**UNIVERSITY OF EDUCATION, WINNEBA**

# INTEGRATING ICT IN TEACHING AND LEARNING BIOLOGY TO IMPROVE THE ACADEMIC PERFORMANCE OF STUDENTS

**PEACE KAMPO**
**(200004746)**

**A thesis in the Department of Science Education, Faculty of Science Education, submitted to the School of Graduate Studies in partial fulfillment of the requirements for the award of the Degree of Master of Philosophy (Science Education) in the University of Education, Winneba**

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# DECLARATION

**Student's Declaration**

I, Peace Kampo, declare that this thesis, with the exception of quotations and references contained in published works which had all been identified and acknowledged, is entirely my own original work, and has not been submitted, either in part or whole for another degree elsewhere.

**Signature:** .....

**Date:** .....

**Supervisors Declaration**

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

**Name of Supervisor: PROF. M. K. AMEDEKER**

**Signature:** .....

**Date:** .....

# DEDICATION

This work is dedicated to my noble friend Mr. Charles Teye Kwesi, my children (Bernard, Brooklyn, Arnold-Mordecai and Alvin-Lucius) and my family.

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# ABSTRACT

The integration of Information Communication Technology (ICT) in to teaching and learning has the potential to transform the teaching and learning process. This study investigated the integration of ICT into the teaching and learning of some selected topics in biology to improve students' performance at St. Martins Senior High School at the Adoagyiri-Nsawam Municipality. The study is an action research. .An intact class of 2 Home Economics was purposely selected. The instruments used for gathering qualitative and quantitative data are observation, interviews, pre-test and post-test. Descriptive function of SPSS was used to organize students pretest and post test scores into percentages, mean scores and standard deviation. The data from observations, and interview was thematically analysed. The findings were that students showed more interest in lessons and were coming to class earlier than before. The results further indicated that when Information and Communication Technology was integrated into lessons students participated and did a lot of research on topics before coming to class. The study concluded that ICT tools improved students' performance when they are used as an enhancement to teaching and learning. Furthermore, the use of ICT tools in the teaching and learning of some selected topics in biology were found to be an excellent pedagogical approach that can be used to bridge up the intellectual disparities in biology and increase performance students. The study concluded that, the ICT center in the school is poorly resourced. Information and communication and technological tools were resourceful tools that motivated and increased students' performance in biology when they were used as an enhancement in the teaching and learning process. Based on the findings, it was recommended that teachers of should integrate ICT tools in the teaching and learning.

# CHAPTER ONE

# INTRODUCTION

## 1.0 Overview

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

## 1.1 Background to the Study

Biology is one of the most important subjects in the educational system that is a requirement entry any biological career pathway. Thus, learning and understanding of the content, process skills and values in biology will provide a strong foundation for the development of individual and nation at large. However, it is saddening to note that student's perform poorly in biology in St. Martins SHS as compared to the other subjects. This is evident in the 2018, 2019, and 2020 comparative analysis of the WASSCE result by the school as shown in Table 1.

**Table 1: Comparative Analysis of WASSCE results from 2018 to 2020**

| Year | Number of students | Number that passed |
|---|---|---|
| 2018 | 276 | 199 |
| 2019 | 268 | 107 |
| 2020 | 221 | 98 |

Source: Field data Saint Martin's SHS (2021)

Students' difficulties in learning biology have been studied by various Researchers across the world (Anderson, et. al, 1990; Seymour & Longdon, 1991; Jennison & Reiss, 1991; Lazarowitz & Penso, 1992). A research conducted by Bahar, et al, (1999)

shows that many concepts and topics in biology, including water transport in plants, protein synthesis, respiration and photosynthesis, gaseous exchange, energy, cells, mitosis and meiosis, organs, physiological processes, hormonal regulations, oxygen transport, genetics, Mendelian genetics, genetic engineering and the central nervous system were perceived as difficult to learn by the secondary school students. Further study was made by Tekkaya, et. al. (2001) and it emerged that hormones, genes, chromosomes, mitosis and meiosis, the nervous system and Mendelian genetics were considered difficult concepts by secondary school students. Student's non-performance in many topics in biology negatively affects their motivation and performance (Ozcan, 2003).

Literature from Çimer (2011) showed that genetics, genetic engineering, genes and chromosomes, protein synthesis, nervous system and cell division (mitosis and meiosis) continue to recur among the topics that are viewed as difficult to teach and learn across the global. He further stressed that the main reasons for the learning difficulties were the nature of the topic (the abstract levels of genetics and protein synthesis), teachers' styles of teaching, students' learning and studying habits, students' negatives feelings and attitudes towards the topics and lack of resources.

Among the biological topics studied at the SHS level in Ghana are: classification of living things, organization of life, cell structure and functions of cell components, transport system, respiration system, homeostasis, nervous coordination, and reproduction system in animals and in flowering plants, ecology, variations, cell division and chromosome, inheritance and mutation (GES syllabus, 2012). Genetics and protein synthesis are few of the topics in biology at senior high level that are rated as most difficult topics in the biology syllabus to teach and learn by both teachers and

learners respectively (Haambokoma, 2007). The Chief's examiners' report for biology theory papers for 2018 indicate that candidates had difficulties answering questions on genetics and protein synthesis in the final examinations (WAEC, 2018).

The study by Agyei, (2013) revealed that 72% of teachers of biology in Adoagyiri-Nsawam Municipal used the lecture method to teach genetics while about 28% used group work. The study further revealed that all the teachers that were observed used question and answer technique, and asked low order questions during the lessons. In most cases, the topic was not taught asserting that the time allocated to biology was inadequate (Agyei, 2013). Other research studies also revealed that teachers do not use teaching and learning aids, lack appropriate teaching and learning aids, do not give homework to learners and conduct practical work when teaching genetics (Chifwa, 2015; Haambokoma, 2007; Musonda, 2013).

To overcome these difficulties and making teaching and learning of biology interesting, there is the need to adopt and integrate new technological ways in the teaching and learning of biology such as: the use of visual materials, teaching through practical work (using ICT resources), teaching biology by connecting the topic to our daily lives, making biology learning interesting, and increasing the diversity of biology questions in classroom assessments and in examination papers. Previous research studies have shown that teachers' use of using visual materials like pictures, posters, models, and computers in the lessons, were found to be effective in making the lessons attractive and interesting for students (Soika., Reiska., Mikser., 2010; Baharvand ., 2001). Studies by Cyrs (1997) and Çimer (2004, 2007) indicated that students remember best those concepts that are presented in a way related to their sensory channels, for example, audio and visual representations (pictures, charts and

models). Their study also probed that multimedia teaching with visual materials were also found to provide more concrete meaning to words, show connections and relationships among ideas explicitly, and provide a useful channel of communication and strong verbal message and memorable images in students. Most of the challenges and difficulties in biology that have been presented have affected students' and teachers' attitudes towards biology and, consequently students' performance in biology.

Information Communication Technology (ICT) in education refers to the use of computer-based communication (tools) that is incorporated into the daily classroom instructional process. In conjunction with preparing students for the current digital era, teachers are seen as key players in using ICT in their daily classroom activities. This is due to the capability of ICT in providing dynamic and proactive teaching-learning environments (Arnseth & Hatlevik, 2012). The aim of ICT integration is to improve and increase the quality, accessibility and cost-efficiency of the delivery of instruction to students. It also refers to benefitting from networking with the learning communities to face the challenges of current globalization (Albirini, 2006). With the support of the International Institute for Communication and Development (IICD), the Commonwealth of Learning (COL), and the United States Agency for International Development (USAID), the Ghanaian Ministry of Education had developed a draft ICT policy for education (MOE, 2015). This represents an extension of Ghana's national education and national ICT policies. The vision is for ICTs to contribute towards reaching innovative and lifelong education and training in Ghana. The guiding principles of the policy include the following:

1. It must fit into national policies on education and Information and Communication Technology (ICT).
2. There is a commitment to establishing strategic partnership with stakeholders;
3. There is a combined effort with government, the private sector, and NGOs;
4. The policy reflects general standards that the Ministry of Education wishes to uphold;
5. An integrated approach must be adopted that integrates all aspects of the value chain in the education process. The policy also provides an overview of goals, objectives, and government commitment in key program areas of ICT infrastructure to education institutions, content development, curriculum integration, teacher training, distance education, administration and support services, and finance.

**1.2 Statement of the Problem**

The Government of Ghana, in collaboration with the Ministry of Education (MOE), introduced the use of Information and Communication Technology (ICT) into teaching and learning and this is reflected in the teaching syllabuses (Biology Syllabus, 2010).This is due to the fact that the ministry realises that the chalk and talk method does not help student very much in learning the sciences. This study therefore investigated the effectiveness in the use of ICT in teaching some selected topics in biology. To date, however, there has been limited research to investigate Ghanaian teachers and students use of technology in teaching and learning and the factors that support or inhibit their effective integration into classroom practice. Seymour and Longdon (2013) found from a research that for Ghana and Africa as a whole to be able to fully integrate ICT into teaching and learning, there is the need for frequent collection and analysis of data on ICT usage. In spite of the numerous efforts put in

place by the Government, International Agencies, Non-Governmental Organizations, Philanthropists and Ghana association of science teachers to help raise the performance of students in science and science- related courses in our various schools, students' performance keeps declining in most schools. This is due to the fact that most of these schools lack the necessary resources for integrating ICT into the teaching and learning of science courses. The effect of this situation deprives and rids the country of its human resources needed for the development of science and technology (Tinio, 2003).

Through observation it has been realized that Biology students in St. Martin's Senior High School, Adoagyiri- Nsawam, in the Eastern Region of Ghana, have been getting very low marks in their Biology class exercises, home assignments and end of term examinations. A critical analysis made on students West African Senior School Certificate Examination (WASSCE) results over a four year period (i.e. 2018-2021) showed that students have been obtaining low grades. Therefore the study sought to investigate the effectiveness of Information Communication and Technology (ICT) in teaching and learning of biology to improve the academic performance of students in St. Martins Senior High School.

### 1.3 Purpose of the Study

The purpose of this study was to investigate the effects of integrating Information Communication and Technology (ICT) in teaching and learning on students' performance in Biology in St. Martins SHS.

### 1.4 Objectives of the Study

The study was guided by the following objectives, to:

1. Determine the availability of ICT resources in St. Martin's Senior High School for teaching and learning Biology.

2. Determine students' performance in biology after they have been taught using ICT tools.
3. Determine the attitudes of students on the use of ICT in the teaching and learning of biology.

### 1.5 Research Questions

The study sought to answer the following research questions:

1. What ICT resources are available for teaching and learning biology in St. Martin Senior High School?
2. What is the effects of ICT integration on students' performance in biology?
3. What are the perceptions of students towards the use of ICT in the teaching and learning of biology?

### 1.6 Research Hypothesis

Ho1: There is no statistically significant difference between the performances of students before and after exposure to ICT integration into teaching and learning of Biology.

$H_A1$: There is statistically significant difference between the performances of students before and after exposure to ICT integration into teaching and learning of Biology.

### 1.7 Significance of the Study

The findings of this study will provide information that could be significant to the following groups of people: Management, Parent Teachers Association (PTA), Old Students Associations (SMOSA) and the founders (SVD) of St. Martins SHS. The results of this study could also add to the already existing knowledge in the field of ICT integration in pedagogy. Finally, the outcome of this study could provide insights for teachers and students to use technology at the SHS level which could be sustainable and transferable to other educational institutions and provide empirical evidence on the impact of integrating ICT into the teaching and learning of Biology in the Senior High School level.

### 1.9 Delimitation

The study was delimited St. Martins Senior High School located in Nsawam-Adoagyiri in the Eastern Region. This study was also delimited to only SHS two (2) students studying Home Economics and offering Biology as an elective subject. The study also focused on integration of ICT in teaching some selected topics in Biology.

### 1.10 Limitations of the Study

The study was carried out only in Eastern Region in Ghana. The study also depended on test and on the respondents' opinions about the integration of ICT during teaching and learning of Biology. People's views might not be taken as complete truth and adequate. Therefore, it would be imperative for one to consider the generalizations of this study carefully. In this study, there was limited literature on ICT integration in education in Ghana. Hence, the study used much of the kinds of research from outside of the country.

### 1.11 Organisation of the Study

This research study is organized into five chapters. The beginning chapter contains the background to the study, statement of the problem, the purpose of the study, research objectives and research questions. The significance of the study, delimitation, limitation, and the organization of the research concludes this chapter. The chapter two of this study contains reviewed literature that relates to the study. It looked at concepts and related to the research topic. The chapter three of the study contains the methodology adopted. It outlined the research design, data collection procedure, research instruments used, sample and sampling technique and the target population used for the study. The chapter four contains a detailed account of the findings of the study. It discussed the key findings. The chapter five covers the summary of the findings, conclusions, recommendations and suggestions for further studies.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.0 Overview

This chapter reviewed related literature to this study that could provide insight into ICT integration in education. The literature was reviewed under the following: ICT in education in Ghana, importance of ICT integration, effect of ICT integration, impact of ICT integration on students' performance, teacher and students' attitude towards ICT integration, teacher and students' skills in ICT, the instructional methods used by teachers in teaching biology. The chapter also showed the conceptual framework of the study and the research gap which the researcher sought to seal.

## 2.1 Background on ICTS in Education in Ghana

According to the Ministry of education (2009), the efforts to introduce ICTs into the sector by the Ministry (primarily through the GES), its development partners and other private sector agencies covered over ten (10) years. Initiatives have spanned pre-tertiary (both public and private schools) and tertiary. Efforts have largely been geared towards the deployment of ICTs to these facilities via the provision of computers and the establishment of ICT laboratories. Access however is still below the standards and numbers demanded. Though comparatively better, the concerns remain for tertiary level institutions.

Additionally, there have been several private sector initiatives to set up Community based ICT centres. These however have been largely confined to urban areas with few available examples of how they have been used to support educational objectives. In a study carried out to review and assess the ICT in Education Initiatives in Ghana

(2005), twenty initiatives were selected and their impact assessed to see what lessons could be learnt. Several positive achievements were noted;

1. Initiatives contributed to a wider number of students and teachers acquiring ICT skills and developing strong interests in ICT and Science
    i. Schools involved in the initiatives were motivated to expand the project and/or acquire more ICT equipment; a number of private-public partners, including Parent Teachers Associations (PTAs) and civil society collaborated in the efforts
    ii. Lessons learnt from initiatives provided good examples for other schools to introduce their own ICT programs

However, the projects themselves faced a number of challenges. At least half of the initiatives had been launched as pilots with none expanded into national initiatives. Implementation challenges included:

2. That Poor selection of schools without the involvement of GES / MOE resulting in duplication and hence some schools had several parallel initiatives while others (especially those in the remote rural towns) had none
3. Lack of policy direction at all levels (schools, districts, national) for the integration of ICT in education; Heavy dependency on external funds, with most initiatives stopped after depletion of initial funding
4. Dumping of obsolete and inappropriate equipment in the schools to support the initiatives.
5. Lack of ownership at the level of the schools, lack of motivation and low level of understanding on the part of recipients about the potentials of ICTs in education.

6. Lack of trained ICT personnel (including teachers) far below the numbers demanded to support the initiatives with most capacity building efforts one-off with no continuous trainings planned for.

Additionally, there was the recognition that to ensure success and sustainability, ICT in Education projects should be implemented not necessarily to increase the number of computers, but should instead be based on supporting discrete educational objectives. The lessons learned from the initiatives further highlighted the need for a coordinated, focused and properly managed approach to the adoption and utilization of ICTs. Such an approach could further improve the accessibility and delivery of quality education and better maximize the impact of ICTs in Education.

### 2.1.1 Vision, Mission and overall policy goals

The need for a nationally accepted ICT in Education Policy for Ghana is more urgent than ever before. With the increased thrust of the Government in using ICTs as a tool for economic growth and development, almost daily new plans and new initiatives are being implemented. However, it was recognised that in the absence of a national policy and sector wide coordination, such initiatives will continue to happen haphazardly, with increased risks of duplication and wasting of scarce resources that do not adequately address the educational objectives and priorities with the sector.

Recognising that ICTs must serve, rather than drive the implementation of educational strategies, this policy document seeks to provide a clear purpose and rationale for how ICTs will be effectively integrated into the sector, including identifying opportunities, issues, challenges and strategies that will be employed. The overall **Vision** of the ICT in Education Policy was to: use appropriate ICTs to support and align the sector Ministry's policies, objectives and strategies, particularly as it relates to equitable

access to education, quality of education, educational management, science and technology and labor market needs

The deployment, exploitation and development of ICTs to accelerate the socio-economic development of the nation has been captured in the Ghana ICT for Accelerated Development (ICT4AD) Policy document (2003), with the main mission to "transform Ghana into an information rich knowledge based and technology driven high income economy and society". Already within this document education is seen as a key strategic pillar.

The **Mission** of this policy was to: Articulate the relevance, responsibility and effectiveness of utilizing Information and Communication Technologies (ICTs) in the education sector, with a view to addressing current sector challenges and equipping Ghanaian learners, students, teachers and communities in meeting the national and global demands of the 21st Century. The fundamental objective of the policy was to ensure that the Ghanaian education sector provides adequate opportunities for Ghanaians to develop the necessary skills, regardless of the levels of education (formal and non-formal), to benefit fully from the Information Society. Towards this end the overall policy goal was: to enable graduates from Ghanaian educational institutions – formal and non-formal – to confidently and creatively use ICT tools and resources to develop requisite skills and knowledge needed to be active participants in the global knowledge economy at all time.

The policy goals as adapted from the National ICT4AD Policy document therefore included:

1. Facilitating the deployment, utilization and exploitation within the educational system to improve on educational access and delivery to support teaching and learning from the primary level upwards
2. Modernize the educational system to improve the quality of education and training at all levels of the educational system and expanding access to education, training and research resources and facilities.
3. To orient all levels of the country's educational system to the teaching and learning of science and technology in order to accelerate the acculturation of science and technology in society and produce a critical mass of requites human resources and a well-informed citizenry.
4. To achieve universal basic education and improve the level of basic and computer literacy in the country.
5. To ensure a population in which all citizens are at least functionally literate and productive
6. To expand and increase access to secondary and tertiary education.
7. To strengthen science education at all levels and in all aspects of the educational system, especially at the basic and secondary levels.

## 2.2 ICT Integration in Teaching and Learning

In many nations around the world, ICT has become an integral aspect of education. According to the findings of Samuel and Zaitun's (2007) study in Malaysian schools, instructors must have the abilities to incorporate ICT into teaching and learning activities for effective integration of ICT in education. In order to apply ICT integration in teaching and learning activities, instructors must be trained in ICT

capabilities. There will be more ICT-integrated activities in the classroom as teachers gain more proficiency with ICT tools.

Integration of information, communication, and technology (ICT) enables teachers to better adapt to global best practices. Traditional teaching techniques have been replaced by technology-based teaching and learning tools and facilities as a result of teachers' preparation (Ghavifekr, 2015). As a result, capable teachers' preparation is essential for integrating ICT into instruction.

With 292 participants, a study on Finnish teachers' usage of technology in the classroom was undertaken. To investigate ICT use in the classroom, the researcher utilized a survey design. Teachers with superior ICT skills used ICT in the classroom more frequently, according to the findings. However, integration was not entirely realized for those teachers who lacked basic ICT knowledge and skills. In affluent countries, there exist inconsistencies between educational institutions' formal architecture and classroom practices (Sipilä, 2014).

According to Ghavifekr (2015), a study on the efficiency of ICT Integration in Schools was conducted in Malaysia, and the researcher employed a survey questionnaire with a sample of 101 participants. One of the primary elements that determined the success of technology-based teaching and learning, according to the study's findings, was well-prepared teachers on ICT integration.

Another study was undertaken in Malaysia to look into the levels of ICT skills and classroom use among technical and vocational teachers. Quantitative techniques were used in the research. A survey method was used to collect data from 329 teachers using a questionnaire. The study's findings found that teachers' ICT abilities were

moderate, and the majority (70 percent) of the instructors surveyed used ICT in the classroom on a regular basis. That is, teachers used ICT in the classroom in a moderate way. Furthermore, the study discovered a link between instructors' ICT competence and ICT integration in classroom instruction (Alazam et al., 2012).

Teachers' understanding of the use of ICT for Biology instruction in secondary schools in Matazu Local Government Area, Katsina State, Nigeria, was researched by Sulaiman, Hindatu, and Lawal (2017). A questionnaire was given to 18 Biology instructors and five school principals as part of the study, which used a survey method. Teachers were aware of the value of ICT in the teaching and learning process, according to the findings of the study. However, the bulk of them did not use ICT to teach Biology. Inadequate ICT infrastructure and power outages were the main barriers to ICT integration in classrooms.

Moluayonge and Innwoo (2017) conducted research in Cameroon secondary schools on teachers' usage of information and communication technologies in education. The data was collected from 320 teachers via a survey method. The findings revealed that low ICT utilization in teaching and learning is mainly related to insufficient ICT infrastructure in Cameroon's secondary schools. Furthermore, the survey discovered that teachers lacked expertise and confidence, had limited access to accessible resources, and received insufficient ICT assistance while implementing ICT in their classrooms.

In an analysis of technological integration in teacher education in Ghana, Agyei (2013) found that the constraints of ICT integration in Ghana were a lack of competent human resources and other institutional variables. According to Tedla (2012), most East African instructors do not use ICT in their classrooms as much as

they could. The cause could be attributed to a number of interconnected elements, one of which is the teacher.

A study was conducted in Kenya on the Influence of Teacher Competency on Integration of ICT in Teaching and Learning in Public Secondary Schools. The findings revealed that majority of the respondents received ICT training to literacy level, and they showed limited ICT competence and confidence to use ICT for teaching and learning process. The result also indicated that teachers believe ICT enhances teaching and learning process (Michael et al., 2016).

A descriptive survey design was used in 12 secondary schools in Nairobi County to investigate the potential and difficulties impacting the incorporation of ICT in teaching and learning. Teachers confront substantial hurdles, according to the study's findings, such as increasing their own technical abilities and knowledge, as well as self-training in the use of ICTs in their classrooms (Amuko, 2015). Teachers' skills for ICT integration in Ghana secondary schools are imperative. However, least is known if secondary school teachers in the Adoagyiri Senior High School are trained on the integration of ICT in classrooms. Hence, this study developed an interest in this issue.

### 2.3 Importance of ICT Integration in Education

Information and communication technology (ICT) is becoming very important in the education sector. To understand the importance of ICT in Education, the meaning of ICT should be understood. ICT is defined as a diverse set of technological tools and resources used to communicate, and to create, disseminate, store, and manage information. These technologies include broadcasting technologies (radio and television), telephony, computers and internet (Yadav and Mehta, 2014). Tinio (2003)

also similarly defined ICT as a set of diverse technological tools and resources used to communicate and manage information.

Information and Communications Technology (ICT) offers innovative tools for restructuring teaching and learning processes in preparing students for the 21st Century skills (Moluayonge and Innwoo, 2017). ICTs are used at homes, schools, workplaces and so on. Integration of ICT in education can enrich teaching and learning processes in many ways. It can improve the quality of teaching, learning and management in schools and so help raise standards (Livingstone, 2012).

The UNESCO policy on ICT states that ICT can help strengthen democratic and transparent education planning and management. Communications technology can expand access to learning, improve equality and ensure inclusion. Where resources are scarce, judicious use of open-source material through technologies can the means to bypass the bottleneck of textbook production, distribution and updating (UNESCO, 2005). ICT provides pupils with a learner-centered environment, opportunities to make decisions and to develop critical thinking skills, opportunities to build new knowledge, analyze, synthesize and assess data and learning materials, ( Fu, 2013; Lu, & Law, 2012).

Additionally, ICT allows students to learn through discovery and inquiry, and to solve problems. Autonomy, capability, and creativity are the three characteristics that enhance learning (Fu, 2013; Lowther *et al.*, 2008). William (2004) argued that research clearly demonstrates the potential of ICTs to increase motivation and autonomy in learning and teaching, and further improve retention of knowledge and skills. The use of multimedia to mediate directly to students, at their own pace, realities and experiences which would otherwise be text-based stimulates their interest

and motivation. William (2004) further admitted that ICT has been observed that when students collaborate in pairs on computers or other ICTs, they experience greater autonomy and self-direction, and teachers become less directive. In doing so, learners tend to experience independent learning which, in turn, fosters confidence in the learning process among themselves.

Larbi-Appau, Otti-Boadi, and Tetteh (2018) in his study showed some emerging important role of ICTs in education. His study showed that when ICTs are used in education, it has increasing positive effects such as increased motivation among learners and teachers, autonomy in learning and improved retention levels among learners. Additionally, increased motivation can raise positive attitude in learner and teachers.

A study by Guay (2007) on the integration of ICTs in the teaching of Islamic Religious subjects, stressed that ICTs may be used as a medium for teaching and learning to develop a more creative thinking in the integrated education process. It is of paramount importance to teachers and educationists that the new era of ICT in education should be developed rapidly to appropriate extent in order to match the capability of students as well as teachers in educational experience due to the development of new information technology which is able to develop a more creative thinking in the integrated education process.

Mewcha and Ayele (2015) proposed that Adwa College in Ethiopia should critically focus to integrate ICT in each course to make courses interactive and easily understandable by their students. They further assert that teachers' productiveness is realized if ICT usage is integrated into the courses they teach. Their study provided that the Adwa college should provide ICT resources such as hardware and software,

effective professionals' development and technical support to teachers and create environments for students in ICT usage. ICTs was perceived to help Religious Education (R.E) teachers to teach better and learners learnt better, promote participation, ambiance transformation in class, creativity, motivation, easier understanding, and higher retention levels among learners in religion studies (Mulima, 2013). Furthermore, Zhang (2013) argued that ICT helps students develop the confidence, be more creative and imaginative as their knowledge paradigm expand. Zhang (2013) further argued that ICTs can better students' communication, knowledge and helps students to possess all four skills in learning through the acquisition of necessary information. ICTs can also help students to be able to express their thoughts and ideas coherently through the resources that ICTs are able to provide during the teaching and learning process. Lewis (2000) also established that ICT fosters pupils' creativity and improves both teaching and learning quality.

Yassanne (2014) ascertained that the integration of computer technology into the teaching of Biology improves students' academic achievement. The study used a quasi-experimental non-equivalent control group design. The findings of the study revealed that the performance and participation of students in the experimental group were better compared to the control group in the post-test results. This result indicates a significant difference between the academic performance of students in Biology who were exposed to computer technology and those exposed to the traditional method of teaching. According to Nyaga (2016), although all teachers and learners were not able to access and utilize Biology digital content, the digital curriculum content had a positive influence on both assessment and achievement of learners of the sampled secondary schools.

Abdullahi (2014) found that ICT increases students' intellectual characteristics through higher order thinking, increased communication skills, problem-solving, and a thorough grasp of the learning tools and content in his study of the use of ICT in Teaching Science Education in Schools. He went on to say that ICT creates a more effective interactive learning environment and equips students with ICT knowledge and abilities.

Zakaria and Khalid (2016) conducted a study on the benefits and constraints of the use of information and communication technology (ICT) in teaching Mathematics. The findings revealed that the benefits of applying ICT in teaching and learning Mathematics were interaction among students, knowledge-sharing, increased motivation and interest, generation of higher-level thinking skills, increased student achievement.

The benefits of ICT integration in teaching and learning, according to Rabah (2015), include increased student involvement, capturing students' attention, aiding diverse instruction, enhancing the learning process, cooperative based learning, and preparing students for the digital world. In Ghana, there are few studies on the integration of ICT in education. As a result, the researcher wanted to see if senior high schools in Southern Ghana were taking advantage of ICT in the classroom.

### 2.4 Effects of Integrating ICT on Academic Performance

According to Macho (2005) the use of ICT in education would enhance students' learning. This notion would have a significant effect on students' performance in various fields of education. The study conducted by Kaulu (2008) revealed that the use of computer based instructions enhanced performance when used as a supplement in the teaching and learning process. The study revealed that physics classroom

computer software enhanced the performance of pupils in kinematics in school physics more than when traditional approaches were used in the teaching and learning process. The study further revealed that the experimental group performed better than the control group with the percentage difference of 10.5%. Ghavifekr (2015) also asserted that ICT integrated into the teaching and learning processes increases learners' performance and improved cognition in academics.

Orora, Keraro and Wachanga (2014) conducted a study on the effects of cooperative e-learning (CEL) teaching strategy on students' achievement in secondary school Biology. The study revealed that students who were exposed to CEL strategy achieved significantly higher scores in the Biology Achievement Test (BAT) compared to those taught using conventional methods. The study further implied that the CEL teaching strategy was more effective in enhancing student's achievement than the conventional methods. Omwenga (2004) further compared the effects of traditional and co-operative class experiment learning strategies on students' achievement and motivation in secondary school chemistry. The study revealed a significant difference in students' achievement. Students who were taught using cooperative class experiment methods were found to have higher achievement in Chemistry than those taught using traditional methods.

However, the rewards or scores in the study were based on the individual learning of the group members. This made students to make sure that every member of the group mastered the content in order to boost their group grade. Wakhaya (2010) carried out a study on the effectiveness of ICT approach on students' 8th grade achievement in mathematics in Palestinian schools. He examined an experimental group of 48 students after studying a course that integrated the use of ICT in instruction. The

students' achievement was examined before and after the experiment. The results indicated that there was an increase in the mean scores by a gain value of 8.94 after the ICT intervention. The study revealed that there was a significant difference in achievement at p = 0.05 level between the mean scores of the pre-test and post-test.

According to Ghavifekr (2015) integration of ICT in education, and the knowledge of ICTs makes both teachers and learners better able to participate fully in the teaching and learning process. Their study also revealed that academic performance and improved cognition in academics by learners have shown to increase when ICT is integrated into the teaching and learning processes. Thompson (2007) also argues that ICT has the potential to provide unlimited access to information and content that is undesirable to learners, thus projecting a strong negative belief relating towards its use. However, Thompson asserts that the next generation of students often referred to as the 'Net Generation', are expecting the integration of Web 2.0 technologies into their learning and teaching programs. It is therefore important that both teachers and learners have a bridging point where they can be able to appreciate ICTs and be able to implement it in the teaching and learning process.

According to Shaheen and Khatoon (2017) ICT enriched modular proved very useful in enhancing achievement scores of experimental groups. When ICT enriched modular approach groups' mean scores were compared to the post test, it was found that the mean of the experimental groups (45.24) was much greater than control group (40.12). The p-value was significant at alpha 0.05 showing the preeminence of ICT enriched modular approach over traditional lecture method. Hermans, Tondeur, Van-Braak, and Valcke (2008) have identified three main stages for ICT to be highly valued and regarded by the teachers; integration, enhancement and complementary.

Integration approach is about implementing the right use of ICT in particular subject areas that involved complex concepts and skills to improve students' achievement and attainment. Besides, the review of the curriculum is also needed so that only related ICT resources and appropriate software will be installed for the main aims and objectives of curriculum to be achieved. Enhancement approach is about using ICT to give great emphasis on the topic introduced. For instance, Microsoft PowerPoint can be used to present the topic in a very innovative and creative way that will lead into discussion and exchanging ideas and thoughts. Finally, complementary approach is when the ICT is used to aid and support the student's learning. This approach allows students to be more organized and efficient in which they can take notes from the computer, submit their works by email from home as long as they meet the deadline, and look for information from various sources provided online to fulfil the task given to them (Hermans et al., 2008).

Opara (2011) found that the mean score of the students taught using inquiry was 54.3 with a standard deviation of 10.54 while the control group that was taught using conventional methods had a mean achievement score of 24.3 with a standard deviation of 4.95. The Z calculated for these means was greater than the Z critical, therefore, the null hypothesis was rejected meaning that inquiry teaching method was considered to be superior to conventional methods. The study further revealed that the experimental group students who were taught using the inquiry method performed better than students in the control groups who were taught using conventional methods (lecture).

### 2.5 Impact of ICTs on the Performance of Students with Regard to Gender

There are many factors that impact on academic performance of students as they are engaged in the teaching and learning process. Some factor includes gender, age group, attitudes, pedagogical approaches, self-concept, socio-economic and cultural factors all have the impact on students' academic performance in biology. However, according to Sadler and Good (2006), low self -esteem, poor self-image, non-assertive behavior among girls, and poorly trained teachers contribute to girls shying away from science and mathematics. Sadler and Good (2006) further asserts that girls believe boys are more superior and intelligent and more capable of handling difficult subjects. Boys in turn perpetuate this myth by dominating in most of what they consider to be "masculine zones" such as computer rooms, science laboratories and technical equipment or engineering laboratories.

UNESCO (2004) also argues that teachers often consider girls as less intelligent and destined for less well-paid jobs than boys. Girls are also given little praise compared to boys. In a study by Sadler and Good (2006) that aimed at improving the participation and performance of girls in achievement was much lower than that of boys partly due to their poor attitude towards science. It also indicated that teachers in normal competitive classes use discouraging remarks on girls' participation in learning science (Sadler & Good, 2006). In a study by Ewumi (2011) on gender differences in achievement in Markurdi metropolis, Nigeria, it was found that boys outperformed girls in science and mathematics achievement.

Another study that was conducted by Ewumi (2011) carried out a study on gender and socio-economic status as correlates of students' academic achievement in high schools in Ogun state, Nigeria. He found a significant relationship between gender

and students' academic achievement ($r = -0.21$; $p < 0.05$). The significant relationship indicated that the male participants achieved higher than the females. However, Lu and Law (2012) attributed the differences in scholastic achievements of male and female due to biological causes and cultural stereotypes.

According to Shaheen and Khatoon (2017) gender differences revealed that female students performed significantly better on the posttest than male students. However, Mhlauli (2014), revealed that boys performed better than girls in general comprehension while there was no significant difference between male and female students in textual comprehension. However, other research studies have reported that males are becoming disadvantaged in schools, and fewer males are interested in science (Dimbisso, 2009). This meant that the academic performance towards the sciences in males may be affected negatively and the females will start performing better in the sciences. The study by Goethals (2001) on the participation of girls in science and technology education in Nigeria showed that the cognitive power necessary for science endeavors is not foreign to girls. He further asserted that the science ability correlates highly with general intelligence in which no consistent gender differences were found. This implies that no gender has advantages over the other in science achievement.

Another study by Kobal and Musek (2001) investigated the relationship between students' gender and academic performance in Basic science in Nigeria. Three hundred (300) students from public schools participated. Findings indicated that no significant gender difference in achievement was found. Nevertheless, female students were found to be slightly better with a mean score of 16.13 in basic science than their male counterparts whose mean score was 16.07. He further asserts that

there are no longer distinguishing differences in cognitive, affective and psychomotor skills achievement of students with respect to gender.

### 2.6 Teachers and Students' Perceptions towards the use of ICT

One of the aspects that affects the use of ICT in the classroom is the teacher's perceptions. When it comes to integrating ICT into school, having a positive perception is vital. Muslem, Yusuf, and Juliana (2018) investigated the attitudes and impediments to ICT use among Indonesian English instructors. The study employed a purposive sampling strategy to pick 26 teachers for a questionnaire and interview. The study's findings revealed that participating teachers had favorable views about the use of ICT in classroom teaching and learning. Teachers believed that ICT support them in their lessons, helps them to find information that enriches their lessons easily and quickly as well as making teaching in the class more interesting.

Hong (2016) conducted an open-ended, semi-structured interview with 23 teachers from various sections of Colorado, USA, to learn about their perspectives on ICT integration. Teachers in the study had a favorable view toward ICT as an instructional tool, according to the findings. They valued ICT as a pedagogical tool and a source of instructional resources. Teachers desired to discover new ways to use ICT to successfully provide instructional materials to students, and they demonstrated their willingness to use ICT in their lessons on a regular basis. This was because they believe that information and communication technology (ICT) is a current trend with several benefits for students. Furthermore, the study discovered that a lack of ICT resources, particularly computers, and an inconsistent internet connection were key impediments to ICT implementation in the classroom.

In an experimental study on in-service Mathematics teachers' integration of ICT as an innovative practice in lower secondary, Daher, Baya'a, and Anabousy (2018) discovered that the teachers had favorable attitudes and beliefs. Despite their favorable feelings, teachers were hesitant to incorporate technology into their courses due to their lack of experience and the various challenges they faced while integrating ICT into education. According to Semerci and Aydn (2018), who used a descriptive research design and a questionnaire to examine high school teachers' opinions regarding ICT use in education for 353 teachers working in different schools in Ankara, Turkey, teachers had favorable perceptions on the use of ICT in education.

Adegbenro, Gumbo and Olakanmi (2017) used a questionnaire and focus group discussion to evaluate in-service secondary school teachers' technology integration needs in an ICT enhanced classroom in Pretoria, South Africa. The study's findings suggested that teachers were enthusiastic about employing computers in their classrooms. Teachers expressed an interest in learning more about how to include computers into the teaching and learning process. Teachers, on the other hand, struggled to integrate ICT into classroom practices due to a lack of knowledge and abilities in using ICT in pedagogical practices. According to Ottestad (2013), an online survey of 247 school leaders and 386 teachers from Norwegian primary and lower secondary schools found a link between school leaders' attitudes and behaviors and teachers' attitudes and behaviors towards ICT integration in classroom activities.

Sánchez *et al* (2012) concluded that teachers showed a positive attitude towards the use of computer tools with the score of 3.83 (from 1= strongly disagree to 5=strongly agree). Their study further revealed that teachers were ready to continue using computer tools in the classrooms. Furthermore, Sánchez *et al* (2012) revealed that

most of the teachers were ready to continue learning computer tools for their use in the classroom. Sánchez *et al* (2012) concluded that teachers considered that computer tools were helpful to keep students' attention, improve the intervention with students with difficulties, and improve the motivation and academic performance of students. Mehra and Newa (2009), and Husain (2010) whose study revealed that teachers exhibited a positive attitude towards the use of ICT. The studies further asserted that ICT must be given higher priority in teacher education curriculum, so that the future teachers can cope with various challenges in education system and more specifically the new roles of teachers in ICT based teaching-learning system. However, Hew and Brush (2007), and Sarangi (2003) in their study found that most teacher educators had negative perceptions about ICT integration.

In Ghana, the introduction of one teacher one laptop in the basic and second cycle schools was to ensure that the current and future inventions will inject the much needed ICT infrastructure, skills and attitudes necessary to spur ICT integration in teaching and learning in Ghanaian schools. A study by Ang'ondi (2013), further revealed that the teachers were also enthusiastic about ICT integration, however, there were several challenges that were still holding them back from fully utilizing the ICTs. Issues such as inadequate infrastructure, lack of knowledge and skills on how to integrate ICTs, teachers' attitudes and beliefs and curriculum, were challenges that the teachers seemed to point out as impediments to the smooth integration of ICTs.

A study by Yang and Kwok (2017) showed that pupils are eager to embrace the use of ICTs in the teaching and learning of genetics, despite them belonging to either control or experimental groups. Furthermore, all 737 participants who answered the questions on the questionnaire showed a positive attitude to the constructs that were measured

in this study. According to the study, all means were above the midpoint of 3.0, ranging from 3.47 to 3.80. The small standard deviation values ranged from 0.81 to 0.90, indicating a narrow spread of item scores around the mean. Other research studies have demonstrated that females had more positive attitudes towards ICTs than males (Van de Pol, Volman, Oort, Beishuizen, 2015). Zhang (2013) study on the Internet Use in English as Foreign Language (EFL) Teaching and Learning in Northwest China indicated that teachers and students showed a positive attitude regarding the use of the Internet in teaching and learning of English. Additionally, Zhang (2013) concluded that new generations students who grow up as a net generation should also facilitate the process of English Learning on the internet.

Tezci (2011) that shows most of pre-service teachers indicated that they only associate elementary ICT tools for educational use. Teachers thought that ICT integration was effective, but ICT tools that were provided in the school were not enough nor in good condition. Furthermore, a research by Chien, Wu and Hsu (2014) has shown that students in school are having high expectation on ICT integration in classroom. This is because the new generation of students are born and grown with technologies, and thus, they could be defined as the “digital native phenomenon” to ICTs. Additionally, their study revealed that the younger the students, the higher their expectations are on ICT integration in classroom. Chien, Wu and Hsu (2014) also proved from their study that the integration of ICT is mostly dependent on the personal factors such as self-perceptions.

Accordingly, Chien, Wu and Hsu (2014) research also showed that teacher and students accepted the use of ICTs and related technologies within and outside classroom. Finally, Chien, Wu and Hsu (2014) concluded that the barriers of ICT

integration in classroom were confidence, competence and attitudes of teachers that reduced the percentage of ICT integration. Studies have established positive attitude among educators in Nigeria towards computer education. For example, Yoloye (1990) found that educationist at the University of Ibadan had positive attitudes towards computer and, in fact, would like to be trained in the use of computers. Similarly, most teachers in Nigeria have positive attitudes towards computer education (Yusuf, 1998). In a "Meta-Review of the effects of Innovative Science and Mathematics", Waite (2004) described studies of ICT-rich teaching approaches as; inclusive of (individualised) computer-based instruction, games, feedback, interactive quizzes, computer based labs, simulations and robotics.

Furthermore, Waite (2004) asserted that ICT-rich teaching approaches lead to gain in more positive attitudes where students enjoy working with computers, feel more safe to experiment and make mistakes, and appreciate the (quick) feedback that ICTs provide. Finally, Waite (2004) found that innovative strategies (computer-based, inquiry-based, context-based, collaborative learning, extra-curricular activities) produced effects on student attitudes and achievement in science and mathematics. However, their study also showed that there was no significant difference between the teaching approaches that were used.

Msila (2015) did a study in South Africa that used an interview to assess teachers' perspectives on the usage of digital technology in the classroom. The findings revealed that younger teachers were more open-minded than older teachers who were put off by the introduction of ICT. Finally, the study found that the success of digital technology in the classroom is more dependent on teacher ability and good attitudes toward technology. Similarly, a study conducted on pre-service Biology teachers'

attitude toward the use of ICT in Biology teaching revealed that pre-service Biology teachers had a positive attitude with no difference in gender or class (Yapici & Hevedanli 2012). The presence of a positive attitude in teachers enhances the use of ICT in instruction. However, least was known about Biology teachers' attitude towards the integration of ICT in teaching and learning in Adoagyiri Senior High School in Ghana.

### 2.7 Factors Affecting the use of ICT in Teaching and Learning Processes

Studies had shown that most schools in had few computers with teachers having inadequate training on use of computer applications, most teachers did not use computer technology for personal growth and instructional purposes Mwanda, Mwanda, Midigo and Maundu (2017). Furthermore, the study revealed that most of the sampled schools had inadequate number of computers which was a major challenge facing the integration of computer into the instruction process. Bingimlas (2009) found that teachers had a strong desire for the integration of ICT into education but they encountered many barriers. Among the major barriers that teachers encountered were; lack of confidence, lack of competence and lack of resources.

Bingimlas (2009) asserted that lack of confidence, competence and accessibility to ICTs have been found to be critical components of technology integration in school. Furthermore, ICT resources such as hardware and software, effective professional development, sufficient time and technical support need to be provided to teachers and schools to elevate some of the barriers to ICT integration. A study by Bingimlas (2009) also established that one component of ICT in itself was sufficient to provide good teaching, but the collaboration of different ICTs. However, the presence of all

components in ICT increases the possibility of excellent integration of ICT in teaching and learning opportunities. According to Alazam, Bakar, Hamzah, and Asmiran (2012), the Malaysian authority recognised the deeper needs of educational performance, incompetence of teachers and the inadequateness of hardware and software. It indicated that the ICT culture in schools should be improved with the use of ICT among teachers through training of teachers in ICTs (Hussain, Morgan & AlJumeily, 2011).

Tezci, (2011) asserted that training and professional development in ICT were not adequately provided for teachers in Turkey. He further argued that technical supports were somehow provided, but could be improved from time to time. Computer laboratories and well-function ICT tools and facilities were not in good condition in most schools. Another key factor that affect the use of ICT in the teaching and learning process is the availability of sufficient computer laboratories and ICT equipment in schools. This is to ensure that subject teachers easily have access to ICT tools whenever needed (Adegbenro, Gumbo & Olakanmi, 2017). Thus, lack of adequate ICT equipment and internet access is one of the key problems that most schools, specifically in rural areas are facing now. For example, results from a research in Kenya shows that, some schools have a computer, but this could be limited to one computer in the office only. Even in schools with computers, the student-computer ratio is high. According to Chapelle (2011) those schools that are equipped with ICT infrastructure are supported by parents' initiative or community empowerment. Mooij, and Smeets (2001) states that ICTs are being considered a major tool for improving accessibility to and efficiency of education in developing countries.

However, despite many promising efforts, there is still a significant digital division between educational institutions located in developing and developed countries. This includes policy and poor ICT infrastructure, lack of training facilities and training, maintenance personnel, limited community participation, gender related issues and ICT access issues especially in rural areas of most African countries. In most schools, technical difficulties sought to become a major problem and a source of frustration for students and teachers and cause interruptions in teaching and learning process. If there is lack of technical assistance and no repair of ICT, teachers are not able to use the computer for temporarily (Jamieson-Proctor *et al*., 2013). The effect is that teachers will be discouraged from using computers because of fear of equipment failure since they are not given any assistance on the issue.

Türel and Johnson's study (2012) revealed that technical problems become a major barrier for teachers. These problems include low connectivity, virus attack and printer not functioning However, there are a few exceptions. Schools in the countries like Netherland, the United Kingdom and Malta have recognized the importance of technical support to assist teachers to use ICT in the classroom (Yang & Wang, 2012). ICT provision and facilities in schools were found to be poorly equipped to deliver ICT, not least because some still operated in "rented houses" (i.e. in buildings that were not purpose-built to serve as schools), shortages of computer equipment (Abatain, 2001; Alshowaye, 2002).

Sahin-Kizil (2011) also reviewed that the use of ICT for educational purposes yield positive outcomes on the part of the students such as increased motivation, active learning, providing efficient resources and better access to information. Moreover, Wang and Woo (2007) reviewed that technology has great potential to increase

learners' motivation, link learners to various information sources, support collaborative learning, and allow teachers more time for facilitation in classrooms.

### 2.8 ICT as a teaching and learning resource

The UNESCO policy on ICT states that ICT can help strengthen democratic and transparent education planning and management. Communications technology can expand access to learning, improve equality and ensure inclusion. Where resources are scarce, judicious use of open-source material through technologies means to bypass the bottleneck of textbook production.

Lowther, Inan, Strahl, and Ross, (2008) however, relates to more recent research into the role of technologies for enhancing 'good pedagogical design' to express congruence between content and implementation (teaching strategies, learning environment, assessment and feedback, underlying learning theories). The author defended educators' use of technology as grounded in 'Why?', 'What?' and 'How' questions around their vision and beliefs about 'why they think their practice matters and how they can best design experiences and environments for pupils.' Moreover, the mobile devices come preinstalled with social media applications like Facebook, Twitter, Wikipedia, YouTube, WhatsApp, Telegram, Instagram, Snapchat 'which are part of what is known as Social Web 2.0, best characterised by the notions of social interaction, content sharing, and collective intelligence' (Player-Koro, 2012. 14). This platform can be used by teachers to disseminate information such as homework, assignments and provide instant live feed-feedback to learners' misconceptions and questions pertaining to the topic under discussion. However, the teachers should at all cost regulate the usage of the social media platform by coming up with ground rules that strict its usage to avoid the platform being misused in a nonacademic way.

However, educators' perspectives have been raised on adapting these kinds of tools and creative media skills for engaging students 'to become the authorities on subjects through investigation, storytelling, and production' (Klein, & Ware, 2003. 18). For example, students and teachers in New Zealand and Singapore are using WhatsApp as a platform to build intercultural understanding and to foster longer term teacher collaboration towards meeting student 21st century learning needs (Watson, 2002).

Similarly, social media platforms like Twitter are being used by teachers and students in a multiplicity of ways, for example: to discover new information; to generate discussion, interest and collaboration; to connect with local and global issues; to explore, exchange and publish thoughts, ideas and perspectives; to communicate information and join professional learning networks (Khasawneh, 2015). The growing accessibility of mobile technologies (in the form of smart phones, iPads, iTunes and smart watches), handheld digital assistants and ubiquitous laptop computer distribution point to increasing the affordance for students to work more continuously across home and school settings, in activities to be initiated outside the school, or practice on exercises to be undertaken when or where desired (Boateng, 2007).

A study by Mulima (2013) that ICTs were valuable pedagogical tools in enhancing the teaching and learning. Other research studies have revealed that teachers use of computers, visual materials like charts, posters and models (computer simulated), were found to be effective for making the lessons attractive and interesting for students (Abdullahi, 2014). According to Aguilar (2012), the transformation of ICT has allowed ICT tools to become educational tools that could further improve the educational quality of the student and revolutionise the way information is obtained, managed and interpreted. Çimer (2004, 2007) concretised this concept by asserting

that providing information in such different modalities (audio, visual, pictures, models and charts) provide more concrete meaning to words, show connections and relationships among ideas explicitly. Çimer (2004, 2007) further asserted that teaching using different modalities provide a useful channels of communication, strong verbal messages and memorable images in students.' This has a way of increasing students' motivation, attitude and improve students' achievement. According to Xenofontos *et al*. (2016) two conditions were compared, the experimental condition (use of the Experiment Design Tool **[**EDT]) and the control condition (no use of the EDT). In each condition, an Inquiry Learning Space [ILS] (an online learning environment) and a virtual lab were selected from the Go-Lab learning platform known as EDT. The results revealed that the integration of the (EDT) in a computer supported inquiry learning environment facilitated the advancement of content knowledge, whereas the development of inquiry skills requires longer experience with such EDT tools or learning environments.

Dede (2014) describes that the use of EcoMUVE (multi-user virtual environment ecosystem) in middle grade curriculum initiative engages students to assume the role of scientists and enable them to investigate research questions by exploring the project virtual environment, and collecting and analyzing data from a variety of sources over time. Findings from the project research showed that while students were initially preoccupied with the technology interface of itself, with time they became increasingly engaged in the student-led, collaborative inquiry experiences afforded by the embedded scientific investigation (Metcalf *et al*., 2014).

According to Ayala (2012) ICTs, as technological tools have increased the degree of significance and educational conception, establishing new models of communication, besides generating spaces for training, information, debate, reflection, among others, as well as breaking up the barriers of traditionalism in the classroom. Abdullahi (2014) further argued that the use of ICT means breaking with traditional media, boards and pens, and giving a way to a teaching role based on the need for training in and updating one's knowledge of teaching methods based on current requirements. This is because ICTs have been found to increase students' engagement, which leads to increased amount of time students spend working outside class time when it is used in the teaching and learning process (Becker, 2000).

Alkahtani (2017) also asserted that ICT is believed to enhance work and education in other ways. He further argued that ICTs can be used to deliver lessons with interesting and enjoyable real world examples, and stimulating visual and audio illustrations from an extremely wide range of sources. His study further augmented that ICT offers well-known benefits such as efficient new ways to compose documents and organize and store information. These components of ICTs can be integrated in the education system to facilitate learning. He pointed out that emails can help teachers and students communicate outside class, holding online tutorials or submitting or returning homework, as well as allowing teachers and students to share their ideas with teachers and students in other schools.

Additionally, dedicated software can be used for students with special needs (such as slow learners) and explaining abstract concepts (Alkahtani, 2017). Fu (2013) also found that ICT facilitates learning without the boundaries of time and place. Fu (2013) further asserted that ICT provides abundant resources such as videos, visual

presentation, and online materials. For example, online course materials and teleconferencing classrooms foster simultaneous interaction between the learner and the teacher and among the pupils themselves (Heemskerk, Volman, Admiraal, & ten Dam, 2012). Isling-Poromaa (2015) further avowed that ICT gives educational equality due to its motivating effects and its ability to differentiate teaching. Hence, ICT is a powerful force required for educational reform so that it can be used effectively in classrooms for instruction, knowledge, and assessment (Player-Koro, 2012). The study from Stošić (2015) also revealed that educational technology improves the quality of education since it includes instructional materials and captures behavior of all participants in the educational process. Others research studies have also augmented that ICT can improve educational quality and associate learning to everyday situations (Lowther, Inan, Daniel Strahl, & Ross, 2008).

### 2.9 Availability of ICT Resources for Integration of ICT in Classrooms

One of the most important variables in ICT integration in teaching and learning is the availability of ICT resources. If these materials are not available in schools, it may be difficult to use ICT effectively in the classroom. A study of ICT availability and use in Chile found that, despite favorable conditions, ICT integration was confined to a few specialized resources such as computers and projectors (Brun and Hinostroza, 2014). In the integration of technology in the classroom, the availability of ICT resources is critical. In most poor nations, teachers' lack of quick access to technology is a major impediment to technology integration. According to the findings of a study conducted in rural parts of South Africa, teachers' main problems in integrating ICT in the classroom were a lack of resources (Mathevula & Uwizeyimana, 2014).

In Ghana, a study was done to examine technological integration in teacher education. The study's findings revealed that one of Gahanna's educational system's obstacles in integrating ICT was a lack of technological resources (Agyei, 2013). Manu (2014) discovered a similar outcome in Nigeria. Inadequate facilities, such as energy and telephone services, were found to be major obstacles to ICT adoption. Another study in Nigeria found that in educational institutions, the availability of ICTs for efficient application in teaching and learning was low (Asiyai, 2014).

In Kaduna State, Nigeria, a research was conducted to analyze the availability, utilization, and management of ICT facilities in the teaching of the English language in secondary schools. The survey found a lack of ICT facilities in schools, the absence of internet in most schools, a low level of utilization of the limited ICT facilities, and frequent power outages during instructional time. The study also found that the majority of instructors lacked the knowledge and abilities needed to use ICT in the classroom. The majority, (78%) of the teachers considered their ICT training to be at a poor level, and this affected productivity. This study demonstrated that teachers have positive views on the use of ICT for teaching English (Yusuf et al., 2013).

A study of the availability and use of ICT resources in secondary schools in Ardo-Kola and Jalingo, Taraba State, Nigeria, discovered that the availability, accessibility, and use of ICT resources in secondary schools for teaching and learning were all very low. ICT resources were not available in the schools under study, according to more than 80% of respondents; ICT resources can only be accessible and utilized by instructors and students if they are available in the schools for teaching and learning (Onwuagboke et al., 2014).

A study conducted to assess the availability and utilization of ICT for teaching and learning and to establish hindering factors for the use of existing ICT resources in secondary schools in Kwekwe, Zimbabwe, revealed that majority of the ICT resources needed for training were not available in the tested schools, and those that have were insufficient. The study also found that accessible ICT resources were being used to a little amount. Lack of power, insufficient resources, fear of technology, and lack of enthusiasm, ICT skills inadequacy, increased ICT costs, and poor physical infrastructure were among the problems that hampered ICT use in these schools, according to the study (Mavellas et al., 2015).

Lack of proper access to ICT resources, as well as insufficient technical and pedagogical assistance, were some of the crucial problems that impeded integrating ICT in teaching and learning practice, according to a study done in Ethiopia. The data analysis revealed that the goal of integrating ICT into teaching and learning has yet to be accomplished (Alemu, 2015).

Ghana has made considerable progress in reforming its educational system. Ghana's government believes that information and communication technology (ICT) can help to improve educational access and quality. In 2003, Ghana developed an ICT for Accelerated Development (ICT4AD) education policy. However, a ten-year study revealed that Ghana has a low penetration level of ICT infrastructure such as the internet, mobile phones, and television; as a result, ICT access is confined to a few people in urban schools. Poor ICT infrastructure and energy, a lack of ICT-trained teachers, and low literacy and understanding about ICT in education were all barriers to ICT deployment in Ghana (Alazam, Bakar, Hamzah & Asmiran, 2012). It is unclear whether or whether the situation has improved. As a result, the researcher

attempted to investigate the availability of ICT services in senior high schools in Adoagyiri.

### 2.10 Teachers and students' ICT skills and knowledge

Teachers and students' ICT skills and knowledge play the significant role in determining the attitude and usage of ICTs by teachers and students in the teaching and learning process. ICT skills can influence the behavior of teachers and students towards its usage in classroom activities. Furthermore, the knowledge teachers and students have on ICT can also influence their choice and usage of ICTs that can be used in the teaching and learning process. According to the study conducted by Husain (2010) teachers thought that using ICT skills in developing and presenting information was an essential technical competency that teachers need to acquire to improve the educational system.

Nevertheless, the study by Zhang (2013) revealed that teachers have some knowledge about Internet use in teaching and learning, but could not very well integrate Internet into teaching and learning. The study further revealed that teachers' knowledge about ICT and network technology was found to be very limited. A study by Abdul Rahim and Shamsiah (2008) established that trainee teachers in Malaysia have confidence to integrate ICT in their teaching practices. And the male teachers are more confident than female teachers in using ICT integration in teaching. Moreover, other research studies have shown that vocational teachers are more confident to integrate ICT in teaching, because they can handle technical subjects, and their experiences enable them to integrate ICT effectively in teaching (Abdul Rahim & Shamsiah, 2008; Yunus, 2007).

Furthermore, only minority of teachers in Malaysia professionally know the basic of ICT. Şahin-Kizil (2011) study also revealed that majority of teachers just had average knowledge in ICT and even a group of the teachers are poor in the related knowledge of ICT in Malaysia. The study further revealed that the level of ICT knowledge among teachers is one of the key factors for Malaysia society to make successful adoption of ICT in its education.

In another study that was carried out by Mewcha and Ayele (2015) the findings revealed that teachers were unable to use of ICT software and hardware in the teaching and learning process. They reported that 55.6% of teachers could not use ICT as instructional tools. This indicate that most teachers in the college were not integrating ICT in the courses they were teaching. However, the majority teachers pointed out that one of the barriers to technology implementation was lack of teachers' technical knowledge and shortage of resources. This showed that equipping the college with ICT was not enough for attaining educational goals but empowering teachers with ICT knowledge and skills. On the other hand, Cabero (2010) recommended that students should also participate as new educational agents. Cabero asserted that students have become a major element for communication and social interaction as a result of being born in a high-technological society. Thus, it can be stressed that students can play an active role in the use of ICT in the teaching and learning process because of their familiarity with the new technologies. Tello (2007) emphasizes that the current situation shows that access to ICT is a major requirement for participation in a technological society. If students who are born in this high technological society can be allowed to participate in the learning and teaching process, then we would be closer to attaining quality education.

The study by Tezci (2010) showed teachers low levels of ICT (software) use for educational purposes in classroom was limited, and might have be strongly influenced by a lot of factors. The findings further revealed that teachers' factors that attributed to low use of ICT in classroom; low levels of teachers' experiences with ICT, low levels of expertise and lack of knowledge, and skills about how to use and adapt ICT in the education programs. Tezci (2010) argues that there is a significant correlation between the levels of knowledge about ICT and the use of ICT in education. His study revealed that the higher the level of knowledge on ICT, the higher its level of use in education. It is imperative that teachers should receive training on the effective strategies and tools that can allow technology integration into classrooms (Almekhlafi and Almeqdadi, 2010) and improve curricula with technology-boosted materials (Goktas, Yildirim, and Yildirim, 2009; Hutchison & Reinking, 2011). Anderson (2006), and Bingimlas (2009) in their research on ICT, the higher the mean level of knowledge, the more the ICT use. Teachers with previous computer experience have higher levels of knowledge on ICT and their ICT use is more frequent. Teacher's levels of ICT use show that they use these technologies as information transmission-based tools. Sarangi (2003) and Alkahtani (2017) whose study revealed that educators had a limited idea about how the available ICT equipment could be used in teaching-learning situation. Their findings were attributed to the poor training opportunities for teachers to develop the necessary ICT skills.

### 2.11 Instructional Methods Used by Teachers in Teaching Biology

The old teacher-centered instructional techniques to teaching must be replaced with learner-centered ones, which ICT can help to support and make students more engaged in their learning. The two most well-known approaches in the teaching process are expository and heuristic. The expository approach, often known as the

teacher-centered approach, includes lecture, demonstration, and other methods. The activities in the classroom are dominated by the teachers. Learners can actively participate in the classroom using a heuristic or discovery approach, often known as learner-centered, which includes discussion methods, problem-solving methods, and the like (Twoli et al., 2007).

In education, the focus has evolved from a traditional teacher-centered method to a more modern learner-centered one. Teacher-centered learning is based on a passive learning model in which teachers dominate learning activities and learners passively interact with their learning. The learner-centered approach emphasizes active and reflective learning, in which students actively participate in their own learning and teachers' roles are to promote and lead students' learning. The shift to a learner-centered approach necessitates a shift in attitude toward knowledge and learning activities (Smart, Witt & Scott, 2012).

Teaching is a method of assisting students in their learning. Effective teaching is a complex endeavor with many interconnected elements. Teaching is more than simply content; it's about boosting students' self-efficacy, drive, and engagement. Teachers can utilize a variety of teaching approaches to assist their students in learning. Learner activation and attention in learning are increased when learner-centered teaching strategies are used (Mykrä, 2015). Technology is helpful for incorporating learner-centered approaches of teaching and learning. Teachers can combine classroom learning and online learning, using a blended learning approach. Blended learning was a more active approach than traditional teaching methods for teaching human anatomy (Pereira et al., 2007). When learner-centered strategies are used in conjunction with blended learning, there are numerous educational benefits. The

benefits of blended learning in the teaching of human anatomy, according to Pereira et al., (2007), were to modernize teaching methods, improve academic performance, increase interaction and communication among teachers and students, and provide students with solid, reliable, continuously accessible, and updateable materials.

A comparison of the teacher-centered and learner-centered approaches to teaching English as a foreign language revealed that both approaches have strengths and weaknesses, nevertheless, learner-centered was determined to be more favorable (Al-Zu'be, 2013). A survey of 126 instructors in northeast Texas and Arkansas was conducted online to gain information on how to create technology-enhanced, learner-centered classrooms. Learner-centered instruction, according to the majority of instructors, is demanding yet gratifying. Respondents also showed positive attitudes towards learner-centered approach and integrating technology in classrooms (An and Reigeluth, 2011). Learner-centered approaches have been tested and proven to make learning more enjoyable, productive, and meaningful and also favors the use of ICT in the classroom.

## 2.12 Conceptual Frame work

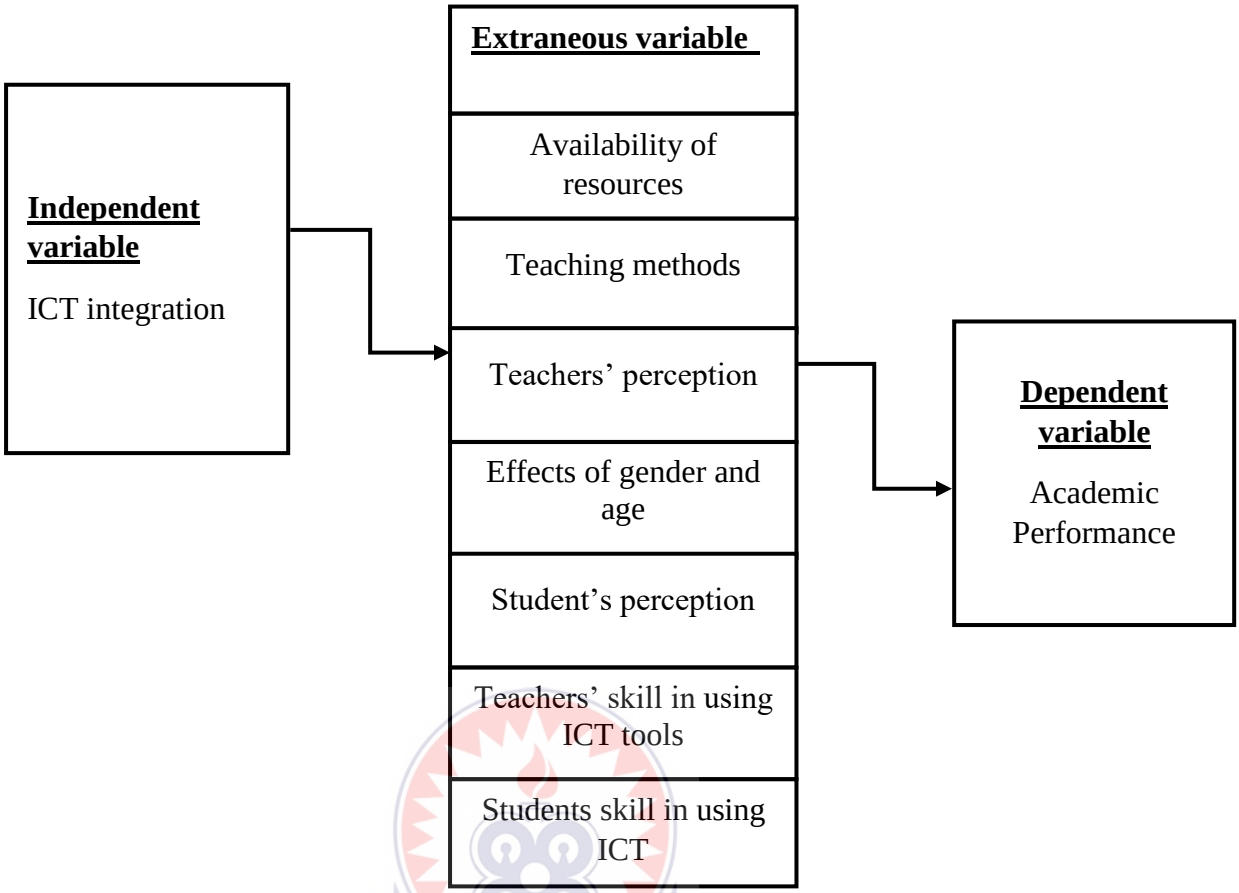


**Figure 1: Conceptual Framework**

Source: Researcher

The purpose of the study was to integrate ICT into teaching and learning biology to improve the academic performance of students. The conceptual framework fig.1 depicts the flow of the influence ICT integration has on student's academic performance. The arrows depict how the independent variable (ICT integration) influence the dependent variable (academic performance). Although the independent variable affected changes on the dependent variable, there were other extraneous variables involved. These include both teacher and students' perceptions in ICT, students attitude toward the ICT integration in the teaching and learning process, the teaching style adopted by the teachers which either supported the integration of ICT

or not, availability of resources and students' performance. These extraneous variables may affect the outcome of the academic performance.

### 2.13 Research Gap

The integration of ICT into Biology is paramount as far as the educational reforms in Ghana with ICT integration is concerned. Although several studies have been conducted on the ICT integration, no such study has been conducted or sited in St. Martin's Senior High School in the Nsawam Adoagyiri Municipality. This study sought to bridge this gap by integrating ICT in teaching and learning of Biology in the school.

### 2.14 Summary

Majority of the literature reviewed showed that even though certain biological concepts have been identified as being difficult to teach and learn in school, teacher's use of poor teaching methods, lack of teaching and learning resources coupled with most biological concepts being too abstract. Some studies have taken interest in addressing these challenges. Further, there are few studies that have been undertaken to bridge the gaps between the traditional approaches and new technological methods in the teaching and learning of biology. Furthermore, inadequate teaching and learning resources and how to make the abstract concepts of some selected topics more user friendly to learners in high schools were among the issues that were raised. Thus, the study intended to use the integration of ICT tools to improve academic performance in biology when used as a supplement to traditional teaching and learning methods. Further, the literature that was reviewed mostly focused on the use of ICTs in education and its implication on the learners and teachers' perceptions. The review also focused on the effect, importance and challenges of ICT integration. However, these studies did not look at the specific topics in biology and how

appropriate ICT tools could be used to enhance learning and to improve upon the perceptions teachers and students. The current study however, used the mixed method approach so that the weaknesses that are conferred by the qualitative approach can be supplemented by the quantitative approach and vice versa.

Even though there are many studies that have been done on integrating ICT in education, few studies have investigated the effects of integration specific ICT tools (video, gene X simulation software and Microsoft excel) in the teaching and learning of biology.

# CHAPTER THREE

# METHODOLOGY

## 3.0 Overview

This chapter describes the research approach, research design, study area, target population, design and method of sampling, tools for research (instrumentation), the reliability and validity of research tools and data collection .

## 3.1 Research Approach

According to Creswell and Clark (2011), choosing one research approach limits the scope of a study, thus one research approach cannot answer all the research questions guiding a study. In this study the research approach used was a mixed method approach.

According to Creswell (2014) a mixed method research is, an approach to research in the social, behavioral, and health sciences in which the investigator gathers both quantitative (closed-ended) and qualitative (open-ended) data, integrates the two, and then draws interpretations based on the combined strengths of both sets of data to understand research problems. The Researcher used a mixed method approach which mitigated limitations and biases found in (both) the qualitative and quantitative approaches because each approach has its own weaknesses and strengthens. According to Kombo and Tromp (2006), the mixed method approach maximises the strengths and minimises the limitations of both qualitative and quantitative approaches. This enabled the Researcher to be confident that the approach used would yield good results for the study.

According to Creswell (2009) there are five types of mixed method approaches, which are: sequential explanatory design, sequential exploratory design, the concurrent embedded design, concurrent triangulation design and the sequential transformative design. The Researcher considered the concurrent triangulation design which is also known as convergent parallel mixed method design to be the best for this study. Creswell (2002, 2003, 2009 and 2012) had consistently revealed that this design is one of the most popular and effective in educational research. The design enabled the researcher to collect and analyse both qualitative and quantitative data concurrently and then have the two data bases merged for comparison to determine if there will be convergence, differences or some combination (Creswell, 2009). Using the design in Fig. 2, the Researcher was able to investigate the effectiveness of ICT tools (pictures, videos, emulations software) on students' performance in Biology in St. Martins SHS when it was used as an enhancement to traditional teaching learning method. To determine the impact of ICT on students' performance in biology, to explore the perceptions of students on the use of ICT tools in the teaching and learning of biology. The Researcher was of the view that using the data that was collected, the research objectives and questions would be addressed.

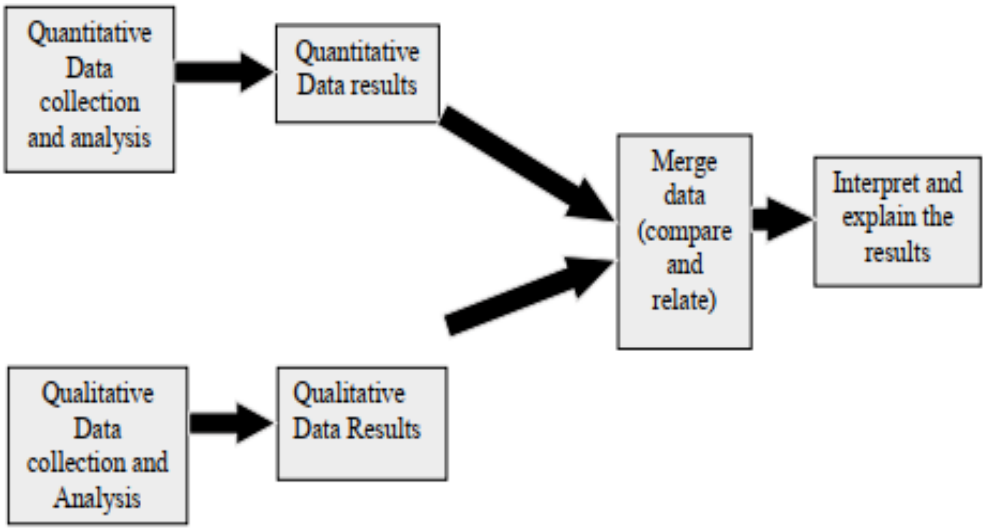


**Figure 2: Concurrent Triangulation Design**

Source: Adopted from Creswell (2014)

### 3.2 Research Design

Research design is a detailed documentation of plan for the collection, and analysis of data. A research design is a plan or strategy that is drawn up for organizing the research and making it practicable, so that research questions can be answered based on evidence and warrants (Cohen, Manion & Morrison, 2018). A research design is defined as the overall plan for collecting data in order to answer the research questions (Creswell, 2009). There are various research designs in various jurisdictions of research work and the choice of a design depends on the aims of the study. According to Amedahe (2002) a research design is a plan or blue-print that specifies how data relating to a given problem should be collected and analysed. Research design deals with specific data analysis techniques or methods that the researcher used (Fraenkel &Wallen, 2000). Some of the different types of research designs are Action research design, survey research design, case study research design, experimental research design and descriptive research design.

In this study, the research design used was action research. This is because the main objective of this study was to improve students' performance using ICT tools teaching and learning some selected topics in biology. Action research is a problem solving research devoted to the solution of an immediate problem in a given situation (Shepard, 2002). According to Parsons and Brown (2002), action research is a process in which a practitioner studies a problem scientifically, evaluates, improves and make decisions. According to Bradbury and Reason (2003), action research is very popular in the field of education because there is always room for improvement when it comes to teaching and educating others. There are different types of method of teaching in the classroom, but action research works very well because the cycle offers opportunity for continued reflection.

In all professional fields, the goal of action research is to improve upon a processes and Action research is also beneficial in areas of teaching practice that need to be explored or settings in which continued improvement is the focus especially in teaching and learning. Action Research is a participatory process concerned with developing practical knowing in the pursuit of worthwhile human purposes. It seeks to bring together action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern to people (Bradbury & Reason 2003). Action research is a research that aims at closing up gaps between research and practice rather than producing knowledge.

Action research design follows a characteristic cycle whereby initially an exploratory stance is adopted, where an understanding of a problem is developed and plans are made for some form of interventionary strategy. Then the intervention is carried out during which time pertinent observations are collected in various forms. Action

research, aims to contribute both to the practical concerns of people in an immediate problematic situation and to further the goals of social science simultaneously.

### 3.3 Study Area

The study took place in St. Martin Senior High School in Nsawam-Adoagyiri Municipality Assembly. Nsawam Adoagyiri Municipality is located approximately 23km from Accra, the national capital. It is situated in the South Eastern part of the Eastern Region between latitude 5.45'N and 5.58'N and longitude 0.07'W and 0.27'W and covers a land area of about 175 square kilometer. In terms of spatial interaction, it is bordered to the South by the Ga West and Ga East Municipalities in the Greater Accra Region and to the North by Akuapem South District. It is also shares boundaries in the North-West with Ayensuano District and in the South West with the Upper West Akim District.

Nsawam Adoagyiri Municipality has a population of 86,000, comprising 42,733 (49.7%) males and 43,267 (50.3%) females. population constitutes 50,864 (59.1%). St. Martin's Senior High School was chosen because the performance students in Biology in WASSCE examinations was low as compared to the national level. The low performance in Biology may discourage other students from studying Biology. St. Martins Senior High School also has a larger student population of 2412 including day students. The researcher's acquaintance with the school may also aid in the gathering of accurate and comprehensive data for the study. Finally, there was only a little amount of such research done in the area.

### 3.4 Population

Population is a group to which the Researcher would like the result of the study to be generalised. It includes all the individuals with certain specified characteristics

(Fraenkel & Wallen, 2003). According to Williaman (2011), Population is a collective term used to describe the total quantity of the subject of study. In other words, population is the larger group to which the researcher would like the results of a study to be generalised (Lodico, Spaulding & Voegtle, 2006). Population is divided into two aspects, target and accessible population.

The target population is the group of interest to the researcher. It is the group the researcher would like to generalise the results of the study (Lodico, Spaulding & Voegtle, 2006). Alvi (2016) also defines target population as all the members who meet the particular criterion specified for a research investigation.

The accessible population is a portion of the population to which the researcher has reasonable access; it may be a subset of the target population. In other words, it is the population from which the researcher can realistically select subjects, which is also known as the available population (Gay, Mills & Airasian, 2012).

Also, the accessible population in research is the population the researchers can apply their conclusions. The accessible population is the subset of the target population and it also known as the study population. It is from the accessible population that researchers draw their samples. The accessible population for this study was Home Economic students enrolled in biology as one of their electives.

### 3.5 Sample and Sampling Techniques

Sampling is defined as the process of selecting a subset of cases in order to draw conclusions about the entire set (Orodho, 2017). The Australian Bureau of Statistics (2004) indicated that the purpose of sampling in any research work is to overcome the problem associated with the vastness of the study population. Leedy (1993) defines

sampling as the process of selecting pieces from a much larger population, a group about which a generalized statement is made, so that the complete group is represented. Singleton and Strait (2010) defined sample as the selected elements (object or people) chosen for a sudy. Ary, Jacobs, and Sorensen (2010) also defined a sample as a portion of a population, or a group selected from a population for observation in a study.

There are different types of sampling technigues that can be used for research, some of which include, random sample, stratified sample, quota sample, purposive sample and convenience sample (Kowalczyk, 2013). Futhermore, sampling, according to Amoani (2005), is the procedure whereby elements or people are chosen from a population to represent the characteristics of that population.

The purpose of sampling is to obtain a group of subjects who will be representative of larger population or will provide specific information needed. The degree of representativeness is based on the sampling technique employ. According to Cohen, Manion and Morrison (2018), there are two main types of sampling techniques. The two main types of sample are probability and non-probability sample. Probability sample is the type where every member of the population has equal opportunity to be selected into the sample. The kinds of probability samples are as follows: simple random, systematic, stratified random, cluster, multistage and multiphase sampling. Non-probability sampling is the where some elements of population have no chance of selection. The kinds of non-probability samples are purposive, quota and convenience. Sampling per say is not a technique for getting information but it ensures that any technique used will help in getting information from a smaller group, which could accurately represent the entire group. Best and Khan (2006) defined an

ideal sample as a number that is large enough to serve as an adequate representation of the population which the researcher wishes to generalize and small enough to be selected economically in terms of subject availability and expense in both time and money. They argued that an ideal sample size may depend on the nature of the population and the type of data that needs to be collected and analysed. It is for this reason that every researcher needs to come up with a good and manageable sample representation of the population.

In this study, purposive sample type was used to select an intact class of 50 form two Home Economics students. In purposive sampling the Researcher selects subjects that are informed about the topic of interest (Schumacher & McMillan, 2010). According to Cohen and Morison (2007), purposive sampling is the selection of sample on the basis of the judgment of the researcher. Purposive sampling relies on the judgement of the researcher when it comes to selecting the units (e.g., people, cases, organizations, events or pieces of data) that are to be studied. The whole class was chosen for this study because there was a need for all students in the class to be exposed to ICT integration for deeper understanding of biological concepts.

### 3.6 Instrumentation

Research instruments are tools of measurement designed to obtain data on a topic of interest from research subjects. Among research instruments used in research include observation, interviews, questionnaires, tests, checklists, tally sheets, flow charts, attitude and rating scales.

According to Frenkel and Wallen (2003), instrumentation refers to the whole process preparing to collect data. It entails not only the selection or design of the instrument but procedures and conditions under which the instrument will be administered. It helps to keep track of what is being observed and how to report for data collection.

In this study, class observation and tests were used. The test were of two forms namely, Biology Performance Test (BPT) as a pre_intervention test and Biology Achievement Test (BAT) as the post intervention test. Research instrument according to Denzin and Lincoln (2001) is a measure designed to obtain data on a topic of interest from a research subject .Data refers to all kinds of information researchers obtain on the subjects of their research (Fraenkel & Wallen, 2003). Data collection for a study can be done either by quantitative method or qualitative method. Quantitative researchers use a variety of instrments to gather data, including tests, questionnaires, rating scales and attitudes scales. Qualitative researchers also have a toolbox data gathering techniques, including in-depth interviewing, participant observation, and content analysis (Fraenkel & Wallen, 2003).

### 3.6.1 Achievement test

Test can be defined as an instrument or systematic procedure for observing and describing one or more characteristics of student using numerical scale. The instruments for this research were the treatment instrument "Biology Performance Test (BAT)" which formed the pre-test and "Biology Achievement Test (BPT) as the post_ test. The treatment instrument, Biology Achievement Test (BAT) on Biology, was self-instructional that lasted for 2 hour for an average student. It contained five lessons structured into modules.

The pre-test performance test (BPT) was used to measure the students' performance in biology before the exposure to the treatment. The post-test (BAT) was used to measure the students' achievement in biology after the treatment. Both pre-test and post-test contained either short-answered questions or structured questions for a total score of 40 marks.

### 3.6.2 Class Observation

Class observation is more than just looking. It is looking (often systematically) and noting systematically people, events, behaviors, settings, artefacts, routines, and so on (Simpson & Tuson, 2003, Marshall & Rossman, 2016). It can be systematic or structured. The use of observation as a principal mode of research has the potential to yield more valid or authentic data than would otherwise be the case with mediated or inferential methods. This is observation's unique strength. Observation is strong on face validity; it can provide rich contextual information, enable first-hand data to be collected, reveal mundane routines and activities, and can offer an opportunity for documenting those aspects of life worlds that are verbal, non-verbal and physical (Clark *et al*., 2009). Observation also enables a researcher to look afresh at everyday behavior that otherwise might be taken for granted, expected or go unnoticed (Cooper and Schindler, 2001). The approach can be carefully prepared by recording schedules, avoids problems such as selective or faulty memory caused when there is a time gap between the act of observation and the recording of the event.

In this study the Researcher was of the view that, when interested in studying the overt character of students, class observations are the primary instrument to use. Class observation was done using observation checklist ( Appendix C) . The checklist was used in determining the number type and number of ICT resources availabe for

teaching and learning biology. It was constructed taking into consideration the number of the following items; Desktops, laptops. projectors, printers, photocopiers, radios, television sets and video players.

### 3.6.3 Interview

Interviews consist of collecting data by asking questions. Data can be collected by listening to individuals, recording, filming their responses, or a combination of methods. Interviews may be unstructured or semi-structured. Unstructured interviews generally consist of one or two open-ended questions. Participants are then free to say as much or as little as they wish and the researcher does not impose their own ideas. Questions that prompt or encourage participants to elaborate can be posed (Patton 2002). In a simple meaning – "an interview is a meeting in which someone answers questions about himself or herself or an event. In this study, an interview schedule list containing a set of structured questions were prepared, to serve as a guide for the researcher. The schedule was used by the researcher, who fills in the questions with the answers received during the actual interview session. It allows interviewers and researchers to get more information, since they can ask follow-up queries or clarifications to the questions they have prepared. Thus, the information gathered is more relevant and useful.

The Researcher is of the view that to know more about students' perception after the intervention. The interview was guided by an interview schedule ( appendix G) which consist of 11 structured questions which students answered Yes or No.

## 3.7 Validity and Reliability of Instruments

Confirmation of validity and reliability of research instrument is crucial for precise and authentic outcomes of the study. Without confirming validity and reliability of the

instrument, conduction of research is useless and timewasting. The goal of a good research is to have results that are reliable and valid (Creswell, 2003).

### 3.7.1 Validity of instrument

Validity of an item refers to the extent to which an item measures what it is supposed to measure (Denzin & Lincoln, 2001). One of the approaches of validating research findings is to use multiple methods of data collection. This is supported by Brewer and Patton (2002) who argued that the combination of methods complement each other by eliminating overlapping flaws. Besides, when methods are combined, which is known as triangulation, inconsistencies are taken care of, thus valid and reliable data emerges (Patton, 2002). The validity of instrument could be determined by using long serving teachers to judge how well the measuring instruments met standards through content (content validity). The instruments appearance – showing genuine features could be checked to ensure originality (face validity). Comparison of the outcome of the prevailing conditions with the predicted outcome could be made for correction to be made (criterion related validity). Experienced teachers in the county could ascertained construct validity during construction of instrument by presenting it for review during piloting.

The Researcher could also ensure that the scores from instrument accurately predicted a criterion measure by making amendments (predictive validity). Finally the results obtained using instrument could be checked if they correctly correlate with other results (concurrent validity) and amendments made to make it valid. In order to validate the findings in this study, the Researcher recorded each and every observation during data collection so as to check for unclear information and then cross check with the respondents. In this study, the content of validity of the tests

were confirmed by matching the test questions to specific objectives as required by the biology curriculum. An intact design was used to obtain data, this method is so strong that when it is used, many common threats to internal validity are controlled since all caliber of students may be present. The Researcher also discussed with his supervisor, other lecturers and colleagues on whether the instruments accurately represent the concept of the study. Their ideas were well considered and appropriately incorporated. Content validity refers to the degree to which the sample of the items represents the content that it is designed to measure (Orodho, 2009). According to Creswell (2012), content validity is the extent to which the questions on the instrument and the scores from these questions are representative of all the possible questions that could be asked about the content or skills.

### 3.7.2 Reliability

The accuracy precision of a measurement procedure of research instruments is commonly known as reliability (Mugenda & Mugenda, 1999, and Creswell, 2012). Mugenda and Mugenda (1999) looked at reliability as the degree to which a research instrument yields consistent results or data after repeated trials. Reliability according to Cohen, Manion and Morrison (2007), means that scores from an instrument are stable and consistent; scores should nearly be the same when researchers administer the instrument multiple times and also scores need to be consistent. The reliability coefficient was found to be 0.813 which showed that the test was reliable.

### 3.8 Pre-Intervention Data

Prior to the intervention, the problem was identified through observation of students' response in class. Moving on to a new topic requires a teacher to access students' prior knowledge, this was done using oral questioning. Responses from students,

showed that about 85% could not answer simple basic questions. To avoid any doubt, students were given the opportunity to go through their previous notes to and to write biology performance test (BPT, a pre-test). The Researcher set simple open-ended questions based on the previous topics in their previous class. The pre-interventions test conducted had thirty open-ended questions. The total score for questions was thirty marks. The score for a correct answer was one mark. A wrong answer chosen scored zero mark. The total score for each student was collated. Results from the pretest are presented in Appendix F. Students' performances were classified into three groups. Students who scored 21 marks and above were classified as 'very good', those who had 11-20 marks as 'good' and students who had 1-10 marks as 'unsatisfactory'.

The analysis of the pre-test (BPT) revealed an urgent need to intervene with appropriate strategies to remedy the situation. It was observed that most of the students in the class did not have any interest in the topic Mitosis and Meiosis. Also, students could not answer questions on basic biological concepts on the topic Biological drawing with key emphasis on orientations. Furthermore, students could not answer questions on the Life processes of some living organism such as butterfly, tilapia, toad as well as certain features of grasshopper. These were among the vital areas where questions were set for external practical examination and students are expected to be a master of them. This prompted the researcher to find out why the students performed poorly even though the topics have been taught in their previous class. Based on this observation, some students in the class were interviewed to get information on the problem identified. The interview was done orally with some structured questions where students gave responses to them. The responses from the

semi-structured interview showed that, more than half of the students could not answer questions on the topics with the following reasons;

1. Teacher did not use teaching and learning aids to make the students understand the topic well
2. Teacher bombarded them with notes and asked them to read textbooks without explaining the notes to them.
3. Teacher did not use activities or engage them in the teaching and learning process making the lessons boring.

### 3.8.1 Intervention activity

The intervention was made of five lessons during which the implementation of ICT integration lessons were ensured.

The intervention used for the class comprised of ICT tools (courseware package, Power Point presentation, and YouTube video all on cell biology and genetics). The courseware package and video were downloaded from the Internet while the PowerPoint presentation was, however, designed by the researcher. Before conduction of the research, students of the class were taught through conventional teaching method. A pre-test (Biology Performance Test, BPT) was given to the students. The assessment score of students from the pre-test allowed the researcher to intervene and provide remedy for the situation. The treatment process was completed in six weeks. This was to allow the researcher to have ample time to assess students after completion of each sub-topic. A lesson plan was prepared by the Researcher to guide the study. Students were taken through the subsequent lessons of cell biology, life processes of some organisms and genetics through the implementation of ICT integration as teaching strategy during each instructional phase. The intervention

strategies also included the use of open ended questions during class sessions to allow learns to think critically rather than memorize information. This also helps learners to construct knowledge for themselves.

Students also asked the Researcher questions when necessary which helped erased some of their misconceptions. The Researcher demonstrated the concept of Mitosis and Meiosis on overhead projector connected to a laptop as students observe what happens. They also checked the relationship between the Mitosis and Meiosis. The Researcher also monitored students' ways of solving biological problems in a more expert way using diagrammatic representation especially in a case where three students were called to present their answers on a question which demanded 'description of Mitosis'. The Researcher intervened in a case where students were confused by diagrammatically presenting the Mitosis. The use of frequent class exercises (appendix D) was also a way of getting the students to learn very often which in turn helped enhance the retention of information gathered for longer periods. Also, prompt marking of exercises with a well drafted marking scheme (appendix E) was implemented to ensure that students get quick feedback on their day-to-day performance as well as serve as a performance guide to students. Questions were also always discussed with students after marking to ensure that the students get the right information as well as make necessary corrections to their misconceptions about certain content.

For the Researcher to know whether students have understood the biological concepts, students were told prepare for a test in the next meeting. This was done to test the retention rate of the students. The post-test instrument, Biology Achievement Test (BAT), was administered to all the participants after the intervention.

### 3.9 Intervention activities

Intervention activities involved using different ICT tools in teaching. Reports on each lesson is presented

#### 3.9.1 Report on lesson 1

**TOPIC: BIOLOGICAL DRAWING**

Instructional objectives: By the end of the lesson the students should be able to:

1. Identify and explain the various orientation of an organism.
2. Apply the rules for biological drawing and labelling.
3. Draw and label a longitudinal section of a hibiscus flower.

**Activities**

A. Materials: Fruits (Orange, mango, pear, apple), hibiscus flowers, knives, cotton wool, A4 sheets, HB pencil, eraser, blade, petri dish, ruler, chart, work sheets of self-instructional learning package SLP).

B. Classroom Organisation: Formal sitting (each student's sits at his/ her own place in class), each student with a set of materials.

C. Relevant Previous Knowledge (RPK): Students were able to identify most of the materials as they have been using them every day.

D. Presentation: In this presentation, the lesson was introduced using one of the ICT tools, a short video on biological drawing (retrieved from YouTube) which lasted for 10 minutes was shown. In the video were scenes which described the various orientations exhibited by an organism.

These were anterior (Head view), posterior (Tail view), dorsal (Back view), ventral (Belly view) and lateral view (Side view). Again, the video showed how to draw a flower observing all the biological rules. The students were then asked to identify and

name the parts of a flower. The concept of sectioning, orientation and rules to be observed in biological drawings were explained. According to Asabere and Haruna (2007), sectioning is a cut made vertically (or longitudinally) or horizontally (or transverse) through a whole or part of an organ of an organism. The types of sectioning were longitudinal, and transverse. The students to performed the transverse and longitudinal sectioning fruits. A picture (retrieved from the internet) was used to show the parts of the sections they had. This is shown below in fig. 3 and fig. 4.

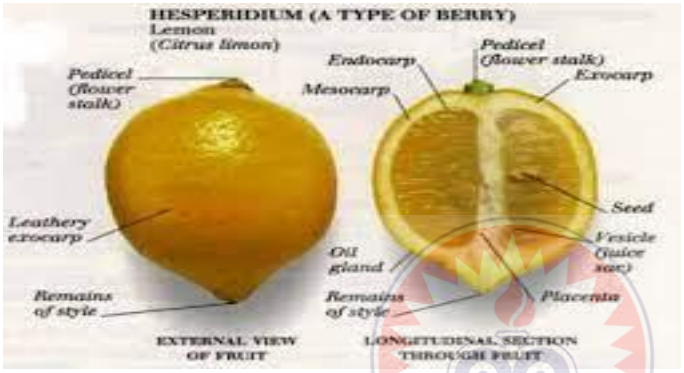


**Figure 3: A Labelled Drawing of the Longitudinal Section of a Lemon**

**Source: Ekko (2006)**

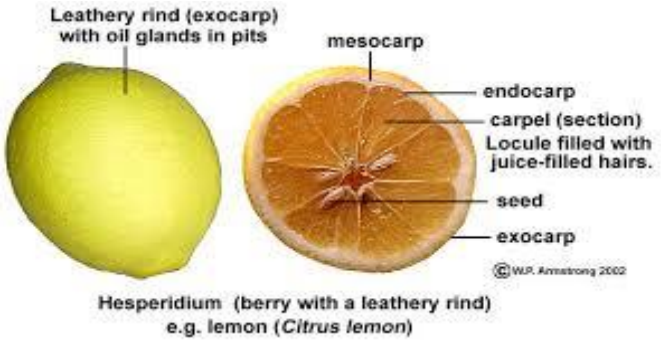


**Figure 4: A Labeled Drawing of the Transverse Section of a Lemon**

**Source: Ekko (2006)**

Students were provided with worksheets to perform the next activity on the hibiscus flower individually. The worksheet contained evaluative questions that allows learners to apply the rules for biological drawing and labelling.

Classroom interaction, according to Awotua-Efebo, (1999), is a practice that enhances the development of the two very important language skills which are speaking and listening among the learners. This practice helps the learners to be competent enough to think critically and share their views among their peers. This practice was not left out during the presentation of the lesson, although the Researcher's role was passive yet it was very crucial. By creating an interactive teaching and learning atmosphere inside the laboratory and through the sessions, responses were gathered from the learners and motivated them to come out with new ideas related to the topic. Lessons where students have multiple opportunities to communicate with the teacher are essential for the effective construction of student knowledge. The Researcher used discussion and brainstorming methods to interact with the learners collectively. As the learners performed the task in the worksheet, the Researcher moved round to supervise the work and also had one-on-one interaction with them.

At the closure of the lesson the Researcher went over the key points again and then projected a picture of a half flower to students. This was done to clear any doubts and to compare with their own. Below is the longitudinal section of a hibiscus flower used.

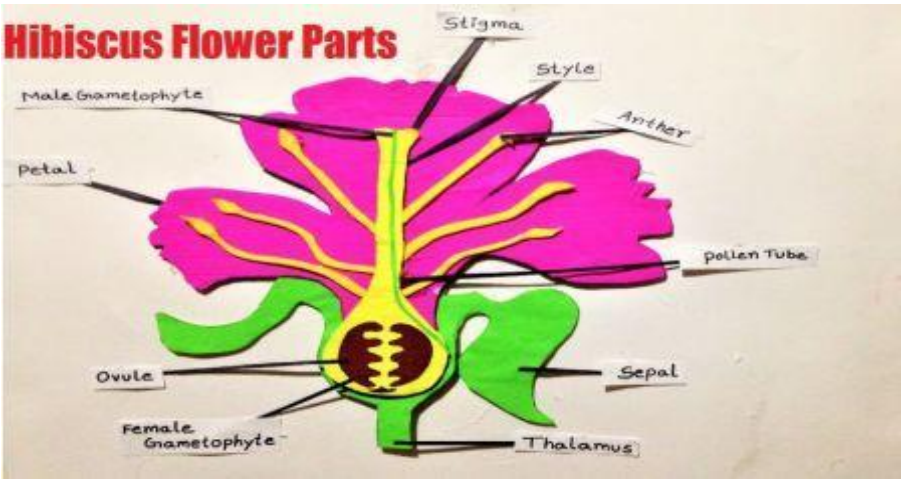


**Figure 5: A Picture of Longitudinal Section of a Hibiscus Flower**
**Source: Ekko (2006*)***

REMARKS: Evaluation was made on the lesson's objectives at the end of the lesson.

Upon collecting and marking the students' evaluative exercises, the Researcher appreciated that the students' level of confidence in biological drawing had improved as compared to their previous drawings. They also exhibited the rules for biological drawing, such as using ruler to rule out the guide lines, labelling horizontally written and smooth out lines. Additionally, the students were able to explain the types of orientation and performed a longitudinal section on the hibiscus flower. Furthermore, in the cause of the lesson, the Researcher, with the help of a laboratory technician observed the students. As the students worked on their task, they were found to be more confident in themselves and independent. The use of ICT tools (projection of video, and picture) together with real object (hibiscus flower) and questioning-answering techniques in the classroom improved the learner's performance.

**Key findings from lesson 1:**

1. Students participated fully in the lesson and made the lesson lively
2. Students level of confidence and in biological drawing had improved
3. Students were able to apply the rules in biological drawing

4. Students were able to label the parts of a flower correctly

### 3.9.2 Report on lesson 2

**TOPIC: Life processes of Butterfly**

Instructional objectives: By the end of the lesson the students should be able to:

1. Classify butterfly using the taxon giving reasons.
2. Outline three external features of adaptation of butterfly
3. Draw and label fully the dorsal view of butterfly.

A. Materials: Petri dish, preserved butterfly, forceps, gloves, projector, laptop computer, hand lenses

B. Classroom Organisation: group/ cluster arrangement. The students sat according to their respective groups

C. Relevant Previous Knowledge (RPK): Students had seen and played with the specimen.

**Activities**

Presentation: The lesson was introduced with a short exercise. The Researcher asked students to observe the specimen with the hand lens and write what they observed which lasted for about 10 minutes. The Researcher continued the lesson by helping them to classify the insect giving reasons why it belongs to the taxa. Students were asked to predict the habitat of the insect which they did correctly after several attempts. Some of their answers were forest and grasslands. The classification was: Kingdom – Animalia, Phylum-Arthropoda, Class-Insecta and Order – Lepidoptera.

Using the projector and a laptop, a short video was displayed showing the movement, feeding, and life cycle of butterfly. Students were given the opportunity to ask questions about what they watched as they video was displayed. Worksheets were

then distributed to the students to perform the next activity on the butterfly. The activities included; identifying the parts of the specimen, indicating the function for each feature identified and linking the features to how it adapts the organism to its habitat. At the close of the lesson, the Researcher went over the key point again and then projected a picture of a well label butterfly (fig. 6) and its life cycle (fig. 7) for them to see. This was done to sustain student's interest in the lesson.

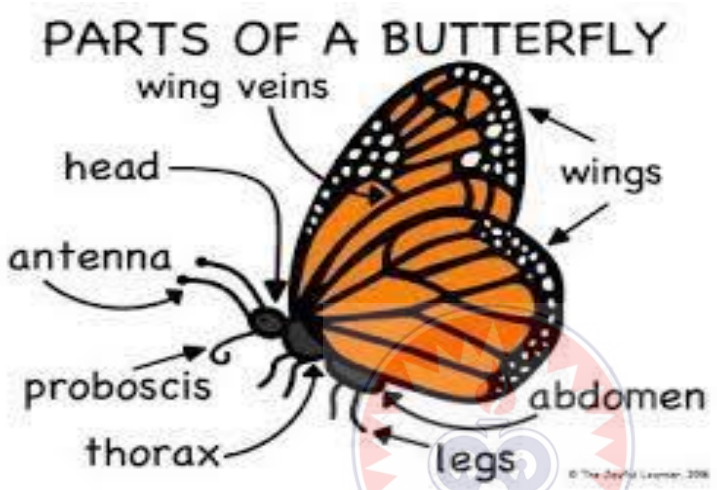


**Figure 6: A Labelled Drawing Showing the External Features of Butterfly**
**Source: (OPLER, n. d)**

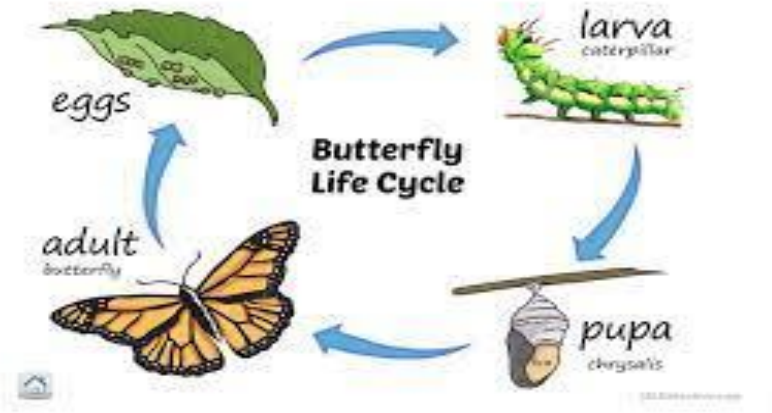


**Figure 7: A Labelled Diagram Showing The Life Cycle of a Butterfly Adopted From Opler.**

**Key findings from lesson**

1. It was noted that, about 70% of students could draw accurately.
2. Students were also able to link the features of the organism to its adaptation.
3. Students manipulative and observational skills had improved based on the questions the asked in relation to the video and real organism.

### 3.9.3 Report on lesson 3

**TOPIC: Mode of life of the common African toad (*Bufo regularis*)**

Instructional Objectives: By the end of the lesson, the students should be able to:

1. Outline two reasons why *Bufo regularis* is classified as an Amphibian.
2. Describe how toad performs movement.
3. Draw the lateral view of the toad

A. Materials: Petri dish, preserved toad, forceps, gloves, projector, laptop computer, hand lenses, hand gloves

B. Classroom organization: group/ cluster arrangement. The students sat according to their respective groups due to the limited toads available

C. Relevant previous knowledge (RPK): Students had seen and played with the specimen in their locality.

**Activities**

D. Presentation: The students were taken out on a short expedition to the school compound to have a firsthand experience of the specimen in its natural habitat. This took only 15 minutes. The students returned to the classroom to continue with the lesson. The Researcher asked the students to observe the preserved specimen with the hand lens with their gloves on and write what they observed which lasted for another

10 minutes. The Researcher led the students to identify and discuss the characteristics and the external features of the specimen using a video retrieved from the internet.

A short video was displayed showing the movement, feeding, reproduction, and life cycle of toad. The Researcher then distributed the worksheets to the students in groups of five to perform the next activities. Which requires the students to draw the lateral view of the toad. At the closure of the lesson the Researcher went over the core points again and then projected the life processes such as feeding, movement and reproduction and life cycle for the students to facilitate better understanding. Below are some pictures exhibiting some of the life processes:

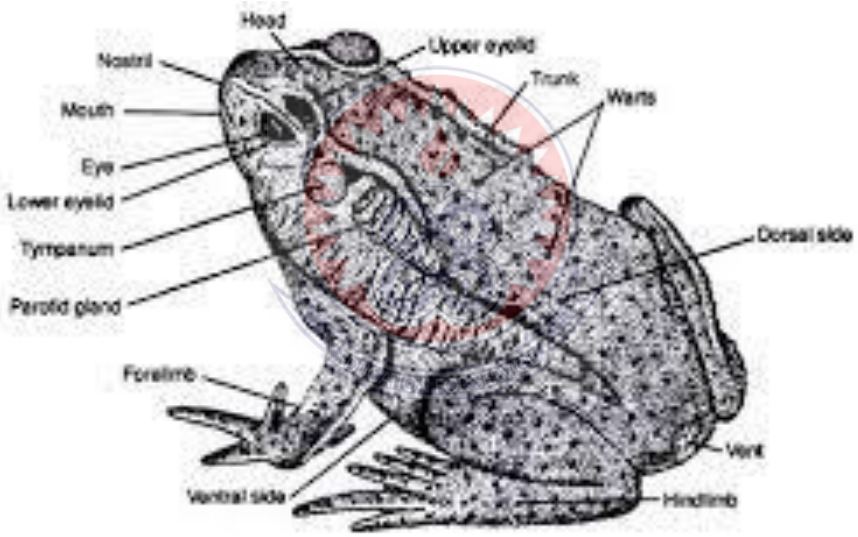


**Fig 8: Diagram of the lateral view of a toad.**

**Figure 9: Toad Performing Crawling/ Walking Movement (McGinnis, 2006)**

**Fig 10: Toad swimming in a pond (McGinnis, 2006)**

**Fig 11: Toads mating (McGinnis, 2006)**

**Figure 12: Toad eggs lay in string of jelly (McGinnis, 2006)**


**Fig 13: Stages in the Development of a Toad from Egg to Adult (McGinnis, 2006)**

Remarks: There was much improvement in this lesson compared to the previous lessons. Also in this lesson, the students sought little clarification from the Researcher. They focused and concentrated on the courseware package and other available learning material that they could find information on, to facilitate their understanding. The students practiced communication with each other and made unique contribution to the lesson. Their observational skills were also improved as they were able to state observable features of the specimen with their functions.

**Key findings from lesson 3.**

At the end of the lesson the Researcher noted that

1. Most students, about 80% sought little clarification as they worked in groups.
2. Their interest was sustained as they focused and concentrated on the learning package (video).
3. They were able to observe and analyse critically the life processes of the toad as shown in the video.

### 3.9.4 Report on Lesson 4

**TOPIC: Mitosis**

Instructional Objectives: By the end of the lesson, the student should be able to:

1. Outline the phases of mitosis
2. Describe what happens at each phase

Materials: projector, laptop, white board, video clips, worksheet, permanent slide, microscope

Relevant previous knowledge (RPK): students have experienced the repeated growing of finger nails as they trimmed them off. Also, students have learnt parts of cells (nucleus, and cell membrane) and their functions

- **Activities**

The lesson was introduced by a hook to draw students' attention on cell division. That is "You accidentally cut your finger whiles working in the kitchen. Over the next few days your finger was completely healed. New skin formed under the old damaged skin. How does that happen?" This hook gave students a real life reason to be curious about cell division. It was one of the perfect lead into learning about mitosis. Students gave different responses which were wrong except few who said "the skin of the finger was growing". The Researcher based on their answers and directed their perceptions towards cell division. PowerPoint was used to present the definition of mitosis and the importance of mitosis (fig 14 and fig 15). Two downloaded videos from YouTube were projected for students to have a fair understanding on the process of mitosis. One of the video showed a general overview of the mitotic process whiles the other showed what happened at each stage of the mitotic process. The videos were played twice where students were firstly told to watch without any interference by the

Researcher. Upon the second watch, the Researcher paused intermittently to explain each phase to the students. Students were allowed to ask questions for clarifications. The Researcher also asked few questions to receive students' responds. This was to foster teacher-students interactions. The Researcher put students into groups of five and gave them two different permanent slides of the mitotic stages. Each group was allowed to observe and draw the phases of slides observed under a compound microscope. At the closure of the lesson, the Researcher went over the key points again and projected overall picture on mitosis to students (figure 14 and 15). This was done to facilitate acquisition of inquiry skills like drawing from the microscope as they were asked to compare their diagrams to the projected. Evaluative test (Appendix D) was given at the end of the lesson, marked and discussed.

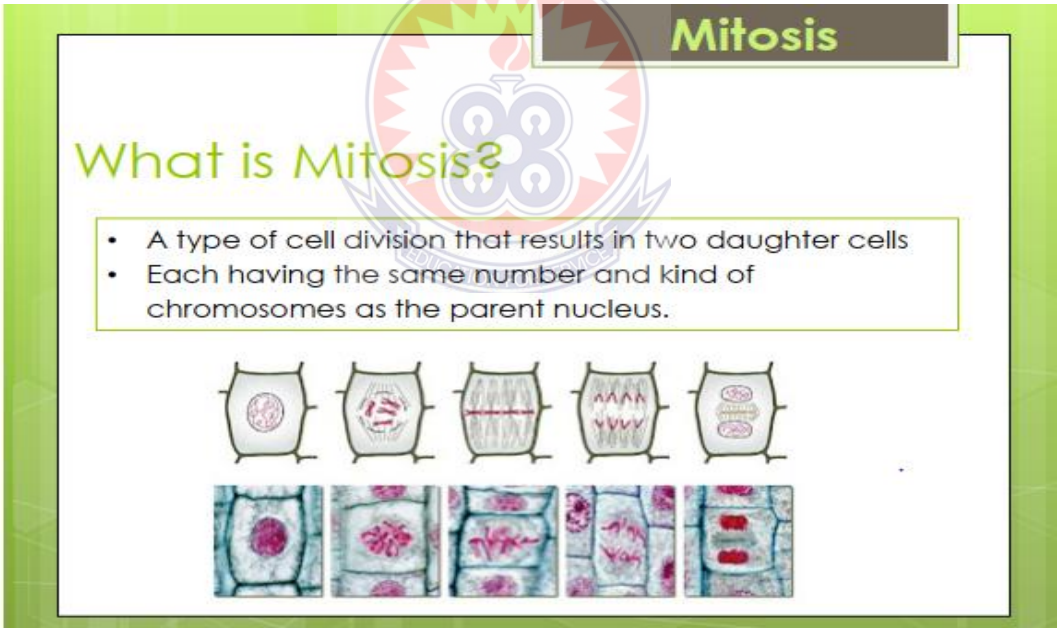


**Fig14: Meaning of mitosis**

**Source: Biology wise**


**Fig15: Functions of mitosis**

Source: Researcher

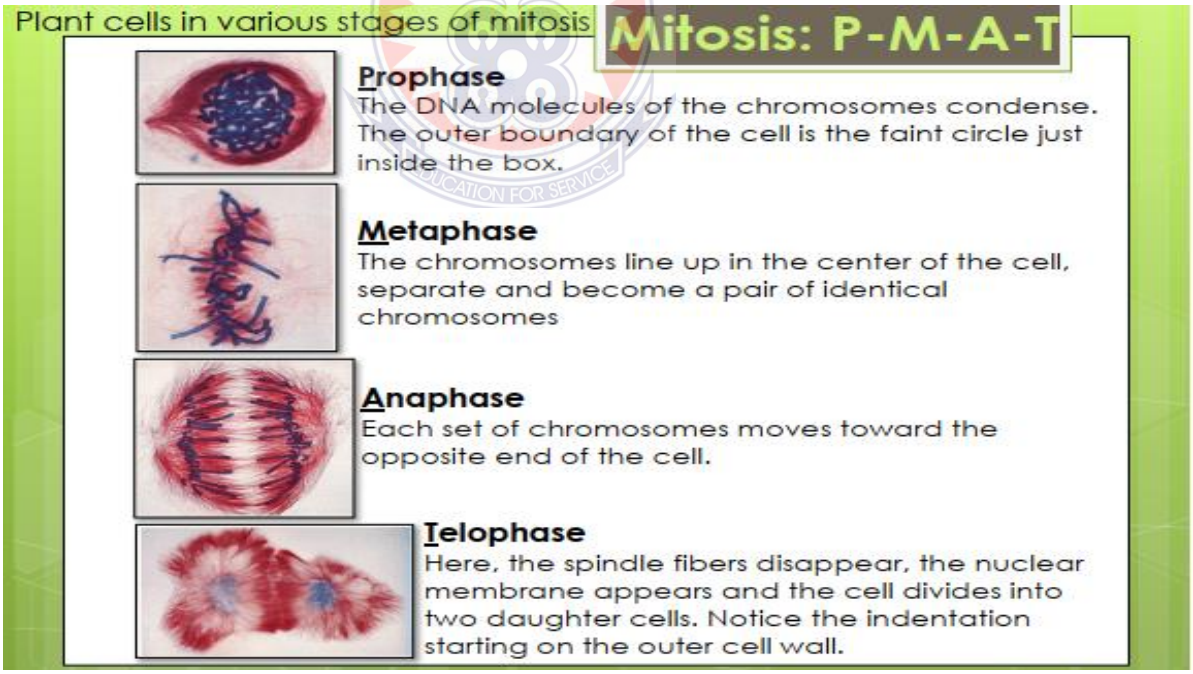


**Fig 16: Events at each phase of mitosis**

**Source: Biology Wise**

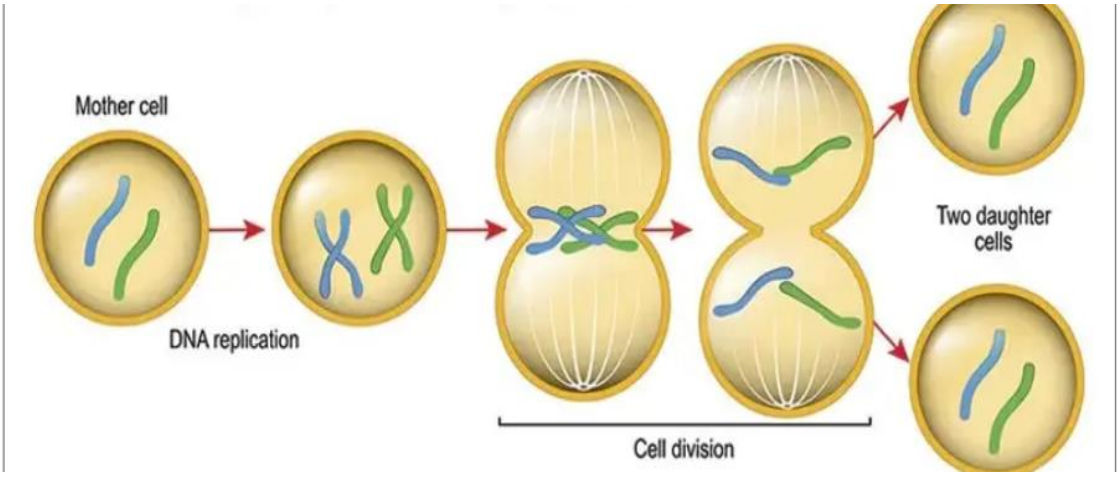


**Figure 17: The mitotic process**

**Image source: Biology Wise**

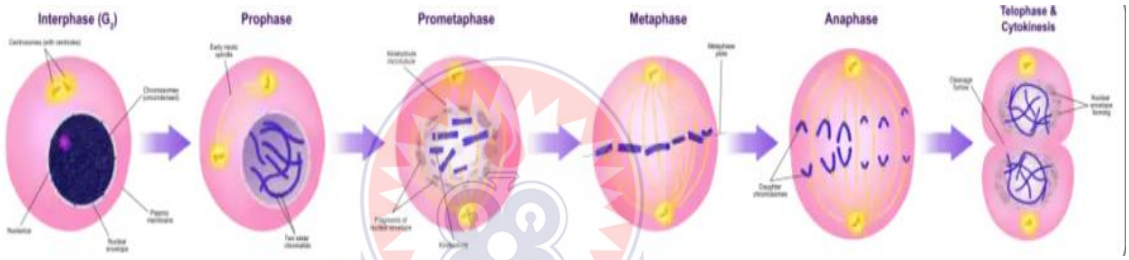


**Fig 18: The stages of mitosis**

Source: Wikipedia (Ali Zifan)

Remarks: The objectives for the lesson were achieved as students were able to define mitosis, outline the phases of mitosis and also they were able to give what happens at each phase of mitosis. There was much improvement in this lesson as the students sought little clarification from the Researcher. They focused and concentrated on the videos pictures presented. Their contributive skills were improved as they asked and answer questions correctly. Their observational skills were also improved as they were able to outline what entailed at each phase rightly. Also, students worked in groups, they tend to appreciate and collectively worked together.

**Key findings of lesson** 4:

1. Students focused and concentrated on the videos and pictures presented.
2. Students sought little clarification from the Researcher.
3. About 90% of students contributed during the questions and answer Session making the class lively.
4. Students' communicative skills improved as they worked in their groups.

### 3.9.5 Report on Lesson 5

**TOPIC: Meiosis**

Instructional objectives: By the end of the lesson, the student should be able to:

1. Define meiosis
2. Outline the phases of meiosis
3. Outline one importance of meiosis

Materials: projector, laptop, white board, videos, worksheets

Relevant previous knowledge (RPK): students have experienced the repeated growing of finger nails as they trimmed them off. Also, students have learnt about specialized cells (egg cell/ ovum, and sperm cell) and their functions.

- **Activities**

The lesson was introduced by a hook to draw students' attention on meiosis. That is "daughter cells produced by single parent have the same number of chromosomes as the parent cell in mitosis. An organism sexually produced by two parents also has the same number of chromosomes as the individual parent. How possible is it?" This hook gave students a real life reason to be curious about cell division. It was one of the perfect lead into learning about meiosis. Students gave different responses which were wrong except few who said "if the organism takes complete chromosome

number from both parents, they will end up having double chromosome numbers which will affect their physical features eg. Four hands instead of two". The researcher based on their answer and directed their understanding towards cell division. Powerpoint was used to present the definition of meiosis and the importance of mitosis (fig19 and fig 20). Two downloaded video from YouTube were projected for students to have a fair understanding on meiosis. One of the video showed a general overview of the meiosis process whiles the other showed what happened at each stage of the meiosis process. The videos were played twice where students were firstly told to watch without any interference by the Researcher. Upon the second watch, the Researcher paused intermittently to explain each phase to the students. Students were allowed to ask questions for clarifications. Few questions were asked to receive students' responds. This was to foster teacher-students interactions. Putting students into groups of five, each group was assigned to write down what happens at each stage in the meiosis. At the closure of the lesson, the Researcher went over the key points again and projected overall picture on meiosis to students (fig 17). This was done to facilitate better understanding. Evaluative test (Appendix D) was given at the end of the lesson, marked and discussed

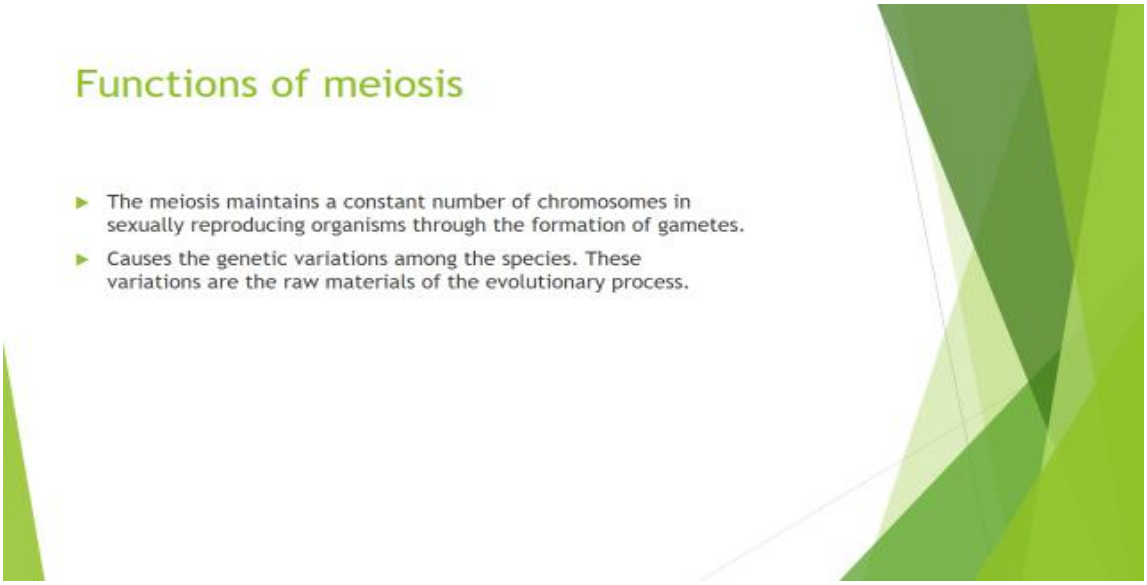


**Fig 19: functions of meiosis**

Source: Researcher

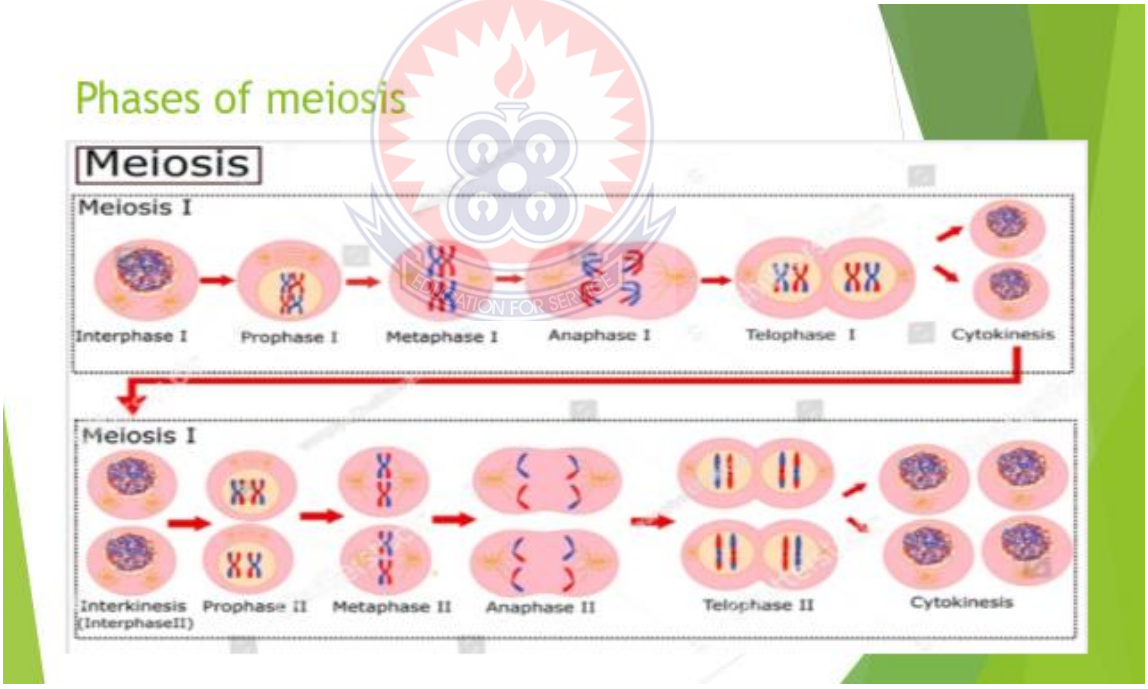


**Fig 20: Various phases of meiosis**

Source: Quizlet.com

Remarks: The objectives for the lesson were achieved as students were able to define meiosis correctly. Students were able to outline the stages of meiosis indicating what happens in each stage.

**Key findings for lesson 5:**

1. Majority of the students, about 90% could outline the stages correctly
2. Students sought little clarification from the Researcher, as the video caught their attention, aroused their interest and improved their observational skill
3. Students were able to describe with diagrams the phases of meiosis.

### 3.10 Ethical Consideration

Research ethics refers to the correct rules of conduct necessary when carrying out research. It describes the need for participants to understand the aims, objectives and potential harm that such involvement may have on them (Seidman, 2006). It also spells out that they have the right to withdraw even after consent has been given. This is consistent with Cohen et al (2000) and Mertens (2010), who stated that informed consent, arises from the participant's right to freedom. Researchers have moral responsibility to protect participants from harm. The primary responsibility for the conduct of ethical research lies with the researcher. Researchers have a responsibility to ensure as far as possible that the physical, social and psychological well-being of the research participants is not detrimentally affected by the research. Research relationships should be characterized, whenever possible, by mutual respect and trust.

In this study, the purpose of the study was carefully reviewed with each participant before they were involved in the research. Punch (2008) was of the opinion that researchers should be mindful of ethical issues especially in social research because it is concerned with data about people. Consideration for moral issues and respect for

participants is essential in social research. Hence, in this research several ethical issues were taken into consideration. The research addressed all ethical concerns which include informed consent, anonymity and confidentiality. A letter was also given to the Headmaster of the school, and the head of science department to seek their informed consent for the study. Anonymity of respondents were also highly taken into consideration in the study. Olivers (2010) pointed out that anonymity is a vital issue in research ethics because it gives the participants the opportunity to have their identity concealed. In this research, numbers were used for identification purposes which could not be traced to the participants. Codes were also adopted where necessary to ensure anonymity of information.

Neither names nor any identifiable information from respondents were taken as a way of ensuring the ethical principle of anonymity. This is to prevent possible victimization of respondents where certain responses may be viewed as unpalatable. Participants were informed that they were under no obligation to participate in the study and that their decision not to participate would bear no negative consequences. On the issue of confidentiality, efforts were made to maintain confidentiality of the responses of the participants. Participants were told that their responses would be kept confidential and that no one known to them would have access to the information provided and none of the respondents names were recorded in the study.

### 3.11 Summary

This chapter described the research methodology that the Researcher used to generate data for this study. The chapter started with the research approach and a detailed description of the study design. The target population and the study population were identified, research sample and sampling procedures used to select participants were

explained. Instrumentation, pre intervention activities and methods of data collection were also discussed. Finally, data handling and methods of analysis and ethical consideration were clearly explained.

# CHAPTER FOUR

# RESULTS, ANALYSIS AND DISCUSSIONS

## 4.0 Overview

In this chapter, the results indicating gender distribution of the target population and presentations of data pertaining to the research questions were discussed. The presentations of results was guided by the information which addressed the research questions:

1. What ICT resources are available for teaching and learning biology in St. Martins Senior High School?
2. What is the perceptions of student's on integration of ICT into teaching and learning biology?
3. What impact do ICT integration have on students' performance in biology?
4. What are the attitudes of students on the use of ICT in the teaching and learning of biology?

## 4.1 Data Analysis Procedure

Analysis is the computation of certain indices or measures along with searching for patterns of relationship that exists among the data group (Kothari, 2004). Data analysis is a process for obtaining raw data and converting it into information useful for decision making by users. Data is collected and analysed to answer questions, test hypothesis or disprove theories. According to Amoani (2005), data analysis has multiple approaches depending on the type of research design the researcher has chosen. In this study the Researcher used Action research and the data was analysed based on the progress made by the students after every lesson. The analysis of the result was based on the progress made in each lesson based on their performance.

Then the analysis was also based on the five lessons and the discussions of the findings were based on the research questions. Raw data was organized, tabulated and analyzed through statistical tool i.e., mean, frequency count and paired-sample t-test. This analysis procedure was chosen because the Researcher needed to know the effect of the intervention at every stage to plan and meet the demands of students since the research is aimed at improving the teaching and learning process in classrooms

The data analysis and presentation was done using the data collected and the research approach (concurrent triangulation design). Thus, data analysis was analysed according to whether it was quantitative or qualitative data. Finally, the findings were presented according to the research questions.

### 4.2 Gender distribution of students

The total participants involved in this study was 50 biology students. They were made up of two males (4%) and 48 females (96%). The percentage of female was more than the male due to the fact that Home Economic class was used and this was dominated by the female students. A clear picture of the distribution of gender is displayed in Table 2.

**Table 2: Gender distribution of sample**

| Gender | Frequency | Percentage (%) |
|---|---|---|
| Male | 2 | 4 |
| Female | 48 | 96 |
| **Total** | **50** | **100** |

### 4.3 Quantitative Data Analysis of students' Pre-test and Post-test Scores

This section analysed data collected using descriptive statistics (mean, percentage, frequency table) and inferential statistics (paired-sample t test).

#### 4.3.1 Analysis of Pre-test results

Table 3 represent the overall pre-test results of students prior to intervention.

**Table 3: Overall Pre-Test Results**

| Marks | Frequency (F) | Percentage (%) | Remarks |
|---|---|---|---|
| 1- 10 | 40 | 80 | Unsatisfactory |
| 11-20 | 8 | 16 | Good |
| 21-30 | 2 | 4 | Very good |
| **Total** | 50 | 100% | |

It showed that out of 50 students, as many as 42 students indicating 84% of students scored below 10 marks of the test. Eight students indicating 16% of the students scored between 10 to 15 marks whiles none of them scored above 15. This performance showed by majority was 'unsatisfactory' whiles few students performed well. Two students indicating 4% of the students were very good. The mean mark for the pre-test was 7.04. Majority of the students, 80% scored below the mean mark. This implies that only 10 students representing 20% had marks above the mean mark. The general performance of the class was below average. The greater number of students who had marks below the mean mark attested to the fact that there was the need to tackle the problem as quickly as possible through the use of appropriate intervention to remedy the situation.

### 4.3.2 Overall post-test

Table 4 represent the overall post-test results of students after the intervention. It showed that out of 50 students, two students indicating 4% of students scored 10 marks and below. Eleven students indicating 22% of the students scored between 11 to 20 marks whiles majority of the students (37 indicating 74% of the students) scored above 21. The performance showed by majority was 'very good' whiles few students performed poor (unsatisfactory). The mean mark for the posttest from the excel analysis was 24.7. From Table 4, it can be observed that 13 students representing 26% of the total number of students scored below the mean mark. Thirty- seven students representing 74% scored above the mean mark. The general performance of the class was good. The greater number of students who had marks above the mean mark attested to the fact that the topic was well understood after the intervention.

**Table 4: Post-test results**

| Marks | Frequency (F) | Percentage (%) | Remarks |
|---|---|---|---|
| 1-10 | 2 | 4 | Unsatisfactory |
| 11-20 | 11 | 22 | Good |
| 21-30 | 37 | 74 | Very good |
| **Total** | **50** | **100%** | |

### 4.3.3 Comparison between Pre-intervention and Post-intervention test results

**C**omparing the performance of students by using data collected from the pre-test and post-test results showed a tremendous improvement. Students who scored below the mean mark in the pre-test reduced drastically from 80% to 26% while those who scored above the mean mark increased from 20% to 76%. This showed how effective the intervention was, as students exhibited mastery of content. This is presented in Table 5.

**Table 5: Comparing Pretest and Post test Results**

| Test | mean | standard deviation | T Stat | p-value |
|---|---|---|---|---|
| **Pretest** | 7.04 | 4.814773 | -27.543 | 1.78E-31 |
| **Posttest** | 24.7 | 5.327058 | | |

### 4.3.4 Analysis to test Hypothesis

**Table 6: Test for Hypothesis**

| | PRE-TEST | POST-TEST |
|---|---|---|
| Mean | 7.04 | 24.7 |
| Variance | 23.18204 | 28.37755 |
| Observations | 50 | 50 |
| Pearson Correlation | 0.604402 | |
| Hypothesized Mean Difference | 0 | |
| Df | 49 | |
| t Stat | -27.543 | |
| P(T<=t) one-tail | 8.91E-32 | |
| t Critical one-tail | 1.676551 | |
| P(T<=t) two-tail | 1.78E-31 | |
| t Critical two-tail | 2.009575 | |

*If the p value is less than 0.05, p is significant (p<0.05) and null hypothesis is true, changes are not by chance. However, if the p value is greater than 0.05, p is not significant (p>0.05) and null hypothesis is false, changes are by chance.*

Results statistical analysis in Table 6, indicated a p-value of 1.78E-31(0.0178x10) which is less than 0.05 ($\alpha$=0.05, p<0.05). Also, the t statistic value (27.543) is greater than the t critical value (2.009575). This means that there is a difference between the pre-test and post test score that is not likely due to chance. The intervention was effective and students know more than they did before the intervention. Therefore, the null hypothesis that, there is no significant difference between the performances of students before and after exposure to ICT integration as an instructional approach in teaching and learning of Biology was rejected. Thus, the null hypothesis (Ho1) was rejected and the alternative hypothesis ($H_A1$) was accepted. There is significant

difference between the performances of students before and after exposure to ICT integration as an instructional approach in teaching and learning of Biology.

The mean difference between the pre-test (M=7.04) and post-test (M=24.7) deduced from Table 6 was 17.66. The comparison of the pre-test and post-test results show that there is an improvement in performance of students' scores when ICT tools were used in the teaching and learning of the selected topics in biology than when traditional methods was used in the teaching and learning of the selected topics. The ICT tools that were integrated in the teaching and learning of biology had a significant impact on learners' performance in biology when used as an enhancement with traditional method of teaching.

It can finally be concluded that integrating ICT tools in the teaching and learning of biology enhance academic performance in biology when it was used as an enhancement tool to traditional teaching-learning approach of biology.

### 4.4 What ICT resources are available in St. Martins for teaching and learning Biology?

This research question sought to find out the ICT resources available in the school for teaching and learning Biology. The study used observation guide *to* determine the ICT resources available in the school for teaching Biology. A summary of the observation is presented in Table 7.

**Table 7: Summary of ICT Resources in the School**

| ICT Resource | Quantity (Frequency) | Percentage (%) |
|---|---|---|
| Desktop computer | 9 | 56.25 |
| Projector | 1 | 6.25 |
| Printer | 1 | 6.25 |
| Television | 1 | 6.25 |
| Video players | 1 | 6.25 |
| CDs, DVDs/VCDs | 3 | 18.75 |
| **Total** | **16** | **100%** |

As shown in Table 7, available desktop computers for students were 9, on average of one computer per six students. The available computer in the schools, however, were mainly used for teaching ICT as a subject. Majority (56.25%) of ICT related materials in the Computer laboratory (ICT lab) were desktop computers, 6.25 % was projectors (LCD projectors). In addition to these, 6.25 % were printers, television and video players. However, digital content of Biology, storage of ICT resources and radios were not available in the Lab. Furthermore, Internet services were not introduced in the school, and resources like tablets, smart phones and educational games were absent in the school. There were no laptops in the school except the personal laptops for elective ICT students.

According to a study by Ishtiaq, Qaiser, Naseer ud Din and Farhan (2017), the infrastructure of the schools should be designed in such a way that ICT is available and easily accessible in order to be successfully used in teaching. Having an under-equipped ICT resource center reflect its absence since it becomes useless to be utilized.

The ease at which students access ICT is important in teaching and learning Biology. The observational findings revealed that majority of the students could not access ICT

in the school. Teachers rarely had access to the ICT resource center since the centre was always occupied by elective ICT students. From the research study of Mwanda, Midigo and Maundu (2017), they recommended that there should be increased accessibility of ICT resources like computers, adequate training on the use of ICT and development of policy framework to guide on the path to effective ICT integration into instruction process. In addition to this, availability and accessibility of the ICT determines the frequency of its use in teaching Biology.

These resources are very few and inadequate for teaching and learning of Biology. This finding was in tandem with a study conducted to assess the technological integration in teacher education conducted in Ghana that showed one of the challenges of Gahanna education system on integrating ICT was lack of technological resources (Agyei, 2013).

These findings are also in tandem with a study conducted to assess the availability and utilization of ICT for teaching and learning and to establish hindering factors for the utilization of existing ICTs in secondary schools. The research showed that most of the ICTs required for teaching and learning were not available in the school, and those that were available were obselate. The study also revealed that the available ICT resources were utilised by teachers to a very low extent (Mavellas, Wellington and Samuel, 2015). Moon (2004) indicated that computers were available for use in teaching if they were strategically located in a Biology classroom (or Biology laboratory). Therefore, for effective ICT integration, the available ICT resources should be easily accessible to the teachers and to the students for use in teaching and learning Biology.

**4.5 What is the Effectiveness of ICT integration during teaching and learning**

Through the use of observation, the researcher assessed the impact of ICT integration on other teaching methods used during the interventions.

*Lecture and Discussion Method*: This method is a combination of lecture method and discussion method. This is very helpful in building an active verbal interaction between the teachers and students. The teacher delivers the lecture and provides some time after the lecture for discussion among the students and teacher in the classroom. It is an important strategy in stimulating the students' interests and understanding of the concept. Some of the underlying principles of this method are; the teacher must arouse interest in the subject and sustain in the mind of students. The teacher must take enough time to build mental pictures, with new concepts, previous knowledge, moving from simple to difficult ideas, for better conceptual development.

The use of ICT tools in this method helped to arouse students' interest in the subject as the Researcher found it easily to disseminate information to students, and students also having the pictorial view of the concepts readily gave their contributions as needed. This made the class very interactive. For instance, students were able to identify and label the parts of an organism when projected on the screen.

*Hands-on activities method*: This method is commonly thought of as a hands on( and minds) on approach where students have the opportunity to gain some experience with phenomena associated with their course of study. In this method, either student participate alone or in small groups.

The use of ICT tools in the classroom such to project certain parts of specimen created an imprint in the minds of the students which enabled them to manipulate

various specimen that were under exploration. This experience becomes impressed more firmly on their minds. For instance, the students were able to perform the transverse and longitudinal sectioning of the fruits.

To conclude, the study showed that ICT tools had positive impact on the various teaching method as it aroused students' interest, enabled the students to grasp concepts taught and solved problems given confidently.

### 4.6 What are Students' perceptions on the use of ICT in Teaching and learning of Biology?

**Table 8: Analysis of Interview on students' perception on ICT integration**

| Item | Interview guide | Number of responds | | | |
|---|---|---|---|---|---|
| | | YES | Percentage (%) | NO | Percentage (%) |
| 1 | The use of ICT tools was an interesting experience. | 50 | 100 | 0 | 0 |
| 2 | The use of ICT tools enhances better understanding of the concepts of selected topics, than the traditional classroom presentation. | 43 | 86 | 7 | 14 |
| 3 | Use of ICT tools allows one to discuss biological concepts with others much more that the traditional approach method. | 46 | 92 | 4 | 8 |
| 4 | My level of motivation on biology has increased with the use of ICT tools. | 48 | 96 | 2 | 4 |
| 5 | The information on all the lessons on ICT tools was clear | 48 | 96 | 2 | 4 |
| 6 | The ICT tools allowed me to understand complicated concepts in biology better | 50 | 100 | 0 | 0 |
| 7 | The use of ICT offered me an ideal environment for learning and sequencing various ideas on each lesson than traditional methods | 50 | 100 | 0 | 0 |
| 8 | The use of ICT in the selected topics made me more creative | 50 | 100 | 0 | 0 |
| 9 | I have learnt more things about biology through the use of ICT than I learned using Traditional methods. | 47 | 94 | 3 | 6 |
| 10 | I would like that biology be taught with the use of ICT tool than using Traditional methods only. | 50 | 100 | 0 | 0 |
| 11 | I recommend the use of the ICT tools in the learning of the topics in Biology | 50 | 100 | 0 | 0 |

### 4.6.1 Quantitative analysis of Interview Data

From the data provided in Table 8, the results showed that 100% of the students appreciated the use of ICT tools as an interesting experience and further agreed that ICT tools increased their degree of interest in the selected topics respectively. It is undeniable that students' interest in the learning of any subject is cardinal as it helps learners to build confidence in themselves, their studies and may improve research and innovation. Besides, most learners (96 %) agreed that the use of ICT tools in the teaching and learning of selected topics has increased their levels of motivation. An increase in motivation essentially boost self-esteem and optimism. This quality is essential in keeping the learners constantly engaged in different aspect during the teaching and learning process. This situation shows that learners' use of ICT tools in the learning process is seen as something positive. ICT is the aid needed by teachers to ensure the effectiveness of both teaching and learning process. Table 4.6 also shows that the use of ICT tools in teaching and learning of the selected topic in biology enable the learners to be more active and engaging in discussions with others more than in the traditional approach learning environment. This item was supported by 92% of the students. This indicates that as learners become familiar with ICT in learning becomes easier which enabled them to be engage more in the lesson.

Furthermore, the results show that students found that ICT tools allowed them to understand complicated concepts in the selected topic and that information is clear when ICT tools are used in the teaching and learning processes as showed by the support of 96% of students.

Information Communication and Technology tools provide dynamic means that can be used to present similar information in difference way so as to reinforce comprehension in the teaching and learning of biology, thus learners are able to learn and view a concepts in biology in different modes. Other than that, learners (100%) recommended the use of ICT tools in the teaching and learning of selected topics as well as other topics in biology and established that in understanding the concepts of the selected topics, the use of ICT tools is better than the traditional approach. Based on the responds from students using the interview guide, the researcher observed that students were willing to embrace ICTs in the teaching and learning of biology.

### 4.6.2 Qualitative data analysis of students' Perceptions on the use of ICT tools in teaching and learning of biology

Thematic analysis was used to analyze qualitative data. Themes were generated from the emerging common factors obtained from the follow-up questions after students' limited responses during the interview.

**Students' knowledge of ICT tools**

**The above theme emerged from the probing question asked "***use of ICT tools allows one to discuss biological concepts with others much more than the traditional approach method."* Student's responses showed much knowledge on ICT tools and how they can be used in the teaching and learning process. Some interviewee stated: *"WhatsApp, Imo and Viber messengers can be used for discussions, submission of home works and delivering lessons to students during weekends and holidays so that we are kept active during the week or school days. These instant messengers can also act as medium through which we can be relaying information (problems) to teachers that we are finding hard to understand especially after classroom hours.*

They further stated;

> *"We have skills because we were born in the technological age, were we have been using video games, computer games, online games and much of our time is spent on surfing the internet. So we do not think that it can be difficult for us to embrace ICTs in classroom settings. Teachers need to engage us in the modern age of technology and the purported difficult of some biological concepts will be a walk-over and history in our learning."*

**Significance of ICT tools**

**This theme emerged when learners were asked "why they would recommend the use of ICT tools in the teaching and learning of biology"**

Learners believed that ICT tools are important aspects in the teaching and learning of biology.

One interviewee stated that:

> *"It was difficult to forget a concepts learnt from ICT tools because lessons on genetics were taught in different learning modalities (audio, video, practical etc.). The interviewee, further, cited that problems that involved the use of graphs could easily be taught or tackled using ICT tools such as Microsoft packages. And those that involved the study of DNA replication and other complicated concepts could be taught using video simulations. Use of ICTs helps to main high retention power and helps in academic prowess."*

Another interviewee stated that:

> *"I strongly believe that the lessons that are ICT based are more creative, interactive, engaging, and inspire us learners to learn new things every day through exposure to different ICT tools. Further, ICT tools can positively improve the learners' self-concept of the selected topics and further developed as positive attitudes towards biology."*

Another interviewee stated that:

> *"ICT tools such as computer based media interaction (Gene-X simulation software) can build the confident in research and problem solving skills in genetics for us learners'. Such Software is able to provide immediate feedback to some series of problems that learners' attempts immediately the tasks are done by a learner."*

**Information Communication and Technology tools could aid and broadens ones Knowledge**

***This theme emerged as further question was asked "why they would*** *like that biology be taught with the use of ICT tool than using Traditional methods only"*. The integration of ICT tool in the teaching and learning of genetics broadens the array of resources to using in the teaching and learning processes. Most learners' indicated that ICT tools have the potential to provide different types of resources for preparation and delivery of content to the learners within and outside the lessons. One interviewee stated that; *"they are a lot of things online that we as students have not even explored when we are learning the selected topics or any subject. The internet for example has all the facilities we can need for effective study and grasping the concepts in ranging from genetics simulation laboratories, e-text books, online consultation blogs and past papers."*

Learners felt that ICT tools used in teaching the selected topics could foster their comprehension of subtopics of other complicated topics better if it can be used as a resource tool in the teaching and learning process.

Another interviewee stated that:

> *"Genetics as a topic has a lot of subtopics, each with a different view point of focus (gene interaction, variations, heredity, DNA replication and mutations) and in order to understand these abstract subtopics better, I believe that ICTs can provide one of the best resources to explaining these concepts."*

**Information Communication Technology tools can bring realism into learning**

> ***The above theme emerged when probing question was asked "why*** *the use of ICT offered me an ideal environment for learning and sequencing various ideas on each lesson than traditional methods"*

Learners believed that it can bring realism in the teaching and learning of selected topics in biology, because of the different resources that ICT tools are able to offer.

One interviewee stated that:

> *"It is not enough to just rely on our super imagination every time we are learning genetics. Some things can be imagined and visualized well, but not all the contents of biology (eg.genetics). As such, ICT tools can be used to give picture and visualize concepts using different forms of ICT tools, for example, a normal cell can be seen deforming in to a sickle cell during the process of mutation through DNA simulations, and mutations can be demonstrated on the computers using computers software with safety and zero contamination levels"*

Another interviewee added that;

> *"…the use of ICT tools can link the imaginary unformed picture to the reality of what obtains in genetics at the genetic level (genes, cell division, DNA), unlike just conceptualizing the processes of genetics with the mind."*

Another interviewee attested that:

> *"…the use of ICT tools bring content to life, and it is really hard to forget the experience of reality outside the book. It helps us to put abstract topics into context and experiencing it as a reality topic."*

In addition, ICT tools can help to create a less intimidating environment for learning genetics for weaker learners.

One interviewee stated that:

> *"I know I am not good with imaginations, visualization and contextualizing text information. For me, as a learner, I learn and understand better concepts or things that I am able to see. It is less intimidating for me then to learn genetics with ICT tools because I am made to see almost everything that is happening. I don't need to start figuring out how the sickle cell looks like or how it is form when I can easily see the process through simulations."*

Learners showed a positive attitude toward the use of ICTs in the teaching and learning of the selected topics in biology. They believed that ICTs can make complicated topics more manageable to learn through the resources it provided

## 4.7 Discussions

### Research question 1

***What ICT resources are available for teaching and learning biology in St. Martins Senior high school?***

The first research question of the study sought to find out the ICT resources available in the schools for use in teaching Biology. The study used observation guide (Table 6) to determine the ICT resources available in the school for teaching Biology.

The Researcher observed that the ICT Resource Center was not well equipped.

The observational findings revealed that majority of the students could not access the ICT in the school. Teachers rarely have access to the ICT resource center since the center was always occupied. The observation guide revealed that nine desktop computers, one projector, one printer, one television, one video players and three CDs were available in the school with majority of the computers been non-functional. However, digital content of Biology, storage of ICT resources and radios were not available in the laboratory. Furthermore, Internet services were not introduced in the schools, and resources like tablets, smart phones and educational games were absent in the school. These resources are very few and inadequate for teaching and learning of Biology. For effective ICT integration, the available ICT should be easily accessible to the teachers and to the students for use in teaching and learning Biology.

**Research question 2**

**What effect does ICT integration have on teaching and learning?**

Through the use of observation, the Researcher identified the following impact of ICT integration on teaching methods:

The use of ICT tools in the Lecture and Discussing *Method* helped to arouse students' interest in the subject as the Researcher found it easily to disseminate information to students, and explain abstract concepts to students with ease. Also student having the pictorial view of the concepts readily gave their contributions as needed. This made the class very interactive. For instance, students were able to identify and mention the various forms of body orientation with explanation, they were also able to observe the rules and regulations in doing biological drawings. The use of ICT tools in the classroom such as large projection of certain parts of specimen created an imprint in the minds of the students which enabled them perform Hands-on activities by manipulating various specimen that are under exploration. This experience become impressed more firmly in their minds. For instance, the students were able to perform the transverse and longitudinal sectioning of the fruits. The use of ICT tools enhanced students' mastery of the content taught. For instance, watching of projected video clips created mental pictures and simulations in the students' mind which enabled them to approach problem given to them with confidence.

ICT integration in the classroom encouraged problem solving method in classroom as students apply their gained knowledge in solving given problem. To conclude, the study showed that ICT tools had positive impact on the various teaching method as it aroused students' interest, enabled the students to grasp concepts taught and solved problems given confidently.

**Research question 3**

**What impact did ICT integration have on the students' performance?**

**C**omparing the performance of students by using data collected from the pre-test and post-test results (Figure 23) showed a tremendous improvement. Students who scored below the mean mark in the pre-test reduced drastically from 80% to 26% while those who scored above the mean mark increased from 20% to 76%. The mean difference between the pre-test (M=7.04) and post-test (M=24.7) deduced from Table 5 was 17.66. Furthermore, statistical analysis from Table 5 also revealed a p-value of 1.78E-31 which was less than 0.05 ($\alpha$=0.05, $p<0.05$).

Also, the t statistic value (27.543) was greater than the t critical value (2.009575). This means that there is a difference between the pre-test and post test score that is not likely due to chance. Thus, the null hypothesis (Ho1) was reject and the alternative hypothesis ($H_A1$) was accepted. There is significant difference between the performances of students before and after exposure to ICT integrated as an instructional approach in teaching and learning of Biology. This showed how effective the intervention (ICT tools) was, as students exhibited mastery of content. The ICT tools that were integrated in the teaching and learning of biology had a significant impact on learners' performance in biology when used as an enhancement with traditional method of teaching.

The results collaborated with Kaulu (2008) findings which revealed that the use of computer based instructions enhance performance when used as a supplement in the teaching and learning process. The study revealed that physics classroom computer software enhanced the performance of students in kinematics in school physics more than when traditional approaches were used in the teaching and learning process. The

study further revealed that the experimental group performed higher than the control group with the percentage difference of 10.5%. The findings are supported by Ghavifekr (2015) who asserted that performance and improved cognition in academics by students have shown to increase when ICT is integrated in the teaching and learning processes. The current study correlates with Behlol (2009) who found a significant difference between the mean scores of experimental and control groups on posttest, concluding that the achievement of experimental group, was significantly appreciable than control group.

Wakhaya (2010) carried out a study on the effectiveness of ICT approach on students' 8th grade achievement in mathematics in Palestine schools. He examined an experimental group of 48 students after studying a course that integrated the use of ICT in instruction. The students' achievement was examined before and after the experiment. The results indicated that there was an increase in the mean scores by a gain value of 8.94 after the ICT intervention. There was a significant difference in achievement at $p = 0.05$ level between the mean scores of the pre-test and post-test.

Accordingly, performance and improved cognition in academics by pupils have shown to increase when ICT is integrated in the teaching and learning processes (Ghavifekr, Afshari, & Amla, 2012). This, therefore, demonstrates that integrating specific ICT tools as enhancement to traditional teaching and learning approach can address the challenges of students' poor performance in biology. It can finally be concluded that integrating ICT tools in the teaching and learning of biology enhance academic performance in biology when it was used as an enhancement tool to traditional teaching-learning approach of biology.

**Research question 4**

**What were the attitudes of students during the use of ICT in the teaching and learning of biology?**

Results from the quantitative analyses displayed in Table 7, revealed that students' showed positive attitudes towards the integration of ICT in the teaching and learning process. Students indicated that ICT integration in the teaching and learning process as an interesting experience and further agreed that ICT tools increased their degree of interest in the selected topics. The results are in line with the research findings by Macho (2005) that revealed that students learn more effectively with the use of ICT as the lesson that designed are more engaging and interesting. Macho (2005) further argued that using ICT in education would enhance students' learning and that ICTs fosters learning among students. It has increased their levels of motivation and enabled them to be more active and engaged in discussions.

According to Pelgrum, (2001) motivated pupils are more successful in mastering the teaching contents because they are active during classes, they question, follow experiments, research, use modern ICT toolSs and are involved in different project activities. The results also revealed that students held ICT tools as advanced organizers which allowed them to understand complicated concepts. The study by Zhang (2013) further argued that ICT helps students to be more creative and imaginative as their knowledge paradigm expand; and ICT helps students to possess all four skills in learning when they are able to acquire necessary information and knowledge. Students also recommended the use of ICT tools in the teaching and learning of selected topics as well as other topics in biology. Based on the responds from students using the interview guide, the researcher observed that students were willing to embrace ICTs in the teaching and learning of biology.

Also, qualitative analysis of responses obtained from the follow up questions thematically emerged that students have knowledge in using some of the ICT tools and would like teachers to allow them to use them for educational purposes especially during weekends and holidays. They also seemed to be children of technology and would not find it difficult to learn with ICT tools. Students also recommended that ICT tools should be used in teaching and learning because it helped them remember concepts taught without forgetting them, makes them more creative and inspires them to learn more. ICT tools integration has helped to broaden their learning resources as it empowers them to do more research online to fish for vital information to improve upon their learning. Lastly, students believed ICT tools can bring realism into learning as ICT tools can be used to give clear picture and visualized concept.

# CHAPTER FIVE

# SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 5.0 Overview

In this chapter, the Researcher presents the summary of the research findings, conclusions from the main research findings which answered the research questions, and finally recommendations. Integration of ICT in education is one of the areas that requires the attention of every scholar who aspires for quality implementation of biology syllabus in the teaching and learning processes in school. It is important to note that the study examined the integration of ICT in the teaching and learning of selected topics in biology in St. Martins Senior High School in the Adoagyiri-Nsawam Municipality with key emphasis on the ICT resources available in the school for teaching biology, how ICT is used to teach biology with a number of teaching methods establish, the impact of ICTs on students' performance in the selected topics, the attitudes of students and teachers on the use of ICT in the teaching and learning process. The Researcher in the sub-sections below presents the summary of findings, conclusions and finally some recommendations.

## 5.1 Summary of the Findings

The research study sought to investigate the influence of integration of ICT in teaching Biology on students' performance in St. Martins Senior High School in the Adoagyiri-Nsawam Municipality, Ghana. The chosen sample for the study were Form 2 Home Economics students. Biology Performance Test (BPT), Biology Achievement Test (BAT)), class observation checklists and interview schedules were instruments used in data collection to increase reliability. The summary presented here was based

on the findings of the study and it was done as per the research questions that guided the study.

**Availability of ICT Resources in St. Martins for Teaching and Learning**

The first research question for the study sought to find out the ICT resources available in the school for teaching Biology. The findings revealed through observation that, there were some ICT resources that could be used by teachers in teaching Biology. The study found that the school had computers, computer laboratory, projectors, Televisions, video players, storage hard discs, and printers. Internet services had not yet been introduced in the school and power supply was not regular in the school. The resources in the schools were inadequate to be used for teaching and learning Biology. The available resources were used mainly for teaching ICT as a subject. Biology teachers never used them in their classroom lessons.

**The use of ICT integration in teaching biology with a number of teaching methods**

The second research question for the study sought to blend ICT in teaching biology with another teaching methods. The findings revealed through observation that, ICT had positive influence on students' performance when collaborated with another teaching method which include lecture and discussion method, Hands-on activities, Problem solving method, and many more as students tend to appreciate and master concepts taught easily and also enjoyed the lesson.

**Students' performance in biology after they have been taught with ICT tools**

The third research question of the study sought to determine students' performance in biology after they have been taught using ICT tools. The study established that students performed better in the selected topics when ICT tools were used as an

enhancement to traditional teaching and learning method. The comparison of the performance of students by using data collected from the pre-test and post-test results showed a tremendous improvement. Students who scored below the mean mark in the pre-test reduced drastically from 80% to 26% while those who scored above the mean mark increased from 20% to 76%. Also, statistical analysis from Table 5, also revealed a p-value of 1.78E-31 which was less than 0.05 ($\alpha$=0.05, $p<0.05$). Also, the t statistic value (27.543) was greater than the t critical value (2.009575). This means that there is a difference between the pre-test and post test score that is not likely due to chance but could be attributed to the intervention (ICT tools) introduced.

**The attitudes of students on the use of ICT in the teaching and learning of biology**

The fourth research question sought to determine the attitudes of students on the use of ICT in the teaching and learning of biology. The study established that students showed a higher degree of ICT knowledge and skills. Also, students held a positive attitude that ICT provided an ideal environment for discussing, sequencing, and explaining abstract concepts of the selected topics of biology better than traditional teaching and learning methods. They believed that different ICT tools could be used in the teaching and learning of biology to bring context to life far much better than when using traditional teaching-learning methods. And as such, students purported that ICT provided good experiences for teaching and learning of biology because of the ICT potential to offer variety of teaching and learning resources. Furthermore, students contended that ICT increased their motivation, interest, creativity and confidence in the learning of the selected topics. They also highlighted that ICTs can be excellent pedagogical tool because of multiple facilities they are able to provide better than traditional teaching-learning methods in the teaching and learning of

biology. This meant that the abstractness of biological concepts could be taught and learned in different multimodalities (visual, text, audio, audio-visual, games and simulations).

### 5.2 Conclusions

There are a number of ICT tools available in the school which could be used in the teaching and learning of biological topics to enhance students' performance in both theory and practical. ICT integration had positive influence on students' academic performance when collaborated with a number of teaching method. Students performed better in the selected topics when ICT tools were used as an enhancement to traditional teaching and learning method. ICT tools were resourceful tools that made students to develop the positive attitude of being more creative, motivated and also improved the teaching and learning of biology through the change in their attitudes towards the selected topics in biology taught. Other factors such as students' skills and knowledge of ICTs, and ICT infrastructure affected students' attitudes towards ICT use in the teaching and learning of biology. Nevertheless, the successful implementation of ICT (educational technologies) in teaching depends largely on teachers, who eventually determine how they are used in the classroom activities. It can be concluded that ICT tools improves students' performance in biology when they are used as enhancement to traditional teaching and learning methods.

### 5.3 Recommendations

The following recommendations were made based on the findings of the study;

1. School Management, Parent Teacher Association (PTA) and old students body (SMOSA) should furnish the ICT laboratory with the needed tools. This would help the implementation of ICT into the teaching and learning processes.

2. Teachers should blend or incorporate the use of ICT with other teaching and learning methods to sustain the learners' interest.
3. Teachers need to be sensitized on the role of ICT integration for effective teaching of abstract biological concepts.
4. Students should be encouraged to use the available ICT tools in the school for research.

### 5.4 Suggestions for Further Research

From the findings and conclusions, the following were suggested for further studies.

1. This study was limited in one school; therefore, a similar study should be conducted on the integration of ICT in teaching and learning in other schools in Ghana, so that comparison can be made.
2. A study should be conducted to explore ICT integration in classrooms and other science subjects since this study focused only on the integration of ICT in teaching and learning of Biology.
3. A study should be conducted to examine student's use of phones in school.

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# APPENDICES

## APPENDIX 'A'

## BIOLOGY PERFORMANCE TEST (BPT)

### MEIOSIS

1. How many daughter cells are produced at the end of Meiosis 2?
2. When does crossing over occur?
3. When does DNA replication take place?
4. Where does chromosomes line up during Meiosis 2?
5. What happens at the end of Telophase 1?

Answers

1. Four daughter cells
2. Prophase 1
3. Interphase
4. The cell's equator
5. Cytoplasm divides and 2 daughter cells are formed

### MITOSIS

1. Which phase of mitosis do spindle fibers formed?
2. The condensed genetic material is called?
3. What structure guides the movement of chromosomes?
4. During which phase does the number of chromosomes briefly double?
5. What is the final phase of mitosis?

### ANSWERS

1. Prophase
2. Chromatids
3. Spindle fiber
4. Anaphase

5. Telophase

**BODY SYMMETRY ORIENTATION AND BIOLOGICAL DRAWING**

1. What type of body symmetry can be found in spherical organisms?
2. What are the 2 types of body symmetry?
3. Name two organisms that have bilateral symmetry?
4. Biological drawings should have guidelines with arrowheads? TRUE/FALSE
5. Biological drawings should be shaded to make it nice and clear. True/False

**ANSWER**

1. Radial Symmetry
2. Radial Symmetry and Bilateral Symmetry
3. Human being, goat, bird etc.
4. False
5. False

**TOAD**

1. Toads belongs to class?
2. The skin of the toad is rough, moist and warty? True or false
3. What is the scientific name for the common African toad?
4. The shortness of the forelimbs is an adaptation to
5. Toads stays mostly?

**ANSWERS**

1. Amphibia
2. True
3. Bufo regularis
4. Shock absorption during landing
5. on land

**TILAPIA**

1. What is the shape of Tilapia?
2. What is the habitat of tilapia?
3. How does Tilapia excrete waste products from its body?
4. Name the types of fins in tilapia?
5. What is the use of air bladder of a Tilapia?

**ANSWERS**

1. Streamlined
2. Fresh water
3. Ammonia
4. Paired and unpaired fins
5. for buoyancy

**GRASSHOPPER**

1. What is the function of the hard exoskeleton of a grasshopper?
2. What is the name of the largest thorax?
3. What structure in the grasshopper is sensitive to sound vibration?
4. How does the Grasshopper escape predators?
5. Grasshopper belongs order?

**ANSWERS**

1. To protect sensitive internal organs
2. Prothorax
3. Tympanum or antennae
4. By using their powerful hind legs which allow them to leap vigrously
5. Orthoptera

# APPENDIX 'B'

## BIOLOGY ACHIEVEMENT TEST (BAT)

### TILAPIA

1. What is the shape of Tilapia?
2. What is the habitat of tilapia?
3. How does Tilapia excrete waste products from its body?
4. Name the types of fins in tilapia?
5. What is the use of air bladder of a Tilapia?

### ANSWERS

1. Streamlined
2. Fresh water
3. Ammonia
4. Paired and unpaired fins
5. for buoyancy

### BODY SYMMETRY ORIENTATION AND BIOLOGICAL DRAWING

1. What type of body symmetry can be found in spherical organisms?
2. What are the 2 types of body symmetry?
3. Name two organisms that have bilateral symmetry?
4. Biological drawings should have guidelines with arrowheads? TRUE/FALSE
5. Biological drawings should be shaded to make it nice and clear. True/False

### ANSWER

1. Radial Symmetry
2. Radial Symmetry and Bilateral Symmetry
3. Human being, goat, bird etc.
4. False
5. False

**GRASSHOPPER**

1. What is the function of the hard exoskeleton of a grasshopper?
2. What is the name of the largest thorax?
3. What structure in the grasshopper is sensitive to sound vibration?
4. How does the Grasshopper escape predators?
5. Grasshopper belongs order?

**ANSWERS**

1. To protect sensitive internal organs
2. Prothorax
3. Tympanum or antennae
4. By using their powerful hind legs which allow them to leap vigorously
5. Orthoptera

**Meiosis**

1. Meiosis occurs in …….. Cells.
2. Chiasma is formed during which stage?
3. When does DNA replication take place?
4. Where does chromosomes line up during Meiosis 2?
5. What happens at the end of Telophase 1?

**ANSWERS**

1. Sex cells.
2. Prophase.
3. Interphase.
4. The cell's equator.
5. Cytoplasm divides and 2 daughter cells are formed.

**TOAD**

1. Toads belongs to class?
2. The skin of the toad is rough, moist and warty? True or false
3. What is the scientific name for the common African toad?
4. The shortness of the forelimbs is an adaptation to

5. Toads stays mostly?

**ANSWERS**

1. Amphibia
2. True
3. Bufo regularis
4. Shock absorption during landing
5. on land

**Mitosis**

1. Mitosis occurs in ……. Cells
2. Name the two major phases
3. Mitosis leads to the production of how many daughter cells
4. The longest phase is
5. Occurs in both plants and animals

**Answers**

1. Somatic or body cells
2. Karyokinesis and cytokinesis
3. 2 cells
4. Prophase
5. True

# APPENDIX 'C'

## OBSERVATION GUIDE

| ICT Resource | Quantity (Frequency) | Percentage (%) |
|---|---|---|
| Desktop computer | 9 | 56.25 |
| Laptop | 0 | 0 |
| Projector | 1 | 6.25 |
| Printer | 1 | 6.25 |
| Photocopier | 0 | 0 |
| Radios | 0 | 0 |
| Television | 1 | 6.25 |
| Video players | 1 | 6.25 |
| CDs, DVDs/VCDs | 3 | 18.75 |
| Total | 16 | 100% |

# APPENDIX 'D'

## EVALUATION TEST

TEST 1
Biological drawing
1. Body symmetry will produce …… distribution of repeated body parts
2. Bilateral symmetry is also referred to as ……
3. The side view of on organism or organ is termed as …….
4. Biological drawings must be labelled. True or False
5. A worksheet enabling students to draw the longitudinal section of an orange

TEST 2
Life processes of butterfly
1. The larvae of the butterfly is known as …….
2. The life cycle of butterfly is an example of ……
3. Which structure on the caterpillar is used for defense?
4. The pupa of the butterfly is known as ……
5. The mouthpart of the butterfly is modified into…….

TEST 3
Life processes of toad
1. The webbed digits of the hind limbs of a toad is an adaptation for ……
2. The structure responsible for gaseous exchange in the tadpole is ……
3. The tongue of the toad is described as long and ……..
4. The life cycle of the toad is an example of …….
5. The fluid secreting membrane beside the lower eye lid is known as …….

TEST 4
MITOSIS
1. What moves the chromatids during mitosis?
2. What is the correct sequence of the process of cell division?
3. If a human cell has 46 chromosomes, how many chromosomes will be in each daughter cell after mitosis?
4 .the nuclear membrane dissolves at which phase?
5. The process has two major phases, karyokinesis and …….

TEST 5
Meiosis
1. Crossing over occurs during which stage……
2. The stage when the cell is not dividing in the cell cycle is known as……..
3. During meiosis daughter cells have …… number of chromosomes
4. Healing of wounds is made possible by ……..
5. Separation of sister chromatids occurs in ……

# APPENDIX 'E'

## MARKING SHEMES

ANSWERS TO BAT
ANSWERS TO EVALUATION TESTS
TEST 1
1. Equal or balanced
2. Zygomorphic
3. Lateral view
4. True
5. Diagram of a named fruit (orange)

TEST 2
1. Caterpillar
2. Complete metamorphosis
3. osmaterium
4. Chrysalis
5. Proboscis

TEST 3
1. Swimming
2. Gills
3. Sticky
4. Complete metamorphosis
5. Nictitating membrane

TEST 4
1. Spindle fibers
2. Prophase _metaphase_anaphase_telophase
3. 46 chromosomes
4. Prophase
5. Cytokinesis

TEST 5
1. Prophase 1
2. Interphase
3. Haploid
4. Mitosis
5. Anaphase

# APPENDIX 'F'

## ANALYSIS FROM EXCELL

| STUDENT ID | PRE-TEST | POST-TEST |
|---|---|---|
| 1 | 23 | 30 |
| 2 | 23 | 30 |
| 3 | 19 | 30 |
| 4 | 15 | 30 |
| 5 | 14 | 30 |
| 6 | 14 | 30 |
| 7 | 13 | 30 |
| 8 | 11 | 29 |
| 9 | 11 | 29 |
| 10 | 11 | 29 |
| 11 | 7 | 29 |
| 12 | 7 | 29 |
| 13 | 7 | 29 |
| 14 | 7 | 29 |
| 15 | 7 | 28 |
| 16 | 7 | 28 |
| 17 | 7 | 28 |
| 18 | 6 | 25 |
| 19 | 6 | 28 |
| 20 | 6 | 27 |
| 21 | 6 | 27 |
| 22 | 6 | 27 |
| 23 | 5 | 27 |
| 24 | 5 | 26 |
| 25 | 5 | 26 |
| 26 | 5 | 26 |
| 27 | 5 | 26 |
| 28 | 5 | 25 |
| 29 | 5 | 26 |
| 30 | 5 | 26 |
| 31 | 5 | 23 |
| 32 | 5 | 25 |
| 33 | 5 | 26 |
| 34 | 5 | 26 |
| 35 | 5 | 26 |
| 36 | 4 | 28 |
| 37 | 4 | 24 |
| 38 | 4 | 20 |
| 39 | 4 | 19 |
| 40 | 4 | 19 |
| 41 | 4 | 19 |
| 42 | 4 | 18 |
| 43 | 4 | 18 |
| 44 | 4 | 18 |

| | | |
|---|---|---|
| 45 | 3 | 18 |
| 46 | 3 | 17 |
| 47 | 3 | 17 |
| 48 | 3 | 17 |
| 49 | 3 | 9 |
| 50 | 3 | 9 |

t-Test: Paired Two Sample for Means

| | *PRE-TEST* | *POST-TEST* |
|---|---|---|
| Mean | 7.04 | 24.7 |
| Variance | 23.18204 | 28.37755 |
| Observations | 50 | 50 |
| Pearson Correlation | 0.604402 | |
| Hypothesized Mean Difference | 0 | |
| Df | 49 | |
| t Stat | -27.543 | |
| P(T<=t) one-tail | 8.91E-32 | |
| t Critical one-tail | 1.676551 | |
| P(T<=t) two-tail | 1.78E-31 | |
| t Critical two-tail | 2.009575 | |

# APPENDIX 'G'

## ITERVIEW SCHEDULE FOR STUDENTS

| ITEM | INTERVIEW GUIDE | NUMBER OF RESPONDS | | | |
|---|---|---|---|---|---|
| | | YES | Percentage (%) | NO | Percentage (%) |
| 1 | The use of ICT tools was an interesting experience. | 50 | 100 | 0 | 0 |
| 2 | The use of ICT tools is better in understanding the concepts of selected topics, than the traditional classroom presentation. | 43 | 86 | 7 | 14 |
| 3 | Use of ICT tools allows one to discuss biological concepts with others much more that the traditional approach method. | 46 | 92 | 4 | 8 |
| 4 | My level of motivation on biology has increased with the use of ICT tools. | 48 | 96 | 2 | 4 |
| 5 | The information on all the lessons on ICT tools was clear | 48 | 96 | 2 | 4 |
| 6 | The ICT tools allowed me to understand complicated concepts in biology better | 50 | 100 | 0 | 0 |
| 7 | The use of ICT offered me an ideal environment for learning and sequencing various ideas on each lesson than traditional methods | 50 | 100 | 0 | 0 |
| 8 | The use of ICT in the selected topics made me more creative | 50 | 100 | 0 | 0 |
| 9 | I have learnt more things about biology through the use of ICT than I learned using Traditional methods. | 47 | 94 | 3 | 6 |
| 10 | I would like that biology be taught with the use of ICT tool than using Traditional methods only. | 50 | 100 | 0 | 0 |
| 11 | I recommend the use of the ICT tools in the learning of the topics in Biology | 50 | 100 | 0 | 0 |

# APPENDIX "H"

## LESSON PLAN FOR COMMON AFRICAN TOAD

| DAY AND DURATION | TOPIC/ SUBTOPIC | OBJECTIVES | CORE POINTS | TEACHING/ LEARNING MATERIALS AND TEACHER/LEARNER ACTIVITIES | EVALUATION ON EXERCISE |
|---|---|---|---|---|---|
| Monday 9:50-11:20am<br><br>Tuesday 11:50-1:20pm<br><br>Thursday 10:30- 11: 30am<br><br>Friday<br><br>2 :00<br>3. 30 | TOPIC<br>Toad/Frog<br><br>Sub-Topic<br>Structure and function<br>Structure and function<br><br>Life processes | By the end of the lessons the student will be able to:<br>Mention six external features of toad or frog and function.<br><br>State three adaptations of toad/frog to its habitat.<br><br>Describe the life processes of toad/frog. (Locomotion reproduction and Nutrition) | External features:<br>The body of the toad is divided into the head and trunk without neck<br><br>On the head are:<br>A pair of bulging eyes<br>A pair of nostrils<br>Wide terminal Mouth<br>Tympanum<br><br>On the trunk are:<br>Two (2) pairs of limbs<br><br>Adaptations:<br>Moist and highly vascularized skin for respiration<br>Short stout forelimbs for absorbing shock during landing when hopping.<br>Webbed hind digit that push against water during swimming<br>Life processes of toad and frog | Preserved toad, chart, laptop,<br>Projector and chalk board illustrations<br><br>ACTIVITY<br>Examine and discuss the external features of toad/frog<br><br>Draw and label the toad to show external features<br><br>Discuss some of the life processes of toad<br><br>Show a short video on the life processes of toad | 1. Mention six external features of toad/frog and their functions<br><br>their<br>2. Draw and label the lateral view of toad. |