the other hand, integration of ICTs into pre-service teacher education is critical in integrating ICTs in K-12 schools. Despite the huge investment of financial and human resources, pre-service teacher education programs do not provide teachers with the necessary skills,

competencies, and experiences to prepare them to use ITCs effectively in their future professions (Bullock, 2004).

Teachers‟ perception of the strength of personalized learning in their schools is strongly related to measures of the IT resources available in the school (Underwood & Banyard, 2008). Counter-intuitively, the virtual learning environment (VLE) which can be seen as a vehicle to deliver personalized learning was not highly valued by teachers. A survey of over 300 teachers (Banyard et al., 2011) asked them to identify their most important pieces of technology. Over half identified their Interactive Whiteboard as their “must have” technology and a further quarter chose their laptop. There were mentions of Google, YouTube, and data-sticks but very few for the VLE.

Few studies investigate the role of professional development through capacity building workshops in expanding and deepening how teachers implement ICT in integrated instruction. The following studies provide some insight into how professional development can be designed to impact a teacher's capacity and willingness to integrate the ICT into science in an era when there is "no room for insecurity in teaching" (LaJevic, 2009, p. 158) and cognitive demands are high. Saraniero and Goldberg (2011) investigated two models of professional development in ICT integration to determine which approach positively impacted teacher practice and student achievement. The researchers developed three randomly assigned groups of teachers who were asked to integrate art and drama with reading lessons. The first group (n=17) attended a summer institute (30 hours) and received 25 hours of coaching during the school year. The second group (n=18) attended the summer institute but received no coaching. The third group (n=33) did not participate in the institute nor did they receive coaching. No statistically significant differences were

found prior to the study between teacher groups in terms of professional qualifications, previous training, or teaching experience.

Using a mixed-methods approach, the researchers determined that teachers who participated in the coaching model demonstrated greater confidence, superior work samples, and more frequent implementation of integrated instruction. The researchers noted that first attempts at lesson plans were modest for all three groups, but the teachers who received coaching developed better second lesson plans in terms of aligning instruction with the objectives and understanding how to authentically integrate the arts and reading content. The institute only group showed no statistically significant improvement between lessons. While teacher confidence in facilitating arts, integrated instruction decreased the following year for both the coached and non-coached groups, those who had received the coaching demonstrated higher confidence overall and greater frequency of implementation.

Differences in student achievement between the three groups on standardized tests were not significant; however, students from the coached institute only have their teachers reported that "students demonstrated higher student engagement and enthusiasm for learning, better retention of curriculum, more creative participation and more self-reflection when utilizing arts integration" (p. 21). Teachers stated that students continued to demonstrate these improved habits of mind and dispositions after the study concluded. Short-term professional development is common; yet, this study shows that ongoing professional development may be necessary to improve teachers‟ abilities to plan for and enact high-quality integrated lessons, particularly when instruction is oriented toward 21st century skills and knowledge.

2.9 Challenges of ICT Integration into Teaching and Learning

Boahen and Atuahene (2021) found that most of the teachers had a strong desire to integrate ICT into teaching and learning. ICT integration in schools has encountered several problems and challenges. External barriers related to access to ICT, environmental supports and teacher ICT literacy and internal barriers related to teacher cognition. When the external barriers are determined, the resolution regarding whether and how to use ICT rests on the shoulders of teachers. The study established that the availability of the ICT facilities is still inadequate in the schools for the students to use. Because of the limited number of functional computers in the computer laboratories, accessibility is timetabled and doesn‟t help a smooth integration into the curriculum of teaching and learning.

Robyler and Doering (2014) address the challenges encountered in the use of technology for teaching and learning. They caution about a number of social, educational, legal/ethical and cultural issues that attention needs to be paid to as teachers and students are exposed to educational technology. Examples include the quality-of-life concerns which have to do with the health risks of prolonged ICT use, young people‟s addiction to ICT devices, plagiarism and academic dishonesty, widening the digital divide, hacking and illegal downloads. To deal with these challenges, they suggest that schools teach these them as part of the required curriculum for students and the professional development for teachers in such a way that students and teachers will be made aware of them and hopefully use technology in ways that limit their negative consequences.

2.9.1 Infrastructural Barriers

This is one of the prevailing themes in the literature on challenges to integration of ICTs in teaching and learning (Opoku-Peprah, 2016). Undoubtedly, modern technologies are costly, and an investment in them requires an expenditure of huge amounts of money, first in the purchase of ICT equipment and then in skills training for staff, maintenance of equipment, wiring, ensuring security and others. Generally, school buildings constructed several years before the introduction of computers in schools lack features that make them suitable for connecting and using computers and other ICT devices. In many institutions, there are reports of scarcity of computers partly because repairs are often delayed when there is a breakdown and principals and ICT coordinators do not usually have the required knowledge to repair broken down equipment. Opoku-Peprah (2016) in his study of the challenges of ICT use in Senior High Schools in Ghana found that there were limited computers and software, no internet access among others. The predominant challenge reported by most of the respondents in his study was inadequate computer laboratories and limited resources and materials for teaching ICT. Similar findings were made by Albugami and Ahmed (2015) in Saudi Arabian secondary schools where ICT implementation was found to be hindered by inadequate space and resources and maintenance challenges.

2.9.2 Human Resource Barriers

Albugami and Ahmed (2015) concur that successful technology integration is complex and requires many interrelated variables, perhaps the most important among these being the right personnel to manage the process. Several challenges associated with human resource are found in the literature, including those relating to principal and teachers‟ professional development, skills gaps and so on.

School heads, as instructional leaders, are expected to support their teachers to integrate ICTs into their lessons. Considering that these leaders are themselves not adequately prepared to effectively take up their roles as technology leaders, the role of challenging, equipping and motivating teachers to use technology in „authentic ways" in teaching and learning becomes a difficulty. The direct result of this, perhaps, is the inadequate professional development and training of teachers in technology integration literacy. Even though technology integration in teaching and learning is a relatively new domain in education where teachers are expected to exploit, teachers lack basic skills necessary to make this a possibility hence resulting in feelings of discomfort to use computers. This inadequate ICT skills and training is a concern in many countries where efforts are being made to integrate technology in education (Albugami & Ahmed, 2015).

In their qualitative study of four Ghanaian schools, Malcom and Godwyll (2013) identified inadequate resource capacity to provide ICT training and equipment servicing and inadequate professional development programs for teachers to upgrade their skills in emerging technologies as apart from other infrastructural issues, some of the challenges confronting successful ICT integration in Ghana.

Another problem identified in the Ministry of Education"s e-Readiness report of 2009 in Ghanaian educational institutions is the wide inequality in the distribution of ICT infrastructure in Ghanaian schools. This problem is further emphasized by Mangesi (2007) and Mfum-Mensah (2003). Schools with more ICT infrastructure were found in the urban areas whereas those in the rural areas had less. This consolidates the fact of the challenges associated with attracting skilled teachers into schools in the rural areas of the country (Ministry of Education, 2009). This situation is likely to widen

the gap between urban (have) schools and rural (have-not) schools (Mfum-Mensah, 2003). The inadequate policy framework for ICT integration in schools is another challenge to effective Implementation in schools (Mfum-Mensah, 2003).

As with organizations outside education, the impact of change on technology decision-making in schools is evident (Kokay 2004). There is little time to enable schools to gather information required to make a decision, nor time to reflect on the effect of the decisions once made. A year in the ICT arena is a very short period as new innovations take center stage in the world of competition by various software companies. Kokay (2004) notes that because of the pace of technology, it is difficult to produce technical plans that look ahead and determine which forms of hardware, software and support will be required to meet the future needs and goals of the school. Implementation of a new policy can often be plagued by a range of problems. An incorrect perception can impede the successful outcome of any change (Al-Sharija, 2012). Technical plans based on uncertainties owing to high speed of innovations can be daunting for change agents as trial and error takes toll on their very confidence necessary for ICT integration process.

One major limitation for change in ICT and education is that many of those involved in helping people to learn in both formal and non-formal contexts have little or no skills in the appropriate use of new technologies (Unwin, 2005). This is particularly so in poorer countries, and most notably in Africa. He notes that there have, to date, been rather few effective and sustainable schemes designed to enhance ICT for e-literacy among teachers.

ICT implementation requires a visionary and focused leadership. However, this can be an intricate issue. Bush (2008) says that vision building is a highly sophisticated and dynamic process which few organizations can sustain. In another observation, he posits that vision building is even more critical, suggesting that visionary leaders may damage rather than improve their school.

2.10 Empirical Studies

Roth (2007) has defined the term "empirical" as the systematic process of deriving and analyzing data from direct or indirect observation. It is a theory of knowledge in philosophy which adheres to the principle that knowledge arises from experience and evidence gathered specifically using the senses. Eisenhardt and Graebner (2007) have discussed on empirical research and suggested that it requires sound literature grounding, then identify the present research gaps and based on it develop the research questions to fulfill these gaps. Empirical research helps in theory building as well as in verification of proposed theories. The empirical studies of this work dealt with Social Studies teachers` ICT content knowledge, Social Studies teachers‟ perception of ICT integration, Social Studies teachers` practices/use of technology integration, barriers to ICT integration in Social Studies, benefits of ICT integration to Social Studies teachers.

A study conducted in Turkey by Tezci in 2011 to investigate the status of Turkish primary school teachers with regards to their attitudes and knowledge levels in ICT use demonstrates that, teachers‟ level of content knowledge in ICT (software) was low. Various variables were examined such as years of experience, gender etc. The study was conducted with 1540 primary school teachers using the computer attitude scale (CAS). The scale was 1-to-5 Liker-type (from 1= completely disagree to 5=

completely agree. The results show that the most commonly used and well-known ICT types among teachers are the Internet, e-mail and word processing, and teachers‟ attitudes towards computers and the Internet are generally positive. It was also found that their attitudes vary with their years of experience and levels of knowledge.

Another study was conducted in Syrian education by Albirini in 2004 to explore the attitudes of high school English as a Foreign Language (EFL) teacher in Syria toward ICT. In addition, the study investigated the relationship between computer attitudes and five independent variables: computer attributes, cultural perceptions, computer competence, computer access, and personal characteristics (gender, age, income, teaching experience, school location, education, and teaching methods as well as computer training background) were also included in order to ensure maximum possible control of extraneous variables. Simple random sample of 326 subjects were selected to participate in the study and were administered questionnaires. The findings suggest that teachers have positive attitudes toward ICT in education. Again, on teachers` computer competence the findings were represented by a mean score on a 4-point, scale ranging from 1 (no competence) to 4 (much competence). The majority of the respondents had no (43.3%) or little (39.5%) computer competence in handling most of the computer functions needed by educators. On average, the respondents reported that they had „„Little Competence“““(mean = 1.78; SD = 0.67) in computer uses.

Valenzuela (2002) conducted a survey on the level of ICT use and expertise by teachers in Chilean secondary schools. Data were collected in six secondary schools in the province of Nuble, Chile, through multiple methods (questionnaires, classroom observations, interviews and document analyses) to measure the level of ICT use and

perceived expertise attained by secondary school teachers. Participants personal information including age, sex, degrees, subject(s) taught, teaching experience were also determined. The results showed that teachers‟ levels of ICT use (n=74), in terms of frequency and range of software types being used, were varied but tended to be low.

In addition, Boakye and Banini (2008) conducted a survey on Teacher ICT Readiness in Ghana in eight representative schools and reported that 71% of the teachers never used the computer for teaching in class and never took their students to the computer lab. The main conclusion was most of the teachers seemed unprepared to integrate ICT in their practice. All schools were in two urban areas: Accra and Kumasi. Qualitative data was gathered via interviews and focus group discussions as well as through school and classroom observation and review of documents produced by administrators, teachers and students. Quantitative data was gathered via questionnaires from students and teachers. The total student sample was 10000 and the teacher sample 500, of which 5048 and 221 respectively responded to the quantitative research instrument.

2.11 Summary of Literature Review

In this chapter, literature was reviewed under the following: Theoretical Framework, Conceptual Framework, concept of technology integration in Education, roles of ICT use in Science education, ICT tool applications in science education, teachers‟ perceptions about use of ICT in Teaching and Learning, ICT Resources available in the Science classroom, Integrated Science Teachers` practices/usage of ICT in the classroom, frequency of Teachers‟ attendance at ICT Integration capacity building workshops, challenges of ICT Integration into teaching and learning.

CHAPTER THREE

METHODOLOGY

3.0 Overview

The main aim of this chapter is to present and describe the methodology adopted for this study. The methodology as indicated in this chapter, describes for the reader important components of this study, such as research philosophy, research approach, research design, population, sample and sampling procedure, data collection instrument, validity and reliability of research instrument, procedure for collecting data and data analysis plan and ethical consideration.

3.1 Research Philosophy

The philosophical approach underpinning this study was the ideology of both the interpretivist and the positivist, which was pragmatism. The nature of this research problem, the purpose, research objectives and research questions raised as well as the research methodology was the reason for picking pragmatism philosophical approach. Bryman (2012) noted that when these two approaches (qualitative and quantitative) are combined, they help in supporting each other.

Pragmatism as a worldview arises out of actions, situations, and consequences rather than antecedent conditions such as those in post positivism. There is a specific concern with applications, that is, what works as well as a solution to problems (DeVellis, 2016). Instead of focusing on methods, researchers emphasize the research problem and use all approaches available to understand the problem. As a philosophical underpinning for mixed methods studies, its importance is in focusing attention upon a research problem in social science research and then using pluralistic

approaches to derive knowledge about that problem. Pragmatism is typically associated with mixed-methods research (Creswell, 2014).

Also as stated in the above, Creswell (2014) was of the view that pragmatism embraces features associated with both positivism, post-positivism and constructivism worldviews. However, Hammond and Wellington (2013**)** stated that both pragmatism and transformative-emancipatory paradigms reject the dogmatic either-or choice between constructivism and post positivism and the search for practical answers to questions that intrigue the investigator.

3.2 Research Approach

Research approach is essential as it enables the researcher to focus and look at in-depth of the problem and make a decision on how to solve the problem, naming, and approaching the research topic (Saunders, Lewis, & Thornhill, 2012**).** In doing research, the approach may be qualitative or quantitative or both. The qualitative involves collecting data that is mainly in the form of words, and the quantitative involves data which is either in the form or can be expressed in numbers. It is often assumed that quantitative approaches draw on positivist ontologies whereas qualitative approaches are more associated with interpretive. Quantitative research is based on a positivist philosophy which tends to be based on deductive theorizing, where a number of propositions are generated for testing, with empirical verification then sought (Creswell, 2013).

Mixed methods research appraoch involves combining qualitative and quantitative methods within a single study to provide a more comprehensive understanding of a research problem or question. By integrating both qualitative and quantitative data collection and analysis techniques, researchers can capitalize on the strengths of each

approach while mitigating their respective limitations. This approach allows for a more nuanced exploration of complex phenomena, offering deeper insights into the underlying mechanisms and processes at play. For instance, in a study examining the effectiveness of a new educational intervention, researchers might use qualitative methods such as interviews or focus groups to gather rich, contextualized data on participants' experiences and perceptions, while also employing quantitative measures like surveys or standardized tests to assess objective outcomes and measure statistical associations (Creswell & Creswell, 2017; Teddlie & Tashakkori, 2019).

Utilizing a mixed methods approach is crucial in research endeavors where a multifaceted understanding of the subject matter is necessary. By employing both qualitative and quantitative methods, researchers can triangulate their findings, enhancing the validity and reliability of their results. Additionally, mixed methods design allows researchers to overcome the limitations inherent in using either approach in isolation. For example, while qualitative methods provide depth and context, they may lack generalizability; conversely, quantitative methods offer statistical rigor but may overlook the intricacies of human experiences. By integrating both approaches, researchers can address these limitations and gain a more comprehensive understanding of the research problem. Thus, mixed methods design serves as a powerful tool for generating robust, nuanced insights that can inform theory, practice, and policy in various fields of study (Creswell & Creswell, 2017; Teddlie & Tashakkori, 2019).Therefore, considering the kind of data collected in this study, both qualitative and quantitative approaches was used thus leading to the mixed method approach as the approach used for the study.

3.3 Research Design

The study employed sequential explanatory mixed method design to explore barriers to ICT integration in the teaching and learning of Integrated Science in JHS in Wa Municipality. Mixed method approach was explained as the class of research that combines quantitative and qualitative research approaches and concepts into a single study. The purpose of this design was to obtain different but complementary data on the same topic (Muijs, 2014) to best analyze the research problem. Sequential explanatory mixed methods design involves initially collecting and analyzing quantitative data, followed by collecting and analyzing qualitative data to explain or elaborate on the quantitative findings. This design allows researchers to first establish relationships or patterns through quantitative data and then delve deeper into understanding the underlying mechanisms or contexts through qualitative inquiry. For instance, in a study exploring factors influencing students' academic performance, researchers might first administer surveys to gather quantitative data on demographic variables, academic behaviors, and grades. Subsequently, they could conduct interviews or focus groups with a subset of participants to gain insights into the lived experiences, motivations, and challenges that may explain the quantitative findings (Creswell & Creswell, 2017).

This approach is particularly valuable when quantitative findings raise questions or unexpected results that require further exploration. By integrating qualitative methods in a sequential manner, researchers can enrich their understanding of complex phenomena and provide more comprehensive explanations. Sequential explanatory mixed methods design allows for a nuanced exploration of research questions by leveraging the strengths of both quantitative and qualitative approaches. It enables researchers to not only identify patterns or trends but also to contextualize and

interpret these findings within the broader social or cultural contexts. Thus, this design offers a holistic understanding of the research topic, contributing to more robust conclusions and informing theory, practice, and policy (Creswell & Creswell, 2017; Teddlie & Tashakkori, 2019).

Sequential explanatory mixed methods design offers distinct advantages in research by combining the strengths of both quantitative and qualitative methods to provide a more comprehensive understanding of complex phenomena. This approach allows researchers to first establish relationships or patterns through quantitative data analysis and then delve deeper into understanding the underlying mechanisms or contexts through qualitative inquiry. By sequentially integrating these methods, researchers can address multiple aspects of a research question, leading to richer insights and more nuanced interpretations. This is particularly valuable when quantitative findings raise questions or unexpected results that require further exploration, as the qualitative component can help elucidate and contextualize these findings (Creswell & Creswell, 2017).

Furthermore, sequential explanatory mixed methods design enhances the validity and credibility of research findings by employing a triangulation of data sources and methods. By corroborating quantitative results with qualitative insights, researchers can validate their findings from multiple perspectives, thereby increasing the robustness of their conclusions. Additionally, this design allows for a more holistic exploration of the research topic by considering both objective measures and subjective experiences. By integrating quantitative and qualitative approaches sequentially, researchers can generate a more comprehensive understanding of the phenomenon under study, facilitating theory development, practical application, and

informed decision-making (Creswell & Creswell, 2017; Teddlie & Tashakkori, 2019). This research design will sample the views and opinions of integrated science teachers on barrier to ICT integration in the teaching and learning of Integrated Science in JHS in Wa Municipality.

3.4 Setting

The study was conducted in the Wa Municipality in the Upper West Region of Ghana. It shares boundaries with Wa West, Wa East and Nadoli Kaleo districts. Wa is the capital town of the Municipality and has trading as its major occupation. This locality was chosen because, the researcher has been residing there for over thirty years and have been a teacher there for the past ten years which makes him have an in-depth background information about the area. There have been disparities in access, infrastructure, and pedagogical practices between urban and rural areas, making Wa an ideal location to explore the challenges associated with ICT integration in a semi-urban setting. Therefore, by selecting Wa municipality as the study area, the researcher can gain insights into the complexities of ICT integration in teaching and learning of Integrated Science within a specific regional context, contributing to both theoretical understanding and practical implications for educational policy and practice.

3.5 Population of the Study

Kusi (2012) defined population as a group of individuals or people with the same characteristics and in whom the researcher is interested. Similarly, McMillan and Schumacher (2010) see population as a group of elements or causes, whether individuals or objects or events, that conform to specific criteria and to which one intends to generalize the results of the research. The target population of the study

was all two hundred and seven (207) Integrated Science teachers in JHS in Wa Municipality of the Upper West Region of Ghana. There are 69 public JHS in Wa Municipality (Wa Municipal Education Directorate, 2021).

3.6 Sample Size and Sampling Techniques

According to Ravitch and Riggan (2017) a sample comprises the elements of the population considered for actual inclusion in the study. Sixty (69) Integrated Science teachers in the Municipality were considered for the study using census sampling technique. Census sampling involves selecting every member of the population under study for inclusion in the sample, ensuring that each individual or unit has an equal chance of being selected (Babbie, 2016). Unlike other sampling methods where only a subset of the population is chosen, census sampling aims to gather data from the entire population, providing a comprehensive and accurate representation of the characteristics and attributes of interest. While census sampling offers high precision and eliminates sampling error, it can be resource-intensive and time-consuming, especially for large populations. Therefore, researchers must carefully consider the feasibility and practicality of census sampling based on the research objectives, population size, and available resources (Babbie, 2016). For interview schedules, Saunders et al. (2012) recommend 3-5 respondents" while Creswell and Creswell (2018) also suggest that a range of eight and fifteen respondents. These recommendations are premised on the claim that in qualitative studies, samples are typically small and based on information needed (Yakubu, 2015). Therefore, these have informed the choice of the researcher to interview 6 out of the 69 teachers.

Based on a situational and contextual analysis (Goldkuhl, 2012), purposive sampling was done in a non-random manner, based on member characteristics and specific criteria relevant to the research problem (Rallis & Rossman, 2014). Purposive sampling as pointed out by Mcmillan and Schumacher (2010) is a sample chosen on the basis of some characteristics possessed by the subjects and deemed important for the research based on the judgment of the researcher. Thus, subjects gender, teaching experience and their qualification were considered in purposively selecting the subjects for the study.

3.7 Instrumentation

Two instruments were used in data collection, interview guide and questionnaire. Interviews are primarily done in qualitative or mixed methods research, they occur when researchers ask one or more participants general, open-ended questions, and record or take notes of their answers. Often audiotapes are utilized to allow for more consistent transcription (Creswell, 2013). The researcher often transcribed and typed the data into a computer file, in order to analyze it after interviewing.

Interviews are particularly useful for uncovering the story behind a participant‟s experiences and pursuing in-depth information around a topic. Interviews may be useful to follow-up with individual respondents after questionnaires, for example, to further investigate their responses (Kothari, 2008). A strength of interviews is that a researcher can freely use probes (prompts used to obtain response clarity or additional information). Questionnaires have many uses, most notably to discover what the masses are thinking. These include market research, political polling, customer service feedback, evaluations, opinion polls, and social science research (O‟Leary, 2014).

Interview Guide

A semi-structured interview guide was designed and administered to six (6) JHS Integrated Science teachers in Wa Municipality. The interview guide sought to guide the interview process between the researcher and the teachers. In order to ensure the validity of the interview schedule they were designed to reflect on the research objectives and questions. Like the questionnaire, the interview guide was divided into sectors covering the critical areas of the research questions of which answers could not be obtained with the use of the questionnaire The interview items were built on the major variables that were the key themes in the research questions involving ICT integration in the teaching and learning of Integrated Science in JHS in Wa Municipality. The questions were also central in triangulating the responses from the questionnaire and in maintaining the focus of the research in order to avoid concentrating on less important points. Though the interview guide was semi-structured, it was interactive and the new issues and ideas that emerged in the course of the interview were further investigated. The questions were put under four main themes: Availability of ICT tools and infrastructure; having three items, Teachers` ICT knowledge; had two items, Usage of ICT; had three items and Challenges of integration; had three items.

Questionnaire

Using the research questions as the basis, the researcher designed the questionnaire for the survey. The questionnaires were used to elicit information from the teachers about ICT integration in the teaching and learning of Integrated Science. The questionnaire consisted of items related to the four research questions. Closed-ended questions were used in the questionnaire to allow the study gather vital information. Again, Likert scale type questions were used. Each premises was on a five-point

scale; 1=Strongly Disagree; 2=Disagree; 3=Uncertain; 4=Agree; 5=Strongly Agree. The choice of the instrument was because the nature of data needed for the study do not involve or require time series over several monitoring rounds of data. It involved collection of information from a sample that had been drawn from a predetermined population at one point in time (Fraenkel & Wallen, 2013).

The questionnaire for the teachers consisted of four (4) sections; that is, sections A, B, C, D, and E covering various relevant areas. Section A gathered information on demographic information, Section B focused on availability of ICT tools and infrastructure needed for successful integration in teaching Integrated Science in JHS in Wa Municipality. Section C solicited data on the ICT content knowledge of JHS Integrated Science teachers in integrating ICT in teaching integrated science, Section D collected data about the extent to which JHS Integrated Science teachers practice/use ICT integration into teaching Integrated Science JHS in Wa municipality, whilst Section E considered the barriers to the successful integration of ICT in teaching JHS Integrated Science in Wa municipality. In all, thirty-three (33) items were captured in the questionnaire

3.8 Validation of Instruments

The validity of the research instruments was ensured by assessing the questionnaire items during their construction using content and face validity. Validity is the extent to which research instruments measure what they are intended to measure (Creswell & Creswell, 2017; Tashakkori & Teddlie, 2010). For face validity, the instruments were given to colleague Master of Philosophy students of the Department of Basic Education in the University of Education, Winneba as well as colleague Integrated Science teachers for scrutiny and peer review. For content validity, the instruments

was given to my supervisor for expert review. They scrutinized the items for their suitability before pre-test. Content validity was measuring instruments whether there has been adequate coverage of the investigative questions guiding the study (Creswell & Creswell, 2017). It indicates that the technique assesses or measures what it is supposed to measure (Creswell & Creswell, 2017). It is a judgmental assessment on how the content of a scale represents the measures.

3.9 Reliability

Reliability refers to the extent to which an instrument measures the same way each time it is used under the same condition with the same subjects (Agyedu et al., 2013). The purpose of reliability is to assess the instrument‟s ability to measure the same way in each administration to the same sample. To ascertain the reliability of the research instrument, a pilot-test, was conducted in the Wa West District which shears similar characteristics with Wa Municipality. The results obtained were used to calculate the Cronbach alpha coefficient. The more the alpha coefficient was closer to 1.00 the more reliable the instrument was. A score of 0.84 was obtained indicating that the instrument was reliable.

3.10 Trustworthiness of the Interviews

Credibility: The researcher ensured accurate reflection on the interviews by cross-checking (replay of audio tape) with the participants regarding what had been experienced.

Dependability: The consistency of results over time. They were later re-visited to say what was said previously.

Confirmability: Linking the results to the data itself. Independent critical readers were employed to evaluate methods for data collection.

Transferability: The applicability of the findings to other settings. The study confirmed findings from other areas.

3.11 Data Collection Procedures

A letter of introduction from the Basic Education Department of the University of Education, Winneba granted me the permission to first collect data for the study. The letter assisted to introduce myself, established rapport with the respondents and sought permission from all the respondents before the due date to administer the questionnaire and interview them. The researcher addressed all requests for clarification on the questionnaire. The respondents were comfortable in responding to the questionnaire because the researcher assured them of strict confidentiality. The questionnaires were administered to the respondents using the drop and pick technique of visiting the sampled schools to distribute the questionnaires then come to pick them from the headteacher on the next day.

As part of the data collection an agreed date and time was scheduled with the six (6) teachers for the interview. The interview guide provided the opportunity for the researcher to directly interact with the respondents and as such, obtained direct answers to the questions. This actually helped provide satisfactory answers to the research questions.

The face-to face interview is presented as enabling a "special insight" into subjectivity, voice and lived experience (Epstein, 2012). To ensure that ethical issues were not violated, before each interview, the researcher briefly talked about the purpose of the interview and gave an overview of the research being conducted. I also sought permission from interviewees to record the interview and to take notes and assured them of anonymity and the fact that the recordings and the notes will be

destroyed as soon as the research was over. At the beginning and throughout the interview, the researcher stressed the importance of confidentiality to the participants and that made them feel at ease to talk to me in confidence. It took five (5) working days for interviewing and administering the questionnaires.

3.12 Quantitative Data Analysis

Data analysis is important for interpreting raw data, in order to obtain the meaning and pattern from data (Bell, 2010). The answered questionnaires were grouped according to the categories of respondents. Questionnaires for the respondents were numbered serially to ensure easy coding and checked for blank options and out of range responses. The coded responses were fed into the computer using the Statistical Package for Social Sciences (SPSS version 21) for Windows, which is capable of analyzing data fed into it. The results was summarized into tables using descriptive statistics.

The coding of the items was done in line with the scale provided as follows; In section B, a five (5) point-Likert scale was given: Strongly Disagree (SD) = 1, Disagree (D) = 2, Undecided (U) = 3, Agree (A) = 4 and Strongly Agree (SA) = 5.

3.13 Qualitative Data Analysis

A qualitative analysis was also employed. A qualitative thematic analysis is a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying patterns (Creswell, 2014). It is an approach of empirical analysis of texts considering their context of communication. The content analysis helped me to focus on the examination of meaning occurring within a particular context. It also helped the researcher to describe the narrative of the qualitative responses generated through the interview.

Thus, an interview was conducted on six (6) respondents and their responses transcribed.

3.14 Ethical Considerations

Ethical issues are highly relevant and require serious considerations. Therefore, to create a mutual respect and relationship with the respondents before the commencement of the data collection, a letter was obtained from the Department of Basic Education indicating the purpose of the study and its significance to the teachers and head teachers in the public basic schools, and the Director of Education in Wa Municipality. In addition, a covering letter was obtained from the Wa Municipal Director of Education to introduce the researcher to the headteachers of the various schools. The headteachers also introduced the researcher to the teachers. Furthermore, each questionnaire had an opening introductory letter requesting for the respondent‟s cooperation in providing the required information for the study. The respondents were further assured that the information provided shall be used for academic purposes only (confidentiality).

The ethical issues the researcher considered were;

Informed Consent: The Researcher informed the participants of the purpose, nature, data collection methods, and extent of the research prior to commencement. Further, the Researcher explained to them their typical roles; this was very critical as the approach was altogether different form the traditional face-to-face approaches. In line with this, the researcher obtained their informed consent in writing and recording.

Harm and Risk: In this research study the Researcher guaranteed that no participants were put in a situation where they might be harmed as a result of their participation, physical or psychological.

Honesty and Trust: Adhering strictly to all the ethical guidelines serves as standards about the honesty and trustworthiness of the data collected and the accompanying data analysis.

Confidentiality: Participants were assured that all information they provided would remain confidential and will not be disclosed to any one in any manner except for in this study. All data collected will be stored in a secure place and destroyed after the study is completed.

Anonymity: Maintaining anonymity for the participants was challenging here because the rest of the school community knew the participants. However, every step was taken to ensure that their identities were not publicly revealed and pseudonyms were used instead of real names.

Voluntary Participation: Despite all the above-mentioned precautions, it was made clear to the participants that the research was only for academic purpose and their participation in it was absolutely voluntary. No one was forced to participate. Participants were informed that they could withdraw before the third week of the data collection.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter provides the results and discussion of the findings. It has been structured into two main parts: the first part provides the personal information of respondents whiles the second part presents the discussion of results from quantitative and qualitative data based on the research questions that guided the study.

4.1 Demographic Information

Table 4.1: Gender of Teachers

Sex	Frequency (*f*)	Percentage (%)
Male	41	59.4
Female	28	40.6
Total	**69**	**100**

Source: Researcher‟s Fieldwork Data (2022)

It can be verified from the data in Table 4.1 that out of the 69 respondents, 41 of them representing 59.4% are males whilst 28 of them representing 40.6% are females. This suggests that the number of males in the study outnumber the females in the study. As such, the findings generated by the study is likely to reflect more on male perspective as opposed to females because the males outnumber the females This also indicates that more females should be encouraged to offer ICT related programs to help bridge the gender gap in participation in the Wa municipality.

Table 4.2: Age Range of Teachers

Age (in years)	Frequency (*f*)	Percentage (%)
Less than 30 years	10	14.7
30-39 years	27	39.7
40-49 years	28	41.2
50 and above	4	5.9
Total	**69**	**100**

Source: Researcher‟s Fieldwork Data (2022)

It can be deduced from the data in Table 4.2 that out of the total number of 69 respondents, 10 of them representing 14.7% are less than 30 years, ages between 30–39 constituted 27 of them illustrating 39.7% of the population. In addition, ages between 40-49 dominated the population who were 28 in number representing 41.2% whereas respondents that are 50 years and above were 4 in number representing 5.9%. With reference to the data above, it can be validated that 37 respondents representing the majority of the respondents are less than 40 years.

Table 4.3: Educational Qualification of Respondents

Qualification	Frequency (*f*)	Percentage (%)
Diploma	55	80.1
Bachelors‟ Degree	10	14.7
Masters	4	5.9
Total	**69**	**100**

Source: Researcher‟s Fieldwork Data (2022)

From Table 4.3, it can be seen that, out of the 69 respondents, 55 of them representing 80.1% had obtained diploma, 10 of them representing 14.7% had obtained first degree, and the remaining 4 representing 5.9% had obtained the masters‟ degree. This depicts that, respondents that had obtained diploma certificate dominated the study. It can be concluded that a chunk of the integrated science teachers held diploma

certificates as professional teachers who had gone through ICT as a subject in the teacher training colleges had knowledge in ICT and hence is expected to integrate ICT in their lessons.

Table 4.4: Teacher experience

Years	Frequency (*f*)	Percentage (%)
Less than 5 years	13	19.1
6–10 years	37	64.7
11-15 years	12	17.6
16 years and above	7	10.3
Total	**69**	**100**

Source: Researcher"s Fieldwork Data (2022)

Data in Table 4.4 reveal that out of the 69 respondents, 13 of them representing 19.1% had worked for more than a year but less than 5 years, 37 of them illustrating 64.7% had worked between 6-10 years, 12 of them representing 17.6% had worked for 11-15 years, whereas 7 of them representing 10.3% had worked for 16 years and above. This implies that majority of the respondents in this study had worked between 6-10 years which further implies that there is so much expertise in this category of teachers and as such they are expected to demonstrate much ICT content knowledge.

4.2 Analysis and Discussion of Results

This part deals with the results of the quantitative analysis and discussion of the research findings followed by their respective qualitative data. The first research question dealt with the available ICT tools and infrastructure needed for successful integration in teaching integrated science, the second considered the ICT content knowledge possessed by JHS Integrated Science teachers for teaching integrated science, the third dealt with the extent to which JHS Integrated Science teachers practice/use ICT integration in teaching Integrated Science whereas the final one

presented the barriers of ICT integration. In addressing each, the responses "Strongly Agree", "Agree" "Strongly Disagree" and "Disagree" on a likert scale were analyzed separately.

4.2.1 Research Question One: What are the available ICT tools and infrastructure needed for successful integration in teaching JHS Integrated Science in the Wa municipality?

Research question one sought to find out the availability of ICT tools and infrastructure needed for successful integration in teaching Integrated Science in JHS in Wa Municipality. In order to establish that, frequencies and percentages were computed using participants responses and is presented in Table 4.5.

Table 4.5: ICT Tools and Infrastructure Available for Successful Integration

	STATEMENT	SA		A		SD		D	
		F	%	F	%	F	%	F	%
1.	Computers are readily available in my school	50	72	9	13	4	6	6	9
2.	Videos and animations are available	40	58	20	29	5	7	4	6
3.	Internet is accessible in the school	20	29	16	23	20	29	13	19
4.	Projectors are available in the school	4	6	6	9	50	72	9	13
5.	Digitalflatbed color scanners are available in school	4	6	6	9	50	72	9	13
6.	Digital MP3 audio recorders with headsets and built-in microphones are available	20	29	10	14	37	54	2	3
7.	The classes experience a virtual field trip on the class computer	40	58	5	7	20	29	4	6
8.	Laser color printer with wireles network capabilities are available	13	19	2	3	40	58	14	20
9.	The school has an ICT lab	40	58	13	19	10	14	6	9
10.	I have personal smart phone	40	58	25	36	2	3	2	3
11.	I have some IT applications on my smart phone and laptop	59	86	5	7	2	3	3	4

Source: Researcher"s Fieldwork Data (2022)

KEY: *f* = frequency, % = Percentage, SA= Strongly Agree, A= Agree, SD= Strongly Disagree, D= Disagree

Data from Table 4.5 shows that 50 respondents representing 72% strongly agreed with the statement that "Computers are readily available in their school" as an ICT tool available for use by science teachers in Wa Municipality, whereas six respondents representing 9% disagreed. It suggests that majority of the respondents did agree that computers are some of the ICT teaching and learning materials readily available in their class. However, some teachers might still deem it not necessary to integrate ICT in teaching integrated science despite their availability in their schools. This finding goes to contradicts Pergrum (2016) assertion from the literature that inadequate access to resources, including home access to computers and classrooms is another complex challenge that prevents teachers from integrating ICT into lesson delivery.

In addition, respondents view on "Videos and animations are available" 40 respondents representing 58% strongly agreed whereas five respondents representing 7% strongly disagree. This makes it evident that majority of the respondents" either agreed or strongly agreed that videos and animations are available for their use in their classes. It suggests that videos and animations are ICT materials available for science teachers in Wa Municipality.

Moreover, six respondents representing 9% strongly agreed whereas 50 respondents representing 72% strongly disagreed with the statement "Projectors are available in class". This clearly depicts that 50 of respondents verified that projectors are not available in their class. It implies that an ICT material that is not available for use by science teachers in Wa Municipality is a projector.

The statement “Digital flatbed color scanners are available in school” saw six respondents representing 9% agreed whereas 50 respondents representing 72% disagreeing to the statement. This points out that majority of the respondents confirmed that digital flatbed color scanners were not available in their schools and implies that digital flatbed color scanners is an ICT equipment that is not available in schools in Wa Municipality for use by science teachers.

Furthermore, the statement “Digital MP3 audio recorders with headsets and built-in microphones are available” was strongly disagreed to by 20 respondents representing 29% whereas 37 respondents representing 54% agreed to it. This signals that majority of the respondents attested to the fact that digital MP3 audio recorders with headsets and built-in microphones are not available for use in their classes. It suggests that other ICT equipment that are not available for use by the Science teachers are digital MP3 audio recorders with headsets and built-in microphones.

Respondents‟ ideas about the statement “Laser color printer with wireless network capabilities is available” saw 13 respondents representing 19% strongly agreeing to the statement whereas 40 respondents representing 58% strongly disagreeing to the statement. It suggests that majority of the respondents have confirmed that laser color printer with wireless network capabilities is not available for use in their classes. Hence, it confirms that another ICT equipment that is not available for the Science teachers to use in their various classes is a laser color printer with wireless network capabilities.

Furthermore, 40 respondents representing 58% strongly agreed to the statement “I have personal smart phone” whereas two respondents representing 3% disagreed to the statement. This means that majority of the respondents attested to the fact that

they have their personal smart phones and implies that Science teachers in Wa Municipality own their personal smart phones to enable them to incorporate ICT into their teaching to an extent.

Finally, 59 respondents representing 86% strongly agreed to the statement "I have some IT applications on my smart phone and laptop" whereas three respondents representing 4% disagreed. This establishes that majority of the respondents verified that they have some IT applications on their smart phone and laptop. It establishes that the teachers have certain ICT applications concerning academics on their smart phones and their laptops. With the world now turning and giving much emphasis towards technology, our educational pedagogy with regards to teaching should be given a facelift in other to meet this technological expectation. However, these technological expectations of the world will only be a mirage without science. Therefore, the 21st century science teacher should practicalized the teaching of science in trying to help achieve these worldly technological expectations. From the results presented above, results from "Computers are readily available in my school", "Videos and animations are available", "Internet is accessible in my school", "My class experience a virtual field trip on the school computer", "The school has an ICT lab", "I have personal smart phone", and "I have some IT applications on my smart phone and laptop" enhances and promotes science teaching.

Though the findings revealed the availability of ICT tools and infrastructure as shown by the quantitative analysis may be convincing and accurate, this may just be a mere guess and may not truly reflect the real issues on the ground. In that regard, the qualitative aspect was brought in to validate the initial responses of the respondents. The interview data proved that respondents did not have access to ICT tools and

infrastructure. Below are the interview responses of the six selected teachers after asking them if they could mention the kinds of ICT tools and infrastructure available in your school?

Tr. 1:

Currently, we don't have enough infrastructure! and the tools that we currently have is desktop, printer and a photocopier. I think this is what we have currently. Based on this, I will say we don't have adequate tools so usually some of the things are drawn on the board so is always pictorial representation. (Interview Data, 2022).

Tr. 6:

In actual fact, in our school we don't have ICT facilities. We were not given laptops and other ICT tools to facilitate teaching and learning in our school. Sometimes it is the ICT teachers that use their own computers in teaching. (Interview Data, 2022).

Tr. 2:

I will say yes and no. Yes, because our school has a desktop computer and all hardware components seem to be intact. No because managing becomes a problem like connection to the internet to have some useful stuffs which might help in integration. I think the presence of electricity is one of the many conditions that influence the availability of ICT tools. My school sometimes lobby with NGOs for some of these tools. (Interview Data, 2022).

Tr. 3:

Actually, some topics or concepts usually influence the availability of ICT tools in teaching integrated science but we do not have. We don't even have any not to talk of adequate. We are only resorting to improvisation. (Interview Data, 2022).

Tr. 4:

I don't know but usually is the government that provide these ICT tools for this integration and sometimes if there is a very vibrant PTA they usually help. Also, if there is any NGO, they can help in that aspect by providing this ICT tools for

integration likewise the presence of electricity lacking in the school. (Interview Data, 2022).

Tr. 5:

No! Errm! considering our number we have over 200 pupils. So, in fact we don't have anything as far as ICT tools are concerned. Also, based on the school's academic performance, some NGO's can decide to come to the aid of the school. (Interview Data, 2022).

These statements infer that ICT tools and infrastructure are inadequate in the schools. Even with schools having desktop, printer and a photocopier, and ICT textbooks, they are not adequate due to learners increase in enrollment, so the teachers rather use their own laptops or do improvise using pictorial representations on their writing boards. The findings established by the ICT tools and infrastructure available in schools correspond previous literature but contradicts the quantitative results. There are many types of art application and installations, some of which are film, video and animation, Internet art, software art, virtual reality and musical environments (Paul, 2008). "Installations come in various sizes and forms, and many are directed to creating environments which can strive to envelop the audience in a projected space to those that immerse them in a virtual world" (Paul, 2008 p. 139). Digital installations sometimes incorporate a special and architectonic element which is usually the focus of the piece (Paul, 2008). Equipment for the classroom should consist of digital flatbed color scanners, digital video cameras, and digital MP3 audio recorders with headsets and built-in microphones, laser color printer with wireless network capabilities and flash or jump drives. Finally, the teacher and students need computers (Liu, 2006). Curriculum integration depicts using technology not for its own sake but for the delivery of curriculum content and it portrays a better picture of

the practice as one that interweaves educational technology skills and relevant curriculum content, not just technological skills in isolation (ISTE, 2000).

According to Ghavifek et al. (2016) ICT resources in education mean teaching and learning using ICT tools. The integration of these ICT tools tends to have some significant effects on both the teacher and the student. Thus, if ICT tools are integrated into the teaching/learning process of integrated science, it will lead to the actualization of the objectives of the Ghanaian STEM project. Integrated Science students can make use of ICT tools to predict and test theories, construct their own models, and then employ them in their investigation. The availability of ICT tools will bring to minimum the cumbersomeness during the teaching processes and will eventually result to a positive outcome at the end of the science lesson. ICT is infinitely more than a tutor, its use for explanatory and experimental purposes will offer integrated science teachers a powerful means of stimulating active learning and it offers integrated science students more responsibility and control.

Pergrum (2016) indicated that inadequate access to resources, including home access to computers and classrooms is another complex challenge that prevents teachers from integrating ICT into lesson delivery. The inadequate computers in classrooms have led most of the students to become unfamiliar with using them and to have poor behavioral attitudes toward using computers in their teaching methods. Pergrum (2016) proved that inadequate infrastructure facilities is one of the many causes of poor ICT integration in schools. He further lamented that unavailability of resources for teaching with technology discourages teachers from using ICT in their teaching.

4.2.2 Research Question Two: What ICT Content Knowledge do JHS Integrated Science Teachers Possess to Integrate ICT into Teaching Integrated Science in Wa Municipality?

Research question two sought to explore the ICT content knowledge JHS Science teachers possess to integrate ICT into teaching integrated Science in Wa municipality. In order to ascertain the fact, frequencies and percentages were employed to compute their responses as indicated in Table 4.6.

Table 4.6: Content Knowledge of Teachers for ICT Integration

	STATEMENT	VH		H		VL		L	
		F	%	F	%	F	%	F	%
1.	I have attended ICT tools usage capacity work shop	40	58	18	26	6	9	5	7
2.	I know how to operate a Computer/Laptop	16	23	48	70	2	3	3	4
3.	I know how to use presentation software (e.g Microsoft PowerPoint)	33	48	30	43	2	3	4	6
4.	I know how to operate a Tablet/Mobile Device	22	32	40	58	4	6	3	4
5.	I know how to use word processor software (e.g Microsoft Word)	44	64	20	29	3	4	5	7

Source: Researcher"s Fieldwork Data (2022)

KEY: *f* = frequency, % = Percentage, VH= Very High, H= High, VL= Very Low, L= Low

In Table 4.6, the data show that 40 respondents representing 58% had very high rate of attendance ICT usage capacity workshop as to the level of teacher"s knowledge and usage of ICT tools in teaching. This makes it evident that majority of the respondents attest to the fact that they had attended ICT usage capacity work shop before. It implies that Science teachers in public basic schools in Wa Municipality have at least once in their lifetime attended an ICT capacity workshop which complements

(Gakime, 2016) who reported that whether inexperienced or experienced, ICT capacity building programs equip teachers' preparedness with sufficient knowledge and skills for the pedagogical use of ICT during learning and teaching

In addition, 48 respondents representing 70% has high rate of operating a Computer/Laptop". This points out that majority of the respondents support the fact that they are abreast with how to operate a computer/laptop. It confirms that the teachers are conversant with how to operate computers being it a desktop or a laptop. However, this may affirm Clarke (2017) assertion that teachers do not use technology to teach because they lacked the content knowledge.

It is further revealed by the data that 33 respondents representing 48% has high rate of using presentation software (e.g. Microsoft PowerPoint)" whereas four respondents representing 6% disagreed. This implies that majority of the respondents confirmed that they know how to use presentation software (eg. Microsoft PowerPoint). This makes it evident that the teachers are well-versed in the usage of presentation software particularly the Microsoft PowerPoint in their lesson deliveries. This however deviates from Bullock (2004) assertion that despite the huge investment of financial and human resources, pre-service teacher education programs do not provide teachers with the necessary skills, competencies, and experiences to prepare them to use ITCs effectively in their future professions

The data again showed that 40 respondents representing 58% high rate of operating a Tablet/Mobile Device whereas four respondents representing 6% disagreed. It confirms that majority of the respondents affirm that they know how to operate a tablet/mobile device. This establishes the fact that Science teachers in public basic schools in Wa Municipality are capable of operating a tablet and or a mobile phone

Finally, 44 respondents representing 64% has high rate of using word processor software (eg. Microsoft Word)" whereas five respondents representing 7% disagreed with the statement.

This implies that the teachers are aware of how to incorporate word processor software such as Microsoft Word in their teaching and learning processes. Though the findings revealed on content knowledge of teachers for ICT integration in teaching integrated science as shown by the quantitative analysis may be convincing and accurate, this may just be a mere guess and may not truly reflect the real issues on the ground. Below are the interview responses of the six (6) selected teachers after asking if they could describe the level of their ICT content knowledge in teaching JHS integrated science.

Tr. 2:

Actually, I am not an expert in ICT but I have fair knowledge in hard ware components and some applications example, Microsoft Excel, Power Point, and Word that I normally use in my lesson delivery. You see, most of the basic tools like, beam balance, beakers and burette are lacking thereby making it difficult for the integration process. Sometimes I google with my phone and move round for the pupils to see some of the concept am trying to impact. So that is how I go about it. (Interview Data, 2022).

Tr. 3:

I can say my knowledge in ICT in teaching is moderate. Well! In rating from 1 to 10, I will give myself 6 out of 10. Imagine been allocated with 50 minutes and you intend to use ICT tools mean while you don't have in-depth knowledge as to how to integrate it you will surely run out of time. Because of this, before I teach certain topics, I usually research on the internet to get adequate information. (Interview Data, 2022).

Tr. 6:

Though I am not an expect in ICT I'm always able to use it in teaching my students. So, percentage wise I can say 70%. Some times before I handle certain lessons, I always do research especially on You Tube which usually help me to deliver my lesson to expectation. As I already mention I only have basic knowledge in ICT. So, in the course of teaching, I may use ICT tools in showing certain concept which my knowledge might not be up to. (Interview Data, 2022).

Tr.1:

As for me, I need additional training. During our era, computers were very scarce. As a result, I am not used to it compared to some of my colleagues who were exposed to ICT tools when they were at college. To me, the Wa Educational Directorate should be organizing in-service training for teachers frequently and educate us more on ICT usage in teaching and learning. (Interview Data, 2022).

Tr.5:

I am not a "computer baby" like the young teachers we have today. During my era, no one was exposed to computer at college not to even talk of smart phone. Though I can type one or two things I face all sorts of challenges. It is my daughter who assists me at times to enter my pupils scores into Microsoft excel. (Interview Data, 2022).

Tr.4:

Even when my husband teaches me, I forget most of them. Computer usage requires constant practice else you will forget. I am always engaged with house chores and the likes. As a result, learning how to use ICT software becomes my problem. (Interview Data, 2022)

These statements suggests that age is a major determinant when it comes to ICT content knowledge of teachers as revealed by the sentiments made by teacher 1 and teacher 5. In addition, on ICT tools that can be used to teach science, teacher 2, 3 and 6 made mention of Microsoft office, Microsoft power point and Microsoft excel.

These findings are parallel to previous literature. Voogt and Tondeur (2015) extrapolate that the application of ICT in learning is situational. For effective integration of ICT in instruction to take place, instructors should be willing to learn, practice and acquire skills and knowledge about the learners, schools, infrastructure, and tools at their disposal, and the environments they find themselves in. In-service teacher professional development demands significant time and resources in which developing nations invest millions a year to build and sharpen teachers‟ skills and competencies. However, most teacher professional development programs go unevaluated and much of it may be ineffective.

Globally, a survey by the Organization for Economic Co-operation and Development (OECD) involving 34 schools discovered that almost 88% reported having attended a Professional Development Programme during the year. Of those, 71% attended at least one workshop; 44% attended an education conference and 37% attended in a teacher network (Global Education Monitoring Report, 2018). Many teachers lack the skills to collect, analyze, interpret and use data to improve their instructions. A study in five OECD countries on teacher pedagogical knowledge revealed that assessment, in addition to research and data use was the least emphasized part of pre-service teacher education (Global Education Monitoring Report, 2018).

Clarke (2017) noted that teachers do not use technology to conduct social experiments because such competencies are lacked. To support effective teaching and learning in schools, teachers need to deliver quality instructions effectively and efficiently. But many education systems pay little attention to what teachers know or what they do in the classroom. Focusing on teachers‟ skills and motivation can pay off (World Bank Report, 2018).

According to Mustafina (2016) young tutors are perceived as having much more desire to be trained in modern technology than older tutors because the ICT revolution turned out to be prominent during the nineties. Teachers born after this period have more interest in using ICT than those who were born earlier. A myriad of researches has investigated the relationships among such variables as age, gender and various technology constructs across diverse work settings; medicine, industry, commerce, education. Findings from these studies have not been conclusive; while some studies have found significant relationships among age, gender and technology, others have reported no significant relationships (World Bank Report, 2018).

4.2.3 Research Question Three: To what Extent do JHS Science Teachers Practice/Use ICT Integration into Teaching Integrated Science in Wa Municipality?

The primary intent of this research question is to examine the extent to which JHS Science teachers integrate ICT. The outcome is presented in Table 4.7.

Table 4.7: Science Teachers Practice/Use of ICT

Statement	SA f (%)	A f (%)	SD f (%)	D f (%	M	SD
I give internet homework assignments to my students after science lessons	20(29)	40(58)	4(6)	5(7)	4.10	0.81
I sometimes allow students to use computer to search for some scientific tools during experiments	20 (29)	42(61)	2(3)	5(7)	4.30	0.68
I use instructional radio/audio taped lessons	23(33)	40(58)	2(3)	4(6)	4.48	0,71
I sometimes use computer in my lesson delivery	4(6)	5(7)	20(29)	40(58)	1.24	2.74
I use a laptop to keep my students class record	40(58)	22(32)	2(3)	5(7)	4.42	0.70
I prepare and develop my lesson plan with the help of a computer	49(71)	10(14)	4(6)	6(9)	4.34	0.72
Mean of Means (MM) =					3.81	

Source: Researcher‟s Fieldwork Data (2022)
M=Mean **SD**=Standard Deviation **SA**= Strongly Agree **A**=Agree **SD**= Strongly Disagree **D**=Disagree **%**= percentage

Data from Table 4.7 shows that respondents view concerning the statement "I give internet homework assignment to my students after science lessons" as science teachers practice or use of ICT in Wa Municipality resulted in (M=4.10, SD=0.81). It suggests that majority of the respondents did appreciate that they give internet homework assignment to their students after science lesson as a mean of 4.10 for this statement was greater than the mean of means of 3.81. This implies that the teachers highly utilized the virtual library to search for information to enable them obtain adequate information concerning concepts they are about to deliver to pupils. However, this contradicts with (Valenzuela, 2002) that, in spite of governments having invested large sums of money in equipment, resources and teacher training with the purpose of improving teaching and learning in the schools, the integration of ICT in education in many countries has been limited.

In addition, respondents view on "I sometimes allow students to use computer to search for some scientific tools during experiments" yielded (M=4.30, SD=0.68). This implies that majority (61%) of the respondents attest that they allow their students to use computers in their lessons as the mean of 4.30 for this item was greater than the mean of means of 3.81. It implies that the teachers try as much as possible to allow their students to use computers during their lesson deliveries.

It was also revealed by Table 7 that the assertion "I use instructional radio/audio taped lessons" produced (M=4.48, SD=0.71). This suggests that majority (58%) of the respondents agreed to the fact that they use instructional radio/audio taped lessons in their respective classes as the mean of 4.48 for this item was greater than the mean of means of 3.81. It confirms that Science teachers in public basic schools in Wa

Municipality use radio or audio taped lessons for delivering certain concepts to learners.

Moreover, on respondents‟ view with regards to the statement “I sometimes use computer in my lesson delivery” resulted in (M=1.24, SD=2.74). This depicts clearly that majority 58% of the respondents indicated that they do not use computers during their lesson deliveries as the mean of 1.24 for this item was less than the mean of means of 3.81. It establishes the fact that the teachers do not use computers during their lesson deliveries and this could be as a result of them not been conversant with computer usage.

In addition, the statement “I use a laptop to keep my students class record” responses from the respondents ended up with (M=4.42, SD=0.70). This shows that majority (58%) of the respondents strongly agreed that they use laptops to keep their students class record as the mean of 4.42 for this item was greater than the mean of means of 3.81. This signals that the teachers use their laptops to keep their students class record.

Finally, the assertion “I prepare and develop my lesson plan with the help of a computer” resulted in (M=4.34, SD=0.72). It confirms that majority (71%) of the respondents strongly agreed that they I prepare and develop their lesson plans with the help of a computer as the mean of 4.34 for this item was greater than the mean of means of 3.81. This means that Science teachers in public basic schools in Wa Municipality prepare and develop their lesson plans with the help of a computer before teaching. Though the findings revealed on the usage/practices of ICT integration in teaching integrated science as shown by the quantitative analysis may be convincing and accurate, this may just be a mere guess and may not truly reflect

the real issues on the ground. So, on that regard, the qualitative aspect was brought in to validate the initial responses of the respondents. Below are the interview responses of the six selected teachers after questioning them about the perceptions and attitudes they have towards ICT integration in teaching integrated science?

Tr. 2:

As for me, I am aware of the basic ones like Microsoft office word, power point which I use to present slides and maybe something small on excel which helps me especially when it comes to the compilation of the scores of my pupils. (Interview Data, 2022).

Tr. 6:

I am not all that good or all that naïve about the usage of ICT for teaching. Maybe, I will rate myself 60 percent. As for the simple ones like Microsoft office, Power Point and Excel, I know how to deal with most aspects. The problem is that equipment to use for ICT integration are not there. When they are available, we can learn from our colleagues who are familiar with them or better still, we can go in for a resource person to teach us. (Interview Data, 2022).

Tr. 3:

To me, the ICT knowledge required of me to teach pupils at this level is at least 90 percent. I know how to use Microsoft office very well since I attended a computer training course. To me, the problem is "Where are the tools and equipment to use for integration"? (Interview Data, 2022)

Tr. 6:

Normally, teachers have a negative perception towards ICT integration because they usually think it wastes time. Again, some are of the view that whatever they can use ICT tools to teach they can equally teach it abstractly. My level of ICT content knowledge is very basic which I use in delivering my science lessons. I will say most JHS science teachers lack knowledge of ICT. So, I will say some have positive perception while some have negative perception based on the level of ICT content

knowledge of the particular teacher. I sometimes use my laptop to show students some concepts that require practical and physical observation. (Interview Data, 2022).

Tr. 3:

I have nothing against ICT tools integration, I will even recommend it on any given day to every science teacher. So as far as I'm concerned, I have no bad attitude/perception towards ICT tools integration hence my frequent usage and practices. I have adequate knowledge in ICT but because of the absence of the tools, my knowledge has no relation to how I teach science. The last time I did it was yesterday during extra classes where I took my laptop to the class and show the pupil how photosynthesis occurs in plants. Then from the video it was easier for me to brainstorm on the definition of photosynthesis. (Interview Data, 2022).

Tr. 4:

Errm! our perception is that ICT integration would be very good and helpful if the tools were available and would have eased the integration process. So, in general I must say science teachers have positive perception and attitude towards ICT integration. Sometimes, as a teacher you need to improvise. So, though I have positive attitude towards ICT integration it doesn't show how I practice or use it. (Interview Data, 2022).

These assertions imply that the teachers are not experts in ICT, but due to the advancement of technology during this era, they have shaped their ICT skills that makes them to search for information online to help them deliver certain concepts. In addition, certain teachers exhibit cold attitudes towards ICT integration because of time consuming nature of integration but even with that, they search for information online at times.

The findings agree with Waite (2004) who indicated that although teachers show great interest and motivation to learn about the potential of ICT, in practice, the use of ICT is however relatively low and it is focused on a narrow range of applications, with

word processing being the predominant use and video/network conferencing, e-mailing and the internet being rarely used. International research suggests that ICT as a tool for promoting learning is not generally well embedded in teachers‟ practices (Cubukcuoglu, 2015). Information technology in the classroom is used in an ineffective way and it has proven difficult to integrate within the traditional curriculum setting.

Abbott and Faris (2000) affirmed the findings by examining pre-service teachers‟ attitudes toward the use of computers before and after a semester-long technology literacy course. The results showed that positive attitudes toward computers increased after the course because of the instructional approaches, meaningful assignments requiring technology, and supportive faculty. Sang et al. (2010) stated that many teachers have a positive attitude towards ICT use in the classroom, but do not believe in their ability to use ICTs in the classroom. Mustafina (2016) indicated that teachers possessed positive attitudes towards ICT in school which also goes to affirm the findings of the study.

Nevertheless, age and gender did not have significant effects on these attitudes. Similarly, a survey of teachers in eight representative schools in Ghana, Boakye and Banini (2008) reported that 71% of the teachers never used the computer for teaching in class and never took their students to the computer lab while 49% used ICT for lesson preparation. The main conclusion was most of the teachers seemed unprepared to integrate ICT in their practice.

4.2.4 Research Question Four: What are the Barriers that Hinder the Successful Integration of ICT in Teaching Integrated Science in JHS in Wa Municipality?

The primary intent of this research question was to find out from the respondents concerning the barriers that hinder the successful integration of ICT in teaching Integrated Science in JHS in Wa Municipality. In order to determine it, frequencies and percentages analysis was carried out using participant‟s responses as presented in Table 4.8.

Table 4.8: Barriers Hindering Successful ICT in Teaching

Statement	SA		A		SD		D	
	f	%	f	%	f	%	f	%
Limited supply of electricity	20	29	24	35	10	14	15	22
Insufficient funds and insecurity	24	35	25	36	5	7	15	22
Little or no ICT related equipment made available nationally for schools	17	25	40	58	5	7	7	10
Lack of Science teachers with ICT skills	25	36	35	51	4	6	5	7
Teachers‟ inability to integrate ICT into integrated science	20	29	42	61	2	3	5	7
High cost of ICT equipment	13	19	50	72	2	3	4	6
Urban bias and poor collaboration between educational policy makers and policy implementers	20	29	42	61	2	3	5	7
Large class size does not permit the integration of ICT in teaching Science	20	29	40	58	4	6	5	7
Pupils sitting arrangement does not permit ICT integration in science teaching	22	32	40	58	3	4	4	6
ICT integration tend to waste instructional time in the classroom	5	7	7	10	17	25	40	58

Source: Researcher‟s Fieldwork Data (2022)

SA= Strongly Agree **A=**Agree **SD=** Strongly Disagree **D=**Disagree **I=** Frequency

The data in Table 4.8 shows that 24 respondents representing 35% agreed to the statement “Limited supply of electricity” as a challenge that hinder the successful integration of ICT in teaching Integrated Science whereas 15 respondents representing

22% disagreed with the statement. It implies that a barrier that limits Science teachers in public basic schools in Wa Municipality to incorporate ICT into teaching and learning is limited supply of electricity in their various schools.

In addition, the data reveals 25 respondents representing 36 % agreed to the statement "Insufficient funds and insecurity" whereas 15 respondents representing 22% disagreed to it. This confirms that insufficient funds and insecurity poses all sorts of challenges to the Science teachers in their quest to fuse ICT into teaching and learning in their respective classes.

Furthermore, 40 respondents representing 58% agreed to the statement "Little equipment made available nationally for ICT in schools" whereas seven respondents representing 10% disagreed. This validates that insufficient ICT equipment made available to public basic schools in Wa Municipality restrict the teachers from incorporating ICT into teaching and learning in a judicious manner. This finding however contradicts with Valenzuela (2002) from the literature that, in spite of governments having invested large sums of money in equipment, resources and teacher training with the purpose of improving teaching and learning in the schools, the integration of ICT in education in many countries has been limited.

Moreover, it was unveiled that 35 respondents representing 51% agreed to the statement "inadequate teachers with ICT skills" whereas five respondents representing 7% disagreed. This establishes that the lack of technical know-how on part of science teachers in public basic schools in Wa Municipality make them to refrain from fusing ICT in their teaching and learning processes.

The data further show that the 42 respondents representing 61% agreed to the statement "Teachers" inability to integrate computer into different subject areas" whereas five respondents representing 7% disagreed with the assertion. It implies that the inadequate skills on part of teachers in transferring ICT knowledge horizontally to a different subject poses all sorts of challenges to them when incorporating ICT in their teaching and learning process.

In addition, it was established that 50 respondents representing 72% agreed to the assertion "High cost of ICT equipment" whereas four respondents representing 6% disagreed. This suggests that the expensive nature of ICT equipment make all the parties; government, schools, and teachers unable to afford them sufficiently for use in schools. This in turn poses all sorts of challenges to science teachers in Wa Municipality when they intend to fuse ICT in their teaching. This finding goes to validate Opoku-Peprah (2016) that, modern technologies are costly, and an investment in them requires an expenditure of huge amounts of money, first in the purchase of ICT equipment and then in skills training for staff, maintenance of equipment, wiring, ensuring security and others.

Furthermore, it was pointed by the data in Table 4.9 that 42 respondents representing 61% agreed to the assertion that "Urban bias and poor collaboration between educational policy makers and policy implementers" whereas five respondents representing 7% disagreed. It implies that most of the schools in the urban centers have their laboratories well-furnished with adequate ICT tools and materials but the reverse happens at the rural centers. This finding is further emphasized by Mangesi (2007) and Mfum-Mensah (2003). Schools with more ICT infrastructure were found in the urban areas whereas those in the rural areas had less. All these in turn results in

limited ICT materials and equipment in these schools which poses all sorts of challenges to teachers.

40 respondents representing 58% agreed to the statement “Large class size does not permit the integration of ICT in teaching Science” whereas five respondents representing 7% disagreed. It implies that the large class sizes that are handled by the teachers and the few equipment available do not pave ways for them to integrate ICT in their teaching.

Moreover, 40 respondents representing 58% agreed to the statement the statement “Pupils sitting arrangement does not permit ICT integration in science teaching” whereas four respondents representing 6% disagreed with the assertion. This means that the manner in which learners are seated in science classes makes it very challenging for teachers to fuse ICT in their teaching. This could be as a result of the large classes handled by the teachers which restricts their movement freely in class.

Finally, seven respondents representing 10% agreed to the assertion that “ICT integration tend to waste instructional time in the classroom” whereas 40 respondents representing 58% disagreed. This confirms that when Science teachers in public basic schools in Wa Municipality do not integrate ICT into their teaching, it is not as a result of them perceiving it to waste their instructional periods but among other factors like their complexity of use and unavailability. Despite the findings on the barriers to ICT integration in teaching integrated science as shown by the quantitative analysis may be convincing and accurate, this may just be a mere guess and may not truly reflect the real issues on the ground. So, the researcher decided to conduct an interview. Below are the interview responses of the six selected teachers after asking

them if their schools have adequate resources for the successful integration of ICT in their lessons.

Tr. 4:

I will say the usage of ICT is poor because most of the teachers in my school do not integrate ICT in their lessons and I don't blame them because they have not been taken through any workshop as to why it is necessary to do that.

Tr. 1:

I will apportion the blame to the non-availability of these ICT tools. Else I must say we teachers can easily adjust so if the tools were there, we would have a fair idea as to how to integrate them.

Tr. 3:

The ICT usage is really low and quite poor which I think it's because we don't have the facilities and resources. I have not done research on that but I believe strongly that most science teachers lack ideas about using ICT to deliver science lessons.

Tr. 5:

I will say no we don't have ICT tools. Only the ICT master sometimes uses a computer in class. The only thing my school can boast of is the availability of electricity.

Tr. 6:

In my view, ICT reduces the work load of teachers especially in the area of lesson notes preparation and searching for certain equipment and information to show to pupils but Master! like I said before we currently have nothing. We have only one desktop which cannot cater for two hundred and something students. Looking at the student population and the number of ICT tools available we still need more.

Tr. 2:

Considering the new curriculum which puts the child at the center of learning and the teacher as a facilitator. So if you have students who like to mingle and explore with ICT tools so you just allow students to explore and learn at their own pace while you facilitate which in a way turn to lessens your work but lack of knowledge about ICT among some teachers is the more reason why most teachers do not use it.

From the respondents‟ perspective, ICT lessens the work load of teachers especially in the area of lesson notes preparation and searching for certain equipment and information to show to pupils but inadequate ICT tools and infrastructure and inadequate teachers with ICT skills are the major barriers to the successful integration of ICT within the Municipality.

The findings agree with previous literature which affirm that insufficient technological knowledge and skills, unsupported pedagogical knowledge and skills have been captured as a crucial challenge to the integration and use of ICT for teaching and learning (Koehler et al., 2012). Inadequate technological know-how is a major reason why teachers and students are not using ICT (Koehler et al., 2013). Boni (2018) found that out of ten Ghanaian senior high schools in Ghana which had computer laboratories, the ones accessible to both students and teachers easily got damaged due to inoperative air-conditioners in the computer laboratories, power fluctuations, obsolete computers and malware attacks.

Mereku et al. (2009) posit that teacher training programs provide little opportunity for teacher trainees to learn skills necessary to integrate ICT into teaching and this perhaps affect the level of integration of ICT into their teaching likewise Taddeo (2006) who posits that “the level of ICT integration will vary depending on factors such as the support structures established, the approach to change, the acceptance and

willingness to change, the available infrastructures, the access and participation in training and development", and many more. Despite the huge investment of financial and human resources, pre-service teacher education programs do not provide teachers with the necessary skills, competencies, and experiences to prepare them to use ICTs effectively in their future professions (Bullock, 2004). Howell and Lundall (2000) identified major challenges such as inadequate electricity, inadequate funds, and insecurity. On top of that, very little of the equipment available nationally is allocated for ICT use in education, in schools. Howell and Lundall (2000) also cited insufficient funds, insufficient number of computers, inadequate teachers with IT skills, teachers" inability to integrate the computer into the different subject areas and inadequate appropriate microcomputer teaching programs as the major challenges facing introduction of ICT in school administration.

Karsenti (2004) conducted another study on the problems blocking public secondary schools from equipping themselves with computers in Kenya. The study established that hardware was one of the major constraints on the use of innovative technologies in school administration. Also, the high costs of equipment greatly influence the teacher"s usage. There was also the difficult of achieving a student-computer ratio of 10:1 and 100% Internet connection in most of the primary, secondary, and higher educational institutions in Ghana.

Flanagan and Jacobsen (2003) summarized the barriers to technology integration into four main themes thus: pedagogy, equity, professional development and leadership. Akbaba-Altun (2006) also grouped these challenges into five (5) main themes namely; infrastructure, personnel, curriculum, administration and supervision. In Ghana, Mangesi (2007) identified such challenges as urban bias, limited skills of

teachers and inadequate collaboration between educational policy makers and policy implementers. Opoku-Peprah (2016) in his study of the challenges of ICT use in S Schools in Ghana found that there were limited computers and software, no internet access among others. The predominant challenge reported by most of the respondents in his study was inadequate computer laboratories and limited resources and materials for teaching ICT.

Mue (2006) in a study of challenges faced in the introduction of ICT in education in Kenya confirmed the inadequate adequate infrastructure in schools as the major challenge with the incorporation of ICTs in education. Similar findings were made by Albugami and Ahmed (2015) in Saudi Arabian secondary schools where ICT implementation was found to be hindered by inadequate space and resources and maintenance challenges.

According to Mfum-Mensah (2003) the introduction of ICT in Ghanaian schools is likely to lead to a digital divide between the urban schools who already have access to most educational resources and rural schools who are already impoverished when it comes to resources. This, he opines, is likely to escalate the existing disparities in Ghana‟s educational system. Flanagan and Jacobsen (2003) assert that, schools in lower socio-economic areas (villages or rural areas) struggle to raise sufficient funds to buy new equipment, and this is sometimes further compounded by instances of irregular power supply to these areas and sometimes outright lack of power supply.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter presents the summary of the study and its key findings, conclusions, recommendations based on the findings, and other suggested areas to be studied.

The study adopted the theory of Technological Pedagogical Content Knowledge (TPACK) developed by Mishra and Koehler (2006) and Technology Acceptance Model (TAM) propounded by Fred Davis in 1989. From the theories, a conceptual framework was constructed using availability of ICT tools and infrastructure, level of teacher‟s knowledge and usage of ICT tools and barriers to the successful integration of ICT. The philosophical approach underpinning this study is pragmatism. Mixed method concurrent triangulation research design was employed for the study. Population comprised all Integrated Science teachers. Census sampling was employed to select 69 teachers for the quantitative studies and from which six (6) teachers were selected for the qualitative studies. Instruments used for data collection were interview guide and questionnaire. Questionnaire data were analyzed using SPSS by employing descriptive statistics (frequency counts, simple percentages, means, and standard deviations) whereas the qualitative data was thematically analyzed.

5.1 Key Findings

1. ICT tools available for use by science teachers in class in Wa Municipality are computers, videos and animations. In addition, the schools have ICT labs containing printers and a photocopier machine. Finally, it was established that Science teachers have their personal smart phones and also have some IT applications on their smart phones and laptops.

2. Concerning the level of content knowledge of teachers and their integration of ICT tools in teaching, it was found that they had attended ICT usage capacity workshops and were aware of how to operate a computer/laptop, and can use radio and audio-taped lessons. In addition, it was found that they are conversant with how to use the presentation software such as Microsoft PowerPoint, Microsoft Word, and Microsoft Excel, likewise the operation of a tablet/mobile device. These skills were used by teachers in surfing the internet for information and properly presenting them to the class. Finally, it was established that age is a major determinant of ICT content knowledge of teachers as most young teachers were able to integrate ICT in their science lessons unlike their older counterparts.
3. As to the level of teachers‟ usage of ICT tools in teaching, though they were not experts, they could make use of radio and audio-taped lessons, use projected instructional slides during their lessons. Finally, the use of ICT tools can provide opportunities for students to watch digital images on mobile phone/tablet likewise providing opportunities for students to watch digital videos on a computer.
4. Challenges that hinder the successful integration of ICT in teaching Integrated Science include limited supply of electricity, few equipment made available nationally for ICT in schools, inadequate teachers with ICT skills, high cost of ICT equipment and poor collaboration between educational policy makers and policy implementers though teachers attest to the fact that it reduces their workload. Finally, large class sizes and the sitting arrangement of pupils also contribute to the situation.

5.2 Conclusions

ICT integration provides sufficient opportunities to improve the teaching and learning of science. The use of ICT in science education offers even more advantages due to the attractive premises to simulate and interactively explore and test experiments which would be too expensive or too dangerous in real settings but this study in Wa municipality proves the opposite. Science teachers in the municipality do not integrate ICT in their science lessons due to the lack of adequate ICT resources in their respective schools. Also, most science teachers" lack the requisite content knowledge in ICT to enable them integrate it effectively into their science lessons which in one way or the other makes the future of science in the municipality bleak. However, considering this 21st century which seems to be driving all nations towards Information and Communication Technology (ICT), science teachers need as a matter of importance to develop their ICT competencies and integrate it into their lesson. JHS science teachers therefore need a lot of in-service training coupled with the provision of adequate ICT resources in order to catch up with the continuous evolving world

5.3 Recommendations

1. On the availability of ICT tools and infrastructure needed for successful integration in teaching JHS Integrated Science in Wa Municipality. Educational stakeholders should make available the necessary ICT tools needed for classroom instruction.
2. On exploring the ICT content knowledge of JHS Integrated Science teachers in integrating ICT in teaching Integrated Science in Wa municipality. The Wa Municipal Educational Directorate should organize in-service training for

Integrated Science in JHS in the Municipality and educate them on how to use ICT tools and equipment within their classrooms at regular intervals.

3. On the extent to which JHS Integrated Science teachers practice/use ICT integration into teaching Integrated Science in the Wa Municipality. Integrated Science teachers in JHS in Wa Municipality should try as much as possible to use ICT during their lesson deliveries to help decrease their workload and to help them to present abstract concepts to learners to enhance their sound understanding.
4. On barriers to the successful integration of ICT in teaching JHS Integrated Science in Wa Municipality. Ministry of Education in collaboration with Government of Ghana should provide JHS in Wa Municipality with adequate ICT equipment and infrastructure to enhance Science teachers‟ successful integration. In addition, it will enable teachers who are not good when it comes to ICT integration to learn with ease.

5.4 Suggestions for Further Studies

1. A study should be conducted to examine the perceptions of students towards ICT usage in teaching Science in selected JHS in Wa Municipality.
2. Finally, another study should also be carried out to investigate the effects of Computer-Assisted Instruction (CAI) on academic performance and interest of pupils JHS in Wa Municipality in selected topics in Integrated Science.

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APPENDICES

APPENDIX A

QUESTIONNAIRE FOR INTEGRATED SCIENCE TEACHERS

UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENT OF BASIC EDUCATION

Dear respondent,

You are please being invited to participate in the survey **"SCIENCE TEACHERS' KNOWLEDGE AND INTEGRATION OF ICT TOOLS IN TEACHING INTEGRATED SCIENCE''**

Your participation in this study is completely voluntary. There are no foreseeable risks associated with this project. Your survey responses will be strictly confidential and data from this research will be reported only in the aggregate. Please take the time to read attentively each item on the questionnaire or statement and give the response best reflects what you currently think.

To respond to items on the questionnaire, please place the mark (√) in the space that best reflect your opinion or situation.

Sincerely,

ABDULAI ISSAH

SECTION A: Demographics of Respondents

1. Gender: (a) Male [ ] (b) Female [ ]

2. Age: (a) Less than 30 years [ ] (b) 30-39 years [ ] (c) 40-49 years [ ] (d) 50 & above [ ]

3. Educational Qualification (a) Diploma [ ] (b) Bachelor [ ] (c) Masters [ ] (d) others

4. Teaching Experience (a) Less than 5 years [ ] (b) 6-10 years [ ] (c) 11-15 years [ ] (d) 16years & above

SECTION B: Availability of ICT Tools and Infrastructure needed for Successful Integration in Teaching JHS Integrated Science

Please indicate the extent to which you agree or disagree with the following on ICT tools and resources available in classrooms. Kindly tick [√] the most appropriate

Statements	**Strongly Agree 5**	**Agree 4**	**Uncertain 3**	**Strongly Disagree 2**	**Disagree 1**
Computers are readily available in class					
Videos and animations are available					
Internet is accessible in class					
Projectors are available in class					
Digital flatbed color scanners are available in the					

school					
Digital MP3 audio recorders with headsets and built-in microphones are available					
The classes experience a virtual field trip on the class computer					
laser color printer with wireless network capabilities is available					
The school has an ICT lab					
I have personal smart phone					
I have some IT applications on my smart phone and laptop					

Are there other ICT tools and infrastructure available in the classrooms that you know about? Please indicate below

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SECTION C: ICT Content Knowledge of JHS Integrated Science Teachers in Integrating ICT in Teaching Integrated Science in Wa Municipality

Please indicate the extent to which you agree or disagree with the following on the ICT content knowledge of JHS Integrated Science teachers in integrating ICT in teaching Integrated Science in the Wa municipality. Kindly tick [√] the most appropriate

Statement	**Very High 5**	**High 4**	**Moderate 3**	**Very Low 2**	**Low 1**
I have attended ICT usage capacity work shop					
I know how to operate a Computer/Laptop					
I know how to use presentation software (e.g. Microsoft Power Point)					
I know how to operate a Tablet/Mobile Device					
I know how to use word processor software (e.g. Microsoft Word)					

In your opinion, what is your level of ICT content knowledge which helps you in teaching Integrated Science in your school. Please indicate below

……

……

……

SECTION D: The Extent to which JHS Integrated Science Teachers Practice/Use ICT Integration in Teaching Integrated Science in Wa Municipality

Please indicate extent to which you agree or disagree with the following on the extent of teacher‟s Practices and usage of ICT tools in teaching JHS Integrated Science in Wa Municipality Kindly tick **[**√**]** the most appropriate

Statements	**Strongly Agree 5**	**Agree 4**	**Uncertain 3**	**Disagree 2**	**Strongly Disagree 1**
I give internet homework assignments to my students after science lessons					
I sometimes allow students to use computer to search for some scientific tools during experiments					
I use instructional radio/audio taped lessons					
I sometimes use computer in my lesson delivery					
I use a laptop to keep my students class record					
I prepare and develop my lesson plan with the help of a computer					

In your opinion to what extend do you use ICT tools in teaching JHS Integrated Science in your school. Please indicate below

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……

SECTION E: Barriers to the Successful Integration of ICT in Teaching JHS Integrated Science in Wa Municipality

In your opinion what are the barriers to the successful integration of ICT in teaching JHS Integrated Science in Wa municipality? Please indicate extent to which you agree or disagree to the following barriers to the successful integration of ICT in teaching JHS Integrated Science in Wa municipality. Kindly tick [√] the most appropriate

Statements	**Strongly Agree 5**	**Agree 4**	**Uncertain 3**	**Disagree 2**	**Strongly Disagree 1**
Limited supply of electricity					
Insufficient funds and insecurity					
Little or no ICT related equipment made available nationally for schools					
Lack of Science teachers with ICT skills					
Teachers‟ inability to integrate ICT into different subject areas					
High cost of ICT equipment					
Urban bias and poor collaboration between educational policy makers and policy implementers					

Large class size does not permit the integration of ICT in teaching science					
Pupils sitting arrangement does not permit ICT integration in science teaching					
ICT integration tend to waste instructional time in the classroom					

Are there other barriers to the successful integration of ICT in teaching JHS Integrated Science in Wa municipality you know about? Please indicate below

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THANK YOU

APPENDIX B

INTERVIEW GUIDE

SCIENCE TEACHERS' KNOWLEDGE AND INTEGRATION OF ICT TOOLS IN TEACHING INTEGRATED SCIENCE

SECTION I: Availability of ICT tools and Infrastructure needed for Successful Integration in Teaching JHS Integrated Science

a) PROBE: Could you describe the types of ICT tools and infrastructure available in your school?

b) PROBE: Do you think your school has adequate ICT tools for successful integration in teaching JHS Integrated Science?

c) PROBE: What are the conditions that influence the availability of ICT tools and infrastructure needed for successful integration in teaching JHS Integrated Science?

SECTION II: ICT Content Knowledge of JHS Integrated Science Teachers in Integrating ICT in Teaching Integrated Science in Wa Municipality

a) PROBE: Could you describe the level of your ICT content knowledge in teaching JHS Integrated Science?s

b) PROBE: Does your knowledge in ICT has any relation to how you teach Integrated Science?

SECTION III: Integrated Science Teachers Practice/Use ICT Integration in Teaching Integrated Science in Wa Municipality

a) PROBE: Do you use ICT tools in teaching JHS Integrated Science? If yes, how do you use ICT tools in teaching JHS Integrated Science. If no why?

b) PROBE: Generally what perceptions and attitudes do Junior High School Science teachers have towards ICT integration in teaching Integrated Science?

c) PROBE: In your opinion, does your attitude towards ICT tools integration in teaching JHS Integrated Science have any link to teacher performance?

SECTION IV: Barriers to the Successful Integration of ICT in Teaching JHS Integrated Science in Wa Municipality.

a) PROBE: Describe the state of integration of ICT in teaching in your school?

b) PROBE: Do you think that Science teachers lack knowledge or ideas regarding ICT integration in teaching JHS Integrated Science?

c) PROBE: In your view do you think ICT integration in teaching Integrated Science increase the work load on teachers?