UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENT OF SCIENCE EDUCATION

THE IMPACT OF INTEGRATING INFORMATION AND COMMUNICATION TECHNOLOGY INTO THE TEACHING AND LEARNING OF BIOLOGY IN GHANAIAN SENIOR HIGH SCHOOLS

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A Thesis in the Department of SCIENCE EDUCATION, Faculty of SCIENCE EDUCATION submitted to the School of Graduate Studies, University of Education, Winneba, in partial fulfillment of the requirements for award of the MASTER OF PHILOSOPHY (SCIENCE EDUCATION) Degree.

NOVEMBER, 2015

DECLARATION

Candidate's Declaration

I, ENTSIE GRACE, 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.

Candidate's Signature : **……..……**

Date : **……..……**

Supervisors' Declaration

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

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(Co-supervisor)

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DEDICATION

This work is dedicated to my Mum, Husband and my Lovely boys (Angus Ohene and Jaxon Ohene).

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ABSTRACT

The study investigated the impact of integrating ICT on the teaching and learning of Biology in a Ghanaian Senior High School. The research was quasi experimental involving a post-test only non-equivalent control group design. The population of the study comprised all the Biology teachers and all Biology students in PRESEC, Osu. A purposive sampling method was used to select five (5) Biology teachers and ninety eight (98) SHS 3 Biology students. The instruments used for the collection of data were tests for the students (i.e. Students Knowledge of Glycolysis Test (SKGT) – pre-test and Students Achievement in Glycolysis Test (SAGT) – post-test) and questionnaire for the teachers. The students' post-test scores and the teachers' questionnaires were subjected to statistical analysis using independent-measures *t*-test and descriptive statistics. The findings revealed that the extent to which the PRESEC, Osu Biology teacher used technology in teaching and learning Biology was very low. The students exposed to the ICT integration instructional approach performed significantly better than their counterparts exposed to the traditional instructional approach. Furthermore, gender had no influence on performances of students after exposure to the ICT instruction. Based on the findings of the study, it is recommended, among others, that innovative and more effective learner-centred instructional strategies, such as ICT integration instructional activities, should be used by Biology teachers to promote meaningful learning of difficult concepts.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter is the introductory section of the research which presents the general background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, hypothesis, and significance of the study and the delimitations of the study.

1.1 Background of the study

The rapid global technological advancement and economic development place a great investment into education. Nowadays, with the expansion of knowledge, advancement of technology as well as globalization issues, the profession 'teaching' becomes a central figure and most challenging, for it requires new planning and technological adaptation to cope with cultural dynamism. Teachers are implementers, and thus need to learn and apply new technologies into their classroom instructions. Research has shown that using Information and Communication Technology (ICT) in education compared to traditional methods is much more effective for teaching and learning process (Hartley, 2007). Research has shown that some teachers use ICT in teaching environment to increase their students' achievements (Brush & Hew, 2007).

Effective ICT integration requires strong technological pedagogical and content-based knowledge (Mishra & Koehler, 2006). Integrating ICT into education is described as fusion of technological resources with daily work and programme and school management. It should be very effective and continuous to enhance schools target and mission (Lawless & Pelligrino, 2007).The use of technology in education is one of the

main challenges for education policy makers (Zalzadeh, 2006). Traditional methods of education are no longer able to meet the needs of today's learners.

The curriculum in the Ghana educational system has been structured in a way that students who are not even taking science as their major field of study are exposed to either basic scientific or technological literacy. In the Senior High School (SHS), science and technology is fused with Integrated Science, while ICT is also taken as a course on its own. It is therefore tangible that the Ministry of Education has also played a role to ensure every school- going Ghanaian child acquires the basic scientific and technological literacy through the formal way. The idea of integrating ICT into teaching and learning (Integration literacy) is another attempt by the Ministry of Education to ensure that teachers also take the mantle and adjust themselves to the technological age.

According to the Ministry of Education, Youth and sports (MOEYS) and Ghana Education Service (2002), integrating ICT in classroom instruction ensures greater motivation, increase self-esteem and confidence, enhances good questioning skills, promotes initiative and independent learning, improves presentation of information or outputs, develops problem solving capabilities, promotes better information handling skills, increasing focus time on task, and improves social and communication skills.

In spite of the attempts made by various world leaders in their countries (e.g. Canada, Mexico, Botswana, Egypt and Pakistan.) to curb the high illiteracy rate of scientific technological issues, research results have indicated that the level of improvement in students understanding of science concepts has shown significant progress. There is a proof that students perform poorly in the sciences (in which Biology is part) than other subjects (Chrisomalis, 2009). Angelo (1991) has found out that in most science

classes, the instructor spends more than 90% of the class time lecturing and reviewing factual content. According to Angelo (1991), some theorists have postulated that students' misconceptions continue to occur even into adulthood, because instructors have not developed the content knowledge or pedagogical skills to stimulate students' lifelong learning. Instead, students have resorted to memorisation of facts for short-term use, without any regard to connection to other disciplines, daily life events, or future use.

The usage of ICT into classroom instruction is a more practical, interactive and innovative aspect rather than theoretical. In effect, the impact of ICT on education is one of the most critical issues (Webber, 2003). It is a powerful instrument that enables practical environment and assists new ways of teaching and learning, and helps students to develop knowledge and skills for cooperation, communication and problem- solving. In view of the positive impact of ICT integration in teaching and learning, the new educational reforms in Ghana which was launched in September, 2007, placed high emphasis on the integration of ICT in all subject areas.

The innovative use of ICT can promote student-centred learning (Drent, 2005). Hence, teachers need to use ICT to enhance student learning, for it helps students to engage in problem- solving and decision- making and reasoning (Grabe & Grabe, 2001). This implies that ICT is important for fast and easy learning to process, store and retrieve information, and as a result students develop cognitive skills and behaviours to solve problems. It is therefore essential for SHS Biology teachers to use technology in teaching and also urge students to use technology in learning Biology; this will enable the students to better understand the Biology concepts taught.

1.2 Statement of the problem

The Government of Ghana, in collaboration with the Ministry of Education and Sports, has made provisions to ensure that Senior High School (SHS) students get access to quality education, which takes into accounts the integration of Information and Communication Technology in instruction (ICT). In view of this, education stakeholders and policy makers in Ghana have made a remarkable step towards the introduction of ICT in Ghanaian SHS that will contribute to knowledge production, communication and information sharing among students and teachers in the school system. Also, there has been a sudden increase of computer laboratories at all levels of the school system and this testifies to the potency of the use of computer technology in education delivery (Asiedu-Addo & Yidana, 2001).

Furthermore, ICT has currently become a compulsory subject for every SHS student in Ghana. To date, however, there has been only 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. Mireku, Yidana, Hordzi, Tete-Mensah & Williams (2009) 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 Organisations, Philanthropists and Ghana Association of Science Teachers to help raise the standard of science and science- related courses in our various schools, science achievement is surprisingly on the decline. This is due to the fact that most of the schools lack the necessary resources for integrating ICT into 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 (Ziman, 1990).

Through observation it has been realized that Biology students in the Presbyterian Senior High School, Osu, in the Greater Accra Metropolitan Assembly of Greater Accra 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 five year period (i.e. 2007-2012) verified the low grades that the students have been obtaining in past WASSCE examinations Biology examinations. WAEC chief examiners' report at (SHS) has shown clearly that most students perform poorly in biology.

It has also been noticed that students in Presbyterian Senior High School (PRESEC), Osu have problems in learning some Biological concepts (e.g., Osmosis and Glycolysis); hence, their approach to answering questions on such concepts is incorrect. This is due to the facts that some Biology teachers in the school fail to demystify the topic to the understanding of the learners so that the learners can take initiative of learning the concepts themselves.

Further observations made by the researcher indicated that students' failure in examinations was due to inappropriate teaching methodology used for teaching Biology. Other factors are lack of practice exercises and lack of reinforcement and feedback from teachers. As a result of this, students claim that Biology is a difficult subject. For these reasons, students do not show positive attitudes towards the learning of Biology in the Presby Senior High School, hence, their poor performance in answering questions pertaining to some topics in biology based on the low scores

they obtain in their class exercises, assignments and examinations. It is against this background that the researcher is interested in the impact of integrating Information and Communication Technology (ICT) into the teaching and learning of Biology in Presby Senior High School, Osu.

1.3 Purpose of the study

Research has shown that the use of ICT in teaching and learning of Biology is very effective in the Science classroom. It has been noticed that the use of ICT in teaching and learning of Biology supports learning by allowing a student to explore phenomena and handle experiments which would not be feasible in school. Integration of ICT into teaching and learning of Biology has been found to help students to visualize abstract knowledge (Becta 2003; Smith 2003). According to Mortimer and Scott (2003), technology use in teaching and learning of Biology offers powerful interactivity, feedback, and an ability to modify material. They assert that dynamic use of ICT in teaching and learning of Biology render concepts more accessible. The use of animation and simulations portray abstract concepts efficiently, hence, learners can decode them more easily than static diagrams and descriptions.

The purpose of the study was to investigate the impact of integrating ICT into the teaching and learning of Biology in the Ghanaian Senior High Schools. Investigating technology use in teaching and learning of SHS Biology is crucial, because this knowledge could provide guidance for ways to enhance technology integration and encourage greater use of technology in teaching and learning Biology. Besides, the study also investigates the factors that influence SHS Biology teachers' technology use and suggests effective ways of integrating technology in Biology instruction at the SHS level in Ghana.

1.4 Objectives of the study

The objectives of the study were to determine;

1. the extent of technology use in teaching by Senior High School (SHS) Biology teachers;
2. the extent to which students will acquire Biology concepts if Information and Communication Technology (ICT) is integrated in the teaching and learning of Biology;
3. any significant change in the performance between male and female students exposed to ICT integrated instructional approach of teaching and learning of Biology; and
4. the difference in the performance between students exposed to Information and Communication Technology (ICT) integrated instructional approach and their counterparts exposed to the traditional instructional approach of teaching and learning of Biology.

1.5 Research Questions

The study sought to answer the following questions:

1. To what extent do Biology teachers in PRESEC, Osu, use technology in teaching?
2. To what extent will students acquire Biology concepts if ICT is integrated in the teaching and learning of Biology?
3. What is the significant difference between the performances of male and female students in the experimental group who were exposed to ICT-integrated instructional approach of Biology teaching and learning?

4. What is the significant change in the performance between students exposed to ICT integrated instructional approach and their counterparts exposed to the traditional instructional approach of teaching and learning of Biology?

1.6 Hypothesis

Null Hypotheses:

***Ho 1*:** There is no significant difference between the performances of students exposed to ICT integrated instructional approach and their counterparts exposed to the traditional instructional approach of teaching and learning of Biology.

***Ho 2*:** There is no significant difference between the mean scores of male and female students who are taught glycolysis using ICT integrated instructional approaches.

Alternative Hypotheses:

***H_A 1*:** There is a significant difference between the performances of students exposed to ICT integrated instructional approach and their counterparts exposed to the traditional instructional approach of teaching and learning of Biology.

***H_A 2*:** There is a significant difference between the mean scores of male and female students who are taught glycolysis using ICT integrated instructional approaches.

1.7 Significance of the study

The outcome of this study could provide insights into teachers and students technology use at the SHS level which could be sustainable and transferable to other educational institutions. The study will provide empirical evidence on the impact of integrating ICT into the teaching and learning of Biology in the Ghanaian Senior High

Schools. This could provide guidance for policy makers and stakeholders in education when structuring and introducing ICT integration policies in SHS. The outcome of the study could also add to knowledge by providing new evidence about the existing factors that influence technology use in Biology lessons in Ghana. This could serve as the basis for future studies on how to address some of the challenges to ICT integration which might lead to improving current practice in ICT integration with regard to Biology instruction.

1.8 Delimitation

The study was delimited to Presbyterian Senior High School located in Osu in the Accra Metropolitan Area of the Greater Accra Region. This study was also delimited to only SHS three (3) students studying Science and Home Economics, who offered Biology as an elective subject. The study was delimited to an aspect of Biology, focusing on Glycolysis in the SHS elective Biology syllabus.

1.9 Limitation of the Study

According to Best and Kahn, (1995) limitation is condition beyond the control of the researcher that place restriction on the validity of the study. The results of the research may be influenced by the following;

Some of the students were absent from lessons during the intervention stage. They were likely not to understand the concepts taught very well. Other students also kept revising their old notes and textbooks on the topics; hence the study may not be solely responsible for their output in the tests. The findings of this study would provide insights into the efficacy of ICT integration instructional approach for Biology lessons.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

The review of literature focused on the work done by researchers in related fields. The topics covered in the literature include the theoretical framework of the study, the impact of technology in teaching and learning Biology, technology use in teaching and learning of Biology, ICT integration by teachers, factors influencing technology use in teaching and learning Biology and differential impact of ICT on male and female students.

2.1 Theoretical framework of the study

The theoretical framework that underpinned the study was based on Jean Piaget's theory of cognitive development and Lev Vygotsky's social constructivism theory. To Piaget (1954), the cognitive development of children toward formal thought could be facilitated through three cognitive processes: assimilation, accommodation and reorganization or equilibration. According to Piaget (1954), when children assimilate, they perceive new objects and events according to their existing schemata, mental models or cognitive structures. The mental models of children, formed by their prior knowledge and experience, therefore, control how they incorporate new experiences and new information into their minds. This may occur when the new experiences of children are aligned with their existing schemata (mental models or internal presentations of the world) or as a result of their failure to change a faulty understanding (Piaget, 1954). Sometimes when children's experiences contradict their existing knowledge, internal representations, or schemata, they may change their perceptions of the experiences to fit their internal representations.

Accommodation, however, results as children reframe or modify their existing schemata or mental representations of the external world to fit their new experiences for learning to occur (Piaget, 1954). Hence, as children exercise existing mental structures, in particular environmental situations, accommodation-motivating disequilibrium results and the children construct new mental structures to resolve the disequilibrium (Piaget, 1954). The state of disequilibrium and contradiction arising between the existing schemata and the more sophisticated mode of thought adopted by the new experience therefore, have to be resolved via equilibrium process.

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

Vygotsky (1978) feels that social learning precedes development. To Vygotsky (1978), every function of the child's cultural development appears twice: first on the social level, and later, on the individuals' level; first between people (interpsychological) and then inside the child (intrapsychological). According to Vygotsky (1978), children are capable of performing at higher intellectual levels

when asked to work in collaborative situations better than when asked to work individually. Vygotsky (1978) also believed that less skillful individuals are better able to develop a more complex level of understanding and skill through collaboration, direction or help of an expert or a more capable peer than they could independently. Social interaction extends a child's zone of proximal development, which is the difference between a child's understanding and potential to understand more difficult concepts.

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

Sometimes, when children's experiences contradict their existing knowledge, internal representations, or schemata, they may change their perceptions of the experiences to fit their internal representations. Accommodation, however, results as children reframe or modify their existing schemata or mental representations of the external world to fit their new experiences for learning to occur (Piaget, 1954). Hence, as children exercise existing mental structures in particular environmental situations, accommodation-motivating disequilibrium results and the children construct new mental structures to resolve the disequilibrium (Piaget, 1954). The state of disequilibrium and contradiction arising between the existing schemata and the more

sophisticated mode of thought adopted by the new experience, therefore, has to be resolved via equilibrium process.

Integration of ICT in the teaching and learning processes can be considered a variant of cognitive tool. That is, it allows students to test hypotheses and more generally "what- if" scenarios and enable learners to ground cognitive understanding of their action in a situation. According to Milligan and Thomas (2004), ICT integration in this respect is compatible with the constructivists' view of education. Light and Mevarech (1992) have pointed out that, since the early 1980s, there has been a growing interest in the potentialities of ICT integration in teaching serving as a facilitator for students learning process. In the view of Newberry (1999), the role of ICT integration in teaching and learning enhances a wide range of school outcomes, including academic achievements, cognitive processes, meta-cognitive skills, motivation toward learning, self-esteem and social development. This seems to indicate that ICT integration in teaching and learning has a positive influence on students' achievements.

2.2 Impact of technology in teaching and learning biology

The important role that Biology plays in the overall personal and intellectual development of the individual cannot be underestimated. Effective Biology teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well (Hanushek, Kain & Rivkin, 2001). Besides, students must learn Biology with understanding, actively building new knowledge from experience and prior knowledge. Therefore, teachers must endeavour to make Biology easy for students to understand the various concepts taught with ease.

In the rapidly changing and technology dependent society, students are now faced with the need for a solid understanding of Biology skills and concepts acquisition. One of the key synergisms of Biology is technology, and as technology advances, it inevitably influences what happens in Biology classroom. Research indicates that technology plays an essential role in the learning of Biology as it influences the Biology that is taught and enhances students learning (National Association of Biology Teachers, 2000).

Technology influences the skills taught and enhances students learning. Technology should, therefore, be used to support the learning of Biology. Using technology in the Biology classroom provides ample learning opportunities for students. According to Wahyudi (2008), technology enables students to learn from feedback. The computer (technology) often provides fast and reliable feedback to students. It enables students to produce many examples when exploring Biological problems. The use of technology allows students to work with dynamic images that cannot be done within traditional teaching.

A study conducted by Gordin, Hoadley, Means, Pea, and Roschelle (2000) supports the use of technology in teaching and learning of Biology. Their findings indicate that computer technology can help support learning and it is especially useful in developing the higher-order skills of critical thinking, analysis and scientific enquiry. Gordin et al (2000) explored various ways computer technology can be used to improve how and what children learn in the classroom by helping students understand core concepts in Biology. According to them computer-based Biology builds confidence and it is a great tool for remediating slower learners.

Besides, National Association of Biology Teachers (2002) in California has observed that, with the use of technology in Biology classroom, students are saved from doing their exercises at a slower pace. This allows them to turn their focus to understanding the concepts and how to apply them. Technology also allows open-ended assignments in which students can learn concepts by "discovery" and are more likely to retain the concepts. The students can also experiment to view different results and methods of solutions to different problems. Without the use of technology, students spend major part of their time and their energy attempting to memorize rules and procedures while using sample exercises as models for their homework problems.

The power of technology leads to fundamental changes in Biology instruction. Palloff & Pratt (1999) opine that the ability to build and run complex Biology models and easy exploration of "what if" questions through parametric variation has opened up new avenues for Biology. In view of this, weaker students often are better able to succeed with the help of technology, and thereby come to recognise that Biology is not for the more able classmates (Carlson, 2010). Technology allows real-world applications to be more used in the classroom (National Council of Teachers of Mathematics, 2008). Besides, Kiano (2008) argues that technology enhances learning by furnishing visual images of Biology ideas and organisation of concepts and analysis of concepts efficiently and accurately.

Moreover, there are several reasons for incorporating technology into Biology instruction. According to Lim (2002), technology is essential in teaching and learning Biology. Technology improves the way Biology should be taught and enhances students understanding of basic concepts. Becta (2003), however, summarises the key benefits of technology in Biology instruction into three; Firstly, promoting greater

collaboration among students, encouraging communication and sharing of knowledge. Secondly, technology gives rapid and accurate feedback to students and this contributes towards positive motivation. Thirdly, the use of technology in Biology allows students to focus on strategies and interpretations rather than spend time on memorising concepts. Technology also supports constructivist pedagogy, wherein students use technology to explain and reach an understanding of Biology concepts. This approach provides higher order thinking and better problem- solving skills.

2.3 Technology use in teaching and learning of biology

Technology use in teaching and learning really has the potential to improve the way Biology should be taught and enhances students understanding of basic concepts (Lim, 2002). Bullock, Thomas & Tyrrel, (1996) suggest that the introduction of technology requires a new mindset on the part of teachers, a shift of Biological focus to a broader perspective of the implications of the technology for learning of the Biology. This means that Biology teachers need to develop knowledge that is pedagogical technological content knowledge that will enable them to use technology in teaching Biology.

Several studies have highlighted Biology teachers' use of technology in the Biology classroom. For instance, Allen (2004) conducted a study to investigate Biology teachers' use of the internet for teaching in America. Out of sixty-three (63) secondary Biology teachers surveyed, the findings indicated that the teachers use the Internet for finding information such as articles about research or professional issues or as a source of data for students to analyze in Biology lessons. No statistically significant relationships were found between use and competency, professional development, or years of teaching experience. Similarly, a study conducted by Mireku

et al (2009) indicated that technology was used in typing examination questions in all institutions and in some cases educators use technology in processing students' examination results. Their findings further indicated that very few teachers in Ghanaian SHS used technology in their teaching. However, no differences were observed at the pre-tertiary level in the amount of time male and female learners use technology for academic purposes.

Banini and Boakye (2008) also conducted a study to find out teachers readiness for the use of technology in Ghanaian schools. Their findings indicated that out of 2221 teachers surveyed, only 24% had received some form of training in the use of computers, with quite minimal training in pedagogical integration of technology. This indicated that although Biology teachers have realised the impact of technology in Biology, they still need professional training on how to integrate it in the teaching of biology. Although, technology use in Biology improves Biology teaching and learning, the level of technology use in Biology falls below average. Their study further revealed that 71% of the teachers did not use technology in classroom, 49% of teachers used technology to prepare lesson notes, 55% of teachers have some knowledge of web browsing, 71% used E-mail and 78% tried to make an effort to learn how to use the computer. These low figures imply that effective integration of technology into Ghanaian classroom instruction is yet to be realised, since teacher readiness for technology use is low.

Bukaliya and Mubika (2011) also surveyed three hundred and twenty (320) Secondary School teachers in Zimbabwe to find out their competence in ICT. Their findings indicated that only 7.5% of teachers were knowledgeable and skilled in computer aided instruction. Waite (2004) opines that even though teachers show great

interest and motivation to learn about the potential of technology, in practice, the use of technology is relatively low and it is focused on a narrow range of applications, with word processing being the predominant use.

Furthermore, Arifin and Faekah (2005) surveyed 554 Form four students in Malaysia to find out gender differences in their computer attitude and skills. Their findings revealed that students were not skillful in computing. Only 17.9% of the students sent messages via E-mail, 16.4% searched for information on web and 20.6% printed documents or images. Boakye and Banini (2008) conducted a study to investigate the level of technology use by Ghanaian students. Out of 5048 students surveyed, the findings indicated that 62% used the computer for general knowledge while 13% used it for communication whereas 10% used it for research. These findings indicate that technology use is gradually gaining grounds among Ghanaian students.

However, a study conducted in USA by Becker (2001) to find out how teachers use computers in instruction revealed that teachers generally used computer technology to support their existing practices (providing practice drills, demonstrations) and communication (such as the use of E-mail) rather than to engage students in the learning that involves higher order of thinking. Besides, Chigona and Chigona (2010) interviewed 14 educators in South Africa to find out the factors affecting technology use for teaching. Their findings revealed that the integration of technology in curriculum delivery was generally low. The analysis revealed that low levels of ICT literacy amongst the educators, rules set by Khanya project on who can use technology and what it can be used for, and insufficient technology support regarding the use of technology for teaching were conversion factors that led to insufficient or no integration of ICT in the Khanya schools in South Africa.

In a similar situation, Abuhmaid (2011) surveyed 120 teachers in Turkey to explore the extent of their ICT usage. The findings revealed that 45.2% of the teachers reported search for additional sources on the Internet and 32.1% reported using ICT to prepare their lessons. However, ICT-based interaction in the school culture appeared to have minimal presence among teachers, as only 4.3% of the teachers reported using ICT for communication and 11.3% of them reported uploading files (e.g. lessons) through the Internet. A study conducted by Cuban (2000) in Washington D.C. to investigate the extent of technology use in instruction revealed that very few teachers used computers in the classroom. In another study, Yildrim (2007) conducted a study to examine teachers' utilization of technology in Turkey. Out of the 402 teachers surveyed, the findings revealed that teachers largely used technology for creating handouts and tests, rather than using it to promote students critical thinking skills and to foster their higher order of cognitive abilities. The findings further indicated that, due to pedagogical support, teachers reported the lowest frequency for the use. Thus, teachers felt most competent on word processing whereas they felt least competent for the use of instructional software.

Several studies from case studies to survey research works have been conducted about the importance of ICT and as why teachers use it. They reveal that the use of ICT is inherently advantageous to support, facilitate and make easier teaching-learning process. As of this importance, research results highlight professional development in the area, supportive models, visionary policy and pedagogical expertise. ICT comprises several multimedia tools, such as computers, broadcasting technologies (radio and television), the Internet, telephone and the like. Nevertheless, computer more than ever has caught the attention of the world-web-community because of its

very nature to process, store and retrieve information, and help students and teachers to facilitate and handle complex problems.

The use of ICT, particularly a computer, stimulates a new atmosphere where teachers and students could interact and collaborate to learn new skills of understanding about any subject matter and solving complex problems. In order for ICT to stimulate a learning environment, the objective needs to be specific and achievable. ICT has three objectives in education: ICT as an object of study, discipline organisation and medium of teaching and learning (Brummelhis, Plomp & Rapmund, 1996). Therefore, ICT is important for students to develop cognitive skills in their daily lives, professionals to organise disciplines and as a medium to promote conducive learning atmosphere among teachers and students. Similarly the innovative use of ICT can promote student-centred learning (Drent, 2005). Hence, teachers need to use ICT to enhance student learning, for it helps students to engage in problem- solving, decision making reasoning (Grabe & Grabe, 2001). This implies that ICT is important for fast and easy learning to process, store and retrieve information, and as a result students develop cognitive skills and behaviors to solve problems.

Research has revealed that the importance of ICT is beyond measure to quantify. It has been reported that teachers' attitude is one of the most critical factors that enhance or inhibit the integration of ICT into classroom instruction (Jager & Lokman, 1999). A teacher's attitude and competence ensure ICT implementation and guarantee further ICT innovation. They also help to promote approaches, standards and harmonisation of ICT tasks, the awareness ICT equity, utilisation and maintenance of ICT, implementation of ICT training, assessment and evaluation, development of ICT, dissemination of pedagogical knowledge, professional development, etc. ICT makes a

classroom a playfield where teachers and students interact, communicate and collaborate during the time of instruction. In the absence of ICT, some students count time to dismiss the instruction, whereas in the presence of ICT students want to stay and buy more time.

2.4 ICT Integration by Teachers

Normally, ICT is not part of a curriculum; like any other discipline it is a separate subject. Because of this, realistic policies are very important for its integration. Hence, it can be taken as an elective subject (separated) and ICT in subjects (integrated). ICT policies need to be formulated and planned to complement and support curricula with technology infrastructure. Nowadays, in the era of tough competition, nations could no longer depend on traditional approach and stand anymore globalisation issues without ICT integration. Strangely enough, none of the sample countries have done a comprehensive pilot study before ICT policy establishment. They have a policy on ICT integration, but it does not reflect the reality and cannot be transformed into an action without exploring the true ground and synthesis of expertise and experiences from other countries. In a focused group discussion, it was discovered that some African countries borrow foreign countries ideas and experiences, and instantly adapt as part of their experiences while some synthesise expertise and experiences and integrate to their own philosophies (Mlitwa, 2011).

Borrowed policies on ICT issue always remain impractical and bound to fail. A realistic policy serves as a framework, blueprint or roadmap to integrate and facilitate ICT implementation in schools. Most importantly, teachers need to play their roles and produce models towards technology application in their teaching profession. It is true that teachers are changing agents for teaching and learning to occur. Their role as

teachers has a far reaching effect to a school performance. Teachers are at the centre of curricular changes and control the teaching-learning process (Brummelhis, Plomp & Rapmund, 1996). Hence, teachers should prepare students for the knowledge society in order to acquire the competency of ICT use to process information. Effective application of ICT into classroom relies on the availability of technological resources, qualified and confident teachers and other internal and external factors that directly or indirectly affect teachers' welfare and morale. In this regard, technological tools assist teachers need for the visions of technological potential and opportunities to use and training to experiment (Bowes, 2004).

Similarly, ICT can change the way teachers teach, particularly in student-centred approaches for developing collaboration and the highest skills (Haddad, 2011). The effective use of ICT in science places considerable pedagogical demands on teachers. Teachers need to be clear on how a particular application will meet learning objectives (Thomas, 2001) and should be aware of its implications: for example, the sanitised data produced by simulations may lead to misconceptions (Hennessy & Osborne, 2003). Similarly, students need information literacy skills so they can evaluate the evidence they find on the Internet (Linn & Slotta, 2000). Research suggests the key to making effective use of ICT is giving students more responsibility for their work (Newton, 2000). Teachers should therefore act as facilitators, guiding investigations and encouraging discussion. However, the science curriculum requires teachers to convey large amounts of content, a factor which remains a barrier to innovation (Hennessy & Osborne, 2003).

However, there is a clear cut difference between teachers who use ICT to facilitate learning for understanding a particular topic and those who use the resource only for

presenting the topic without direct application (Dede, 2000). First teachers employ the pedagogical expertise and maximise the use of ICT for students' achievements. ICT competency standard has three things: technological literacy, deep knowledge and knowledge creation (UNESCO, 2011). Similarly, some researches indicated that several school leaders perceive that the lack of ICT related to knowledge is a major challenge to the realisation of ICT (Pelgrum, 2002). Several studies reveal that teachers' characteristics play a greater role on the use of ICT. Teacher characteristics refer to the educational level, teaching and computer experiences, age, gender, and financial position. A study by the National Center for Educational Statistics (2005) reported that teachers with fewer years of teaching experiences use computers more than teachers with longer years of teaching experience.

2.5 Factors influencing technology use in teaching and learning Biology

Technology use in teaching and learning Biology has become a major concern to stakeholders and policy makers in education throughout the world. Technology use in Biology is influenced by several factors. Nor (2004) used a qualitative methodology to study conditions that facilitated the implementation of information and communication technology integration in Malaysian secondary school curriculum. The findings revealed two sets of conditions:

(i) essential conditions (such as availability of technology resources and acquisition of technology knowledge), and

(ii) supporting conditions (such as accessibility of technology resources, presence of support, desire to change among teachers, school practices, influence of external forces and teachers commitment to the innovation) significantly influenced the teachers technology use.

Besides, Noms et.al (2003) surveyed rural and urban respondents in California, Florida, Nebraska and New York to investigate the extent of technology use in K-12 in U.S.A. Out of the 3,665 teachers surveyed, the analysis revealed that appropriate access to technology infrastructure is a key factor in the effective technology integration process. The study revealed substantive correlation between technology access and use. Similarly, Varden (2002) used Ely's conditions as a framework to identify conditions that influence the adoption and integration of laptop computers by teachers in United States High Schools. The results indicated that the conditions of 'dissatisfaction with status quo', presence of knowledge and skills, participation, commitment and leadership, were more prevalent among teachers who were early adopters than late adopters.

Research conducted by Crisan (2004) categorised variety of factors that influence technology use in teaching into contextual factors and the personal factors. He argued that contextual factors encompass the school context. The availability of and access to technology facilities and resources, teachers technology skills, teachers technology professional development, developmental ethos and key persons in promoting the use of technology and developmental policy with regard to integrating technology into the Biology scheme of work. Besides, Bennison and Goos (2008) surveyed 485 Biology teachers in Australia to investigate the factors influencing technology use in Biology teaching. Their findings revealed that pedagogical knowledge and beliefs, access to hardware and software and participation in professional development courses were factors influencing technology use in teaching and learning of Biology. Similarly, Mireku et al (2009) conducted a study to investigate pedagogical, integration of ICT. Their findings revealed that availability of ICT syllabuses/manual; computers and

computer laboratories that can be accessed periodically were factors that influence technology use at the SHS level in Ghana.

In order for the school to be proactive regarding technology in the classroom, Williams (1998) argues that the school should have a technology plan, reviewing the curriculum to fit the technology needs in instruction and ensuring that the staff has skills. He argues for tapping school and community resources to ensure sustainable funding mechanisms. In a similar study, Valdez (2004) points out that if the tremendous potential of technology is to be optimised, educators and community members need to develop a comprehensive learning and technology plan long before technology equipment starts arriving. He further observed that most research studies on technology implementation show that much of the frustration with technology can be attributed to inadequate or nonexistent planning. Adequate planning may be especially lacking in how technology is used to improve learning and determining how teachers receive professional development to enhance students learning. Also, Bosley and Moon (2003) mention case study research in the United Kingdom that identified a number of factors that enables teachers to successfully engage in innovative practice. These were previous involvement in innovations (technology and non-technology based) support at senior management level for implementing new practices and addressing financial implications where appropriate involvement of several members of staff, a prevailing culture with students of collaboration and mutual support and willingness to take risks, accepting that some ventures will succeed while others may not.

Several studies have been conducted that addressed the relationships between demographic variables such as gender, age, teaching experience and usage of

technology. Al-Ghaith, Sanzogni and Sandhu (2010) conducted a study to investigate factors influencing the adoption and usage of online services in Saudi Arabia. Out of the 651 participants sampled, the findings revealed that income level, age, gender and geographic location have a significant effect on peoples access to and use of Internet and its services. On the contrary, D'Silva, Hassan, Samah and Shaffril (2008) conducted a study to investigate the factors influencing the effective use of technology among Malaysian teachers. Out of the 318 teachers sampled, the findings revealed that gender, age and teaching experience did not significantly influence teachers actual usage of technology. Besides, Norris et.al (2003) surveyed rural and urban respondents in California, Florida, Nebraska and New York to investigate the extent of technology use in K-12 in U.S. A. Out of the 3,665 teachers surveyed, the findings revealed that gender and teaching experience did not have significant influence on teachers technology use.

Besides, Venkatesh and Morris (2000) conducted a study in Minnesota to investigate gender, social influence and their role in technology acceptance and usage behaviour. Their findings revealed that men emphasized more on perceived usefulness in determining behavioural intention to use, while women regarded perceived ease of use as a more significant factor in determining behavioural intention to use. Similarly, Adentwi Amartei, Brefo and Sarfo (2011) conducted a study to investigate rural and urban students attitude towards ICT in Ghana. Out of the 324 SHS students sampled, the findings revealed that the locality of the male and female students did not influence their attitudes towards technology. Their analysis further revealed that students attitude towards technology do not differ in terms of gender. However, Lee (1997) conducted a study in Virginia to investigate the effects of high school restructuring and size on early gains in achievement and engagement. He found out

that, male teachers were more active in computer and they were also found to be more confident in handling computers than female teachers. Li and Kirkup (2007) conducted a study to investigate gender and cultural differences in internet use. Their findings revealed that, using computers was a male dominant activity and males had more positive attitudes towards the use of technology as opposed to females. Similarly, Kahveci (2010) conducted a study in Turkey to find out students perception to use technology for learning. Out of 158 students surveyed female students were less confident in using technology compared to male students. He also found a significant difference in the effect of confidence between male and female students.

Furthermore, Atan, Aziz, Bakar, Luan, Meseran, Sidek and Yunus (2005) conducted a study in Nigeria to determine if differences existed between females and males in terms of their ICT competencies in word processing, presentations, World Wide Web, electronic mail usage, spreadsheet applications, database applications, multimedia applications and virtual class applications. Their findings revealed that, the mean values of female participants were statistically higher than those of males when it came to inserting (4.71 to 4.33) and editing (4.65 to 4.34) texts. Once again, the mean scores for females were higher than those of males inserting texts (4.45 to 4.03) and deleting slides (4.41 to 3.95) in presentations. The mean values for females were higher than for males in search engine (4.57 to 4.16) and file uploads (4.47 to 4.14). However, females and males did not perceive themselves as skillful in creating their own homepages. Also, females scored significantly higher than the males in four out of the five items related to the e-mail usage. Females were significantly more skillful than males in composing (4.69 to 4.41) e-mails and sending attachments (4.67 to 4.34). No significant difference, however, was found between both genders in relation to opening attachments. The comparative analysis showed that there was no

significant difference between female and male competencies in terms of their competency in spreadsheet, database, multimedia and virtual class applications. Similarly, Almekhlafi and Almeqdadi (2010) conducted a study to investigate teachers' perceptions of technology integration in the United Arab Emirates. Out of 100 teachers sampled, the findings indicated that the mean scores for female teachers on technology use were all above 4.4, while the mean scores for male teachers ranged from 2.5 to 3.5. The One-Way ANOVA statistical test further revealed that there was a significant difference in technology use between male and female teachers. This implies that gender has influence on the teachers technology use.

Besides, a study by Lundstrom and Martin (2002) to examine the role of teachers experience as a factor for the integration of computers in some Sweden schools revealed that almost 60% of the teachers in their study who had under ten years of teaching experience believed computers in the classroom were essential and hence they used it extensively, while only 25% of teachers over twenty- eight years of teaching experience shared this belief. Besides, Miller and Zidon (2002) conducted a study to investigate affiliations of attitudes and experience with need for learning computer skills in USA. Their findings indicated a weak relationship existed between years of teaching and technology usage. Maguire and Rosen (1990), who reviewed a literature on understanding teachers' perceptions towards computer and computerized instruction, concluded teachers teaching experience does not eliminate computer phobias and many experienced teachers display some wariness, discomfort and/or mild anxiety in relation to computers.

Furthermore, Lau and Sim (2008) conducted a study to explore the extent of ICT adoption among secondary school teachers in Malaysia. Out of 250 secondary school

Mathematics and Science teachers sampled, elderly respondents (aged over forty five years) made more frequent use of technology in school on a five point rating scale. On a five point rating scale, the results further revealed that young teachers aged below thirty -five recorded a higher mean of competency than 34-45years and over 45 years. Besides, Sia (2000) conducted a study to investigate computer anxiety and computer literacy among urban secondary school teachers in Miri and Sarawak. The findings revealed that the younger, less experienced teachers used computers in a broader, more transformational fashion. Since these teachers are probably more likely to be computer proficient, would have had more digitally focused teacher education courses, and will be less constrained by prior habits or attitudes than their older more experienced colleagues. The findings further revealed that computer literacy levels among secondary school teachers were low; there were significant difference in computer literacy levels teachers of different age groups and teachers with different years of computer experience with different software. Gattiker and Nelligen (1998) also conducted a study to investigate computer attitude and learning performance for management education and training. Their findings revealed that age does affect teachers' perception of information technology and its usage.

Several studies have shown that participants self-efficacy in technology use significantly influences technology usage. D'Silva, Hassan, Samah and Shaffril (2011) conducted a study in Malaysia to investigate what affect perceived ease of ICT usage. Multiple linear Regressions (stepwise method) were used to determine most significant variables that contributed towards perceived ease of ICT usage. Out of the 240 respondents sampled, the findings indicated that self-efficacy contributed towards perceived ease of ICT usage. Besides, Anderson and Maninger (2007) conducted a study in Abu Dhabi to investigate pre-service teachers' abilities, beliefs and

interactions regarding technology integration. Their findings revealed that students' self-efficacy beliefs significantly influenced their interactions to use software in their future classrooms. They further found that students' self-efficacy and interactions were moderately correlated with each other. They, however, argued that the best predictors of interactions were self-efficacy beliefs, gender and valued beliefs.

2.6 Differential impact of ICT on male and female students

There are differences across gender in the way students learn concepts (Bennett, 2003). According to Birch, Gardiner and Sankey (2010), male students have a different learning style compared to their female counterparts. Lau and Yuen (2010) also indicate that there are differences across gender in the way students learn concepts.

According to Fouji & Islam (2010) gender does not influence students' performance in Science generally. This finding is consistent with the findings of some recent researchers on the same subject matter. Studies by Candan, Türkmen & Cardak (2006), Pulat (2009), Eravwoke (2010) and Ajaja (2011) did not report any significant difference in achievement between males and females in their studies. They all reported that learning gains were not limited to any particular sex.

ICT can also be seen as an effective tool for developing individual cognitive structure, psychomotor and affective abilities. Interestingly, a study by Agbatogun (2006) discovered that with global technological wave that is affecting every sector and every aspect of academic life whether male or female, experienced or inexperienced, humanities, and science or vocationally- oriented need to struggle zealously to be computer literate in order to face the present educational challenges. Bataineh and

Baniabdelrahman (2005) confirm that male students performed better in their academic work than their female counterparts when ICT is integrated in their studies. This is supported by Onasanya, Shehu, Oduwaiye and Shehu (2010), who pointed out that ICT, has more positive impact on male students than female students. According to Onasanya, et al. (2010), ICT accelerates academic success by making information easily available.

Other researchers disagree with the fact that male students perform better than female students when ICT is integrated into teaching and learning (Hogarty, 2000; Martin, 2001; Garrison & Kanuka, 2004). According to Ramirez (2003) and Liu (2005), gender has no influence on students' academic performance when ICT is integrated into teaching and learning. This finding was supported by Agbatogun (2006) who also confirmed the findings of Ramirez and Liu. The findings are also consistent with a similar finding carried out in Cameroon by Tchombe (2008) found that there was no significant difference in performance between male and female students who were instructed by ICT integration instructional approach. He concluded that both male and female students feel that access to ICT makes learning easier and accessible.

A recent research conducted in Cameroon shows that there is no significant difference between male and female students' performances when ICT is integrated into their studies (Mbah, 2010). The result in the study was supported by the findings of Kiptalam & Rodrigues (2011). Both researchers concluded that gender has no influence on the impact of ICT on students' academic performances.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter provides the methodology that was employed in the study which includes the population and setting of the study, sample and sampling procedures, research design, research instruments, data collection procedure and the method of data analysis that was used.

3.1 Population and Setting

A research population is a large well-defined collection of individuals or objects having common characteristics (Castillo, 2009). According to Castillo (2009), there are two types of populations: the target population and the accessible population. The target population also known as the theoretical population refers to the group of individuals to which researchers are interested in generalising the conclusions. Whilst the accessible population which is also known as the study population is the population which is available for the researcher for which they can apply their conclusions. The target population for this study was all third year Biology students of PRESEC, Osu and all Biology teachers of PRESEC, Osu in the Greater Accra Metropolitan Assembly of Ghana. However the accessible population was Biology students from one intact SHS 3 Science class, Biology students from one intact SHS 3 Home Economics class and Biology teachers of PRESEC, Osu. PRESEC, Osu was chosen for the study because the researcher has been teaching in the school for the past five (5) years and is familiar with the academic environment in the school.

3.2 Sample and Sampling Technique

The sample is a carefully selected representative group from population for a study. Fifty (50) Biology students from one intact SHS 3 Science class, forty eight (48) Biology students from one intact SHS 3 Home Economics class and five (5) Biology teachers of PRESEC, Osu were sampled for the research. The Biology teachers and the students from the Science and Home Economics classes were selected by purposive sampling. A purposive sample, also commonly called a judgmental sample, is one that is selected based on the knowledge of a population and the purpose of the study. The subjects are selected because of some characteristic (Crossman, 2013). Purposive sampling can be very useful for situations where one needs to reach a targeted sample quickly and where sampling for proportionality is not the main concern.

Third year (SHS 3) students were used in the study, because Glycolysis is taught during the third year of the SHS science programme as it forms part of the SHS 3 elective Biology syllabus.

The participants were categorised into the experimental groups and the control group based on the performance of the intact classes on a pre-test instrument ("Students Knowledge of Glycolysis Test"- SKGT) which was used for the study. The pre-test instrument was administered to all participants in each selected class in their classrooms at the same time. The mean scores obtained by the intact classes in the SKGT were used as the basis of the categorisation of participants into the experimental and control groups. The class which obtained the lower mean score was selected as the experimental group while the class with the highest mean score was selected as the control group. This was done to investigate whether the performance

of the class with the lower mean score would improve much more with the ICT integration teaching approach than the class with the highest mean score which was taught with the traditional teaching approach. The mean scores on the SKGT of the intact classes included in the study are provided in appendix L.

3.3 Research Design

The study employed the quasi–experimental research design and survey research design. Quasi-experimental research involves selecting groups, upon which a variable is tested, without any random pre-selection processes (Shuttleworth, 2008). Quasi-experimental research approach was used for the study because the researcher used intact classes which did not permit random selection and assignment of participants. Quasi-experiments are useful in instances, such as evaluating the impact of public policy changes, educational interventions or large scale health interventions, where it is not feasible or desirable to conduct an experiment or randomized control trial (Campbell, Cook and Shadish, 2002). Quasi-experimental research design involves selecting groups, upon which a variable is tested without any random pre-selection processes (Shuttleworth, 2008). Campbell et al (2002) have identified several types of quasi-experimental designs. According to them, these quasi-experimental research designs include, but are not limited to the one-group post-test only design; the one-group pre-test post-test design; the removed-treatment design; the case-control design; the non-equivalent control groups design; the interrupted time-series design and the regression discontinuity design.

The study made use of the post-test only non-equivalent control group design of the quasi-experimental research design. Post-test only non-equivalent control group research design involves administering an outcome measure to two groups or to a

programme or to treatment group and a comparison (Gribbons & Herman, 1997). Post-test only non-equivalent control group design of quasi-experimental design was used, because the study investigated the effect of two teaching approaches: ICT integration teaching approach and the traditional teaching approach, on experimental and control groups, which have not been equated by randomisation (Cohen, Manion & Morrison, 2008) in two groups of students (i.e. SHS 3 Science and SHS 3 Home Economics students) from PRESEC, Osu in the Greater Accra Metropolis of Ghana.

There was one experimental group and one control group, all of which were intact classes. Participants in the experimental group were taught section three unit four of the second year SHS Elective Biology syllabus, which deals with "Glycolysis", using ICT integration teaching approach while those in the control group were also taught the same section and unit of the SHS Elective Biology syllabus using the traditional instructional approach.

The researcher used "Glycolysis made easy" (which was adopted from Sun Flower for Science, and animations on Glycolysis from particular websites (http://www.youtube.com/watch?v=-Gb2EzF_XqA, http://freevideolectures.com/Course/2548/Biology/23andhttp://www.khanacademy.org/test-prep/mcat/biomolecules/carbohydrate-metabolism/v/glycolysis) when using the ICT integration teaching approach. The post-test instrument (Students Achievement in Glycolysis Test-SAGT) was administered to all participants after the experimental group had been treated with the intervention and the control group treated with the traditional instructional approach. This was done to assess the effectiveness of incorporating ICT into the teaching and learning of Biology on the performance of the SHS 3 Biology students who were used in the study.

The study also employed survey research design. Survey research design are procedures in quantitative research in which investigators administer a survey to a sample or to the entire population of people to describe the attitudes, opinions, behaviours, or characteristics of the population (Creswell, 2012). Surveys use standard set of questions to get a broad overview of a groups opinions, attitudes, self-reported behaviours and demographic and background information (Barnes & Onley, 2008). According to Babbie (2007), there are two basic types of surveys: Cross-sectional surveys and Longitudinal surveys. Cross-sectional surveys gather information on a particular population at a distinct time; longitudinal surveys on the other hand, collect information over a period of time. Cross-sectional survey was used for the study to collect information from Biology teachers on technology use among SHS Biology teachers and the factors that influence their use. The cross-sectional survey method enabled the researcher to collect information about technology use in SHS Biology teaching and its impact on students' performance in Biology within minimal effort. Besides, respondents' anonymity was easily protected without having to identify respondents.

3.4 Research Instruments

The instruments that were used for the study were questionnaire and test. The researcher used questionnaire because it takes less time to administer them and also to ensure anonymity of the respondents (Fraenkel & Wallen, 2003; Muijs, 2004). The questionnaire enabled the researcher to collect potential information about technology use in teaching and learning SHS Biology in PRESEC, Osu. It was structured questionnaire which was made up of close format, open-ended format and rating scale type of questions. The open-ended questions enabled the researcher to probe a little

deeper and explore Biology teachers' attitude towards technology use in teaching Biology.

The items were based on Likert-type of scale. Likert-type scale was used because it is easy to construct and more reliable than others scales (Hill & Tittle, 1967). The scale also provides the researcher the opportunity to use frequency and percentage as well as mean scores to compute the data. Likert scales are often observed to give data with relatively high reliability (Gabel & Wolf, 1993). The questionnaire was self-administered by the researcher. Items on the questionnaire which were not clear to respondents were explained to them in order to elicit the right responses.

Students Tests

The pre-test (SKGT) and post-test (SAGT) consisted of 20- item paper, which were made up of three sections-A,B and C. Preceding section A of each test instrument was a portion that briefly stated the purpose of the test and also asked participants to provide personal data, such as, name, gender and class of participants. This portion also contained general instructions to answering items in all three sections of the test instruments. Additionally, each section of the SKGT and SAGT begins with specific instructions regarding how to respond to items in that section.

Section A of the SKGT and SAGT were both made up of ten (10) multiple choice items, numbered as items 1 to 10. Each of the multiple choice items in SKGT and SAGT had a stem about an aspect of the concept of Glycolysis followed by four options or alternatives. The options comprised one correct answer and three plausible distracters. Each correct answer circled or chosen was awarded one (1) mark, resulting in a total score of ten (10) marks for section A.

Section B was made up of five (5) true/false items, which appeared as items 11 to 15 on the SKGT and SAGT. Each of the five true/false items had a statement about an aspect of the concept of Glycolysis followed by **True** or **False**. Participants were required to circle **True** if they agreed with a statement or **False** if they disagreed with it. Each correct option chosen was awarded one mark, giving a total score of five (5) marks for section B of the SKGT and SAGT.

Section C was made up of five (5) short essay or short- answer items numbered as 16 to 20 on SKGT and SAGT. Item 18 on the SKGT consisted of two (2) sub-questions, 18(i) and 18(ii). Item 19 on the SAGT also consisted of two sub-questions, 19(i) and 19(ii). All participants' responses to one short essay or short-answer items were scored before scoring participants responses to the next short essay or short-answer items. This helped to keep one frame of reference and one set of criteria in mind while scoring responses to a particular short answer item by all participants. It also prevented carrying over impressions formed while scoring the responses of a participant to a particular item to the participant's next response(s). Also, to ensure uniformity in the scoring of all items, marking guides were prepared for the marking and scoring the SKGT (Appendix I) and SAGT (Appendix K). Items in section C had a maximum score of two, three or four marks giving total scores of 12 marks and 13 marks for the SKGT and SAGT, respectively. The SKGT and SAGT therefore, had overall total scores of 27 and 28 marks respectively.

The pre- test was administered two weeks before the treatment (i.e. intervention). The pre-test was used to find out specifically the strengths and weaknesses of the students level of understanding of Glycolysis. The intervention was implemented over a period of four weeks during the second term of the 2013/2014 academic year of SHS in

Ghana. The post-test was administered a day after the intervention. The intervention was designed in a form of a lesson delivery and discussion in the class and the school's computer laboratory. It included slide presentation, use of animations (which was adopted from Sun Flower for Science) and guided internet search from specified web sites. Students were given exercises and research questions after each lesson.

Teachers' Questionnaire

The teachers' questionnaire consisted of four main parts (A-D). Part A contained nine items that elicited information on the background of the participants and the level of availability of technology resources available for teachers. Questionnaire 1 to 3 of the variables in part (A) covered respondents gender, age and teaching experience. These data were in tune with the purpose of this research since the respondents' gender, age and teaching experience might have significant influence on participants' technology usage. Question 4 to 8 of the variables in part (A) also elicited information on the level of availability of technology resources available for teachers. Question 9 elicited information on teachers' participation in professional development courses related to the integration of ICT in teaching and learning of Biology. The second part (B) consisted of five items that elicited information on participants' self-perceived efficacy in technology use. The third part (C) consisted of seven items that focused on the extent to which the Biology teachers used technology for general purposes and in teaching. The last part (D) consisted of both close and open- ended items. The close-ended part consisted of seven items that also elicited information on teachers' self-perceived efficacy in technology use. The open- ended consisted of two questions that elicited information teachers perceptions towards technology use in teaching and learning SHS Biology. Teachers' perceptions have an influence on attitude developed

toward technology use in teaching Biology. The teachers Questionnaire is presented in Appendix G.

3.5 Validity of Research Instruments

Validity determines whether the research instrument truly measures that which it was intended to measure or how truthful the research results are (Joppe, 2000). To ensure that participants' scores from the SKGT and SAGT were meaningful and allow for good conclusions to be drawn from the sample studied, (Creswell, 2012). Both test instruments were presented to one Senior Lecturer in the Science Education Department of the University of Education, Winneba. The test instruments were also presented to two SHS Elective Biology teachers with considerable teaching experience in the Accra Metropolis for their comments and suggestions in order to correct the errors that were associated with the items on the SKGT and SAGT.

3.6 Reliability of Research Instruments

Reliability, according to William (2006), refers to consistency or 'dependability' of the measurement or the extent to which an instrument measures the same way each time it is used under the same condition with the same subjects. In order to ensure that the research instruments produced scores that were stable and consistent and their test items were devoid of any ambiguities (Creswell, 2008) as much as possible, the SKGT and SAGT were pilot tested using 25 SHS 2 Elective Biology students in Ebenezer Senior High School, Dansoman, in the Greater Region of Ghana. Data from the pilot- test were statistically analysed to determine the reliability of the test instruments using the Spearman- Brown prophecy formula since all items on both SKGT and SAGT were dichotomously scored. The analysis yielded reliability

coefficients of .58 and .61 for the SKGT and SAGT, respectively. According to Ary, Asghar, Ary & Lucy (2002), if the measurement results are able to be used for making a decision about a group or for a research purposes, or if an erroneous initial decision can be easily corrected, then scores with modest reliability coefficients in the range of.50 to.60 may be acceptable. The above reliability coefficients for the SKGT and SAGT therefore, signify that both test instruments were considerably reliable.

3.7 Data Collection

The researcher administered the questionnaires personally to the Biology teachers. This was to help improve the collection and response rate of the questionnaire. The questionnaires were collected as soon as they were completed by the respondents. The test, quizzes, class exercises and assignments which were given to students were collected and analysed regularly to reveal potential difficulties. The result of the pre and post-tests was used as data for the study.

The data collection procedure was divided into three phases: pre-treatment phase, treatment phase and post-treatment phase. This is illustrated diagrammatically below in figure 1.

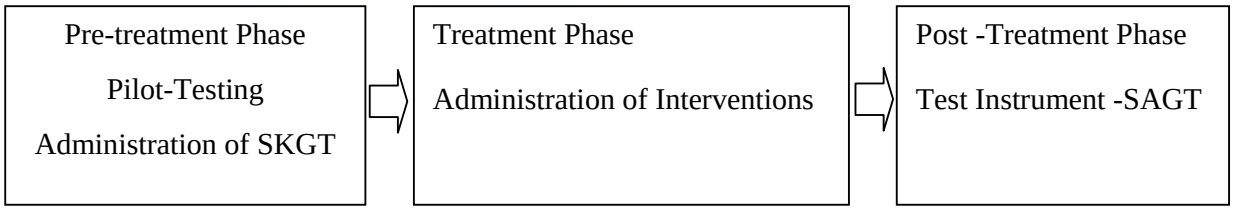

Figure 1: The Process of Data Collection

Pre-Treatment Phase

This phase lasted for only one week. The researcher visited the Pilot school to seek from the school's head to conduct a pilot-test in the school. Two familiarization visits were made to Ebenezer Senior High School. The first visit was for the introduction of the researcher to the Head of Ebenezer Senior High School and also to seek permission to conduct the Pilot-test in the school. The Head of Ebenezer Senior High School subsequently informed the respective subject teachers about the study in order to solicit their cooperation and assistance for the study.

The second visit to the school was for the conduction of the pilot test. The researcher pilot-tested the SKGT and SAGT on twenty five (25) third year SHS Elective Biology students in Ebenezer Senior High School in the Greater Accra Metropolitan Assembly in the Greater Accra Region of Ghana.

The pilot test was then administered to the sampled students of PRESEC, Osu in their respective classrooms. One Biology teacher assisted the researcher in the administration of the SKGT. Mean scores obtained by the participants on the SKGT were used to designate the intact classes into the experimental group and control group. The class that obtained the lowest mean score was designated as the experimental group and the one with the highest mean score, as the control group. This was done to find out if the performance of the class with the lowest mean score would be much more improved than that with the highest mean score after administration of the intervention.

Treatment Phase

The treatment phase of the study lasted for four weeks in the second term of the 2013/2014 academic year in the Ghanaian SHS calendar.

The experimental group was taught section five, unit four of the SHS3 Elective Biology syllabus, which deals with Glycolysis. The traditional approach to teaching incorporated with the ICT integration approach on "Glycolysis made easy" (which was adopted from Sun Flower for Science) and animations on Glycolysis from particular websites were used. The experimental group was instructed by using the ICT integrated instructional approach. The strategy used was based on Think Board consisting of four modes introduced by Haylock and Yager constructivist approach. In the first step, the tutor asked the students some questions at the beginning of the instruction in order to activate the prior relevant knowledge of the students and to promote student-centered interaction and agreement. For example, the researcher began the instruction with a question 'What is meant by Glycolysis?' The second step involved the exploration of students' understanding. The students were allowed to discuss the question among themselves in groups using their previous knowledge on Glycolysis. During the discussion, the students realised their own and others' thoughts, shared their ideas, defended their answers and reached a consensus on the question without the interference of the teacher. The groups constructed their tentative answers freely and submitted a common answer to the teacher after the discussion. Through that the researcher had opportunity to be informed about the students' previous ideas. Students through this process had cognitive conflict of their ideas, which were not adequate to answer the question. Based on the answers, the researcher used ICT integrated instructional approach to explain the concepts. While explaining the concept, the researcher emphasised on students' misconceptions and

why they were wrong. Scientifically correct explanation was presented by using ICT integrated approach. Since Glycolysis is an abstract topic, examples were given using analogies, videos, computer animations and diagrams illustrations. The teacher wrote on the board the key words and phrases of concept to be learned, and brainstormed the meanings as clearly as possible for students to copy them in their notebooks. Students were put into groups of five after every lesson to research on the assignment given them in the school's computer laboratory.

The control group was also taught the same section and unit of the SHS3 Elective Biology syllabus using only the traditional instructional approach, which involves lecture, demonstration, illustration and discussion, without the incorporation of the ICT integration approach on Glycolysis. Both groups were instructed by the same teacher (researcher) on the content. During the treatment phase, Glycolysis was covered as part of the regular time scheduled for the course. In the control group, the teacher directed a strategy of instruction representing the traditionally designed approach, which is usually lecture/discussion method. The teaching strategies relied on teacher and textbooks explanation. The students were made to study their textbooks on their own before the lesson. The teacher treated the entire class as a unit, dictated notes on Glycolysis, especially the key points to the students. The main principle was that the teacher was the master of the subject matter and solely had to transfer that knowledge as a fact to students. The teacher defined, explained and described the concepts, and after which some concepts were discussed through questions asked by the teacher. Assistance was provided to the needy students who could not understand the concept. The students had the opportunity to ask questions which the teacher provided the answers. The lessons in this group were purely teacher-centered.

Post-Treatment Phase

The post-treatment phase of the study was undertaken in the last week of data collection period in each of the classes. After the administration of the intervention in the experimental class, the SAGT was administered to all participants in the experimental and control groups. One Biology teacher helped the researcher with the administration of the SAGT in one of the classes. This was done to assess the effectiveness of the incorporation of the ICT instructional approach on Glycolysis in the teaching and learning process on the performance of SHS 3 students in Biology. The procedure of the pre-test was repeated after the post-test on the same day that the last concept of Glycolysis was taught. The remedial teaching was conducted to the group after marking the post-test to explain to students areas that they were still having difficulties. ICT instructional approach on Glycolysis was used to instruct the control group at this stage.

3.8 Method of Data Analysis

The responses from the questionnaire were coded and analysed using SPSS (Statistical Package for Social Science) 16.0 software version. Descriptive statistics such as percentage scores were calculated for participants' responses. Independent sample t-test was used to test the null hypothesis that there was no significant difference between the performances of PRESEC, Osu students exposed to ICT integrated instructional approach and their counterparts exposed to the traditional instructional approach of teaching and learning of Biology.

The independent sample t-test is used when two separate sets of independent and identically distributed samples are obtained, one from each of the two populations being compared (Brian, Press, Saul & William, 1992). The most common use of this

test is for pre- and post-test scores for a sample when they are exposed to some intervention in between the pre- and post-tests. The reason why independent sample t-test was used instead of dependent samples t-test is because the scores were for the two different groups of students, which suggests that there will be an underlying relationship between the scores.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter presents the results and discussions of findings of this study to provide an understanding of the impact of integrating Information and Communication Technology (ICT) into the teaching and learning of Biology in Presby Senior High School, Osu. The results and discussion are presented in the order of the research questions and the null hypothesis. The guiding research questions of this study were to determine whether the Biology students in the Presby Senior High School, Osu would perform better academically or not when ICT Instructional Approach has integrated into the teaching and learning of Glycolysis. The primary source of data for the research was the academic performance in the pre-test and post-test scores for both students instructed by ICT Instructional Approach (IIA) and Traditional Instructional Approaches (TIA). The Student t-test analyses of the collected data were performed alongside with the discussion. Additional questionnaire for the Biology teachers was collected as well in order to help explain the extent to which SHS Biology teachers use technology in teaching Biology. All of the data from this study were intended to complement one another in order to provide evidence for the interpretation of impact of the IIA on the students' performance in Biology. Findings of the study are discussed in the light of available literature.

4.1 Presentation of Results and Findings of the Study According To Research Questions and Hypothesis

RQ 1: To what extent do SHS Biology teachers use technology in teaching?

The first question raised in this study was to find out the extent to which SHS Biology teachers used technology in teaching. To answer this question, the Biology teachers general use of technology and their use of computer in teaching Biology, were examined. As indicated in chapter three, the Biology teachers were made to respond to a five-point Likert scale items on the frequency of engaging in various activities that involved technology.

Biology Teachers General use of Technology

Table 1 shows the percentage of general usage by PRESEC, Osu teachers in the various ICT applications.

Table 1 Proportion of Biology Teachers Ratings of Their General Usage of Technology

	Count in Frequencies				
	Every day	**Once a Week**	**Once a Month**	**Once a Term**	**Never**
Finding information on internet for teaching	1	3	1	0	0
Communication with colleagues and students	1	3	1	0	0
Sending email	1	3	1	0	0
Attaching files to email message	3	1	1	0	0
Preparing teaching notes/materials using MS Word	0	0	1	1	3
Creating spreadsheet (MS Excel)	0	0	0	1	4
Making presentations (Power Point)	0	0	0	0	5
Creating data base (MS Access)	0	0	0	1	4

The results in Table 1 show that 3 out of the 5 Biology teachers in PRESEC-Osu used technology once a week for finding information on the internet for teaching communicating with colleagues and students, sending email and attaching files to email messages. However, only 1 out of the 5 teachers used technology to create spreadsheet (MS Excel) and database (MS Access). The results also show that all the teachers never made presentations in the classroom with Power Point. This indicates that, although majority of the teachers often used technology in general Internet application, very few of them used technology in teaching.

Analysis with Respect to Research Question Two

RQ 2: To what extent will students acquire a Biology concept if ICT is integrated in the teaching and learning of Biology?

In answering research question two, students' relevant previous knowledge about glycolysis was analysed using Pre-Test (SKGT) and also their responses to item 17 of section C, Post Test – SAGT (Appendix I) were analyzed.

Table 2 Distribution of Control Group Students' Understanding of Glycolysis During The Pre-Test

Conception	Number of control Students	Percentage (%)
Sound Understanding	0	0
Partial Understanding	4	8
No understanding	46	92
Total	**50**	**100**

From Table 2, Sound Understanding (SU) represents above average students who were able to score above 55%; Partial Understanding (PU) represents those who were able to score between 35% and 55% and No Understanding (NU) represents students who scored below 35%. No student (0%) showed a sound understanding of glycolysis. However, 8% of the students had partial understanding of glycolysis and as high as 92% of the students had no understanding of glycolysis during the Pre-Test.

Table 3 Distribution of Experimental Group Students' Understanding of Glycolysis During The Pre-Test

Conception	Number of Students	Percentage (%)
Sound Understanding	0	0
Partial Understanding	8	17
No understanding	40	83
Total	**48**	**100**

No student (0%) showed a sound understanding of glycolysis. However, 17% of the students had partial understanding of glycolysis and as high as 83% of the students had no understanding of glycolysis (Table 3).

Table 4 Percentage Distribution of Pre-test of students in the Experimental group and the Control Group

Conception	Percentage (%) of Control Group	Percentage (%) of Experimental Group
Sound Understanding	0	0
Partial Understanding	8	17
No understanding	92	83
Total	**100**	**100**

These results reveal that the control group performed better than the experimental group (Table 4). Unpaired *t*- Test analysis showed that the difference in performance between the control group and the experimental group was statistically significant, ($p<0.05$), (Appendix C). This indicates that the control group had a better previous knowledge of Glycolysis concept than their counterparts in the experimental group. Therefore, it was concluded that there was a statistically significant difference in performance between the control group and experimental group. Hence, the experimental group students were subjected to an intervention by integrating ICT into the teaching and learning of Biology to see if they would acquire a Biology concept better if ICT was integrated into the teaching and learning of Biology.

In answering research question two, students' responses to item 17 of section C (post-test) were analysed. As an intervention, the control group was taught using the traditional instructional approach whilst the experimental group was taught using the ICT integrated instructional approach of teaching and learning of Biology. The

students acquisition of Glycolysis determined using students level of conception ranging from Sound Acquisition of the concept to No Acquisition of the concept. In item 17 of section C, students were to use a diagram to explain in summary the chain reaction in glycolysis (Figure 2). From Tables 2, 3 and 4, Sound Acquisition represents students who were able to write all the five steps correctly, Partial Acquisition represents students who were able to write the first three steps correctly and No Acquisition represents those who could not write the first three steps correctly.

Answer:

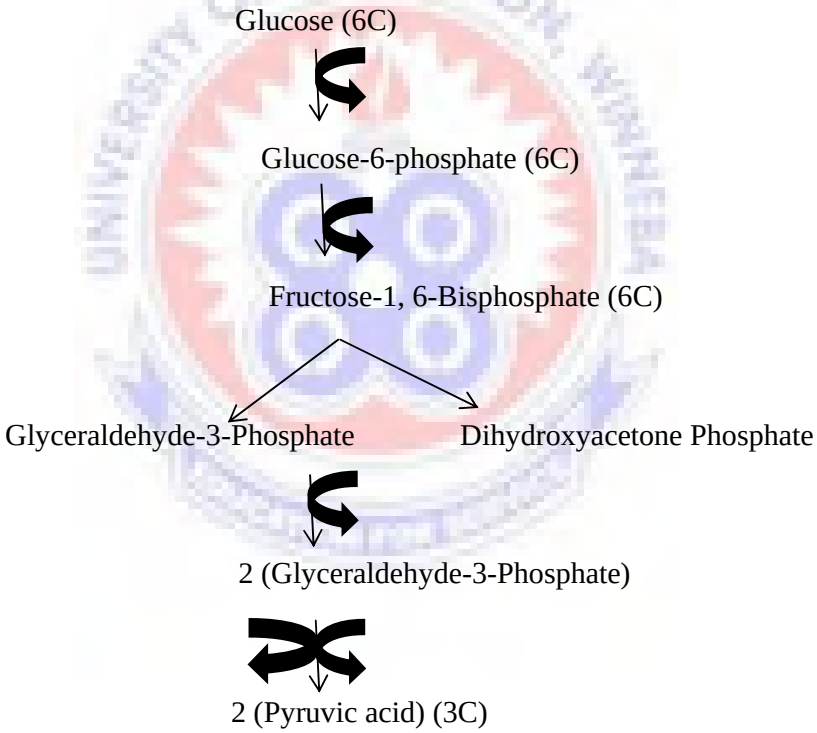

Figure 2 Chain Reactions in Glycolysis

Table 5 Distribution of Control Group Students Acquisition of Glycolysis Concept During The Post-Test

Conception	Number of Students	Percentage (%)
Sound Acquisition	0	0
Partial Acquisition	10	20
No Acquisition	40	80
Total	**50**	**100**

None of the students exhibited a sound acquisition of the chain reaction of glycolysis by providing all the relevant information in the process (Table 4.2c). However, 20% of the students from their marked sheets acquired the concept partially by not stating the energy investment phase which involves the use of ATP to excite and destabilise glucose ($C_6H_{12}O_6$). 80% of the students showed misunderstanding of the concept (Table 5).

Table 6 Distribution of Experimental Group Students Acquisition of Glycolysis Concept During The Post-Test

Conception	Number of Students	Percentage (%)
Sound Acquisition	48	100
Partial Acquisition	0	0
No Acquisition	0	0
Total	**48**	**100**

All the students in the experimental group (100%) showed a sound acquisition of the chain reaction of Glycolysis (Table 6). These results reveal that the experimental

group performed better than the control group (Tables 5 and 6). Students t- test analysis showed that the difference in performance between the experimental group and the control group was statistically significant, ($p<0.001$), (Appendix F). Therefore, the performance of the SHS 3 students exposed to ICT integration instructional approach of teaching and learning of Biology was significantly ($p<0.001$) different from their counterparts exposed to the traditional approach. This indicates that the participants exposed to the ICT integration approach had a better conceptual understanding of glycolysis than their counterparts exposed to the traditional instructional approach. The difference was attributed to the ICT integration instructional approach. Thus, the ICT integrated teaching activities had more positive effect on the understanding of the experimental group than their counterparts exposed to the traditional approach. Hence, students will acquire Biology concepts better if ICT is integrated in the teaching and learning of Biology.

Table 7: Frequency Distribution of Test Scores of students in the Control Group

Marks	Frequency of Pre-Test	Frequency of Post-Test
1-4	0	0
5-8	30	31
9-12	20	19
13-16	0	0
17-20	0	0
21-24	0	0
25-28	0	0
Total	**50**	**50**

Out of 50 students, 60% of them scored marks in the below average performance level (5-8). 40% of the students scored marks within the 9-12 range which is below average in the pre-test. None of the students (0%) scored marks above 12 (Table 7). However, in the post-test after the students were taught by TIA, about 62% of the students still scored marks in the below average performance level (5-8). Also, 38% of students scored marks within the 9-12 range which is also below- average. No student scored marks in the average performance (13-20) and above average performance ranges (21-28).

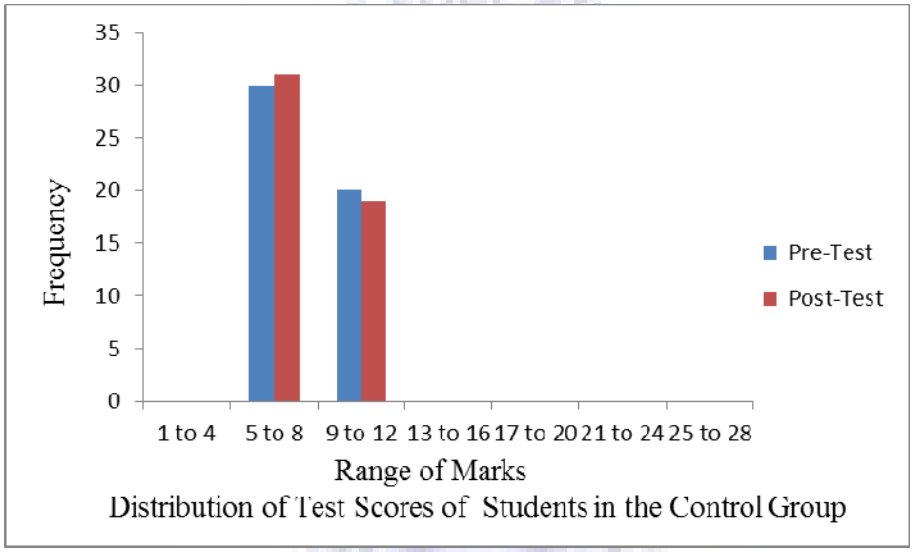

Figure 3 Distributions of Test Scores of Students in the Control Group

The pre-test and post-test can be seen closely plotted against each other. From figure 3, it can be noticed that the pre-test and post-test results of the control group did not differ much in terms of the scored marks obtained. Paired *t*- Test analysis showed that there was no significant differences between the pre-test scores and the post-test scores of the control group ($p > 0.05$). Which means that the students pre-test scores

did not change or there was no significant change after the intervention with traditional teaching method.

Table 8: Frequency Distribution of Test Scores of students in the Experimental Group

Marks	Frequency of Pre-Test	Frequency of Post-Test
1-4	20	0
5-8	24	0
9-12	4	0
13-16	0	0
17-20	0	3
21-24	0	20
25-28	0	25
Total	48	48

Out of 48 students, 42% of the students scored marks within the (1-4) range and 50% scored marks within the (5-8) range which is below average performance level. Also, 4% of the students scored marks within the (9-12) range which is also below average performance. None of the students (0%) scored marks above the 9-12 range. However, after the experimental group were taught by IIA and post-test was administered, no student (0%) scored marks below the average range (1-12) level. About 6% of the students performed averagely (17-20 marks). Also, 42% of the students scored marks ranging from 21 to 24, which is also an average performance level. As high as 52% scored marks from 24 to 28, this is above average performance. These higher marks scored at the above average level and no student scoring marks in

the below average level suggest that IIA of teaching has a higher positive impact on the students' performance in Biology.

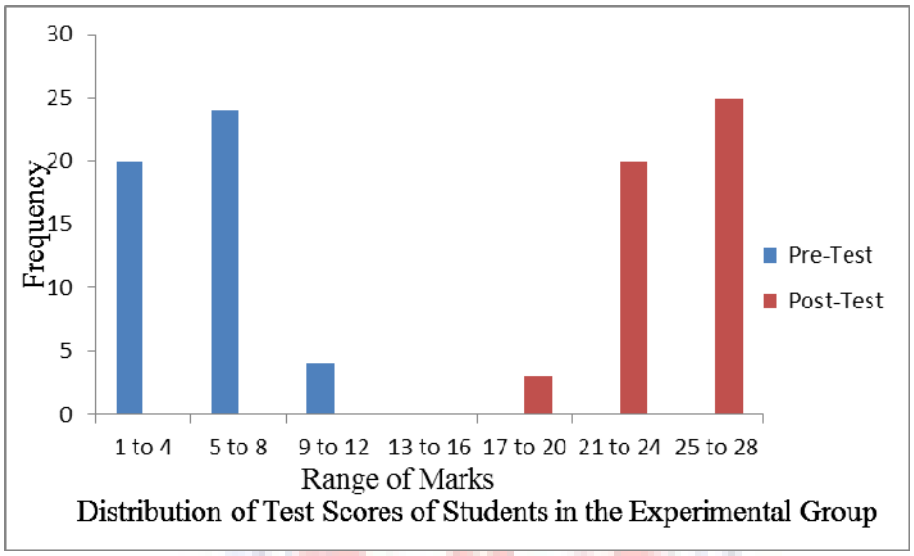

Figure 4 Distributions of Test Scores of Students in the Experimental Group

From Figure 4, the pre-test and post-test scores of the experimental group differed. Paired *t*- test analysis showed that the differences between the pre-test and the post-test scores of the experimental group was statistically significant, ($p<0.001$), as shown in Appendix E. This means that the students' pre-test scores were significantly higher than those of the post-test.

Table 9 shows the results of the post-test of students in the experimental group and the control group. The scores were to determine the performance levels of the two groups.

Table 9: Percentage Distribution of Post-test Scores of Students in the Experimental Group and the Control Group

Marks Score	Percentage(%) of Control Group	Percentage (%) of Experimental Group
1-9	80	0
10-18	20	4
19-27	0	96
Total	100	100

Considering the result in the Table 9, whilst no student scored marks in the below average range from the experimental group as high as 80% of the students scored marks in the same range from the control group. None of the students from control group scored marks in the above average range while as many as 95.8% of the students from experimental group scored above average. These results mean that students learn better and understand the concept of Glycolysis when they are taught by IIA than when they are taught by TIA. Thus, the ICT integration teaching activities had a positive effect on the understanding of Glycolysis by the SHS 3 students.

Analysis with Respect to Research Question Three

RQ 3: What is the significant difference between the performances of male and female students in the experimental group who were exposed to ICT- integrated instructional approach of Biology teaching and learning?

To answer this research question, the pre-test and post-test scores of male and female students in the experimental group were computed and analysed. The analysis was carried out using the t-test statistics as shown in Appendix A. The percentage distribution showing the performances of the male and female students in the experimental group as presented in Table 10.

Table 10: Percentage Distribution of Pre-test of Male and Female students in the Experimental group

Marks Score	Percentage(%) of Males	Percentage (%) of Females
1-9	96	92
10-18	4	8
19-27	0	0

In the Table 10, whilst 96% males scored marks in the below average range 92% of the females scored marks in the same range. Once again, whilst 4% of the males had average marks, 8% of the females had marks in the same range. None of the males or the females scored marks in the above average rang in the pre-test (Table 10).

Unpaired *t*- Test analysis showed that the differences in performance between the --- male and the female students in the experimental group were statistically not significant, ($p>0.05$).

Table 11: Percentage Distribution of Post-test Scores of Male and Female students in the Experimental group

Marks Score	Percentage(%) of Males	Percentage (%) of Females
1-9	-	-
10-18	4	4
19-27	96	96

None of the male or female students in the experimental group scored marks in the below average range. 4% each of both the male and the female students from the experimental group scored marks in the average mark range. Whilst 96% males

scored marks in the above average range, %96 of the female students scored marks in the same range (Table 11).

Unpaired *t*- test analysis showed that the differences in performance between the male and the female students in the experimental group was statistically not significant, ($p>0.05$). The results from the analysis showed that the IIA of teaching was effective for both male and female students in the experimental group. This indicates that their understanding of glycolysis was mostly the same; hence, gender had no influence on the impact of ICT on students' academic performances.

Analysis with Respect to Research Question Four

RQ 4: **What is the significant change in the performance between students exposed to ICT integrated instructional approach and their counterparts exposed to the traditional instructional approach of teaching and learning of Biology?**

To answer research question four, the performances of the students during post-test were determined and analyzed.

Table 12 Distribution of Students Performance of Post-test

Marks of Students	Experimental Group		Control Group	
	No. of Students	(%)	No. of Students	(%)
1-9	0	0	40	80
10-18	2	4.2	10	20
19-27	46	95.8	0	0
Total	**48**	**100**	**50**	**100**

In Table 12, a comparative study of the marks of the control group and the experimental group showed that the experimental group performance was better than the control group. It was noticed that, out of 50 students from the control group, 40 (80%) scored marks between 1 and 9. Meanwhile, 10 (20%) scored marks ranging from 10-18, and no student scored marks in the 19-27 range. From the experimental group, it was seen that, none of the students scored marks within the 1-9 range whilst 2 (4.2%) of the students scored marks within 10-18. Meanwhile, as many as 46 (95.8%) scored marks within 19-27. This indicates that, the experimental group performed quite better than their counterparts in the control group as seen in Table 12.

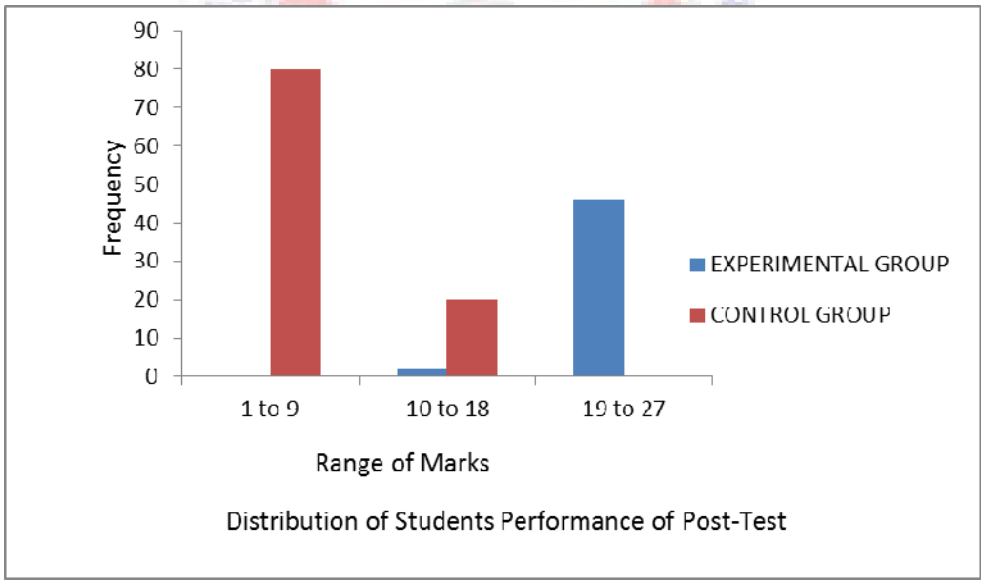

Figure 5 Distribution of Students Performance of Post-Test

Table 13 Comparison of Performances of the Experimental and Control Groups

Groups Compared	Test	Mean	SD	*t* – value	*p* – value
Experimental Group	Post-test	24.21	1.98	46.3913	3.932×10^{-61}
Control Group	Post-test	8.2	1.37		

The mean score for the control group, exposed to the traditional approach to teaching and learning of Biology, on the SAGT was 8.2 (SD=1.37) while that for the experimental group exposed to the ICT integration approach to teaching and learning and learning of Biology was 24.21 (SD=1.98). These results (Table 13) clearly show that the experimental group performed better than the control group.

Unpaired *t*- test analysis showed that the difference in performance between the experimental group and the control group was statistically significant, ($p<0.001$). There was a statistically significant difference in the performances between the SHS 3 students exposed to ICT integration teaching and learning of Biology compared to their counterparts exposed to the traditional approach.

This signifies that the participants exposed to the ICT integration approach had a better understanding of the concept of Glycolysis than their counterparts exposed to the traditional instructional approach. Therefore, it was concluded that there were significant differences in performance between participants exposed to the ICT integration approach of teaching and learning of Biology and their counterparts exposed to the traditional instructional approach. The difference was attributed to the ICT integration instructional approach. The null hypothesis (H_01) was therefore rejected.

4.2 Discussion of Results

The study was conducted to find out the impact of integrating ICT into teaching and learning of Biology in Ghanaian Senior High Schools using PRESEC, Osu. In order to achieve this, four research questions were answered and the hypothesis formulated for the fourth question was tested.

The research question one investigated SHS Biology teachers' use of technology in teaching Biology. The findings revealed that the Biology teachers often use technology for general computer applications such as finding information on the internet for teaching, communicating with colleagues and students, sending emails, attaching files to email messages and preparing notes for teaching. However, the extent to which these teachers use technology in teaching Biology was very low. This finding is consistent with the findings of Banini and Boakye (2008), who also found that majority of the teachers in SHS level in Ghana did not use technology in classrooms but often use technology to prepare lesson notes, browse the web and send emails. The findings are in consonance with Mireku et al (2009) who reported that technology is used in typing examination questions in all institutions and, in some cases, educators use technology in processing students' examination results but very few teachers use technology in their teaching in Ghana.

The finding is also consistent with similar studies carried out in different countries. For instance, Waite (2004) found that even though teachers show great interest and motivation to learn about the potential of technology, in practice the use of technology is relatively low and it is focused on a narrow range of applications, with word processing being the predominant use. Moreover, Becker (2001) concludes that teachers generally use computer technology to support their existing practices

(providing practice drills and demonstration) and communication (such as the use of email) rather than to engage students in learning that involves higher order thinking. This indicates that the use of technology in Biology instruction is yet to be realised and utilised.

It is quite surprising that the extent to which the SHS Biology teachers use technology in teaching is very low, because majority of the teachers believe that technology plays important role in teaching and learning Biology. The Biology teachers' low technology use due to the fact that Biology teachers lack the skill to integrate technology in their teaching, since they had little opportunity to participate in professional development courses related to technology integration.

With respect to research question two, the findings of the study indicated that students learnt Biology concepts better when ICT was integrated in the teaching and learning of Biology. This is because the performance of the SHS 3 students exposed to the ICT integration teaching and learning approach performed better than their counterparts exposed to the traditional instructional approach to the teaching and learning of Biology. The independent measures t – test analysis results indicates that the difference between the means of participants in the experimental group and the control group on the SAGT was significant ($p < 0.05$). In the light of the findings of the study, the ICT integration teaching and learning approach appears to benefit the experimental group, in that, the performance of the SHS 3 students exposed to the ICT integration teaching and learning approach was better than their counterparts exposed to the traditional instructional approach to the teaching and learning of Biology.

This finding is consistent with the findings of Pallof and Pratt (1999), who opine that the ability to build and run complex Biology models and easy exploration of "what if" questions through parametric variation has opened up new avenues for Biology learning. Their finding further revealed that weaker students often are better able to succeed with the help of technology, and come to recognize that Biology is not for the more able classmates. Besides, Kiano (2008) argues that technology enhances learning by furnishing visual images of Biology ideas and organization of concepts and analysis of concepts efficiently and accurately. According to Lim (2002), the use of technology in teaching and learning process enhances and also improves students understanding of concepts. He further argues that ICT integration approach in Biology teaching and learning allows students to focus on strategies and interpretations rather than spending time on memorising concepts. Hence, ICT integration approach in Biology teaching and learning supports constructive pedagogy, wherein students use technology to explain and reach an understanding of Biology concepts in order to improve upon their performance in Biology.

The findings of this study tallies with the research conducted by Hoadley, Gordin, Means, Pea & Roschelle, (2000). They support the use of technology in teaching and learning Biology. Their findings indicate that computer technology can help support learning and it is useful in developing the higher-order skills of critical thinking, analysis and scientific enquiry. According to them ICT integration in teaching and learning in Biology builds confidence and it is a great tool for remediating slower learners to improve upon their performance. National Association of Biology teachers (2002) also observes that the use of technology in Biology classroom saves students from doing their exercises at a slower pace. According to them the power of

technology in teaching and learning of Biology leads to the improvement in students' performance in the Biology classroom to a greater extent.

The study is also in agreement with the research conducted by Wahyudi (2008). According to Wahyudi (2008), ICT integration in Biology lessons enables students to learn from feedback. He explains that ICT integration approach enables students to produce many examples when exploring Biological problems. His findings revealed that the use of technology allows students to work with dynamic images that cannot be done within traditional teaching approach. Drent (2005) also found that the use of ICT in teaching and learning process can promote student-center learning. According to Drent (2005), ICT integration activities in teaching and learning help students to engage in problem-solving and decision making. The findings indicate that, ICT is important for fast and easy learning to process, store and retrieve information, and as such it enables students to improve upon their learning.

The third research question in this study was to investigate whether there was a significant difference between male and female students with respect to understanding of Glycolysis. When the students were instructed using IIA the t-test analysis indicated in Appendix A that there was no significant difference between male and female students ($p > 0.05$). Again, it was established that there was no significant interaction between gender difference and integration of ICT into teaching and learning of Biology in terms of understanding of Glycolysis concepts. This meant that there was no significant difference in academic performances between the male and female students who were instructed by ICT integration instructional approach. The reason why no significant difference was found in this study might be due to the fact

that the ICT integration instructional approach used for the treatment had catered for the learning differences of both male and female students in the experimental group.

The finding of this study is in consonance with the findings of some research works by (Hogarty, 2000; Martin, 2001; Garrison & Kanuka, 2004). They established that there was no significant interaction between gender difference and integration of ICT into teaching and learning. Ramirez (2003) and Liu (2005) also opine that gender has no influence on students' academic performance when ICT is integrated into teaching and learning. This finding was supported by Agbatogun (2006) who also confirmed the results of Ramirez and Liu. The findings are also consistent with a similar research carried out in Cameroon by Tchombe. Tchombe (2008) found that there was no significant difference in performance between male and female students who were instructed by ICT integration instructional approach. He concluded that both male and female students felt that ICT made learning easier.

The study is also in agreement with the research conducted in Cameroon, which confirms that there is no significant difference between male and female students' performances when ICT is integrated into their studies (Mbah, 2010). Similar results have been reported by Kiptalam & Rodrigues (2011) in Kenya. Both researchers concluded that gender had no influence on the impact of ICT on students' academic performances.

Findings with respect to research question four were positive in that the performance of the SHS 3 students exposed to the ICT integration teaching and learning approach was better than their counterparts exposed to the traditional instructional approach to the teaching and learning of Biology. Comparison of students performance after the intervention showed that, the experimental group made the highest mean gains than

the control group. This indicates that the experimental group had better understanding of the concept Glycolysis after the treatment. Thus, there was a significant improvement in the performance of the experimental group over the control group after the treatment. This means that the Biology students who were exposed to ICT instructional approach understood better the concept taught in the study than those who learnt in the traditional approach after the treatment. The findings of this study thus supported the research hypothesis that there is a significant difference between the performances of PRESEC, Osu students exposed to ICT integrated instructional approach and their counterparts exposed to the traditional instructional approach of teaching and learning of Biology.

These findings reaffirm those of Lim (2002), Akour (2006) and, Akpan and Andre (2000), which indicated that the achievement scores of students exposed to ICT integration teaching and learning approach were higher than those students exposed to traditional or conventional approach of teaching and learning method. Akour (2006) has also observed that students taught using traditional instruction combined with the use of ICT integration approach performed significantly better than students taught using only the traditional instructional approach in a college setting. Again, Akpan and Andre (2000) examined the prior use of ICT in learning frog dissection in improving students learning of frog anatomy and morphology. The study of Akpan and Andre (2000) indicated that students who received the prior use of ICT in learning frog dissection learned significantly more anatomy than students who were taught the dissection only without the ICT integration approach to teaching and learning.

The findings are also in consonance with those of Mwei, Too and Wando (2011) and Udousoro (2000) in Mathematics and Bayrak (2008), Karamustafaoglu, Aydin and Ozmen (2005) and Kiboss and Ogunniyi (2003) in Physics and Okoro and Etukudo (2001) in Chemistry. These studies also found that ICT integration approach in teaching and learning was effective in enhancing students' performance better than the traditional approach of classroom instruction in subjects other than Biology. For instance, in a study to investigate the effects of ICT integration approach to teaching and learning on University students achievements in Physics, Bayrak (2008) affirmed that students in the experimental group who were exposed to ICT integration approach to teaching and learning, were more successful than students in the control group who were exposed to face-to-face instruction. Additionally, ICT increases students' engagement in task process. When students are taught using computer or other ICT components, they stay focused and remain on the task with full concentration. Furthermore, ICT decreases students‟ emotional detachment since it arouses students' interest and, therefore, enables the students to fully participate in classroom activities. To elaborate on this notion, Kay (2007) has indicated that students benefit and engage more in task if computers are used as an instructional device. Kay (2007) further asserts that ICT that utilise a visual dimension, including digital video, photography or video conferencing are found to be engaging for students. On the part of students‟ retention of subject matter, the use of ICT decreases students' cognitive load, and memorisation of concepts. This, in turn, helps the students to retain concepts for long period of time; hence, ICT serves as a tool for preventing forgetting. Mierhenry & Wiman (1969) support this statement by stating that:

"…people will generally *remember 10% of what they read, 20% of what they hear,*

30% of what they see and 50% of what they see and hear."

Additionally, the multiple intelligence theory suggests that an individual's capacity for learning is influenced by the manner in which the subject matter is presented. To this end, the effect of ICT on students learning behavior cannot be overemphasized. ICT motivates students, increases their engagement time on task, increases their retentive capacity and enables students to learn on their own.

The study has thus demonstrated that ICT integration in teaching and learning of Biology had a positive impact on SHS 3 Biology students' performance in Biology.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter presents a summary of the findings, conclusions and outlines recommendations including areas for further research.

5.1 Summary of Findings of the Study

The study investigated the impact of integrating ICT into teaching and learning of Biology at PRESEC, Osu. Specifically, it explored the SHS Biology teachers' general technology use in teaching and learning Biology as well as, the differences in performance between the experimental and the control groups in SAGT. Biology teachers and students in PRESEC, Osu in the Greater Accra Metropolitan Assembly of Greater Accra Region were used for the study. Purposive sampling technique was used to select five (5) Biology teachers and ninety eight (98) SHS 3 Biology students for the study. Self-administered questionnaire and tests were used as the instruments for the study. The questionnaire was based on the SHS Biology teachers' general technology use in teaching and learning Biology while the tests were based on the SAGT. The data collected were analyzed using both quantitative and qualitative methods. Descriptive statistics was used to find out the extent to which SHS Biology teachers use technology in teaching and learning of Biology. Descriptive statistics and Independent measures *t*- test were also used to find out if significant differences existed between the experimental and the control groups' performances on the SAGT. The major findings of the study are as follows:

Findings

SHS Biology Teachers use of Technology in Teaching and Learning of Biology

The extent to which SHS Biology teachers in PRESEC, Osu used technology in teaching Biology was very low. The study revealed that majority of the Biology teachers use technology for general applications, such as finding information on the internet for teaching, communicating with colleagues and students, sending emails, attaching files to email messages and preparing teaching notes for teaching. However, the extent to which the teachers used technology in teaching Biology was very low.

Differences in Performance between Male and Female Students in Experimental Group

It was noticed in the study that there was no significant difference between the performances of male and female students in the experimental group when ICT was integrated into the teaching and learning of Biology. The study revealed that the ICT integrated instructional approach catered for the learning differences of both male and female students with respect to learning of a Biology concept. This shows that gender has no influence on students' academic performance when ICT is integrated into teaching and learning of a Biology concept.

Differences in Performance between Experimental and Control Groups

The performance of the experimental group was significantly better than that of the control group on the SAGT, signifying that the PRESEC, Osu SHS 3 Biology students exposed to the ICT integration instructional approach performed significantly better than their counterparts exposed the traditional instructional approach. This indicates that the ICT integration instructional approach had a positive impact on

students understanding of Biology, especially, by enhancing the students understanding of the concepts of glycolysis, and thus improving their performance.

5.2 Conclusions

The study revealed that the extent to which SHS Biology teachers use technology in teaching was very low, even though majority of the teachers believed that technology plays important role in Biology. This was found to be due to the fact that the Biology teachers lacked the skills to integrate technology in their teaching, since they had little opportunity to participate in professional development courses related to ICT integration.

The extent to which the Biology teachers use technology in teaching and learning of Biology is crucial, because the knowledge gained could provide insight into teachers technology use at the SHS level that could be sustainable and transferable to other educational institutions.

The results of the study also imply that students exposed to the ICT integration instructional approach to the teaching and learning of Biology can perform significantly better than their counterparts exposed to the traditional instructional approach. The study has also shown that students exposed to ICT integration teaching and learning activities acquired Biology concepts to a greater extent better than their counterparts exposed to the traditional instructional approach.

5.3 Recommendations

Based on the major findings of this study, it is recommended that:

- Innovative and more effective learner-centered instructional strategies, such as ICT integration instructional activities, should be used by Biology teachers to promote meaningful learning of difficult Biology concepts like Glycolysis. Appropriate ICT instructional activities or packages should therefore be developed or adopted for use in the Ghanaian school system.
- The Heads of the various SHS should organize in-service training in professional development courses related to the integration of ICT in teaching and learning of Biology for their teachers.
- The Heads of the institutions should make budgetary allocations annually to maintain, replace and expand ICT facilities and resources in the schools in order to promote effective integration in the teaching and learning process.
- The Heads of the institutions in collaboration with the Heads of Departments should emphasize the use of computer laboratory exercises during weekends and after classes as part of the co-curricular activities in the Secondary Schools. This will enable the students to get enough time to use laboratory computers in learning Biology.
- The Curriculum Research Development Division (CRDD) of the Ghana Education Service in collaboration with the related agencies in the Ministry of Education should carry out research to review critically the Biology curriculum and revise the existing syllabus to explicitly state what ICT tools must be used and how it should be used in teaching and learning process.
- The Ministry of Education, Ghana Education Service and CRDD and other stakeholders associated with science education should also push for structural

modifications in science education to promote the use of ICT integration instructional activities in the teaching and learning of Biology at the SHS level.

5.4 Limitations of the Study

The following can be considered as limitations to the study. The study was designed to focus on learning Glycolysis by SHS 3 students; hence, the findings may not be generalisable to cover the entire SHS elective Biology syllabus. Also, the study was intended to include all Biology students of PRESEC, Osu in the Greater Accra Metropolitan Assembly but was conducted using only two SHS 3 classes offering elective Biology in the school. The findings may therefore not be generalized to cover all the elective Biology students in PRESEC, Osu in the Greater Accra Metropolitan Assembly.

5.5 Suggestions for Further Studies

The following suggestions are made for further research:

- It is suggested that the study should be replicated to include SHS1 and SHS 2 Biology students in PRESEC, Osu.
- It is suggested that the study should be replicated to include SHS in Accra Metropolitan Assembly.
- Similar studies should be conducted in other regions in Ghana and the results compared with the current findings by stakeholders.
- It is suggested that the study should be replicated using ICT integration instructional activities on other difficult Biology concepts, such as genetics, water transport in plants, protein synthesis, mitosis, meiosis, etc. This would

also provide a basis for greater generalization of the conclusions drawn from the findings of the study.

- Similar studies should be carried out on the use of ICT integration instructional approach on other Science subjects at different levels of Science education, to provide sound basis for the integration of ICT instructional packages in Science education in Ghanaian schools.

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APPENDIX A

t-Test Analysis (Post-Test) with Respect to Research Questions 3

t-Test: Two-Sample Assuming Unequal Variances

	BOYS	*GIRLS*
Mean	24.08333	24.04167
Variance	3.644928	6.389493
Observations	24	24
Hypothesized Mean Difference	0	
Df	43	
t Stat	0.064439	
P(T<=t) one-tail	0.47446	
t Critical one-tail	1.681071	
P(T<=t) two-tail	0.948919	
t Critical two-tail	2.016692	

APPENDIX B

t-Test Analysis (Pre-Test) with Respect to Research Questions 3

t-Test: Two-Sample Assuming Unequal Variances

	BOYS	*GRLS*
Mean	5.043478	5.26087
Variance	3.679842	4.383399
Observations	23	23
Hypothesized Mean Difference	0	
Df	44	
t Stat	-0.36716	
P(T<=t) one-tail	0.357631	
t Critical one-tail	1.68023	
P(T<=t) two-tail	0.715262	
t Critical two-tail	2.015368	

APPENDIX C

t-Test Analysis (Pre-Test) with Respect to Research Question 2

t-Test: Two-Sample Assuming Unequal Variances

	EXPERIMENTAL	*CONTROL*
Mean	5.208333333	8.1
Variance	3.657801418	2.1734694
Observations	48	50
Hypothesized Mean Difference	0	
Df	88	
t Stat	-8.358899045	
P(T<=t) one-tail	4.27036E-13	
t Critical one-tail	1.662354029	
P(T<=t) two-tail	8.54073E-13	
t Critical two-tail	1.987289865	

APPENDIX D

t-Test Analysis (Control Group) with Respect to Research Questions 2

t-Test: Two-Sample Assuming Equal Variances

	PRE TEST	*POST TEST*
Mean	8.1	8.2
Variance	2.173469	1.877551
Observations	50	50
Pooled Variance	2.02551	
Hypothesized Mean Difference	0	
Df	98	
t Stat	-0.35132	
P(T<=t) one-tail	0.363051	
t Critical one-tail	1.660551	
P(T<=t) two-tail	0.726103	
t Critical two-tail	1.984467	

APPENDIX E

t-Test Analysis (Experimental Group) with Respect to Research Questions 2

t-Test: Two-Sample Assuming Equal Variances

	PRE-TEST	*POST-TEST*
Mean	5.125	24.20833
Variance	3.81383	3.913121
Observations	48	48
Pooled Variance	3.863475	
Hypothesized Mean Difference	0	
Df	94	
t Stat	-47.5632	
P(T<=t) one-tail	7.32E-68	
t Critical one-tail	1.661226	
P(T<=t) two-tail	1.46E-67	
t Critical two-tail	1.985523	

APPENDIX F

t-Test Analysis (Post-Test) with Respect to Research Questions 2 and 4

t-Test: Two-Sample Assuming Unequal Variances

	EXPERIMENTAL GROUP	*CONTROL GROUP*
Mean	24.20833333	8.2
Variance	3.913120567	1.87755102
Observations	48	50
Hypothesized Mean Difference	0	
Df	83	
t Stat	46.39134679	
P(T<=t) one-tail	1.9658E-61	
t Critical one-tail	1.663420175	
P(T<=t) two-tail	3.93161E-61	
t Critical two-tail	1.98895978	

APPENDIX G

UNIVERSITY OF EDUCATION, WINNEBA

Department of Science Education

Technology Use in SHS Science Classroom

TEACHERS QUESTIONNAIRE

Dear Colleague,

The purpose of this questionnaire is to gather data on your observations on Technology Use in SHS Science classroom in your school. Your thoughtful and truthful responses will be greatly appreciated. Please answer each question to the best of your knowledge. Your name is not required. Your responses will be kept completely confidential. Thank you for taking time to complete this questionnaire.

INSTRUCTIONS

Please tick [√] in the appropriate space provided below and supply answers where required.

A. Background Information

1. Gender Female ☐ Male ☐
2. Age…… years
3. Teaching experience…….. years
4. Do you have a computer laboratory in your school? YES ☐ NO ☐

b. If yes, how many computers are there in the laboratory? .....

c. If yes, how many of the computers are in good use? …….

5. Are any of the computers connected to internet? YES ☐ NO ☐

b. If yes, how many? …….

6. Do you have a personal computer? YES ☐ NO ☐

7. Do you have Projectors in the ICT laboratory? YES ☐ NO ☐

Is it connected to the internet? YES ☐ NO ☐

8. Are specialized software for teaching Biology installed on the laboratory computers? YES ☐ NO ☐

9. Have you participated in professional development courses related to the integration of ICT in teaching and learning of Biology?

YES ☐ NO ☐

B. Teachers Technology Usage

10. Do you use computers to do the following activities? Please tick.

	I use computers	Yes	No
(i)	To find information on internet for teaching		
(ii)	To communicate with colleagues and students		
(iii)	To prepare teaching notes/materials using MS word		
(iv)	To make presentations (PowerPoint)		
(v)	To send email		

C. Teachers Technology Usage

11 a. How often do you use technology in the following areas? Please, rate your frequency of usage: *Everyday, Once a week, Once a month, Once a term or Never.*

	I use computers					
(i)	To find out information on internet for teaching					
(ii)	To communicate with colleagues and students					
(iii)	To prepare teaching notes/materials using MS word					
(iv)	To make presentations (PowerPoint)					
(v)	To send email					

D. Ability to use Technology

12. How would you rate your ability in using computers?

	Rate your ability to do the following using computers					
(i)	Finding information on internet for teaching					
(ii)	Communicating with colleagues and students					
(iii)	Preparing teaching notes /materials using MS word					
Iv)	Making presentations (PowerPoint)					
(v)	Sending emails					

13. Give two (2) reasons why you think using technology in Biology classroom would be beneficial to teachers

(i)……..……

……

(ii)……

……..……

14. Give two (2) reasons why you think using technology in Biology class would be beneficial to students

(i)……

……

(ii)……

……

APPENDIX H

UNIVERSITY OF EDUCATION, WINNEBA

SCIENCE EDUCATION DEPARTMENT

(PRE-TEST) DATA COLLECTION INSTRUMENT FOR M.PHIL IN SCIENCE EDUCATION THESIS RESEARCH

NAME OF PARTICIPANT……..

GENDER OF PARTICIPANT……

CLASS……

GENERAL INSRUCTIONS: This test contains twenty (20) questions grouped in three (3) sections, namely, sections A,B and C. Please answer ALL the questions in ALL three sections of the test.

SECTION A

MULTIPLE CHOICE QUESTIONS

INSTRUCTIONS: The following questions are followed by four options lettered A to D. Find out the correct option and circle A, B, C or D to indicate your answer.

1. The primary energy substrate for cell activity is known as……

   (a) Amino Acids (b) Glucose (c) Vitamins (d) Fats

2. All constitute the three phases into which cell respiration is divided EXCEPT?

   (a) Glycolysis (b) Respiratory chain

   (c)Kreb's cycle (d) Respiratory synthesis

3. How many NADH are produced by glycolysis per glucose?

   (a) 1 (b) 2 (c) 3 (4)

4. How many carbon atoms are contained in a molecule of glucose?

   (a) 2 (b) 5 (c) (d) 6

5. Bacteria living in the soil can perform …… respiration.

(a) Aerobic (b) Tissue (c) Anaerobic (d) Cellular

6. Glucose → Ethanol → Carbon dioxide + Energy

The equation above is undertaken by?

(a) Yeast (b) Bacteria (c) Sucrose (d) pepsin

7. Enzymes are influenced by the following EXCEPT?

(a) Heat (b) pH (c) Light (d) Heavy metal ion

8. In Eukaryotes, glycolysis and fermentation takes place in the?

(a) Lysosome (b) Nucleus (c) Mitochondrion (d) Cytoplasm

9. Respiration includes three phases EXCEPT?

(a) Pulmonary ventilation (b) Diffusion of gases

(c) Transport of oxygen (d) Transport of carbon dioxide

10. One mole of glucose releases …….. of energy

(a) 2880kJ (b) 1880kJ (c) 2080kJ (d) 1080kJ

SECTION B

Choose True or False

11. Lactic acid causes muscles to cramp. True or False

12. Tissue respiration is getting energy out of glucose. True or False.

13. Nitrogen remains unchanged in both inspired and expired air? True or False.

14. Breathing is difficult at high altitude because atmospheric air pressure at high altitude is too low. True or False.

15. Glycolysis takes place in the nucleus. True or False.

SECTION C

16. What are enzymes?

17. How many ATP molecules are produced for each glucose molecule used in aerobic respiration?

18. (i) What is Glycolysis?

(ii) Mention two products of this process?

19. Define the following terms

(i) Aerobic respiration (ii) Anaerobic respiration

20. In which structure does exchange of gases takes place in the respiratory system of humans?

APPENDIX I

UNIVERSITY OF EDUCATION, WINNEBA

SCIENCE EDUCATION DEPARTMENT

(POST-TEST) DATA COLLECTION INSTRUMENT FOR M.PHIL IN SCIENCE EDUCATION THESIS RESEARCH

NAME OF PARTICIPANT……..

GENDER OF PARTICIPANT……

CLASS……

GENERAL INSRUCTIONS: This test contains twenty (20) questions grouped in three (3) sections, namely, sections A,B and C. Please answer ALL the questions in ALL three sections of the test.

SECTION A

MULTIPLE CHOICE QUESTIONS

INSTRUCTIONS: The following questions are followed by four options lettered A to D. Find out the correct option and circle A, B, C or D to indicate your answer.

1. How many carbon atoms are contained in a molecule of glucose?

(a) 2 (b) 5 (c) (d) 6

2. How is the energy obtained to synthesize ATP from the biochemical reactions of glycolysis?

(a) The energy is derived from spilling oxygen molecules

(b) The energy is derived from the substrate level phosphorylation

(c) The necessary energy is derived from the liberation of carbon dioxide from glucose molecules.

(d) Light provides the necessary energy.

3. The energy substrate for cell activity is known as?

(a) Amino Acids (b) Glucose (c) Vitamins (d) Fats

4. All the following constitute the three phases into which cell respiration is divided EXCEPT?

(a) Glycolysis (b) Respiratory chain

(c)Kreb's cycle (d) Respiratory synthesis

5. How many NADH are produced by glycolysis per glucose?

(a) 1 (b) 2 (c) 3 (d) 4

6. Which of the biochemical pathway does not require oxygen?

(a) Glycolysis (b) Matrix reaction

(c) Electron transport system (d) Glycolysis and fermentation

7. All the following are true of pyruvate EXCEPT?

(a) Enters mitochondrion (b) It is decarboxylated

(c)It is dehydrogenated (d) It does not combine with co-enzyme A.

8. How many ATP are used up in Glycolysis per glucose?

(a) 2 (b) 4 (c) 8 (d) 12

9. In an anaerobic environment, which set of reactions directly follow glycolysis?

(a) Kreb's cycle (b) Electron transport chain

(c) Fermentation (d) Conversions

10. Which one of the following is the third molecule in the glycolysis pathway?

(a) Glucose-6-phosphate (b) Fructose-1,6- Bisphosphate

(c) Phosphoenol (d) 3-phosphoenol

SECTION B

Choose True or False

11. An isomerization reaction occurs converting Glucose-6-phosphate to Fructose-6-phosphate. True or False.

12. Some ATP is created through substrate level phosphorylation. True or False.

13. The co-enzyme NAD is a key electron carrier in biological redox reactions. It exists in two forms, one oxidized (NAD^+) and the other reduced ($NADH + H^+$). True or False.

14. Hexokinase is an enzyme involved in Glycolysis. True or False.

15. The first step of glycolysis is irreversible. True or False.

SECTION C

16. List any two ways of how ATP is utilized in the animal.

17. With the use of a diagram, explain in summary the chain of reactions in glycolysis.

18. (i) Outline the net products of Glycolysis.

    (ii) What is the fate of pyruvic acid under anaerobic condition?

19. State the full meaning of the following

    (i) NAD (ii) ATP

20. State one difference between aerobic and anaerobic respiration.

APPENDIX J

MARKING SCHEME FOR PRE-TEST

SECTION A

1. B
2. D
3. B
4. D
5. C
6. B
7. C
8. A
9. D
10. A

SECTION B

11. True
12. True
13. True
14. True
15. False

(Scoring: 1 mark each) **Sub-total = 15 marks**

SECTION C

16. Enzymes are organic catalysts which are found within living organisms to speed up certain biochemical reactions that take place within the organisms. (1 mark)

17. Two Molecules (1 mark)

18. (i) Glycolysis is a series of enzyme catalyzed reactions in the cytoplasm which involves a stepwise breakdown of glucose to pyruvic acid with a net gain of two molecules of ATP and the formation of NADH molecules. (1 mark)

    (ii) Energy, Lactic acid (1 mark)

19. (i)Aerobic respiration is a series of enzyme catalyzed reactions in the cell in which organic molecules mainly glucose is broken down in the presence of oxygen to release energy as ATP molecules. (1 mark)

    (ii)Anaerobic respiration is the incomplete oxidation of glucose to carbon dioxide and alcohol or lactic acid with the release of low amount of energy. This takes place in the absence of oxygen. (1 mark)

    20

20. Alveolus (1 mark)

APPENDIX K

MARKING SCHEME FOR POST-TEST

SECTION A

1. D
2. C
3. B
4. D
5. D
6. C
7. C
8. A
9. A
10. B

(Scoring: 1 mark each) Sub-total = 10 marks

SECTION B

11. True
12. True
13. True
14. True
15. True

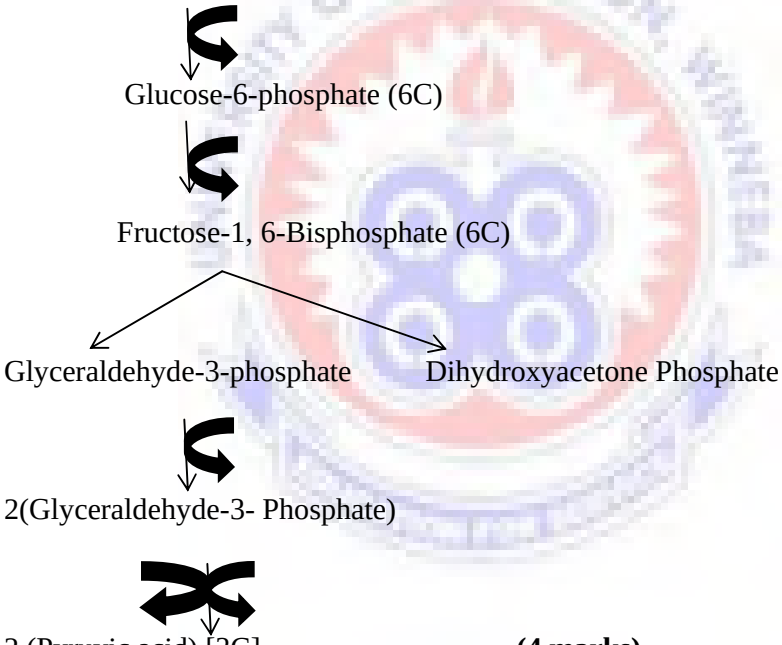
(Scoring: 1 mark each) Sub-total = 5 marks

SECTION C

16. It is used;

- in muscular contraction for movement and doing work
- for nerve impulse transmission
- for transport of materials against concentration gradient in the cell
- in the synthesis of materials such as protein, hormones and degradation of materials, example glucose.
- for cell division and secretory activities. **(1 mark for 2 correct points)**

17. Glucose (6C)



(4 marks)

18. (i) The products are;

- Electrons as H^+ ions
- 4 ATP molecules (giving a net gain of 2ATP molecules)
- Two molecules of a 3-carbon compound called pyruvic acid **(2 marks for two correct points)**

- (ii) Under aerobic condition pyruvic acid enters the Kreb's cycle as Acetyl Coenzyme A and combines with oxaloacetic acid to form citric acid. The citric acid is degraded in stepwise manner to form NADH, $FADH_2$, one ATP molecule and carbon dioxide molecules. The NADH and $FADH_2$ are oxidized in the electron transport chain to produce large amounts of ATP molecules. **(2 marks)**

19. (i) NAD (nicotinamide adenine dinucleotide) **(1 mark)**

(ii) ATP (Adenosine triphosphate) **(1 mark)**

20.

Aerobic Respiration	Anaerobic Respiration
Occurs in the presence of oxygen	Occurs in the absence of oxygen
Complete oxidation of glucose	Incomplete oxidation of glucose
Large amount of energy produced	Low amount of energy produced
Alcohol or lactic acid is not produced	Alcohol or lactic acid produced

(1 mark for one correct point)

APPENDIX L

Mean Scores on SKGT of Intact Classes Included in the Study

Class	Group	Mean Score
3 Science	Control Group	8.1
3 Home Economics	Experimental Group	5.21