UNIVERSITY OF EDUCATION, WINNEBA

THE EFFECT OF COMPUTER SIMULATION AND CONCEPT MODEL ON SELECTED SHS STUDENTS'CONCEPTUAL UNDERSTANDING OF CELL CYCLE

VERONICA VIDZRO

2018

UNIVERSITY OF EDUCATION, WINNEBA

THE EFFECT OF COMPUTER SIMULATION AND CONCEPT MODEL ON SELECTED SHS STUDENTS' CONCEPTUAL UNDERSTANDING OF CELL CYCLE

VERONICA VIDZRO

(8150130007)

A THESIS IN THE DEPARTMENT OF SCIENCE EDUCATION, FACULTY OF SCIENCE EDUCATION SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, AND WINNEBA IN PARTIAL FULFILLMFNT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF PHILOSOPHY (SCIENCE EDUCATION) DEGREE.

JANUARY, 2018

DECLARATION

Candidate's Declaration

I, **VERONICA VIDZRO**, hereby declare that this thesis, with the exception of quotations and references contained in published works which have been identified and acknowledged, is entirely my own, work, and it has not been submitted, either in part or whole, for another degree elsewhere"

Signature ………………………………………..

Date……………………………………………..

Supervisors' Declaration

I, **DR. JAMES AWUNI AZURE** hereby declare that the preparation and presentation of this thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Education, Winneba.

Signature ………………………………………..

Date……………………………………………

ACKNOWLEDGEMENTS

I wish to first of all thank the almighty God Jehovah to whom I owe my life, my refuge, my breath of life, for his love, protection, care and sustenance during the period of this study. I am grateful for how far He has brought me. I acknowledge the support and guidance I received from Dr. James Azure my supervisor, I will forever remain grateful to him for all his suggestions corrections and encouragement which made it possible for me to come out with this thesis. I am indebted to Prof. Yaw Ameyaw and Prof. Eminah for their criticisms and corrections, I am grateful.

To all lecturers in the Science Department I say thank you. I would like to thank Mr. Albert Eshun, my able Head of Science Department Saltpond Methodist High School, for his immense support in diverse ways to ensure that this study is completed, I am grateful. I also wish to thank Mr. Abbassah Kwofie of Methodist High School for his words of encouragement.

My acknowledgement is incomplete if I fail to thank my sister and friend Isabella Agbesi for her immense support and encouragement which made it possible for me to complete this work.

I am also grateful to my husbands for his support. Lastly to the heads and staff of the schools I used for my studies, the authors of the books and materials I used and all who contributed in diverse ways to make this project successful, I say a big thank you and may the almighty God, Jehovah richly bless you all.

DEDICATION

This work is dedicated to my dear children Aba, Ewurama, Kukua, and Kiki and to my father J.M. VIDZRO and my dear sister Gloria Vidzro also to my husband Mr. Samuel Kwesi Kittah

TABLE OF CONTENTS

Content **Page**

LIST OF TABLES

LIST OF ABBREVIATIONS

MOE:	Ministry of Education
GES:	Ghana Education Service
GAST:	Ghana Association of Science Teachers
CRDD:	Curriculum Research and Development Division
WASSCE:	West African Senior School Certificate Examination
BIOPET:	Biology Performance Test
SHS:	Senior High School
STATCC:	Students Achievement Test of Cell Cycle
Specific Misconception:	Specific Misconception
SU:	Specific Understanding
PU:	Partial Understanding
NU:	No Understanding
PUWSM:	Partial understanding with specific misconception

LIST OF APPENDICES

ABSTRACT

This study investigated the effect of Computer Simulation and concept model on selected Senior High School conceptual understanding of cell cycle. The target population was SHS biology students in the Central Region of Ghana. The accessible population was second year elective biology students in Mfantseman Municipality in the Central Region. The study employed quasi-experimental design and 70 second year elective biology students were purposively selected to participate in the study. Two instructional instruments namely computer simulation and concept model were introduced to the students. Data was collected using interview schedule and tests. The data collected were analysed using SPSS version 20. Some quantitative data was analysed using means and simple percentages. The result of the study that students who were exposed to computer simulation and concept model performed better than their counterparts who were taught through the traditional method. Additionally, the research indicated that using Computer simulation and concept model in teaching cell cycle improved students" knowledge and sustained their interest as it changed the abstract nature of the concept to concrete for easy understanding. Again the study revealed that students in the experimental had higher mean scores in the posttest than those in the control group. The study further indicated that statistically, CAI has no influence on the performance of gender in cell cycle. Therefore emphasis must be placed on the use of Computer Assisted Instruction (CAI) and concept model in the teaching and learning of biological concepts. Methodist Senior High School and Kweigyir Aggrey Secondary Technical School should have an equipped computer and Information Technology (ICT) laboratory connected to internet to ensure an effective integration of Computer Simulation in teaching.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This write up discusses the background to the study, problem statement, purpose of the study, objectives, research questions, significance of the study, delimitation, limitation and definition of terms, abbreviations and organization of the study.

1.1 Background to the Study

Biology is a science subject being taught at the senior secondary school. Biology appears to be the most popular science subject at the secondary level. Biology teaching helps learners to understand biological concepts, principles theories and laws. Among others, the objectives of teaching biology at secondary school level as stated by the Nigeria National Policy on Education F.M.E (2004) involve ability of the learners" to develop an awareness of the environment, to have meaningful and relevant knowledge in biology necessary for successful living in a scientific and technological world and to make room for technological advancement. One of the rationale for teaching biology at stated by the Ministry of Education (2010) in the teaching syllabus for elective biology is for the survival of human and the development of the nation.

Biology occupies an important position in the school curriculum and it is central to many science related careers such as biochemistry, Medicine, veterinary practice, nursing. Pharmacy, Entomology, midwifery and Public health due to the skills, knowledge, and attitudes acquired through the study of Biology However some topics in Biology appear to be difficult for students. Johnstone and Mahmoud (1980) suggested that genetics was one of the challenging topics in

Biology. Lazarowitz and Penso (1992) identified cells, physiological processes and hormonal regulation as difficult topics in Biology. According to Bahar, Johnstone and Hansell (1999) monohybrid, dihybrid crosses and Linkages in genetics, meiosis, central nervous system, alleles and genes as being topics of highest difficulty. Finly, Stewart, and Yarrock (1982) identified protein synthesis, photosynthesis, cellular respiration, Mendellian genetics and cell division as complex yet important for students . These topics they said actually lower the overall performance of students in biology. It is in the light of this that the researcher has decided to employ computer simulation and concept model in the teaching of cell cycle to improve selected Senior Secondary School students" conceptual understanding of cell cycle.

Cell cycle is a vital topic which is not taught in isolation. Relevant knowledge of other topics such as cytology, cell Biology, Deoxyribonucleic acid (DNA) replication, Replication of chromosome and Genetics are crucial in understanding of this topic, hence teaching of cell cycle requires much effort and time.

There are some difficulties in the teaching of cell cycle and these includes misconceptions which may arise from learning experiences (Driver & Bell,1986): these conceptions often persist after instruction and these may be due to students level of concrete or abstract cognition (Piaget, 1929).These misconception may persist throughout the students course of studies despite teachers repeated instruction even at higher levels. Teaching -learning strategies employed by Teachers are another possible source of students difficulties in learning these biology concept (Tekkaya, Ozkan, & Sungur,2001). Although goals and objectives are the main points that direct teaching methodology, systematic and properly planned lesson presentations are essential in effective teaching. The focus of the study is not only on what students should learn, but how to teach them and present different topics to learners .Poor performance in science can also be blamed on overcrowded classroom where individual attention is lacking and assessing students becomes very challenging. Poor teaching and learning material and lack of adequate relevant science equipment, are among the causes of poor performance of students in science (Abdullahi, 1982; Bajah ,1979; Ogunniyi ,1979; Kareem, 2003) Students poor performance in biology can be attributed to gender differences, missed ability groups, too large classes, overloaded biology syllabus , ill-equipped laboratories among others (Ajayi, 1998). Most students find it difficult to learn mitosis and meiosis concepts. These difficulties can be attributed mainly to terminology and abstract level of these concepts. Terminology is very complicated and includes many foreign terms such as chromosome,gene, allele, chromatid, and DNA. Students always mixed these terms with each other especially gene and allele. Students generally memorized these concepts and forgot them after some time. Tolman (1982) Suggested that the difficulty in learning meiosis and genetics came from the sequence in which in these topics were presented in biology textbooks. Stewart (1983),Cho, Kahle and Norland (1985) stressed the importance of relationships among the concept of meiosis and genetics and the ambiguous and incorrect use of genetic concepts in textbooks. These factors presumably create difficulties not only in genetics but also other concepts in biology such as photosynthesis and respiration (Asci,Ozkan & Tekkaya, 2001; Capa, 2000) .Kearsey and Turner, (1999) Suggested that figures presented in a text book have an important roles in explanation, contextualization, and illustration of the text. They concluded that learning from text book is enhanced by the presence of figures hence improvement to figures in the textbooks are necessary to reduce students difficulties. Teachers ability to devise innovative ideas is very crucial in increasing students understanding of biological concepts .It is obvious that no students intending to take up many science related careers can do without the studying of biology.

Gender difference on biology as a subject has been the area of interest to many researchers and curriculum planners (Cakiroglu, 1999; Shamai, 1996).This study aimed at using computer simulation and concept model in the teaching and learning of the cell cycle in order to eliminate the abstract nature of this concept so as to make the concept real to improve students‟ performance in biology as a whole.

Our modern world is dominated by science and technology and our country is not is left out. In almost all institutions, students spend hours absorbed in some of these technologies such as you tube, whatsapp, instagram, face book and other computer games. Engaging in these technology may seems time wasting but some of these technologies such as digital gaming, social networking and computer simulation deserve a second look (Chalmers, 2000).Although these technologies are perceived by many people as entertainment, their effect on how students learn, interact and reason cannot be overlooked . For many years computer as one of the tools of information communication technology continue to influence and advance our lives in countless ways.

The computer simulation also has the option of allowing students to perform experiments while using models that give an integrated visual depiction for the set of concepts involved.

Computer simulation and concept model are very important tools in improving the conceptual understanding of cell cycle among Ghanaian students at the second cycle level.

Conceptual model is the representation of system made of the composition of concepts which are used to help someone know, understand, or stimulate the subject the model represents. It can also be defined as visual representation of set of ideas that clarifies the concept. Physical model is the smaller or the larger visible copy of an object.

Scientists have used model systems not only to help them understand new phenomena and to explain these phenomena to others, but also to do simulations of actual experiments. Simulation is then defined as the dynamic execution or manipulation of the model system (Barton, 1970).

Significantly, Gentner and Toupin (1986) have found that at least by age 8 children are able to understand such relational models in a nonscientific context. This finding suggests that students may be ready to understand appropriate relational models in science and that such model can be used as an important tool in science education. Computer technology offers new possibilities for designing model systems for science teaching. Visual model gives object attributes, and relations of the referent domain this is called "pictorial models" because they represent visual attributes. The pictorial computer simulation can be used to extend the range of the students' experience, performing more experiments or performing experiments that would be difficult for him/her to do. For example, in Operation: Frog (Goldhammer & Isenberg, 1984), the student can gain experience in performing dissections, and in Measurements: Length, Mass, and Volume (Blake & Grenetz, 1984) the student can gain experience with obtaining basic measurements of objects on the computer screen. They also mentioned here that the core idea behind the pictorial model could be generalized such that the pictorial model would be one in a class of models that attempt to provide might be explore how these sounds or rhythms change under different conditions. While such a class of models can provide a rich array of experiences, we believe that more experience is not necessarily enough to ensure in the manner of an expert. They believe that the student often needs something different,something that will put the student into direct contact, not only with the observable aspects of objects, but with representations of intrinsically unobservable attributes and relations that are relevant to understanding a particular phenomenon offer great flexibility as providers of modeled systems. The designer can use iconic or abstract representations. Iconic symbols are readily interpretable, because they generally look as close as possible to how reality looks. Frog example, in the Operation: Frog software, the frog on the screen looks like a real frog. With more abstract symbols, the conventions used may not be immediately obvious from the visual itself.

1.2 Statement of the Problem

The elective Biology syllabus for the Senior High Schools(SHS) has concepts such as cell cycle, respiratory quotient, protein synthesis, enzymatic reactions in mitochondria, and Krebs, s cycle. Under the topic cell cycle the specific objectives stated that students should be to explain the term cell cycle, outline the phases of cell cycle, describe the process of mitosis and its importance. However, cell cycle is among the Biology topics poorly understood by students and perceived by many teachers to be difficult and abstract (Songer & Mintzes,1994) .Chief examiner‟s report 2007-2013 stated clearly that there was a decline in biology performance especially in Paper1. The chief examiner suggest that in overcoming the weaknesses teachers should make conscious effort to cover the syllabus and also to make the teaching of science practical based and meaningful to enhance students understanding and interest. Biological concepts such as protein synthesis, glycolysis, biochemical nature of photosynthesis, cell cycle must not be taught in abstract.The Chief Examiner‟s report (2013) also stated that many candidates could not define breeding, meiosis and mitosis scientifically. More work he said has to be done in the schools to upgrade the knowledge of students in these areas. Again poor performance was ascribed to candidates for Chemistry and Biology in the Chief Examiner‟s Report of 2011. Some candidates were said to have demonstrated insufficient understanding of subject-matter in that same report. At annual GAST conferences, Cell Cycle runs through the topics most participants perceive as challenging at the Biology panels.

A pretest administered by the researcher proved that second year Home Economics students of Methodist Senior High School, Saltpond, did not understand the concept of cell cycle. Kolawole (2008) observed that the teaching approach employed by a teacher is one of the important causes of poor performance of students in science subjects in WASSCE.

In an attempt to cover the syllabus before WASSCE most teachers employ the lecture method which does not stimulate students creativity ,innovative and inquiry skills ,and other desirable scientific skills.

The teacher centered approaches where students are passive recipients of knowledge are being practiced in most of secondary schools today.

It is in the light of these observations that the researcher has decided to use computer simulation and concept model to enhance the understanding of this seemingly abstract concept.

1.3 Purpose of the Study

The main purpose of the study are to determine the effect of computer simulation and concept model in the teaching and learning of cell cycle among second year elective Biology students of Methodist Senior High School, Saltpond and Kweigyir Aggrey Secondary Technical,Anomabu as opposed to the lecture and the teacher centered methods of teaching.

1.4 Objectives of the Study

The objectives of the study are to :

1. To examine students preconception about cell cycle before intervention.
2. To determine the impact of computer simulation and concept model on the performance of students exposed to it and those taught using traditional method.
3. To determine if computer simulation and concept model influence the performance of gender with respect to cell cycle.

1.5 Research Questions

The following research questions were used for the study:

1. What is the students‟ understanding of cell cycle before being exposed to computer simulation and concept model?
2. To what extent does the performance of the experimental group and the control group students differ with respect to cell cycle before the intervention?

3. To what extent does the performance of students exposed to the computer simulation and concept model differ from their counterpart taught by the traditional method?
4. To what extent is the performance of gender influence by computer simulation and concept model interventions?

1.6 Research Hypotheses

The following research hypotheses were tested in the study:

Ho1: There is no significant difference in the performance of students exposed to computer simulation and concept model and those exposed to the traditional method of instruction.

Ho2: There is no significant difference between the performance of male and female students in cell cycle when exposed to computer simulation and concept model.

Ho3: There is no significant difference in the performance of the experimental and control group of students‟ preconceptions about cell cycle.

1.7 Delimitation

The study considered only students selected from two public Senior High Schools in the Mfantseman Municipality. This is because the public schools use similar curriculum given by Ghana Education service. The study specifically delved into the impact of computer simulation on selected SHS students‟ conceptual understanding of cell cycle other teaching methods in the field of technology were not considered. The study was restricted to second year Science and Home Economics S.H.S students due to time and financial constrains more so analysis of the Biology WASSCE results shows that most students especially Home Economics do not perform well. The study could not cover other challenging topics in biology such as Genetics, DNA replication, protein synthesis, cellular respiration, photosynthesis but restricted to cell cycle.

1.8 Limitations

Purposive sampling technique employed by the researcher decreases the generalization of the findings hence the study could not be generalizable to all areas of teaching science. A larger sample size could have generated more accurate results in the statistical tests. Another limitation was that some students were truant during the intervention stage and this could affect their understanding of the concept.The semi-structured interview structured interview required a lot preparation hence time consuming.

1.9 Significance of the Study

It is hoped that the outcome of this research would enable teachers especially biology teachers to appreciate the importance of concept model and computer simulation in the teaching and learning of challenging topics in biology.

The researcher presumes that the outcome of the study would improve students understanding of cell cycle and demystify the view that the teaching and learning of cell cycle as a concept in Senior High School is difficult.

The researcher also anticipates that the study would encourage science teachers in the Mfantseman Municipality to employ more effective and innovative teaching methods to help students embrace meaningful learning and avoid rote learning of biology concepts. And also advocate for the use of computer assisted instruction in the teaching and learning of biology concepts in the Mfantseman Municipality.

1.1.1 Organisation of the Thesis

The write up of the Thesis consisted of six chapters. The first chapter is about the introduction to the study , the second chapter focuses on review of related literature for the study. The third chapter discusses the methodology employed for the study, the fourth chapter is about the presentation of the results, chapter five is devoted to the discussion of the results and chapter six present the summary of the study , conclusions and recommendations.

1.1.2 Definition of Terms

Concept model :Is defined as visual representation of set of ideas that clarifies the concept.

Physical model: Is the smaller or the larger visible or tangible copy of an object.

Simulation : Is the method of mimicking reality so that it would be better understood, it also involves representing reality of physical or social interaction**.**

Experimental group: Refers to students who would be exposed to computer simulation and concept model in learning cell cycle. This the group that would receive the treatment.

Control group: Refers to students who would not be exposed to computer simulation and concept model. This group would not receive the treatment but would be taught using the usual traditional, lesson notes, marker and board method.

Conventional Approach :Refers the traditional method of teaching with lesson notes and prepared teaching notes only.

Technological literacy: competency in the use of information and communication technology. It involves the ability of an individual to effectively use technology to access, evaluate, integrate, create and communicate information to enhance a learning process through problem solving and critical thinking.

Sound Understanding: It is the ability of the student to explain and outline phases of cell cycle, state areas in plants and animals where meiosis and mitosis occur and also state the products of meiosis and mitosis cell division.

Partial Understanding: It is the ability of the student to explain and outline phases of cell cycle, state areas in plants and animals where meiosis and mitosis occur and also state the products of meiosis and mitosis cell division but omits quiescent phase.

Partial Understanding with specific misconception: It is the ability of a student to explain cell cycle but replaces the phases of cell cycle with stages of mitosis and meiosis and could not state areas in plants and animals where meiosis and mitosis occur correctly and also fail to state product of mitosis cell division correctly.

Specific misconception: It is the ability of the student to explain cell cycle but outline phases of interphase instead of phases of cell cycle and state reproductive cells as areas in animals and plants where mitosis occur and also exchange the products of meiosis with mitosis cell division.

No understanding: Inability to explain cell cycle and outline the phases of cell cycle. Failure to mention reproductive and somatic cells areas where meiosis and mitosis occur respectively and inability to state the product of mitosis and meiosis correctly.

1.1.3 Abbreviations

MOE:	Ministry of Education
GES:	Ghana Education Service
GAST:	Ghana Association of Science Teachers
CRDD:	Curriculum Research and Development Division
WASSCE:	West African Senior School Certificate Examination
BIOPET:	Biology Performance Test
SHS:	Senior High School
STATCC:	Students Achievement Test of Cell Cycle
Specific Misconception:	Specific Misconception
SU:	Specific Understanding
PU:	Partial Understanding
NU:	No Understanding
PUWSM:	Partial understanding with specific misconception

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter discusses the theoretical framework of the study, empirical evidence of the study, previous research on computer assisted instruction, conceptual framework of the study, gender issues influencing the use of computer simulation in teaching science, history of computer assisted instruction, the use of computer simulation in teaching Biology, students attitude towards the teaching of science, students difficulty with the conceptual understanding of cell cycle, perceived difficulties of biology students ,perceived difficulties of biology teachers in using Information Communication Technology (ICT) tools in teaching, history of concept model**,** the summary of cell cycle, misconceptions in studying scientific concepts and conceptual change, and finally Psychological Basis for Using Computer Simulation in Teaching Science.

2.1 Theoretical Framework of the Study

This study employed the social development theory by Lev Vygosty. The major theme of Vygotsky's theoretical framework is that social interaction plays a fundamental role in the development of cognition. Vygotsky (1978) states that "Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals."

A second aspect of Vygotsky's theory is the idea that the potential for cognitive development depends upon the "zone of proximal development" (ZPD): a level of development attained when children engage in social behavior. Full development of the ZPD depends upon full social interaction. The range of skill that can be developed with adult guidance or peer collaboration exceeds what the learner can attain alone.

Vygotsky's theory was an attempt to explain consciousness as the end product of socialization. For example, in the learning of language our first utterances with peers or adults are for the purpose of communication but once mastered they become internalized and allow "inner speech". Vygotsky's theory is complementary to Bandura's work on social learning and a key component of situated learning theory as well. Because Vygotsky's focus was on cognitive development, it is interesting to compare his views with those constructivists as (Bruner) and a genetic epistemologist (Piaget).

The Social Development Theory includes three major concepts. These are comprised of the Role of Social Interaction in Cognitive Development, the More Knowledgeable Others (MKO) and the Zone of Proximal Development (ZPD).ZPD is the gap or the difference between what the learner cannot do without help or guidance from others and what he or she can do with help or support from others. On the other hand MKO is someone who has better understanding or ability level than learner. Social interaction explains the way people engage with one another .It explains language development emphasizing the interaction between the developing child and linguistically knowledgeable adults. Vygotsky stress the fundamental role of social interaction in cognitive development, according to him higher mental processes in the individual have their origin in social processes.

The Social Development Theory (SDT) mainly asserts that social interaction has a vital role in the cognitive development process. With this concept, Vygotsky's theory opposes that of Jean Piaget's Cognitive Development Theory because Piaget explains that a person undergoes development first before he achieves learning, whereas Vygotsky argues that social learning comes first before development. Through the Social Development Theory, Vygotsky states that the cultural development of a child is firstly on the social level called interpsychological, and secondly on the individual or personal level called intrapsychological. The MKO is any person who has a higher level of ability or understanding than the learner in terms of the task, process or concept at hand. Normally, when we think of an MKO we refer to an older adult, a teacher or an expert. For example, a child learns multiplication of numbers because his tutor teaches him well. The traditional MKO is an older person; however, MKOs could also refer to our friends, younger people and even electronic devices like computers and cellphones. For instance, you learn how to skate because your daughter taught you this skill. The ZPD is the gap between what is known and what is unknown by the learner.

It is the difference between the ability of learner to performer a specific task under the guidance of his MKO and the learner`s ability to do that task independently. Basically, the theory explains that learning occurs in ZPD.

The traditional model where the teacher or tutor transmits or transfers information to her students is practiced in many educational institutions, however, the Social Development theory has been able to change this tradition because it explains that the student (learner) must have an active role in learning for this process to occur faster and more efficiently.

According to Vygotsky (1978), social learning precedes development. To Vygotsky (1978), every function in the child"s cultural development appears twice: first on the social level and later, on the individual level. According to Vygotsky (1978), students' problem solving skills fall into three categories: skills which the student cannot perform, skills which the student may be able to perform, skills that the student can perform with the help of others.

Vygotsky (1978) pointed out that children are capable of performing at higher intellectual levels when asked to work in collaborative situations than when asked to work individually. Vygotsky (1978) stated that less skillful individuals are better able to develop a more complex level of understanding and skills through collaboration, under the direction of an expert or a more capable peer than they could independently; this is what is termed „scaffolding". Scaffolding therefore allows students to perform tasks that would normally be slightly beyond their ability without that assistance and guidance from the teacher.

Social interaction extends a child"s zone of proximal development (ZPD), which is the distance between the actual development level as determined by the independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. Knowledge construction actually occurs in this zone (Swan, 2005). Vygotsky"s views concerning the zone of proximal development (ZPD) provide a strong support for the inclusion of cooperative learning strategies in classroom instruction. Kagan (1989) has pointed out that every cooperative learning strategy, when used appropriately, enables learners to move beyond the text memorization of basic facts and learning lower level skills.

According to Woolfolk (2007), Vygotsky asserted that cultural tools (such as rulers, pipette, and computers) and psychological tools (such as works of art, signs, symbols, codes, and language) play vital roles in knowledge construction. Vygotsky was particularly concerned with the role of language in thinking and learning. He pointed out that language and thought were closely related (Swan, 2005). All higher order mental processes such as reasoning and problem solving are achieved by psychological tools. Language is crucial to knowledge construction as it provides a way to express ideas and ask questions, and the links between the past and the future.

According to Swan (2005), Computer-based instructions are potential aids to students in assimilating and accommodating new knowledge.

The use of computer simulation conforms to the constructivist theory as students actively participated in the learning process to construct their knowledge under the guidance of their teacher but not passive recipients of knowledge from the teacher. The concept model which shows the stages of both mitotic and meiotic cell division enabled the students to interact with each other also get assistance from each other which created a conducive atmosphere for collaborative learning.

The visual conceptualization of cell cycle and the stages of cell as appeared on the screen actually excited the students and sustained their interest in cell cycle.

Computers encourage learning as they provide a stimulating environment and promote enthusiasm. Computers may help the reticent student who is afraid to make mistakes in a classroom situation. Students feel more successful, and are more motivated to learn and have increased self confidence and self-esteem when using computer in learning. As students identified the stages of cell cycle and cell division with the models they acquire skills which now make them more independent .This conforms to a second aspect of Vygotsky's theory, the idea that the potential for cognitive development depends upon the "zone of proximal development" (ZPD): a level of development attained when children engage in social behavior. Full development of the ZPD depends upon full social interaction. The range of skill that can be developed with adult guidance or peer collaboration exceeds what can be attained alone.

Constructivist learning theory says that all human knowledge is constructed from a base of prior knowledge and meaning from an interaction between their experiences and their ideas. Children are not blank slate that knowledge cannot be imparted without the child making sense of it according to his or her current conceptions. Therefore children learn best when they are allowed to construct a personal understanding by experiencing things and reflecting on those experiences. It involves learning by doing what they are interested in to derive their own knowledge and meaning. The Constructivist model of instruction sought to create environment where children actively construct their own knowledge, rather than depending on the teacher"s explanation.

Accordingly, the constructivist theory holds that learning is always built upon knowledge that a student already knows; this prior knowledge is called a "schema". Because all learning is filtered through pre-existing schemata, constructivists suggest that learning is more effective when a child is actively engaged in the learning process rather than attempting to receive knowledge passively. Instructions are effective when verbal information is presented aurally rather than visually. (The modality principle).

2.2 Background/History of Computer Assisted Instruction

Computer Assisted Instruction (CAI) as the name suggests, is the use of a computer to provide instruction. The format can be from a simple programme to teach typing to a complex system that uses the latest technology to teach new keyhole surgery techniques. CAI draws on knowledge from the fields of learning, cognition, Human Computer Interaction (HCI) amongst others.

Computer Assisted Instruction (CAI) also involves the use of computers to perform different tasks, such as calculations, electronic communication, under the control of a set of instructions called a programme. These programme results are stored or routed to output devices, like video display monitors, printers etc. It also performs a wide variety of functions that are reliable, accurate, and fast activities entails hands-on activities, discovering of new ideas through the use of computer assisted instructions and sometimes the display of animation packages.

However, the rapid developments in hardware and software ask for new terminologies and conceptualizations to study and discuss the potential of computers in education. The term computer technology, often used in the 1960s and 1970s, has been replaced by information and communication technology (ICT, mostly used in Europe) or information technology (IT) or Technology (in North America). ICT refers to all technologies used for processing information and communication. Because of the integration of computers with communication systems including audio and video technology, terms such as multimedia or digital media are also being used. The development of computer technology from processing information to also supporting communication augmented its potential for education. In particular, the immersion of computer and other technologies in everyday life, as well as the different representations of technology (e.g., tablets, smart phones, robots), require educational researchers and professionals to rethink the potential of technology for education. Some therefore (e.g., van‟t Hooft, 2008) prefer to speak about ubiquitous technology, to refer to the ever presence of technology in the environment but not typically seen or noticed. Although we realize that ICT has its limitations we will use this term in this article. We need to realize, however, that ICT is a broad concept. Its impact on curriculum, pedagogy, and student learning can only be discussed from the perspective of specific ICT applications, either hardware or software, that is being used in the teaching and learning process. Rapid changes in technology lead to changing conceptualizations of the use of computers in educational practice. In this respect, the term Computer Assisted Instruction (CAI) seems a bit obsolete and closely connected to a specific type of computer use in instruction (Dede, 2008).CAI was adopted in the early days of computer use in education, indicating either a type of software program for education or a type of instructional process.

The use of computers in schools seems to help pupils to be creative in problem solving, thereby developing positive interest in their studies. In this respect, the whole purpose of education in a country like ours is to develop and enhance the potentials of human resources and progressively transform them, into a knowledge society. Jones (2002) emphasizes that professional development in the effective use of computers, as in most fields of study, assumes that learners will be able to return to a classroom and use the skills, training, and knowledge acquired to earn a living and contribute meaningfully to the advancement of society.

Computer as instructional material has made a significant contribution to a wide range of group-learning activities. They can, for example, be used to manage or structure a group-learning process, by guiding the group through a simulation exercise of some sort. This can provide a vehicle through or with which a group of learners interact, and gain access to information, investigate simulated situations, which can lead to creativity Indeed, virtually all these are ways in which computers can be used to determine pupils interest in learning. It can also be used in group-learning situations. Learners in groups thus, do not only benefit from the feedback they receive from the computer, but also from the feedback they receive from one another. Considering the views of Izzet and Ozkan (2008) many research studies abound that, investigated the efficacy of computer assisted instruction (CAI) using different variables: different groups of student, different ability levels, gender among others. For instance, Izzet and ozkan (2008) in their study found that CAI both increases motivations towards learning and developments of academic achievement of students.

Since the early days of computer technology in education in the 1960s, it was claimed that computers can assist practice and hence improved student learning. Since then computer technology has developed, and its potential for education has increased.

The introduction of Information and Communications Technology (ICT) into the curriculum of Ghana for both public and private schools encompassing the first and second cycle institutions in 2007 (Michayahu, 2010), is to complement other subjects for a holistic development so that those who avail themselves to formal education will derive the maximum benefits from it.

ICT is so important in the world today that it makes it imperative for every young person to be competent in the use of ICT for the many tasks that he/she will have to accomplish (Curriculum Research and Development Division (CRDD), 2007).

In 2007, the government of Ghana and China signed a loan agreement of RMB 250.0 million Yuan (USD 30.0 million). The amount was to help develop the first phase of the Ghana National Communications Infrastructure Backbone Project which is to help facilitate the penetration of ICT infrastructure in the country (Concessional Loan agreement between Ghana and the Export-Import Bank of China, 2007).

2.3 Computer Simulation in Teaching Biology

Simulation is used where it is not practical or feasible to provide the learning in “real-life” (for example, pilot training). Simulations are more appropriate when use in more appropriate environment such as laboratory or in a regular classroom.

The use of computer simulations for science teaching is increasing steadily (Gallagher, 1987). To date, among the primary arguments for using computer simulations has been that they give students the opportunity to witness or perform experiments that might otherwise be too expensive, time consuming, or too dangerous for students to do in the laboratory. Computer simulations can be used to address the problem of teaching for conceptual change and understanding. In particular, computer simulation allows students to perceive what cannot be directly observed in laboratory experiments. The concepts and ideas used for interpreting the experiments should also be made accessible to the student. In particular, computer simulation allows students to perceive what cannot be directly observed in laboratory experiments. The concepts and ideas used for interpreting the experiments should also be made accessible to the student. Such simulations are termed" conceptually enhanced simulations" because they are based on models that provide explicit representations for sets of interrelated concepts. Students can perform experiments using these simulations, enabling them to conceptualize the experiments they perform with real-world materials in terms of the scientist's concepts and theories. Computer simulation also has the option of allowing students to perform experiments while using models that give an integrated visual depiction for the set of concepts involved. According to De Jong &Van Joolingen (1998) computer simulation can be divided into two main groups namely simulation containing a conceptual model and those based on operational model. Simulation with conceptual model include principles, concepts, and also facts related to the system being simulate the operational model on the other hand involves sequence of cognitive and non-cognitive operation procedures that can be applied to the simulated systems (De Jong &Van Joolingen, 1998).

Secondary students spend a considerable amount of their time completing application-oriented activities. In performing these tasks, students are asked to make a variety of inferences about a subject area by prudently using facts, concepts, and strategies or problem-solving skills. Unfortunately, it is easier just to teach students rote memory information and procedural knowledge (i.e., the literal algorithms used in solving a problem) than the comprehension and problem-solving skills called for in many application items. In teaching problem Solving, one way to enhance cognitive skills is through educational simulations. Simulations are thought to increase student participation and allow low-achieving students much-needed practice in applying what they've learned to new situations (Cohen & Bradley, 1978).

Gredler (1996) differentiates between two types of simulation these includes experiential and symbolic types of simulation. In experiential simulation the student takes on a vital role in a particular scenario and experiences the responsibilities and the privilege of the role in a bid to solve a challenging problem. Symbolic simulation on the other hand is the type of simulation where many possible executions of systems are considered simultaneously.

The fact that one can build computer simulations that are based on different, equally valid models provides an excellent opportunity for teaching students about the constructive nature of scientific inquiry and high-lighting how different models and frameworks can be used to guide inquiry.

A broad range of ICT applications can be incorporated in constructivist learning environments, such as general productivity tools (e.g., wikis, blogs, spreadsheets, the Internet),specific ICT applications to help individual learning (e.g simulations, data logging, multimedia cases), as well as ICT applications that support collaborative learning (e.g., discussion forums, shared workspaces, virtual worlds). Because of the wide range of applications and settings there are no met analyses available that provide information about the effect of ICT-enhanced constructivist learning environments on student learning.

Sahin (2006) also saw computer simulation in two main perspectives which included instructive pedagogies and reflecting constructive. Constructive simulation may comprise integrated simulation, experiential simulation and conceptual simulation. It provides learner with contextual environment in which they occur example exploring the Bioworld Instructive Simulation is also the type of simulation which involve learners as external players on the conditions provided (Sahin, 2006).The type of simulation package employed in this study include instructive simulation ,constructive simulation, experiential simulation and conceptually enhanced simulations a type of simulation which gives explicit representation of the concept being studied.

2.4 Effect of Students Attitude towards Learning and Teaching of Science on their performance

Most science programs attempt to foster positive student attitudes towards science and scientists. But just what factors influence student attitudes? The social climate of learning that exists in the classroom may be one factor related to science attitude. Research has shown that student perception of the physics classroom‟s social environment accounts for 13-46% of the variance in physics achievement, knowledge of science processes, interest in science, and science activities. Using classes from several different subject areas, revealed that course achievement was related to the perceived classroom environment.

Thus far, researchers have concentrated mainly on the relationship between perceived classroom environment and cognitive outcomes. However, it is likely that those variables which affect advancement in the cognitive area would also affect advancement in the affective area, as Bloom (1971) has suggested. It seems probable that the atmosphere in which a student encounters science could affect his attitude toward it which would in turn affect their understanding of scientific concepts and their performance.

One variable which may affect the relationship between the perceived learning environment and student attitude toward science is the subject being taught, e.g., biology, chemistry or physics. Usually, biology is a required subject with a fairly heterogeneous population of students, while chemistry and physics, which are usually electives, have much more homogeneous and select populations. In addition to the different subject matter and composition, a maturity gradient usually exists, with biology taken by sophomores, chemistry by juniors, and physics by seniors. Also, a previous study completed by the author (Lawrenz, 1976) indicated that the perceived classroom environment varies with the science taught.

Any student who continues in science from biology through chemistry and on to physics is likely to have a positive attitude toward science. There also may be a maturation effect allowing for the development of more stable attitude towards the learning of science.

Physics and chemistry students may enjoy the challenge of a difficult class, whereas the more heterogeneous biology students may find a difficult class threatening. In this regard it has also been shown that students tend to learn more in classes perceived as difficult. Thus, it seems desirable for chemistry and physics teachers to make their classes challenging. On the other hand, students may develop a negative attitude toward science in biology class which may seams less challenging.

Johnson and Johnson (1974) found that students prefer cooperative rather than competitive situations. It also seems reasonable that students who perceive their teacher as having favorites or who feel uncomfortable in class might have lower attitudes toward science. Biology teachers play a critical role, since they influence who will or will not continue in science. It appears that biology teachers‟ efforts might be most fruitful if they attempt to reduce the incidence of perceived teacher favoritism.

Positive attitudes toward science are likely to be found in classes perceived as having little internal conflict. There is a tendency for a challenging chemistry or physics class to have a more positive attitude toward science, but this tendency is reversed in biology classes.

Selwyn (1999) emphasized that computer assisted instruction (CAI) improves a positive attitude towards science. Cotton (1991) also noted that the use of CAI promotes more positive attitude towards quality of instruction, and the course content as well.

Abimbade (2006) reported of low students‟ attitudes towards introduction of computer in the Classroom as a result of low teacher‟s attitude. But Hayes and Robins (2000) submitted that there was an increase in students‟ attitude toward computer-assisted instruction.According to Rogers and Ford (1997), a positive attitude towards science may improve students „academic performance not only in science classes but in other subject areas.

According to Etkina and Mestre (2004), a teacher‟s role in students‟ attitudinal change is very essential in the teaching and learning process. To them, providing the opportunity and the learning environment for the students to reconstruct their own conceptual knowledge and understanding leads to a lasting improvement in students‟ attitudes toward learning and to greater chances of success in their studies and lives

Students‟ motivation to learn science can be affected by whether they find the subject enjoyable, place value on the subject, and think it is important for success in school and for future career aspirations. In addition, developing such positive attitudes towards science among students is an important goal of science education in many countries.

2.5 Perceived Difficulties of Students with the Concept of Cell Cycle

Biology is interrelated and covers a wider field of concept than other fields of Science. Due to this students find biology to be voluminous and some of the concepts to be difficult and hence memorise these concepts since they cannot study them meaningfully**.** One of such concepts perceived by most students to be difficult is Cell Cycle. Cell Cycle is the series of events that take place in the cell leading to its division and duplication of its DNA to produce two daughter cells. To ensure proper division of the cell, there are control mechanism known as cell cycle checkpoints. Cell cycle is also known as cell – division cycle, it is a vital process by which as single- celled fertilised egg develops into a matured organism. It also the process by which hair, skin, blood cells and some internal organs are renewed. Cell Cycle last for an average of 24 hours in human cells but cell division last for about an hour. Cell cycle occurs in two main phases namely the interphase and the M phase (mitosis and meiosis) It is the stage where actual cell division occurs. The M phase begins with karyokinesis and ends with cytokinesis. Interphase is the stage where the cell grows and prepares to divide. Interphase occurs in3 phases: G_1 phase (Gap$_1$), S phase (synthesis) and G_2 phase (Gap2). At G_1 phase the cell is metabolically active and grows, at S phase DNA synthesis or replication occurs. It is the period where the amount of DNA per cell doubles but the number of chromosome remains the same. Proteins are synthesized at G_2 phase and cell growth continues. However some cells in adult animals example the heart cell do appear not to undergo division they divide occasionally when the need arise to replace cells lost through injury or cell death. These cells exit from the cycle at G_1 phase and enters an inactive phase called the quiescent stage (G_0) cells at stage become metabolically active.

Johnstone and Mahmoud (1980) suggested that genetics was one of the challenging topics in Biology. Lazarowitz and Penso (1992) identified cells, physiological processes and hormonal regulation as difficult topics in Biology. According to Bahar , Johnstone, and Hansell (1999) monohybrid, dihybrid crosses and linkages in genetics, meiosis, central nervous system, alleles and genes as being topics of highest difficulty. Finly, Stewart, and Yarrock (1982) identified protein synthesis, photosynthesis, cellular respiration, Mendellian genetics and cell division as complex yet important for students . These topics they said lower students" performance in Biology.Teaching learning strategies employed by Teachers is another possible source of students difficulties in learning these biology concepts (Tekkaya, Ozkan, and Sungur,2001).

A concept like cell cycle perceive as a challenging concept by many students could only be memorised and recall during examinations due to its abstract nature.The teacher therefore has the responsibility of making this concept very real and more practical to the student. This call for employing a teaching method which is more practical, student centered, and that can sustain the student"s interests. The teacher also has the responsibility of starting from the basics which serves as a building block for complex concepts .We need to focus on the quality of what students learn than the quantity or volume of information given to them. Students should know the importance of learning the concept, cell cycle. This would bridge the gap between students" learning and the rationale behind students" learning

2.6 Summary

Cell cycle is one of the important concepts in Biology and it is taught in cytology and genetics. The process of cell cycle is indeed complicated and required knowledge from other areas in biology such as cell biology, nucleic acids and protein synthesis, and cell theory. The complex and the abstract nature of cell cycle and other similar biological concept may explain why many students perform poorly in Biology. Cell cycle begins with interphase where the cell prepares to divide.

The interphase is divided into three further phases:G1 phase (Gap 1), S phase (Synthesis) and G2 phase (Gap 2).During interphase, the cell grows, accumulating nutrients needed for mitosis, preparing it for cell division and duplicating its DNA.

Cell division in part of the larger phase cell cycle, it the process where by a parent cell divides into two or more daughter cells. Types of cell division basically include mitosis and meiosis. Mitosis occurs in somatic or body cells in which a mother cell divides into two daughter cells, which are genetically identical to each other and to their parent cell. The two new daughter cells are said to be diploid (2n).

Meiosis is a specialised kind of cell division that reduces the chromosome number by half resulting in the production of haploid daughter cells. Meiosis ensures the production of haploid phase in the life cycle of sexually reproducing organisms whereas fertilization restores the diploid phase. Meiosis leads to the formation of haploid gametes.

Meiosis involves two sequential cycles of nuclear and cell division called meiosis I and meiosis II but only a single cycle of DNA replication occurs. .Four daughter cells are produced at the end of meiosis II. Meiosis when compared to mitosis has a longer prophase I phase .The following events occur at prophase I but are absent at the prophase of mitosis they include bivalent, synapsis, chiasmata and crossing over .Whereas mitosis ensure growth, cell replacement and repair of worn out tissues also serve as a means of asexual reproduction in unicellular organism Meiosis helps in the production of gametes also help to maintain the diploid number of chromosome in successive generation.Cell division begins with Karyokinesis and ends with cytokinesis.

According to the cell theory, cells arise from preexisting cells. The process by which this occurs is called cell division. Any sexually reproducing organism starts its life cycle from a single-celled zygote. Cell division does not stop with the formation of the mature organism but continues throughout its life cycle (Cooper*, 2000).*

2.7 Empirical Evidence of the Study

Akpan and Andre (2000) investigated the effectiveness of computer simulation with dissection of frog. They found out that students exposed to simulation before the digestion performed better than their counterpart not exposed to computer simulation. (Akour,2008) also saw that at college level, students taught by the conventional instruction method combined with CAI performed significantly better than those taught using only the conventional method.

Simulations are thought to increase student participation and allow low-achieving students much-needed practice in applying what they've learned to new situations. Many of the simulations used in the research had never been field tested and thus were of unknown quality. The great variation in the quality of the games used in terms of complexity, levels of sophistication, and interaction among participants are major source of the weak results.

Doob,(1972) noted that With computer simulations, the effects of different variables can be demonstrated quickly and less instructional time is required to demonstrate causal relationships and essential concepts. Unfortunately, very few experimental studies involving educational computer simulations have been documented.By failing to analyze thoroughly the instructional goals of simulations, some researchers did not design measures to capture everything taught by the games noted (Megarry, 1979).

Ogunleye (2007) also noted that computer expands pedagogical resources available to teachers in science classroom thus supporting teaching. The implication of this is that the introduction of computer in the delivery of biology instruction as a science subject in classroom may improve the quality of pedagogical delivery and students" learning. Ochoyi and Ukwumunu (2008) submitted that the integration of computer in secondary school curriculum produced positive effect on students" learning.

The use of computer technology enables learners to be active in the learning process, to construct knowledge, to develop problem solving skills and to discover alternative solutions (Özmen, 2008).Cotton (1997) also concluded that the use of CAI as a supplement to traditional instruction method yields higher achievement than the use of the traditional method alone.

Only when computers are integrated into the curriculum as a vital element for instruction and applied to real problem for a real purpose, will children gain the most valuable skills and ability to use the computer to learn better. Izzet and ozkan (2008) in their study found that CAI both increases motivation towards learning and developments of academic achievement of students.

Halis, (2002) pointed out that, the use of computers in Science and Mathematics subjects as an instructional aid makes the lessons more interesting and encouraging and so makes the more complex Science concepts be learnt easily in an effective way. In contrary, the findings of Karen indicate that there is a negative relationship between the use of computer-assisted instruction and mathematics achievement scores.

2.8 Previous Research on CAI

Various researches have been conducted in the field of CAI in a lot of countries. However, the outcome of these researches indicate that CAI is not uniformly effective in that some studies show no significant differences in achievement between CAI and non-CAI students especially those studies that compared CAI alone against conventional instruction.

Kausar, Choudhry, and Gujjar (2008) indicated that CAI proved to be significantly superior to classroom lecture in terms of achievement in knowledge, analysis and synthesis of the Bloom"s taxonomy when they conducted a comparative study to evaluate the effectiveness of CAI Versus classroom lecture for computer science students. In terms of evaluation and application skills, they found out that CAI proved to be very much effective in increasing those skills as compared to classroom lecture. This study seems to suggest that CAI is able to improve student achievement and performance.

CAI has the potential for improving student achievement scores in pre-college classes. Ivers and Barron (1998) reported significant learning increases when pre-service teachers worked in a paired condition using computer based instruction that was designed for learning. CAI is effective in improving performance and correcting misconceptions of pre-service teachers. Ryan (1991) did a meta-analysis of achievement effects on micro computer applications in elementary schools in reading and mathematics and found out that CAI was able to increase academic achievement. He indicated that a typical student score would be raised from the 50th percentile to the 62nd percentile when exposed to CAI. After analyzing 28 studies, Kulik, Kulik, and Bangert (1985) also concluded that a typical student score in the 50th percentile with conventional instruction would score in the 68th percentile with CAI. Snowman (1995) also reported that computer- based education has a positive effect on secondary students. He came to this conclusion when his meta-analysis showed that the typical student in a computer based class scored as the 60th percentile while the typical student in a traditional class scored at the 50th percentile in final examinations.

These studies seem to suggest that the CAI is capable and has been able to improve student achievement. However, it should be noted that the discussion is never one sided in that Delafuente, Araujo, and Legg (1998) indicate that exam scores for pharmacy calculations taught in a traditional lecture format are similar to exam scores for those students learning the same material by CAI. Thus, there was no significant difference in final exam score between students taught by CAI and those by the traditional instruction. Fletcher-Flinn and Gravatt (1995) examined studies from 1987 to 1992 and realized that there were no significant differences between CAI and traditional instruction, when the modes of instruction were delivered by the same teacher. Again, some researchers also found no significant difference between students taught by CAI and those of the conventional instruction. A study by Chang (2000) also produced mixed results. Whiles the CAI group performed better generally as compared to the traditional approach group, the traditional approach group performed better on test items involving application level items.

While the CAI did well on knowledge and comprehension level items. Imhanlahimi and Imhanlahimi (2008) also found that the traditional method of instruction proved to be superior when compared to computer-assisted instruction. This review has shown that when CAI is used on its own i.e. used to replace the teacher, the result is not uniform. Thus whereas some research found CAI to be superior to the conventional approach, others found otherwise.

However, it has been found that student achievement increases when CAI is used in addition to or supplements the conventional instruction. Cotton after analyzing 59 research reports came to the conclusion that the single best-supported finding in the research literature is that the use of CAI as a supplement to traditional, teacher-directed instruction produces achievement effects superior to those obtained with traditional instruction alone. Many authors (Akour, 2008; Basturk, 2005; Bontempi & Warden-Hazlewood,2003 and Tabassum,2004) support this conclusion. On attitudes, Mitra (1998) has indicated that many studies that have been performed about the effects of CAI on students‟ attitudes do not agree whether or not it makes positive changes in attitudes towards science and science learning. CAI improves academic achievement besides influencing students‟ attitudes and motivation when used in addition to regular instruction. The use of CAI leads to more positive attitudes toward course content, quality of instruction and school in general. Selwyn (1999) also indicated that CAI improves a positive attitude towards science. Ybarrondo (1984) has indicated that even though CAI did not affect student achievement, students expressed their interest in the CAI material. The students felt that they had learned from it and would like to participate in CAI lessons in the future. A result of research on educational simulations, on the whole, has been discouraging. After an extensive review of studies conducted in the early 1960s. The effects of simulations were no greater than for conventional instruction. Students neither learned more facts and concepts than they did in conventional instruction nor showed the anticipated increases in critical thinking and problem solving. At best, the results have been mixed regarding the effects of educational simulations. Current research in computer simulations and other computer enrichment activities, although limited, also indicates little support for these techniques Much of the research on simulations has been plagued by fundamental weaknesses in research design. Several interventions have been much too brief, usually with only one play of the simulation. Quite a few studies used rather crude quasi-experimental designs involving intact classes being assigned to treatments on a nonrandom basis. In some cases, the intent of the simulation games, and hence the research hypotheses, were poorly formulated (Williams, 1980). Finally, there are problems with criterion measures used in many simulation studies. By failing to analyze thoroughly the instructional goals of simulations, some researchers did not design measures to capture everything taught by the games.   Many of the simulations used in the research had never been field tested and thus were of unknown quality. The great variation in the quality of the games used in terms of complexity, levels of sophistication, and an interaction among participants are major sources of the weak results reported.

2.9 Perceived Difficulties of Biology Teachers in Using ICT Tools

The rapid growth in Information Communication and Technologies (ICT) have brought remarkable changes in the twenty first century, as well as affected the demands of modern societies. ICT is becoming increasingly important in our daily lives and in our educational system. Therefore, there is a growing demand on educational institutions to use ICT to teach the skills and knowledge .However science teachers need to consider certain factors before deciding on the use of particular electronic equipment or software four of these factors are discussed below.

Teachers" computer competence is a major predictor in teaching. Evidence suggests that majority of teachers who reported negative or neutral attitude towards the integration of ICT into teaching and learning processes lacked knowledge and skills that would allow them to make informed decision in selecting particular software. Teachers with more experience with computers have greater confidence in their ability to use them effectively. Teachers competence relate directly to confidence. Teachers" confidence also relate to their perceptions of their ability to use computers in the classroom, in relation to their children"s perceived competence. Self-efficacy is the confidence that individual has in his/her ability to do the things that he/she strives to do. Thus teachers" confidence refers both to the teachers" perceived likelihood of success on using ICT equipment for educational purposes and on how far the teacher perceives success as being under his or her control .teachers" computer self-efficacy is described as a judgment of their capability to use a computer., teachers" computer self-efficacy influences their use of ICT tools in teaching and learning. Similarly teachers" implementation of ICT depends on simplicity of computer use and perceived teacher self-efficacy .Teachers technical competence with technology is a factor of improving higher confidence in the use of electronic equipment.

Teacher"s technical competence and pedagogical efficiency have significant to selection of particular software so as to integrate ICT in teaching and learning processes. That teachers competence relate directly to confidence. Teachers" confidence also relate to their perceptions of their ability to use computers in the classroom, Level of confidence influences their use of computers in their classroom many teachers who do not consider themselves to be well skilled in using electronic equipment feel less confident about using it in front of a class of children who perhaps know more than they do.

Studies concerning teachers‟ gender and ICT use have cited female teachers‟ low levels of computer use due to their limited technology access, skill, and interest. Research studies revealed that male teachers used more ICT equipment such as computer, radio, and microphone, loud speaker in their teaching and learning processes than their female counterparts. The science teacher must consider factors such as ICT competence of the teacher and the learner, his self –efficacy, his skills, technological access, and interest, confident level, Technical competence and pedagogical efficiency.

Teachers are implored to adopt and integrate electronic equipment into teaching and learning activities, but teachers‟ preparedness to integrate this equipment into teaching determines the effectiveness of the technology and not by its sheer existence in the classroom.

2.1.1 Effect of computer simulation on the performance of gender.

Science education reform has emphasized the need for integrating computer technology into learning, teaching, and assessment. One possibility for providing better education in science is to modify science teaching and learning with special emphasis on computer technology such as computer–based laboratories, interactive videos, and simulations, intelligent tutors, internet and the World Wide Web. Although the combination of science and technology seems to be a promising approach to reforming science education there are some inherent problem.

Kahle and Meece(1994),in synthesis of research found gender differences in science achievement. Rowe(1993) pointed out systematic gender differences in the use of computers in the classroom, where girls are often not given appropriate support and context for learning with computers" .The gender differences in computer use are more evident at the secondary level than at the elementary level(Harttie &Fitzgerald,1988). According to Rowe (1993) computers are tools which can be used for variety of purposes, however in the absence of broader perspective, many schools subsume them under mathematics or science curricula, and thus they take on an existing stigma of sex stereotypes". Cheek and Agruso (1995) stated that "available research suggests that widespread use of computer technology tools raises significant issues for females and underrepresented populations in mathematics, science and technology fields). As cited by Rowe (1993), when students were asked the subject they do not like much now that they are using computer, 30% of girls and 12% of boys said mathematics, 11% of girls and 30% of boys said science).

2.1.2 Brief Explanation of Concept Model

Conceptual model is the concrete representation of set of ideas which are used to help know, understand, or stimulate the subject the model represent. It can also be defined as visual representation of set of ideas that clarifies the concept. Physical model is the smaller or the larger visible copy of an object**.** Scientists have used model systems not only to help them understand new phenomena and to explain these phenomena to others, but also to do simulations of actual experiments.

Significantly, Gentner and Toupin (1986) have found that at least by age 8 children are able to understand such relational models in a nonscientific context. This finding suggests that students may be ready to understand appropriate relational models in science and that such model can be used as an important tool in science education. Computer technology offers new possibilities for designing model systems for science teaching. Visual model gives object attributes, and relations of the referent domain this is called "pictorial models" because they represent visual attributes. The pictorial computer simulation can be used to extend the range of the students' experience, performing more experiments or performing experiments that would be difficult for him/her to do. For example, in Operating a frog, the student can gain experience in performing dissections, and in Measurements: Length, Mass, and Volume, the student can gain experience with obtaining basic measurements of objects on the computer screen. The core idea be-hind the pictorial model could be generalized such that the pictorial model would be one in a class of models that attempt to explore how these sounds or rhythms change under different conditions and such a class of models can provide a rich array of experiences. We believe that the student often needs something different- something that will put the student into direct contact, not only with the observable aspects of objects, but with representations of intrinsically unobservable attributes and relations that are relevant to understanding a particular phenomenon offer great flexibility as providers of modeled systems. The designer can use iconic or abstract representations. Iconic symbols are readily interpretable, because they generally look as close as possible to how reality looks. Frog example, in the Operation: Frog software, the frog on the screen looks like a real frog. With more abstract symbols, the conventions used may not be immediately obvious from the visual itself.

2.1.3 Misconceptions in Studying Scientific Concepts and Conceptual Change

When students enter science classrooms, they often hold deeply rooted prior knowledge or conceptions about the natural world. These conceptions will influence how they come to understand their formal science experiences in school. Some of this prior knowledge provides a good foundation for further, formal schooling, while other conceptions may be incompatible with currently accepted scientific knowledge. The importance of prior knowledge and the struggle to replace that knowledge with or help that knowledge evolve into scientifically-sound knowledge has spurred a large tradition of research in developmental and instructional psychology and science education.

Despite the fact that the term students‟ misconception is widely used in scientific literature, not all researchers agreed to define student‟s prior knowledge as misconceptions.The term misconception has many synonyms Tomita (2008) noticed.

Initially referred to as misconceptions (Wandersee, Mintzes, & Novak, 1994), these conceptions are also known as naive conceptions (Champagne & Klopfer, 1984), nonscientific beliefs, pre-instructional beliefs (Chinn & Brewer, 1993), intuitive knowledge (Vosniadou, Ioannides, Dimitrakopoulou, & Papademetriou, 2001), phenomenological primitives or p-prims, facets (Minstrell, 1992), or alternative frameworks (Carey, Evans, Honda, Jay, & Unger, 1989). Regardless of terminology, the point is to recognize that a students' prior knowledge is embedded in a system of logic and justification, albeit one that may be incompatible with accepted scientific understanding.

Smith, diSessa, and Roschelle (1993) observed that novices‟ interpretations of scientific concepts and experts‟ perceptions of scientific knowledge are very different. Researchers argued that clarification of the terms misconceptions, alternative beliefs, and preconceptions is necessary.

The prefix to the most common term misconception emphasizes the mistaken quality of students" ideas. Terms that include the qualifier alternative indicate a more relativist epistemological perspective. Students prior ideas are not always criticized as mistaken notions that need repair or replacement but are understood as understandings that are simply different from the views of expert student alternative conceptions are incommensurable with expert concepts in a manner parallel to scientific theories from different historical periods Preconceptions and naïve beliefs emphasize the existence of student ideas prior to instruction without any clear indication of their validity or usefulness in learning expert concepts. However, researchers who have used them have tended to emphasize their negative aspects. This epistemological dimension emphasizes differences in content. The content of student conceptions whether mistaken, preexisting,or alternative is judged in contrast to the content of expert concepts. In 1993 Smith et al. made an overview of seven widespread assertions, which represent a traditional theoretical position in the misconception research.

The first assertion is students have misconceptions: Coming to the class, students already have got some understanding of the problem. "Before they are taught expert concepts, students have conceptions that explain some scientific phenomena that expert concepts explain, but these conceptions are different from the currently accepted disciplinary concepts presented in instruction.

Secondarily misconceptions originate in prior learning: It is another common opinion that misconceptions arise from students prior learning, either in the classroom or from their interaction with the physical and social world for example, the persistence of the "motion implies a force" misconception is rooted in everyday perceptual-motor experiences with pushing and pulling objects‟.

The third assertion: Misconceptions can be stable and widespread among students. Misconceptions can be strongly held and resistant to change. Referring to Smith et al. (1993) argued that sometimes misconceptions even coexist alongside the correct approach:

Perhaps most troubling is that students can doggedly hold onto mistaken ideas even after receiving instructions designed to dislodge them. It does not necessarily mean that instruction has failed completely. It can succeed in imparting the correct concept that then competes with the prior misconception.

Assertion four: Misconceptions interfere with learning**.** Researchers in physics have reported that misconceptions even cause students to misperceive laboratory events and classroom demonstrations" (Smith, 1993).

Assertion five: Misconceptions must be replaced. The opinion that the learning of science is a replacement or removing of novices‟ misconception by expert concept is the central idea of misconception research. Learning involves the acquisition of expert concepts and the dispelling of misconceptions. The assumption that removing misconceptions has no negative consequences because they play no productive role in expertise is implicit in the replacement view.

Assertion six: Instruction should confront misconceptions. Confrontation begins as an external, social interaction in the classroom, but for confrontation to succeed, the competition between misconception and expert concept must be internalized by students. Confrontation and replacement are therefore inextricably linked. Successful instructional confrontation leads to learning by replacement.

Assertion seven: Research should identify misconceptions. During the last three decades many works have been done in one straight direction to identify as much as possible misconceptions in different scientific domains. Much less emphasis was given to modeling the learning of successful students in those domains, to characterizing how misconceptions evolve, or to describing the nature of instruction that successfully promotes such learning. When we consider the corpus of misconception research, the major research effort has been to identify more misconceptions. Some researchers identify misconceiving as misunderstanding, but this point of view is not always correct.

Maznichenko (2002) argued that misconceiving and misunderstanding have a common feature: both of them lead to an inadequate perception of the reality, but there are a few distinctions between them: Mistakes and misunderstanding are caused only by personal insight and sensitivity of the learner. Misunderstanding is casual, but misconceiving is not the occurrence of misconceptions obeys some rules, which is discussed further.

Misunderstanding may happen according to any particular and specific case, but misconceiving is total; it influences all world-perception of the learner. When a person realizes that he/she has misunderstood or made a mistake, he can correct it easily.A person usually does not have any resistance to changing his ideas and thoughts; he does not follow his misunderstandings anymore. A misconception, on the other hand, is very resistant to any change. The big issues are that once a misconception has been formed, it is extremely difficult to change, and that possessing misconceptions can have serious impacts on learning. Misconceiving can be a reason for misunderstanding.

In general, the research on misconceptions and the research on conceptual change are intertwined very closely. Many scientists argued that to overcome existing misconceptions, some kind of conceptual change has to occur in the students mind. Each theory of conceptual change explains misconceptions in different ways; therefore, depending on definitions of "what misconceptions are, each theory offers particular ways for removing (orat least clarifying) misconceptions.

A consequence of that is the fact that each theory usually presents its own approach to the curriculum. Thus, initial students" knowledge about to-be-learned material has to be evaluated very carefully. Halloun and Hestenes (1985) took an attempt to explain the importance of this evaluation. They argued that if misconceptions are not recognized early in the course "the student will not only fail to understand much of the new material, but worse, he is likely to dress up his misconceptions in scientific jargon, giving the false impression that he has learned something about science.

Ohlsson (2009) noticed that "the goal of conceptual change theories is to understand and propose a way to overcome stubborn resistance to change". Before describing the most known theories of conceptual change, which are overviewed in this chapter, it is necessary to present the approach of Chi (2008). The researcher distinguished three types of learning: Missing and Adding; when a student has no prior knowledge, in this case prior knowledge is missing, and the learning process consists of adding new knowledge. Gap filling; a learner may have some correct prior knowledge, but that knowledge is incomplete. In both missing and gap filling conditions, knowledge acquisition is of the enriching kind (Carey, 1991). Conflict; a student may have acquired ideas, either in school or from everyday experience, that are in conflict with" to- be-learned concepts (Vosniadou, 2004). Under this condition, the knowledge acquisition is of the conceptual change kind. (Chi, 2008).

Tomita (2008) referring to Duit (1999), defines a conceptual change as the pathway from pre-instructional or prior conceptions to post-instructional, desired conceptions. In the present time, various theories of conceptual change exist. Many of them have common features and disagreements, but all those theories are agreed on one point: the conceptual change process is a function of time. There is no consensus among scientists on how and why conceptual change occurs.

Some known theories of conceptual change are:

- Kuhn"s theory of paradigms" shifts. Kuhn (1962)
- Theory of Gradual Transformations of Naïve Theories. Carey (1999).
- Theories of Mental models and beliefs" revision. Ioannides and Vosniadou (2002); Linder (1993); McCloskey (1983); Smith, Blakeslee, and Anderson (1993); Vosniadou (1994); Vosniadou andBrewer (1992).
- Jean Piaget"s theory of learning (Assimilation & accommodation) Posner, Strike, Hewson and Gertzog (1982); Ozdemir and Clark (2007)

Jean Piagets" theory of learning had the enormous impact on the educational psychology of the twentieth century. Piaget considers a conceptual change from two perspectives: assimilation and accommodation. Discussing some aspects of Piagetian theory, Posner, Strike, Hewson and Gertzog (1982) clarified that sometimes students use existing concepts to deal with new phenomena. This variant of the first phase of the conceptual change we call assimilation. Often, however, the student" current concepts are inadequate to allow him to grasp some new phenomenon successfully. Then, the student must replace or reorganize his central concepts. This more radical form of conceptual change we call accommodation.

In 1982, talking about assimilation-accommodation theory, Posner et al. noticed that for successful conceptual change, a new concept has to be:

Intelligible; the new conception must be obvious to make sense to the learner, Plausible;the new conception must be seen as reasonably true, Fruitful ; the new conception must appear potentially productive to a learner for solving current problems.

Researchers argued "the major goal is to create a cognitive conflict to make a learner dissatisfied with his or her existing conception. Then, a new idea as intelligible, plausible, and fruitful may be accepted.

Another understanding of conceptual change comes from "the building of mental models" perspective: Ioannides and Vosniadou (2002); Linder (1993); McCloskey (1983); Smith, Blakeslee, and Anderson (1993); Vosniadou (1994); Vosniadou and Brewer (1992). Discussing mental models, Chi (2008) argued that knowledge might be misconceived at three hierarchically different grain- sizes" levels: Beliefs, Mental models, and Ontological Categories.

Individual beliefs are at the lowest level, and categories are at the highest. According to Chi (2008), to achieve a conceptual change, teaching instructions should be different depending on the level to which misconceiving knowledge belongs. The author defines *beliefs* as students „prior knowledge, which on the grain-size can be called single ideas, corresponding more or less to information specified in a single sentence or statement. As a described earlier, students" prior beliefs can be missing or incomplete. For example, a student might not know that the atoms" core consists of neutrons and protons, and telling the student this piece of information would be *adding* to his prior beliefs. Chi (2008) proposed that "conceptual change can sometimes be readily achieved as a belief revision through explicit or implicit refutation of prior false beliefs. But such beliefs revision can be achieved only when misconceived knowledge conflicts in the contradictory sense. In other words, the conceptual change occurs when old beliefs contradict new information. The researcher argued that *mental models* as well as *beliefs* can be in conflict with the correct scientific model to varying degrees, such as a missing or non-existing mental model or an incomplete mental model. By Chi‟s definition, "learning would begin by adding and gap filling in missing components. Adding and gap-filling a mental model would not constitute conceptual change" (Chi, 2008, p.67). A good example of mental models has been described by Vosnidadou, Vamvakoussi and Skopeliti (2008). The majority of young children believe that the Earth is flat.

This conversation about the shape of the Earth was described by Yin (2005) referring to Vosniadou and Brewer (1992) presents an interaction between a child‟s previous knowledge and upcoming new information. Learning in school that the Earth has a spherical form and is an astronomical object, they do not refuse their previous ideas, but they form new synthetic mental models about the Earth.

Some children formed the interesting model of dual earth, according to which there are two earths: a flat one on which people live and a spherical one, which is up in the sky, and which is a planet. Another common misrepresentation of the earth was that of a hollow sphere. According to that model, the earth is spherical but hollow inside. People live on flat ground inside the bottom part of the hollow sphere. Alternatively, the earth was conceptualized like a flattened sphere or truncated sphere with people living on its flat top, covered by the dome of the sky above its top (Vosnidadou et al., 2008,).

Most students seem to have their knowledge of biology lectures in special „compartments"" of their brain. They do not link them to their every-day life understanding: „Presumably most of the graduates would have been able to explain the basics of photosynthesis, but perhaps they had stored their learning about the scientific process (where carbon in the tree originates from gaseous carbon dioxide in the air) in a different compartment from their „everyday knowledge" that plants get their nutrition from the soil.

Chi (2008) argued that students" knowledge consists often of an inter-relative system of false and correct beliefs. This system is coherent, but sometimes it is a flawed mental model. As a consequence, a mental model is in conflict with a scientific model. Therefore, it leads to unscientific predictions and explanations. When a student learns new information from a teacher, two outcomes are possible. In the first case, when a student understands that his initial concept was wrong, his flawed concept usually is changed to the correct concept.

A conceptual change would happen. In the other situation, when a student does not recognize through instructions that his initial concept was wrong, new information is assimilated into the flawed mental model. The conceptual change would not occur.

Chi (2008) proposed that "many misconceptions are not only, in conflict" with the correct scientific conceptions, but moreover, they are robust; therefore, the misconceptions are difficult to revise, so conceptual change is not achieved". The researcher proposes that certain misconceptions are robust because they have been mistakenly assigned to an appropriate ontological category: Our claim, then, is that some false beliefs and flawed mental models are robustly resistant to change because they have been laterally or ontologically miscategorized.

That is, if a misconception belongs to one category and the correct conception belongs to another ontological category, then they conflict by definition of kind and ontology. It means that conceptual change requires a shift across ontological categories".

2.1.4 Psychological Basis for Using Computer Simulation in Teaching Science

The use of computer simulation as a tool for teaching in the classroom is quiet new however the psychological principles underlying the use of computer simulation games and animations is not new. The use of this new tool is based on existing psychological principles of repetition, reinforcement, and motivation. Many theories emphasized the benefit of these learning principles. The law of effect is a psychological principle advanced by Thorndike in 1898 on the matter of behavioral conditioning. The law states that responses that produce a satisfying effect in a particular situation become more likely to occur again in that situation and responses that produce a discomforting effect are less likely to occur again in that situation. He beliefs that a pleasing effect strengthens the action that produced it, The essential idea of the law is that behavior can be modified by its consequences. When stimulus and response are associated the response is likely to occur without stimulus being present. It implies that if a satisfying situation follows a learning experience, the learner would likely not forget what has been learnt. Using simulation in the teaching and learning of science, the learners receive an immediate effect of the learning process and the novel teaching approach used.

Brunner (as cited in Tagore, and Amissah, 2002) also stressed the benefit of motivation in the teaching and learning process. Bruner (1961) in one of his learning theories stated that although extrinsic motivation may work in the short run, intrinsic motivation has more value. This implies that teachers should provide feedback that is directed towards intrinsic motivation Bruner argue that curiosity drive of the learner must be directed towards more powerful intellectual pursuit and suggested the use of games to help develop the sense of curiosity in the learner.

Conclusion drawn from these theories is that students experience science more practically and understand the world around them better when games are used in the teaching and learning of science.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter highlights the research design that was used in carrying out this study, the population, sampling and sampling techniques, validity and reliability of the instruments used for the study. It also describes the method of data collection and analysis.

3.1 Research Design

Quasi- experimental was the design used for the study because the subjects were not assigned randomly to the controlled and the experimental groups (Creswell, 1994).According to Harris (2006) quasi-experimental design is often described as nonrandomized intervention studies.

Seidu (2007) defines research design as the procedures and methods used to gather data that is appropriate to the subject under investigation. Sample students were not randomly selected, the control and treatment groups were sampled purposively.

Pretest and posttest of non-equivalent group design was used to collect data to find out if there is any significant difference in the academic achievement between the control group and the experimental group that is students taught by the traditional method and those taught using concept model and computer simulation.

3.2 The Study Area

The study was conducted at Methodist Senior High School located in Saltpond and Kwegyir Aggrey Secondary Technical Senior High School, Anomabu both located at the Mfantseman Municipality. Methodist Senior High School is located at Saltpond the capital of Mfantseman Municipal adjacent the Saltpond post office and about 300 meters away from the sea. Saltpond is sandwiched between Mankessim and Cape Coast.It is about 12km and 30km away from Mankessim and Cape Coast respectively.

Methodist Senior High School was founded in 1981 by Rt Rev. Ebenezer K. Baiden who also became the first Headmaster of the school. He was then the superintendent minister of the Wesley Methodist Church, Saltpond. The school was solely manned by the church but later become government assisted school in 1990.

The Municipality is noted for its commercial activities especially at Mankessim. There are six Senior High Schools in the municipal 2 private and 4 public schools. The private schools include Obama Senior High and ST. Andrews Senior High. The public schools are Methodist and Mfantseman Senior High, Mankessim and Kweigyir Aggrey Secondary Technical School. The main occupation of the people of Saltpond is fishing and trading. Methodist Senior High School is not well endowed in terms of infrastructure but have a sound academic record. Kweigyir Aggrey Secondary Technical Senior High School was founded by the late Rev.Dr. A.W.E. Appiah on 22nd January 1940 with only six boys. He named the school Aggrey Memorial College after his late uncle Emmanuel Kweigyir Aggrey .His aim was to perpetuate the memory of his uncle by means of an institution which would give young boys and girls Secondary Education to fit into a higher field of studies.

The school was initially established in the heart of Cape Coast Township along Junkwa road but later moved to its present location at Anomabu along the Cape Coast Accra road sand witched between Cape Coast and Saltpond.

Kwegyir Aggrey School is about 8.4 km away from Salt pond and 22km away from Cape Coast. The main occupation of the people of Anomabu is fishing.

3.3 Population

According to Creswell (2008), population is defined as a group of individuals or objects who have the same characteristics. Population according to him is the limits within which research findings are applicable and that a population could be large or small and a researcher needs to decide the group to use for the study. Population is the entire group of people, objects, animals, institutions, establishment which the researcher intend to study. Target Population to the researcher refers to the entire group of people the researcher is interested in in order to make generalisations. Accessible population or the study population is the population from which the sample is obtained. Target population was all elective biology Home Economics and Science students in the Central Region. The accessible population for this study was 270 second year elective Biology students in Methodist Senior High School – Saltpond and Kweigyir Aggrey Secondary Technical School – Anomabu both in the Mfantseman municipality. The schools were mixed.

3.3 Sampling Techniques

In statistics, a sample is a subset of a population that is used to represent the entire group as a whole (Goodwin, 2010; Nicholas 2008). It is often impractical to survey every member of a particular population because the sheer number of people may be too large. In most cases is it simply not possible to collect data on every individual in a population instead a smaller sample is used to gain information about the larger population.

Sampling techniques as defined by Castillo (2009) are the strategies used by the researcher during the process of sampling . Sampling on the other hand is the process by which a sample is selected from the population. The non-probability sampling technique employed was purposive sampling technique. This technique was used because the researcher had to select from classes that she was teaching. Also a pretest conducted by the researcher showed the students in these classes did not understand the concept of cell cycle.

3.4 Sample

The sample for the study was 70 second year elective biology students. Two intact classes of Form two Home Economics and Science classes were selected using purposive sampling technique.

The sample was made up of 35students from Methodist High School Saltpond and 35 Senior High School students from Kweigyir Secondary Technical School, Anomabu. Methodist Senior High students were chosen because of their familiarity and accessibility to the researcher, therefore information about the performance and achievement of the students were readily available for the study. Also upon analysing WASSCE results from 2012 to 2016 the researcher found out that most students especially the Home Economics students did not perform well in Elective biology. There were 35 students in the treatment group and 35 students in the control groups respectively. The second year students were selected because they were taken through cytology, cell biology and nucleic acids which serve as previous knowledge for the study of cell cycle. Kweigyir Aggrey is a sister school which the researcher usually visits to interact with students and to share ideas and experiences with fellow science teachers. The mean age of student"s was16 and their ages ranged between 15 and 18 years.

3.5 Research Instrumentation

The instruments used for the study were Biology performance Test (BIOPET), Standard achievement test on cell cycle (SATCC) Semi-structured interview and concept model and computer simulation. Two parallel tests of comparable standard were constructed by the researcher, one was used as a pretest was termed (BIOPET) and the other as a posttest was also termed (SATCC).

The pre-test was conducted based on cell cycle. This concept is in the elective biology syllabus perceived by many students to be difficult. It was conducted to find out if the two groups will perform at the same level, to review students" previous knowledge and also to assess their difficulties in the stages of Mitosis and events that occurs at interphase before implementing intervention or the treatment. The post-test was also based on the topic cell cycle in humans which the researcher taught during the treatment or the experiment. The STATCC was used after the intervention to assess students" performance in the concept after being exposed to the computer simulation and concept model. Both the pre-test and the post-test each consisted of (15) item multiple choice questions and (5)essay test items (Appendix D). The tests consisted of three parts. Part A requested students to provide personal information such as their name ,age ,sex, and class .The second part B provided general information about the objective of the test and the third part consisted of twenty test items. The aim of these tests was to find out the performance of students before and after the treatment or the experiment.

Ten students from the experimental group were randomly selected to participate in the interview by tossing a coin all those who selected cocoa took part in the interview before and after the experiment. This was to find out their preconception about cell cycle before introducing the experiment or intervention and the effect of computer simulation on their conceptual understanding of cell cycle.

3.6 Interview Schedule

A semi-structured interview was one of the instruments used for this study rather than using a fully structured interview which may be too rigid , formal and restrictive. The choice of the type of interview was to provide a relaxed atmosphere where students can freely provide vital information. At the beginning of the interview session, interviewees were assured of confidentiality and anonymity.The interview was conducted to find out students preconception about cell cycle.

3.7 Pilot Testing

The two parallel tests of comparable standards used in the research work were pretest and posttest. The instruments were pilot tested to determine their validity, reliability and the consistency. The pilot test was carried out in Mfantseman Girls Senior High School using ten second year elective Biology Science and Home Economics students.

3.8 Validity of the Instrument

Alhassan (2006) explains validity as the extent to which an instrument measures what it is intended to measure and performs as it is designed to perform. According to him, validity of a research instrument is concerned with how well the instrument measures the concept(s) it is supposed to measure. To ensure the validity of the test items , the tests were given to two experienced biology teachers for criticism and evaluation based on the instructional objectives specified in the Biology Syllabus for Senior High School(2010). Their suggestions and criticisms were used to improve the validity of the instruments. Table of specifications for the lesson plan was used to develop the test items to ensure the content validity of the test items . The researcher then consulted her supervisor to cross check the test items to ensure content and construct validity. The interview schedule was given to colleague graduate students for their critique and advise and was further cross checked by the supervisor as well.

3.9 Reliability of the Instrument

According to Yin (2003) a research instrument is said to be reliable if the research is repeated by another Researcher and it produces similar findings and conclusions. Reliability is the extent to which results are consistent over time, and become an accurate representation of the total population under study (Joppe, 2000). According to him, the research instrument can be considered reliable if the results of the study can be reproduced under similar situation. According to Jonassen (2000) a valid instrument is certainly reliable. The researcher tested for the reliability of the instrument using Test –retest reliability which is sometimes called retest reliability. It measures tests consistency, Having a good reliability signifies internal validity of atest and ensures that tests taken in one sitting are both representative and stable over time. Test re-test analyses are conducted over two time-points (T1,T2) over relatively short period of time, to mitigate against conclusions being due to age-related changes in performance. Test-retest reliability coefficients also called coefficients of stability vary between 0 and 1.Where 1 is perfect reliability and 0 is no reliability. The reliability coefficient for both pretest and post-test was calculated using the Test-retest reliability coefficient. The reliability coefficient value was 0.7 hence the instruments are reliable.

3.1.1 Treatment of the groups

Using Computer Simulation and concept model in the Teaching of Cell Cycle (intervention).The study employed two different treatments.

The experimental and the control group were selected from two schools namely Methodist Senior High School and Kweigyir Aggrey Secondary Technical school. Although statistically there was no significant difference between the two groups when the pretest scores were analysed. However students from Kweigyir Aggrey SECTECH had higher scores than students from Methodist SHS hence they were assigned the control group and those from Methodist SHS were assigned the experimental group by the researcher. The study employed two different treatments. The treatment for the experimental group was computer simulation and concept model.

The researcher began by revising the previous knowledge of the students in the definition of cell division, interphase, mitosis and meiosis, cytokinesis, karyokinesis , reviewing the stages of interphase, mitosis and meiosis ,explaining events occurring at interphase and outlining the main stages of cell cycle, significance of mitosis, meiosis, cytokinesis, karyokinesis, difference between mitosis and meiosis. The software was installed on a computer in biology laboratory was projected on a screen for students observe.

It shows the animation of the stages and processes involved in cell cycle. The software displayed the diagram of cell cycle ,the stages of mitosis and meiosis, and the events that occur at interphase. The animation helped the students to visualize the stages of cell cycle, interphase mitosis ,and the complex stages of meiosis and the products of both meiosis and mitosis were shown in the animation.

To enhance students" understanding of the topic power point presentation was also employed by the researcher.

The concept model formed part of the intervention. The researcher used concrete visual models depicting the stages of mitosis and meiosis for in depth explanation to students . Students were put into groups to use the models to outline the stages of mitotic and meiotic cell divisions. The researcher moved from one group to another to guide the students.

3.1.2Traditional Approach to the Teaching of Cell Cycle

The control group were taught using the traditional approach.The traditional approach in the teaching of this abstract concept employed use the of blackboard illustrations, demonstrations, concrete objects as indicated in the lesson plan (see Appendices F&G). Lecture, discussion and the questions and answers methods were some of the instructional methods employed by the researcher. The two different teaching strategies(Computer Simulation and the traditional approach) were independent variables and the academic achievement of the students was dependent variable.

3.1.3 Data Collection Procedure

Introductory letters were obtained from the Head of Science Department, UEW, to facilitate familiarization and support for smooth data gathering. Permission was also sought from the subject teachers concerned. Time-tables were collected from the subject teachers for the researcher to know periods to meet the students and also for effective planning.

Before the real study the biology teachers of the two intact classes introduced the researcher to the students. The study lasted for six weeks in the second term of

2016 /2017 academic year. Data was collected three stages namely pre-intervention stage, post-intervention stage and interview stage.

The instruments developed by the researcher were administered under the supervision of the researcher to prevent respondent from copying from each other and they responded to items accordingly. Scripts were collected, marked and recorded and marked scripts given to the students after the post-test to provide feedback to the students. The two tests were used to collect data quantitatively and the interview was used collect qualitative data. Ten students from the experimental group were interviewed individually by the researcher to find out the impact of computer Simulation on their conceptual understanding and perception of cell cycle. With the permission of the interviewees all the interviews were recorded using the computer sound recorder.

3.1.4 Data Analysis

The study employed both qualitative and quantitative data analysis methods. The interview were analysed qualitatively whiles the two tests were analysed quantitatively. According to McMillan and Schumacher (1997),quantitative data analysis presents statistical results represented with numbers whiles qualitative data analysis presents facts in narration with words.

Quantitative data analysis

The descriptive statistical analysis of both the pre-test and the post-test included the mean, standard deviation, percentages, frequency counts. The inferential statistical tool used was independent sample test also known as the unpaired t-test for both the pre-test and post-test for the two groups. The t-test was used for numerical data to determine if observed differences between the means of the control and the experimental groups could be considered statistically significant. The descriptive statistics describes or give information about the population either through numerical calculations or graphs or tables whiles the inferential statistics make inferences and prediction about the entire population using the sample of data taken d from the population understudy.

Qualitative data analysis

The second phase of the analysis was carried out to find out the common conception that students had about the concept of cell cycle as indicated on the interview schedule. The interview schedules identified the major common patterns of conception among the students. The responses from the interview were recorded to describe the attitude of students towards the concept cell cycle and their level of understanding of cell cycle.

CHAPTER FOUR

RESULTS

4.0 Overview

This chapter is dedicated to the analysis of the findings or results obtained during the study. Research question 1 was analysed qualitatively using responses to the interview schedule in Appendix A, while research questions 2, 3 and4 were analyzed quantitatively the results were used to answer the research questions raised in the study.

4.1.0 Presentation of Results by Research Questions.

4.1.1 Research Question 1

What is the students" understanding of cell cycle before being exposed to computer simulation and concept model? This question sought to find out students" knowledge of the cell cycle before intervention.

Item 8 of the interview schedule required students to state the aspect of cell cycle they found most challenging. Hence to answer this question students need to know what cell cycle is and the phases of cell cycle such as interphase, mitosis, meiosis and cytokinesis.

For the question which aspects of cell cycle do you find most challenging the expected answer should have been: Explanation of cell cycle, as series of events which occur in a cell leading to its division and replication of its DNA, Phases of cell cycle explained. Interphase (G1, S, G2), M-phase (mitosis, and cytokinesis). M-phase It is the stage where actual cell division occurs. The M phase begins with karyokinesis and ends with cytokinesis. Interphase is the stage where the cell grows and prepares to divide. Interphase occurs in 3 phases: G_1 phase (Gap_1), S phase (synthesis) and G_2

phase (Gap2). At G_1 phase the cell is metabolically active and grows, at S phase DNA synthesis or replication occurs. It is the period where the amount of DNA per cell doubles but the number of chromosome remains the same. Proteins are synthesized at G_2 phase and cell growth continues. However some cells in adult animals example the heart cell do appear not to undergo division they divide occasionally when the need arise to replace cells lost through injury or cell death. These cells exit from the cycle at G_1 phase and enters an inactive phase called the quiescent stage (G_0) cells at stage become metabolically active.

A student who is able to explain cell cycle and able to outline the phases and explain each of the phases and also explains the quiescent stage shows sound understanding of the concept. A student who is able to explain cell cycle and outline and explain the phases but omits the quiescent stage shows partial understanding. If a student explains cell cycle but outline the stages of mitosis instead of phases of cell cycle that student has partial understanding with specific misconception. A student who explains cell cycle but outline the stages of mitosis instead has specific misconception. If student could not explain cell cycle and could not outline the phases of cell cycle that student has no understanding of the concept.

Students responses: prophase, metaphase, anaphase, telophase.

Approximately 44% of the students showed sound understanding, and 20% of them showed partial understanding Also12.86% showed partial understanding. Again 14.28% showed specific misconception. Whilst 8.57% showed no understanding. The results are indicated in Table 1.

Table 1: Distribution of students' understanding of phases of cell cycle for the pre-test

Level of understanding	Number of students	Percentage (%)
Sound understanding	31	44.29
Partial understanding	14	20.00
Partial understanding with specific	9	12.86
misconception	10	14.28
Specific misconception	6	8.57
No understanding		
Total	**70**	**100**

The second item9a: identify areas in (i) plants and (ii) animals where mitosis and meiosis occur were a bit more demanding than the first question as the results in Table 2 show.

Table 2: Distribution of students' understanding of areas in plants and animals where mitosis and meiosis occur.

Level of understanding	Number of students	Percentage (%)
Sound understanding	13	18.57
Partial understanding	10	14.29
Partial understanding with specific	22	13.43
misconception	17	24.29
Specific misconception	8	11.42
No understanding		
Total	**70**	**100**

The students were asked to identify areas in (i) plants and (ii)animals where mitosis and meiosis occur. Students were expected to mention specific areas in plants and animals where mitosis and meiosis occur. The expected answer was; in plants mitosis occur in meristematic tissues such as the shoot tip, root tip and in the bud. In animal‟s mitosis occur dividing and growing areas such as the skin cell, muscle cell, nerve cell and in the cartilage. Whilst meiosis occur in pollen grain and in the egg cell in the ovary of the flower of plants, however in animals meiosis occurs in the egg cell(ovum) and the sperm cell in female and male respectively.

Some responses of students were: stem, branches, roots. (areas of mitosis in plants).

Head, ear, eye,(areas of mitosis in animals)

Meiosis: petals, sepals stalk (in plants)

Mammary gland, vagina, penis,(in animals)

Students who are able to mention specific areas in plants and animals where mitosis and meiosis occur without mixing them up ,show sound understanding. If a student mentions areas in animals where mitosis and meiosis occurs but fail to mention areas in plants where the two types cell divisions occurs, this student shows partial understanding. A students who mentioned non-meristematic tissue such as parenchyma, collenchyma tissues as areas in plant instead of meristematic regions such as bud, root and shoot tip where mitosis occurs shows partial understanding with specific misconception. If a student mentioned that mitosis occurs in the reproductive cells of both plants and animals then the student has specific misconception. A student shows no understanding if he or she failed to mention reproductive cells as areas in both plants and animals where meiosis occurs and mitosis as occurring in body cells of animals and in the growing regions of plants.

However, the students were not conversant with specific areas in plants and animals where mitosis and meiosis occur. Some mention any parts of plants and animals. The results are shown in Table 2. Only 18.57% of the students showed sound understanding they stated correctly areas in plants and animals where mitosis and meiosis occur. Also 14.29% showed partial understanding. Approximately 13% of students showed partial understanding with specific misconception Again 24.29% of showed specific misconception Lastly11.42% of the students showed no understanding.

Another question 9c: sought to find out if students know the products of mitosis and meiosis. State the main products of mitosis and meiosis.

Approximatly 14.29% of the students showed a sound understanding and 85.71% of them showed no understanding. The results are shown in Table.3. .

Table 3. Distribution of students' understanding of the products of Mitosis and Meiosis

Level of understanding	Number of students	Percentages (%)
Sound understanding	10	14.28
Partial understanding	15	21.43
Partial understanding with specific misconception	19	27.14
Specific misconception	17	24.29
No understanding	9	14.86
Total	70	100

9c: What are the main products of i. Mitosis ii. Meiosis?

Some responses of students: daughter cells, young nuclei

Expected answers should have been;

i. The product of Mitosis is two genetically identical diploid cells.

ii. The product of Meiosis is four haploid cells. The daughter cells vary genetically.

A student shows sound understanding the products of mitosis and meiosis if he or she states that the product of mitosis is two genetically identical haploid cells and the product of meiosis as four haploid cells which are genetically non- identical. A student shows partial understanding if he or she mentions the product of meiosis but failed to mention the product of mitosis. If a student fail to mention diploid and haploid cells in his or her answer as product of mitosis and meiosis respectively that student shows partial understanding with specific misconception. A student who exchanged products of mitosis with the product of meiosis had specific misconception. If a student could not mention the product of mitosis and meiosis as two genetically identical diploid cells and4 genetically non-identical haploid cell rather mentioned only daughter cells that student had no understanding of the product of meiosis and mitosis cell division.

As indicated in Table 3, 14.28% of the students continued with the second part of question and answered it correctly. Approximately 21% of them showed partial understanding by mentioning only the products of meiosis but failed to state the products of mitosis correctly. 27% of them had partial understanding with specific misconception. They failed to mention diploid and the haploid cells of mitosis and meiosis respectively. Again 24.29 % of them had specific misconception as they exchanged the products of meiosis with the product of mitosis. Lastly14.86% showed lack of understanding as they failed to identify the products of meiosis and mitosis correctly.

Qualitative Analysis of interview results conducted with 10 students on cell cycle.

A qualitative analysis was performed on cell cycle to find out some preconceptions that students had when answering questions on cell cycle on the interview schedule in appendix A. Some incorrect responses of the students on cell cycle are presented in table 4 below.

Table 4. Incorrect responses to interview questions on cell cycle.

1. Failure to identify the phases of cell cycle instead students stated the stages of mitosis: as prophase, metaphase, anaphase and telophase
2. Failure to identify specific areas in plants and in animals where mitosis and meiosis occurs. In plants roots ,stem ,branches were mentioned as areas where mitosis occurs .They failed to realised that mitosis occurs in somatic cells whereas meiosis occurs in reproductive cells.
3. Not being able to realised that prophase1of meiosis is longer than prophase of mitosis They could not mention that events such as chiasmata synapsis crossing over, bivalent occur at prophase1 of meiosis but are absent in prophase of mitosis.
4. Could not realize that that there are two successive divisions in meiotic cell division instead mentioned the four stages such as Prophase,Metaphase,Anaphase,and Telophase for both meiosis and mitosis.
5. Could not differentiate between the products of meiosis and mitosis. There were no of mentioned haploid and diploid cells as products of meiosis and mitosis respectively.
6. Failure to identify the differences between mitosis and meoisis.
7. Not being able to realised that meiosis is a reduction division instead students" used 2n to denote mitosis.
8. .Failure to separate interphase from the stages of mitotic and meiotic cell division. This was evident when the students" were asked to drawing of the stages of mitosis and meiosis.

4.1.2 Research question 2

To what extent do performance of the experimental and the control group differ with respect to cell cycle before the intervention?

In answering research question 2, students‟ scores in the pretest were analysed using mean scores, and standard deviation and the null hypothesis was tested using the independent sample test. The result of all the students‟were presented in Table 5.

Also a null hypothesis was formulated as follows :

Ho_3: There no significant difference in the performance of the experimental and control group about cell cycle before the intervention.

Table 5: Mean scores,Standard deviation and t-test pretest scores of experimental and control group.

Groups compared	Test	Mean score	Standard deviation	t-value	p-value
Experimental	Pretest	18.63	11.03	.105	.917
Control	Pretest	18.89	9.49		

In Table 5, the mean score of the control group was a bit higher than the mean score of the experimental group in the pretest. The t- test analysis of the mean score of the pretest of the two groups showed no significant difference (t=.105; p> 0.05) (see Appendix H).

This means that there was no significant difference in the performance between the two groups at the beginning of the studies before exposure to computer simulation and concept model. This implies that the two groups were comparable on their initial understanding of cell cycle. Therefore the null hypothesis could not be rejected.

4.1.3 Research Question 3

To what extent do the performance of students exposed to computer simulation and concept model differ from that of their counterpart taught by the traditional method?

In order to answer this research question a null hypothesis was formulated as follows;

Ho_1; There is no significant difference between the performance of students exposed to computer simulation and concept model and those taught by the traditional method. The result of the hypothesis testing is shown in Table 6.

Table 6: Mean scores, Standard deviation and t-test result of posttest scores of the experimental and control groups.

Groups compared	Test	Mean test score	Standard deviation	t-value	P-value
Experimental	Posttest	33.49	5.66	5.012	.000
Control	Posttest	25.26	7.89		

In Table 6, the mean test score of the experimental group was higher than the mean test score of the control group. The t- test analysis of the mean score on the posttest for the two groups shows significant difference at a probability level of 0.05 between the two groups. ($t=5.012; p<0.05$) (see Appendix I).There is significant difference between the performance of students exposed to computer simulation and concept model approach and their counterpart taught by the traditional method of cell cycle. The performance of the experimental group was better than the control group in the posttest. This implies that the experimental group had better conceptual understanding of cell cycle than the control group after the treatment. Hence the null hypothesis could be rejected.

4.1.4 Research Question 4

To what extent is the performance of gender influenced by computer simulation and concept model interventions?

The question sought to find out if gender performance is influenced by computer simulation. In order to answer this research question a null hypothesis was formulated as;

Ho_2; There is no significant difference in the performance between male and female students exposed to computer simulation and concept model in cell cycle.

Table 7: Mean score, standard deviation and t-Test of pretest and posttest scores of Male and Female students in the experimental group.

Group Compared	Test	No. of students	Mean Test Score	Standard Deviation	t-Value	p-Value
Male	Pretest	21	21.14	11.66	.108	.708[b]
Female	Pretest	14	19.57	12.65		.
Male	Posttest	21	33.57	4.73	.378	.915[b]
Female	Posttest	14	33.36	7.03		

Not significant, $p > 0.05$

In Table 7, in the experimental group, the mean test score for male was a bit higher than that of the female in both pretest and posttest. However there was no significant difference between their mean test scores when the t-test analysis on both the pretest and posttest was performed, ($t=.108; p>0.05$ and $t=.378; p>0.05$) respectively. (see

Appendix I). The conclusion drawn from this analysis was that at a probability level of 0.05, there was no significant difference between the performance of male and female students who were exposed to computer simulation and concept model method of teaching cell cycle.

This means that both female and male in the experimental group were comparable in their conceptual understanding of cell cycle. Therefore the performance of gender is not influenced by computer simulation and concept model. Hence the null could not be rejected.

CHAPTER FIVE

DISCUSSION OF THE RESULTS

5.0 Overview

Findings from the study are discussed in line with research questions and supported with appropriate Literature as follows:

5.1 Research question 1 What is students' understanding of cell cycle before being exposed to computer simulation and concept model?.

Students understanding of cell cycle before intervention.

Research question 1 sought to find out students understanding of cell cycle before being exposed to computer simulation and concept model.

The qualitative analysis of the students conceptual understanding of cell cycle indicated that most of the Senior High School students who participated in the study had no meaningful understanding of cell cycle.

Students" difficulty to define mitosis and meiosis under the following headings (site for the process, main products and the number of chromosome in each daughter cell) were reflected in their responses in the pre-test (Appendix C) and their inability to support their answers with diagrams of stages of mitosis and meiosis.

The results of this study showed that majority of Senior High Students who took part in the study had no conceptual understanding of cell cycle hence several incorrect responses about the concept as outlined in Table 4 were identified. These incorrect responses were identified during the interview section. The students level of understanding of the concept cell cycle ranged from partial understanding to nounderstanding. These misunderstandings held by the students" on the concept of cell cycle may be as a result of prior learning experience on the concept and this continued after instruction this may be due to the students" level of cognition .These misunderstanding may also result from the traditional teaching method employed by Senior High School biology teachers in teaching this and other perceived difficult topics in biology. The lecture method makes it very difficult for students to fully understand the concept. This conforms with the findings of Kolawole (2008) that the teaching approach employed by a teacher is one of the important causes of students‟ poor performance in WASSCE. It is also consistent with the findings of Tekkaya, Ozan, and Sungur,(2001) who suggest that the teaching strategies employed by teachers is another possible source of students difficulties in learning these biological concepts.

The difficulties students face in understanding this concept and equally difficult topics in biology is as a result of the sequence in which the topics were presented in biology text books .This conforms with the findings of Tolman (1928) that the difficulty in learning meiosis and genetics came from the sequence in which these topics were presented in biology textbooks. Another level of difficulty in understanding this concept is lack of relationship between meiosis and other concepts and incorrect and ambiguous use of certain terms. This is consistent with the findings of Stewart (1983) and Cho ,Kahle and Norland (1985) who stressed the importance of relationship among the concepts of meiosis and genetics and condemns the incorrect and ambiguous use of genetic concepts in text books. Therefore the introduction of computer assisted instruction and concept model was very appropriate in overcoming these incorrect responses as outlined in Table 4 of the study. This intervention is consistent with the findings of Cotton (1991) that computer assisted instruction promotes more positive attitude towards quality of instruction and the course content as well.Students gave more correct responses after the intervention.(Appendix A1).

5.2 Research Question 2: To what extent do the performance of the experimental group and the control group students differ with respect to Cell Cycle?

Difference in performance between the experiment group and control group before intervention.

This question was intended to find out the extent to which the performances of the experimental and the control group students differ with respect to cell cycle before the intervention. From the students" performance in Table 5, the t-test analysis of the mean test score shows no significant difference (t=.105; p>0.05).This showed that the two groups were comparable on their initial understanding of cell cycle. The comparism between the control and the experimental group conforms with the findings of Fletcher-Flin and Gravatt (1995) that there were no significant differences between CAI and traditional method of instruction. The two groups were comparable in their initial understanding of cell cycle.

5.3 Research question 3: To what extent do the performance of students exposed to computer simulation and concept model differ from their counterparts taught by the tradition?

The effect of different teaching methods on the performance of the two groups of students.

This question sought to find out the extent to which the performance of students exposed to computer simulation and concept model differed from their counterpart taught by the traditional method.

The performance of the experimental group who were exposed to computer simulation had significantly improved over the control group in the posttest. This may be as a result of the exposure of the experimental group to computer simulation and concept model. This method enabled the students in the experimental group to actually conceptualise and visualise the phases of cell cycle which includes interphase, mitosis and meiosis. The use of computer simulation helps to eliminate the abstract nature of this concept and makes it appear real, therefore enhancing students" conceptual understanding of the concept. This is consistent with Morrel (1992) findings that the use of computer adds to the teachers" instructional strategies and enriches the students" experiences. Chalmers, (2000) investigation proved that engaging in technology activities may seem time wasting but some of these technologies such as digital gaming, social networking and computer simulation deserve a second look. Although these technologies are perceived as entertainment by many people, their effect on how students learn, interact and reason cannot be overlooked.

The simulation game has greatly reduced the level of abstraction. The use of computer assisted instruction has also facilitated the organization of student"s conceptual structures to aid in better understanding of the concept. This is in conformity with the findings of Ochoyi and Ukwumunu (2008) who reported that integration of computer in secondary school curriculum produced positive effect on students" learning. Cotton (1997) also reported that then use of CAI as a supplement to traditional instruction method yields higher achievement than the use of the traditional method alone. Significant improvement in the performance of the experimental group is also consistent with the findings of Ozmen (2008) that computer technology enables learners to be active in the learning process, to construct knowledge, to develop problem solving skills and to discover alternative solutions to problems.

The physical models depicting the stages mitosis, meiosis and interphase were presented to the students to interact with under the guidance of the researcher who was acting as a facilitator. The models were tangible and hence helped to reduce the abstract nature of the concept making the concept cell cycle more concrete and meaningful to students in the experimental group. These physical models actually helped the students to appreciate, visualize, conceptualize the stages of mitosis, meiosis and interphase and also the products of mitosis and meiosis were grasped with ease. This was evident in their ability to outline the process of mitotic and meiotic cell divisions and describing the arrangement of chromosomes at each stage of cell division in the posttest.

The concept model presents the concept visually and this actually helped students to understand new phenomena and also explain the phenomena to others. This is consistent with Gentner and Toupin (1986) who found that at least at age 8 children are able to understand such relational model in nonscientific context. Hence conceptual models can be used as an important tool in science education.

5.4 Research Question 4 To what extent is the performance of gender influenced by computer simulation and concept model interventions?

The effect of interventions on the performance of male and female students in the experimental group.

The objective of this question was to find out the extent to which the performance of gender is influenced by computer simulation and concept model with respect to cell cycle.

The result of the study revealed that the male students of the experimental group performed slightly better than the female students in both pretest and posttest than their female counterpart (see Table 8 and also Appendix I). However the t-test analysis of the mean score showed no significant difference ($t=.108; p>0.05$) even though it appeared the male students would perform better towards the concept understudy using computer simulation and concept model than their female counterparts. The study shows that CAI seems to have no influence on the performance of gender with respect to cell cycle. It can be deduced that computer simulation strategies improved the performance of both male and female without any statistical significant difference between the two sexes. This assertion conforms with the findings of Yusuf and Afolabi (2010) that gender had no influence on the performance of students in biology. It also conflicts with Harttie and Fitzgerald (1988) who reported that gender difference in the use of computer assisted instruction are more evident at the secondary school level than at the elementary level.

5.5 Discussion of the interview

A heartwarming aspect of the study was provided by the interviewees of the experimental group. Almost all the students in the experimental group appeared content with the computer simulation approach this was evident in expressions such as wao! Very interesting, that should be repeated again, this should be adopted by all teachers, were made by the students. This might be as a result of the significant gain the experimental group made after the intervention. The responses from the interview suggested that students conceptual understanding of cell cycle was greatly enhanced as a result of exposure to simulation games this also opened doors for leaning other scientific concepts. The use of computer simulation in teaching scientific concepts influenced students" attitude towards the learning of science, this conform with the findings of Selwyn (1999) that computer assisted instruction improves positive attitude towards science. Izzet and Ozkan (2008) in their study found out that CAI both increases motivations towards learning and development of academic achievement of student.

Most if not all students in the experimental group seemed happy and satisfied with the simulation method that was used in teaching them cell cycle. This may due to the fact that the experimental group made significant gain in their performance after the treatment. Reflecting on students responses from the interview revealed that several opportunities abounds when students use computer simulation in learning a scientific concept.

One of such opportunities that the use of computer simulation offers is the conceptualization and the visualization of abstract concept like the cell cycle. The models depicting the stages of meiosis and mitosis enable students to manipulate the physical objects and visualized the positions of the chromosomes at each stage of mitotic and meiotic cell divisions.

This conforms with the findings of Gilbert (2005) that in science education visualization plays a major role by providing the simulation of physically manifest and theoretically framed behaviors of the system under study. Lepper and Gurtner (1989) noted that the use of CAI in addition to regular instruction improves students‟‟ academic achievement besides influencing student‟‟s attitudes and motivation.

CAI enable students to achieve at higher levels, researchers have also found that CAI enhances learning rate. Student learning rate is faster with CAI than with conventional instruction. In some research studies, the students learned the same amount of material in less time than the traditionally instructed students; in others, they learned more material in the same time. This is consistent with the work of Capper and Copple (1985) that CAI users sometimes learn as much as 40 percent faster than those receiving traditional, teacher-directed instruction.

Closely related to the above is the finding that CAI is more effective for teaching lower-cognitive material than higher-cognitive material. This research makes essentially the same point that CAI is particularly effective for reinforcing the basic, fact-oriented learning most often engaged in by younger, lower achieving students.

The following is a list of reasons given by students for liking CAI activities and/or favouring them over traditional learning. These students‟ preferences also contribute to our understanding of why CAI enhances achievement.

Students say they like working with computers because computers:

Are infinitely patient, never get frustrated, or angry allow them to work privately, never forget to correct or praise are fun and entertaining and promotes Individualise learning, Are self-paced ,do not embarrass them when they make mistakes. Make it possible for them to experiment with different options, give immediate feedback, are more objective than teachers, are impartial to race or ethnicity, are great motivators, give them a sense of control over learning, are excellent for drill and practice, call for using sight, hearing, and touch, teach in small increments, help them to improve upon their spelling build their proficiency in computer use, which will be valuable later in thier life, eliminate the drudgery of doing certain learning activities by thier hand (e.g., drawing graphs) Work rapidly closer to the rate of human thought.

Many of these items point to students' appreciation of the immediate, objective, and positive feedback provided by computer learning activities by comparison with teacher-directed activities. The use of CAI in the teaching and learning of scientific concepts is cost effective.

This is consistent with the study of Walberg (1969) that CAI activities are significantly more cost-effective than tutoring and suggested that computers be used more extensively in schools.

CHAPTER SIX

SUMMARY, IMPLICATIONS, CONCLUSIONS, RECOMMENDATIONS AND SUGGESTION FOR FURTHER RESEARCH

6.0 Overview

This chapter talks about the summary of the major findings, their implication for science teaching, and conclusion. The chapter also included recommendations, suggestion for further research and above all the contribution of the study for Science Education.

6.1 Summary of the major findings from the study

The major findings of the study have been summarized under the following headings:

1. **Common patterns of conceptions of students on cell cycle and cell division**.

The qualitative analysis of the conceptual understanding of the subjects showed that most of the Senior High School students who participated in the study had no meaningful understanding of the concept of cell cycle and therefore had lot of misunderstanding about cell cycle(see Table 4).The students" misunderstanding on cell cycle ranged from partial understanding, to no understanding. Such misunderstandings show that the students did not know the basics of the concept which requires the knowledge of cytology, cell Biology, Deoxyribonucleic (DNA) replication, replication of chromosomes and genetics which are crucial for the understanding of the concept " cell cycle". The eight common patterns of conceptions identified by the 70 students are as follows:-

1. Failure to identify the phases of cell cycle instead students stated the stages of mitosis.

2. Failure to identify specific areas in plants and in animals where Mitosis and Meiosis occurs. In plants roots ,stem ,branches were mentioned as areas where mitosis occurs .They failed to realised that Mitosis occurs in somatic cells where Meiosis occurs in reproductive cells.
3. Not being able to realised that prophase1of meiosis is longer than prophase1 of mitosis. Could not mention events such as chiasmata synapsis, crossing over, bivalent occur at prophase1 of meiosis but are absent in prophase of mitosis.
4. Could not realize that that there are two successive divisions in meiosis cell division instead mentioned the four stages such as Prophase, Metaphase, Anaphase, and Telophase the two cell divisions.
5. Could not differentiate between the products of meiosis and mitosis. There were no of mentioned haploid and diploid cells as products of meiosis and mitosis respectively.
6. Failure to identify the differences between mitosis and meoisis.
7. Not being able to realize that meiosis is a reduction division.
8. Failure to separate interphase from the stages of mitotic and meiotic cell division

2. Difference in the Performance between the experimental and the control groups before and after Treatment

At the beginning the of study or in the pretest there was no significant difference in the performance between the two groups (Table 6 & Appendix I).This implies the two groups were comparable on their initial understanding of cell cycle. However there was statistically significant difference in the performance between the control and the experimental group in the posttest or after the treatment. The experimental group performed better in the posttest than their counterpart in the control group. This shows that the experimental group had better understanding of the concept cell cycle than the control group after being exposed to computer simulation and concept model. This means the performance of the experimental group had improved significantly over the control group. This implies that the Senior High School Biology students who were exposed to simulation games instructional learning method were able to retain more scientific concepts that they were taught than those in the control group who were taught using the traditional teacher- centered approach of instruction.

3. The difference in Performance Between Male and Female Students within the Experimental group Before and After Treatment

Statistically there was no significant difference in the performance between male and female students of the experimental group in both pretest and posttest(see Table 6 Appendix I).This implied that both male and female students in the experimental group were comparable on their conceptual understanding of cell cycle and cell division before and after the treatment. The implication is that gender seems to have no influence on the performance of students through the use of computer simulation game approach to teaching and learning cell cycle.

4. Views and Perceptions of the Experimental Group Students on computer Assisted instruction

Very positive views and perceptions were expressed by the experimental group students on computer assisted instruction approach during the interview. Students were of the view that the computer assisted instruction provided a very good learning environment and promotes better cooperation among them. They went ahead to express their views and perceptions about the use of computer in learning as follows: computer are infinitely patient, never get tired, frustrated or angry. Allow students to work privately never forget to correct or praise, are fun and entertaining, promotes individual learning, are self-paced. They do not embarrass them even when they make mistakes, make it possible for them to experiment with different options, and give them immediate feedback.

Computers according to the students are more objective than teachers .Free teachers for more meaningful contact with students are impartial to race or ethnicity are great motivators, give a sense of control over learning, call for using their sight, hearing, and touch, teach in small increments, build proficiency in computer use, which will be valuable later in life eliminate the drudgery of doing certain learning activities by hand (e.g., drawing graphs) They work rapidly closer to the rate of human thought. Several opportunities arise when students use computer assisted instruction in learning scientific concepts. For example they have the opportunity to conceptualize and visualize the stages of mitotic and meiotic cell division and the position of the chromosome at each stage of two cell divisions.

Student had the opportunity to dialogue and interact among themselves and also share their views, and above all uncovers their misunderstanding and was able to assess their performance and how they progress in their learning. According to the experimental group the concept became very real to them and its abstractness in eliminated.

6.2 Educational Implication of the study for the Teaching of Science.

The results of the study show clearly that Senior High School Students who participated in the study lack sound conceptual understanding of cell cycle and cell division. These students memories abstract scientific concepts which leads to several misunderstandings that they had about cell cycle. This study suggests that innovative and effective teaching methods need to be used to help students to develop meaningful learning styles and quit the rote memorization of hurriedly copied notes which are usually dictated by teachers in a bid to finish the syllabus before WASSCE.

To develop meaningful learning and positive attitude toward science, science teachers need to vary their teaching methods and adopt contemporary teaching methods such as computer simulation game approach and concept model to actively involve students in the learning process so that they can independently construct and organise their knowledge so that they can apply these knowledge to solve their own problem and the problems in their own community easily and effectively. These objectives can only be achieved if students are empowered to become responsible and independent learners.

In a developing country like Ghana where the absence or the scarcity of resources retard the teaching of science, teachers of science need not to throw in the towel, but rather use contemporary and innovative teaching methods such as computer simulation to help students to understand challenging topics in biology and to improve upon their performance in biology. Science teachers should be encouraged to use computer assisted instruction packages and concept model in teaching abstract and perceived difficult biological concepts so as to build up students confidence, motivate them and demystify the notion that the teaching and learning of science more especially biology is difficult.

The findings of this study showed that Senior High School biology students who participated in the study have no appropriate conceptual understanding of cell cycle and result in a lot of miunderstandings about cell cycle and cell division before the intervention. The students" conceptual understanding of cell cycle ranged from partial understanding to no understanding. The result is in conformity with the findings of Lazarowitz and Penso (1992) who identified cells as one the topics perceived difficult by students as difficult. The traditional approach usually makes it difficult for students to fully appreciate what happens at the each stage of mitotic or meiotic cell division and the behaviour of chromosomes at the various stages of the two cell divisions. The results of the study revealed that students who were exposed to computer simulation and concept model approach performed better than their counterparts who were exposed to the traditional method. This implies there has been an increase in performance in students exposed to computer simulation and concept model.

The study also revealed that there has been significant retention of scientific concept on the part of students exposed to computer assisted instruction than those exposed to the traditional approach. The study showed that the performance of students who previously performed poorly had improved significantly through the use of computer assisted instruction approach. This finding conforms with the findings of Cotton (1997), who concluded that the use of computer assisted instruction as a supplement to the traditional instruction method yields higher achievement than the use of traditional method alone. Izzet and Ozkan (2008) in their study found that computer assisted instruction both increases motivation towards learning and development of academic achievement of students. It realize that, only when computers are integrated into the curriculum as a vital element for instruction and applied to real problem for real purpose will children gain the most valuable skills and ability to use the computer to learn better.

The study also revealed that students‟ perception about cell cycle and cell division had improved as a result of exposure to computer simulation approach than their counterparts who were taught using the traditional approach. One outstanding finding was that the use of computer assisted instruction and concept model, boosts student‟s interest and motivated the students and also increased their desire to learn scientific concepts including cell cycle and cell division.

The result of the study also revealed that there was no significant difference between the performance of male and female students in the experimental group who were exposed to computer assisted instruction towards the comprehension of cell cycle and cell division. Hence, the use of computer assisted instruction to teaching and learning of cell cycle and cell division seems to have no effect on the performance of male and female students in cell cycle.

The study also revealed that a lot opportunities for learning using computer simulations abounds; these opportunities are absent in the traditional, teacher centered approach.

Simulation game method helped the students to conceptualize and visualize the positions and behavior of chromosome at stage of mitotic and meiotic cell division. Students had the opportunity to interact and share ideas with each other freely on uncover their misunderstandings and also empowered to learn independently. Students also had the opportunity to assess the progress of their work in the learning of science. The students suggested that computer simulation should complement the teacher centered or the traditional method .They added that computer assisted instruction made the learning and the understanding of abstract and perceived difficult scientific concept easier and interesting. Students argued in favour of the use of computer simulation approach in the Senior High Schools.

6.3 Conclusions

The present study shows that the Senior High School biology students who participated in the study have not developed appropriate conceptual understanding of cell cycle and hence had a lot of misunderstandings about the concept. The students" conceptual understanding of the process of cell cycle and cell division and suitable diagrams ranged from partial understanding no understanding.

The result of the study revealed that students who were exposed to computer simulation performed better than their counterparts who were taught using the traditional method. The study suggests that students exposed to computer simulation retained significantly the concept taught than those taught using the traditional method approach. This conclusion conforms with the findings of Tabassum (2004).

The study also indicated that there is no statistically significant difference between the performance of male and female students exposed to computer simulation in cell cycle. Therefore CAI seems to have no effect on the performance of gender in cell cycle.

As teachers, attention should be the quality of what the children learn and not quantity of information passed on to the students in a bid to complete the syllabus within a short time. Cytology concept such as cell cycle is learnt effectively if the teacher varies his or her teaching methods including contemporary teaching methods like computer simulation. Students on the other hand need to know the essence of learning such abstract and complex concepts since they are crucial to expand their knowledge in biology.

Hence Ghanaian science teachers more especially biology teachers need to be encouraged to use computer assisted instructions in teaching scientific concepts for learners to appreciate the role of science in their daily life and also to understand science this would remove the phobia of learning science and hence develop a positive towards the learning of learning.

6.4 Recommendations

Reflecting on the summary of the findings of this study, the following recommendations are made:

1. Computer assisted instructions and concept model when properly integrated can help the students to visualize the concepts and thereby develop positive attitudes towards the learning of science. This would also improve their conceptual understanding and performance in biology.
2. Computer simulation as a type of instructional mode is capable of transforming students from passive receipt of knowledge to active learners hence should be used to teach biology and other science subjects in secondary schools in the region.
3. Stimulating biological games should be designed locally to boost student‟s interest and their motivation in the field of biology. This would draw more students towards the learning of science specifically the learning of biology thereby increasing the number of Biologist in the region.
4. There is the need to provide schools with well-equipped computer laboratories, and staffing the laboratory with well-trained permanent computer literates and skillful technicians to support schools, administrators, teachers as well as students in the region.

5. The Government should make computers affordable to students through subsidiary ways and also make internet accessible in all Senior High Schools. Projectors should be given to schools in addition to computers to help teachers to integrate CAI in their teaching and learning of challenging concepts in biology.
6. Both male and female students should be given equal opportunity in the use of CAI in learning scientific concepts all the Senior High Schools in the region.

6.5 Suggestion for further studies

The educational implications of the findings of the study call for further research in the area of Cell cycle and cell division. The following are the recommendation for further research:

1. It is suggested the study should be conducted on a larger scale to include more Senior High School students in other parts of the region. This would provide the opportunity to evaluate the two teaching methods and to arrive at generalized conclusion.
2. Science teachers and software developers in the region should be encouraged to collaborate to develop interesting animations for teaching scientific concepts.
3. Larger sample of male and female students should be used in similar studies in different schools to find out the attitude of male and female towards the computer simulation games in other areas of science.
4. Workshops should be organized periodically as well as in -service training (INSET) by the Regional Education directorate in collaboration with

regional Science co-coordinator and other supporting agencies in science education in the region for science teachers at Senior High School level on challenging biological concepts. This would help upgrade the teachers" knowledge, improve the teachers" competency and keep the teachers well informed and abreast with time and also help the teacher to employ effective and modern methods of teaching complex biological concepts.

5. Science teachers should be sponsored by the Municipal assemblies to attend the annual GAST conference where these challenging topics are handled.

REFERENCES

Abimbade, A. (2006). *Information and communication technology in education*: Teachers‟ Preparation and Quality Assurance. A paper presented at the 19th National Conference of Curriculum Organization of Nigeria (CON) September 12-15.

Abuhmaih, A. (2011). *ICT training courses for teacher professional development in Jordan.Adams,* N.B. (2002). Educational Computing Concerns of Postsecondary Faculty. *Affecting teachers' use of Information and Communication Technology International Journal of instruction*.

Akour, A. (2008). *The effects of computer-assisted instruction on Jordanian college students'achievements in an introductory computer science course*. Electronic Journal for

Akpan, J.P., & Andre, T.(2000). *Using computer simulation before dissection to help student learn anatomy*. Journal of computers in mathematics and science Teaching, 19(3), 297-313.

Alhassan,S(2006), Modern Approaches to Research in Educational Administration Kumasi, Ghana payless publication.

Anderson, G. **J. (**1970) Effects of classroom social climate on individual learnings. *America Educational Research Journal.* **7,** 135-152.

Anderson, G. **J. (**1971**).** *The assessment of learning environments: A manual for the Learning Environment Inventory and the My Chss Inventory.* Halifax, Nova Scotia, anada: Atlantic Institute of Education.

Bahar, M.,Johnstone A.H. and Handsell, M.H.(1999)Revising Learning Difficulties in Biology. Journal of Biological Education.33 (2).84-86

Bangert-Drowns, R., Kulik, J., & Kulik, C. (1985). *Effectiveness of computer-based education in secondary schools.* Journal of Computer Based Instruction, 12(3), 59-68. 84.

Barton, R. F. (1970). *Simulation and Gaming*, Prentice Hall, Englewood Cliffs, New Jersey, p. 6.

Basturk, R. (2005). *The effectiveness of computer-assisted instruction in teaching introductory statistics.* 8(2), 170–178.

Bloom, B. **S.**(1971) Affective consequences of school achievement. In **J.** H. Block (Ed.), *Mastery learning.* New York: Holt, Rinehart, and Winston.

Bontempi, E., & Warden-Hazlewood, L. (2003). *Factors in effective computer-assiste instruction*.

Branscrum,D.(1992).*Educators need support to make computing meaningful*. It is time to wield technology wisely .Macworld, September 1992,pp.83-88.

Brenestuhl, D. (1975). *Cognitive vs. affective gains in computer simulation*. Simulation & Games, and student achievement. In M. Wittrock (Ed.), Third handbook of research of teaching (pp. 328-375), New York: Macmillan.

Brookline. Carnine, D., & Kinder, D. (1985). *Teaching low performing students to apply generative and schema strategies' o narrative and expository material remedial and Special Education*, 6(1), 20-30.

Bruner J.S.(1961) The act of discovery Harvard Educational Review 31: 12-32.

Budoff, M., Thormann,J ., & Gras,A . (1984). *Microcomputers and special education.* Cambridge, MA: Brookline Cohen, R., & Bradley, R. (1978). *The use of simulation games to create real worlds for special education students*. Reading improvement, 15, 275-278.

Capper, J., and Copple, C. (1985) *Computer Use in Education*: Research Review and Instructional Implications.Washtington,DC: Center for Research into Practice.

Carey**, S.** (1999). Sources of conceptual change. In E. K. Scholnick, K. Nelson, & P. Miller (Eds.), *Conceptual development: Piaget's legacy* (pp. 293-326). Mahwah, NJ: Lawrence Erlbaum Associates.

Carey, S., Evans, R., Honda, M., Jay, E., & Unger, C. (1989). *An experiment is when you try it and see if it works*: A study of grade 7 students' understanding of the construction of scientific knowledge. *International Journal of Science Education,* 11, 514-529.

Carine, D., Lang, D., & Wong, L. (1985). *Health Ways*. Unpublished computer program.

Castillo, J .J.(2009).ResearchPopulation.RetrievedNovember21,2017from htt://www.experiment-resources.com./research population.html.

Chalmers, P.A. (2000).User interface improvements in computer-assisted instruction, the challenge, Computers in Human Behaviour, pp. 507-517.PDF(106K) Cited By in Scopus (8)

Champagne, A., & Klopfer, **L**. (1984). *Research in science education: The cognitive psychology perspective*. In D. Holdzkom & P. B. Lutz (Eds.), *Research within reach: Science education* (pp. 172-189). Charleston, WV: Research and DevelopmentInterpretive Service, Appalachia Educational Laboratory.

Chang, C.-Y. (2000). Enhancing tenth graders"earth-science learning through computer- assisted instruction. Journal of Geoscience Education, 48, 636–641.

Cheek,D.W .,& Agruso,s.(1995).Gender and equity issues in computer –based science assessment. Journal of science Education and Technology.4 (1),75-79. Chemistry, and physics courses.13,315-323.

Chi, M. T. H**.** (2008*). Three Types of Conceptual Change: Belief Revision*, Mental Model Transformation, and Categorical Shift. In S. Vosniadou (Eds.), International *Handbook of Research on conceptual Change* (pp. 61-82). New York and London: Routledge Taylor & Francis Group.

Chi, M.T.H., Slotta, J.D., & DeLeeux,**N**. (1994). *From things to processes: a theory of Conceptual Change for learning science concept.* 4, 27-43.

Chinn, C, & Brewer, W. (1993). *The role of anomalous data in knowledge acquisition*: A theoretical framework and implications for Science Instruction. *Review of Educational Research,* 63(1), 1-49.

Cho,H.,Kahle,J.B andNorland F.H (1985) An investigation of Biology Textbook as Sources of Misconceptions and difficulties in Genetics and some suggestions for teaching Genetics. Science Education,69(5).707-719.

Cohen, R., & Bradley, R. (1978). The use of simulation games to create real worlds for special educations students. Reading Improvement, 15, 275-278.

Collins, M. (1984). The effectiveness of computer-delivered reaction procedures on low performing secondary students' reasoning skills. Unpublished doctoral dissertation,

Cooper, GM. *(2000).* "Chapter 14: The Eukaryotic Cell Cycle". The cell: a molecular approach (2nd ed.). Washington, D.C: ASM Press. ISBN 0-87893-106-6

Cotton, K. (1991). Computer-assisted instruction. School improvement series: research you can use retrieved 10/11 /2017.Available from www. nwrel.org / scpd/sirs/5/cu10.html

Cotton, K. (1997).Computer –assisted Instruction. North West Regional Education Laboratory. RetrievedNovember10, 2017,fromhttp:// wwwborg.com/rparkany promOrignal/ETAP778/CAI.html

Cresswell, J.W. (1994).Research design: Qualitative and Qualitative approach. California: Sages Publication.

Cruickshank, D., & Tefler, R. (1980). *Classroom games and simulations*. Theory into Practice, 19, 75-80.

Curriculum Research and Development Division (CRDD) (2007).*Syllabus for Information and Communications Technology for Junior High School.* .

Darch,C ., Carnine,D ., & Kameenui,E. (1986). *The role of graphico rganizersa nd social structure in content area instruction.* Journal of Reading Behavior, 18(4), 275-295

de Jong,T. & Van Joolingen, W.R.(1998).*Scientific discovery learning with computer simulations of conceptual domains.* Review of educational research,68,179-201.

Dede, Chris, 2008. *Theoretical perspectives influencing the use of information technology in teaching and learning*. In: Voogt, Joke, Knezek, Gerald (Eds.), International Handbook of Information Technology in Primary and Secondary Education. Springer, New York, pp. 43–62.

Delafuente, J. C., Araujo, O. E., & Legg, S. M. (1998*). Traditional lecture format compared to computer-assisted instruction in pharmacy calculations.* Spring. American Journal of Pharmaceutical Education 1–8..

Dogra, B. (2010). *Constructivist Classroom Activities for Biology Learning*; Journal of Indian Education; No-2.

Doob, P. (1972). *Prospect for simulation gaming in health planning and consumer health education.* (ERIC Document Reproduction Service No. ED 070 596).

Driver,R., &Bell,.B, (1986).Students‟ thinking and the learning of science: A constructivist view, The school science review,67(240),443-456.

Duit, R. (1999). Conceptual change approaches in science education. In W. Schnotz, S. Vosniadou & M. Carretero (Eds.), *New Perspectives on conceptual Change* (pp. 263-282). Oxford: Pergamon.

Emery, E., & Enger, T. (1972). Computer gaming and learning in an introductory economics course. Journal of Economics Education, 3, 77-85.

Environment Inventory and the My Chss Inventory. Halifax, Nova Scotia, Canada: Atlantic Institute of Education, 1971. (a)

Etkina, E., &Mestre, J.P. (2004). "Implications of Learning Research for Teaching Science to Non-Science Majors. "SENCER Backgrounder PRESENTED AT SSI 2004. Retrieved on March8, 2015 from http://serc.carleton.edu/files/sencer/backgrounders/sencer_implications.pdf

Federal Ministry of Education (F.M.E 2004) National on computer Education Lagos: Nigeria Education Research Council NERDC 4TH Edition.

Fennessey, G., Livingston, S., Edwards, K., Kidder, S., & Nafziger, A. (1975). *Simulation, gaming, and conventional instruction*: An experimental comparison. Simulation & Games, 6, 288-3.

Fletcher-Flinn, C. M., & Gravatt, B. (1995). *The efficacy of computer assisted instruction* (CAI): a meta-analysis. Journal of Educational Computing Research, 12(3), 219–242.

Gallagher, J. (1987). *A summary of research in science education* - 1985. Science Education, 77(3): 307-457.

Gentner, D. (1983). *Structure-mapping*: A theoretical framework for analogy. Cognitive Science 7: 155-170.

Gentner, D. and Toupin, C. (1986). *Systematicity and surface similarity in the development of analogy.* Cognitive Science 10: 277-300.

Gilbert, J.K.(2005). Visualization in Science Education.The Netherlands: Springer..

Gredler, M.(1996).*Educational games and simulations*: A technology in search of(research) paradigm. In D.H Jonassen (Ed.),Handbook of research for educational communication and technology (pp.521-540).New York: Macmillan.

Halis, I.,(200). *Instructional Technologies and Material Development*. Nobel Publication and distribution.

Halloun, I. & Hestenes, D. (1985). The initial knowledge state of college physics students. *AmericanJournal of Physics*, Vol. 53, Issue 11, pp. 1043-1055

Halloun, I. (1998). Views about science and physics achievement. The VASS story. In E.F. Redish & J.S. Rigden (Eds.), *Proceeding of the International Conference on Undergraduate Physics Education* (1996) (pp. 605- 613). Washington, DC: American institute of Physics.

Hattie, J. & Fitzgerald,D.(1988).*Sex differences in attitudes*, achievement *and use of computers.* Australian Journal of Education. 31,3-26.

Hayes, B. G and Robins, E. H.(2000). *Assessing counselor education students' attitudes towards computers and multimedia instruction*. Journal of Humanistic Education and Development.

Hewson, P.W. (1981). A conceptual change approach to learning science. *European Journal of Science Education, 3*, 383-396.

Imhanlahimi, O. E., & Imhanlahimi, R. E. (2008). *An evaluation of the effectiveness of computer assisted learning strategy and expository method of teaching biology*: a case study of lumen. Christi international high school, ,Uromi ,Nigeria Journal of Social Science 16(3),pp.215-220.

Ioannides, C., & Vosniadou, S. (2002). The changing meaning of force. *Cognitive Science Quarterly, 2*,5-61.

Ivers, K. S., & Barron, A. E. (1998). *Using paired learning conditions with computer-based instruction to teach preservice teachers about telecommunications*. Journal of Technology and Teacher Education, 6(2–3), 183–191.

Izzet, K. and Ozkan K. (2008). The Effect of Computer Assisted Instruction on the Achievement of Students on the Instruction of Physics Topic of 7th Grade Science Course at a Primary School. Journal of Applied Sciences, 8: 1067-1072. Institute, Denizl.

Johnson, D. W., & Johnson, R. T. (1974) Instructional goal structure*: Cooperative, competitive or individualisitc. Review of Educational Research.* 44(2).

Johnson,D.W.,&Johnson,R.(1987).LearningTogetherandAlone:Cooperation,Competitive and Individualistic Learning Journal for Research in Mathematics Education,22(5),362-365.

Johnstone, A, H., & Mahmoud, N.A. (1980).Isolating Topics of High Perceived Difficulty in School Biology. Journal of Biological Education. 14(2), 163-166.

Jonassen, D.H (1989). *Mapping the structure of content in instructional systems technology*. Educational Technology*, 29(4).*

Jones, A.(2002*). Linking pedagogy and technology for teachers*. Paper presented the World Computing Conference, Beijing British Journal of Psychology Research

Jonnassen, D.H(200).*Computer as mind tools for schools :Engaging critical thinking* (2^{nd} ed.) Upper Saddle River,Prentice-Hall.

Joppe, M. (2000). The research process. Retrieved December 12, 2013 from the website, http://www.ryeson.ca/~mjoppe/rp.htm.

Kagan, S. (1989) *Cooperative Learning*. San Juan Capistrano, CA: Resources for Teachers.

Kahle, J.B.,& Meece, J.(1994).*Research on gender issues in the classroom*. In Gabel, D.L.(Ed.), Handbook of research on science teaching and learning. New York: Macmillan Publishing Company.

Kausar, T., Choudhry, B. N., & Gujjar, A. A. (2008). *A comparative study to evaluate the effectiveness of computer assisted instruction* (CAI) versus classroom lecture (CRL) for computer science at ICS level. The Turkish Online Journal of Educational Technology, 7(4), 11–21, Retrieved on 5/5/09 Available from. www.tojet.net

Kolawole .E.B.(2008).Effect of Competitive and Cooperative Learning Strategies on Academic Performance of Nigerian students in mathematics Education.Edu. Res. Rev.3 (1) ;pp.003-037.

Kuhn, T.S. (1962). *The Structure of Scientific Revolutions*. The University of Chicago Press..

Kumar, R., & Gupta, V. K. (2009*). An introduction to cognitive constructivism in education.* Journal of Indian Education, Nov. 2009 NCERT New Delhi.

Lavelle, S. (2009). Introduction. In S. H. Christensen, B. Delahousse, & M.Meganck (Eds.), *Engineering in context* (pp. 29-32). Denmark: Academica, ISBN 978-87-7675-700-7.

Lawrenz, F. P. (1976) *Student perceptions of the classroom learning environment in biology, Chemistry and physics courses.* Journal of Research in Science Teaching, 1976, 13,315-323.

Lazarowitz,R.& Penso, S. (1992)High school students difficulty in learning Biology concepts, Journal of learning Biology Education 26(3) 215- 223.

Lepper, M. R., & Gurtner, J. (1989). *Children and computers: approaching the twenty-first century.* American Psychologist, 44,170–178.

Linder, C.J. (1993). A challenge to conceptual change. *Science Education, 77*, 293-300..

Macmillan,J.H.,&Schumacher,M.(1997).*Research in Education: a Conceptual Introduction* (4th ed)New York: Adisson Wesley.

Mayer R.E. 2001. Multimedia learning, Cambridge University Press, New York British Journal of Psychology Research Vol.3, No.4, pp.35-45, October.

Maznichenko, M.A., (2002) *Overcoming of professional and pedagogical errors as a stage in professional development of the teacher.* Doctoral dissertation (in Russian). Sochi State Pedagogical University. Online http://diss.rsl.ru.

McCloskey, M. (1983). Naïve theories of motion. In D. Gentner & A. L. Stevens (Eds.), *Mental models* (pp. 299-324). Mahwah, N.J.: Lawrence Erlbaum Associates.

Megarry, J. (1979). *Monitoring Simulation/Games for Learning*,9 , 170-177

Michayahu, A. K. (2010). *Educational Reforms In Ghana, 1974-2007*. Retrieved November 8, 2011, from ttp://ghanaweb.com/GhanahomePag Concessional Loan agreement between Ghana and the Export-Import Bank of China (2007). *Loan for ICT Infrastructure* (ElectronicVersion). Retrieved January 2012, from http://www.mofep.gov.gh/speech-china-24907.pdf.

Ministry of Education(2010).*Teaching syllabus for Biology*. Accra Ghana: Curriculum Research and Development Division.

Minstrell, J. (1992). Facets of students' knowledge and relevant instruction. In R. Duit,F. Goldberg, and & H. Neidderer (Eds.), *Research in physics learning: Theoretical issues and empirical studies.* Kiel, Germany: IPN

Mitra, A. (1998*). Categories of computer use and their relationships with attitudes toward computers.* Journal of Research on Computing in Education, 30(3), 281–294.

Morell,P.D.(1992). The effect of computer-assisted instruction and students. Achievement in high school biology; School Science and Mathematics 92(4) pp.177-181.Full Text via Cross Ref.

Ochoyi, U. E and Ukwumunu, A. I. (2008).*Integration of ICT in secondary school curriculum in Nigeria:* Problems and Prospects. Proceedings of 49thAnnual Conference of Science Teachers‟ Association of Nigeria (STAN).

Ogunleye B. O. (2007*). Teachers' perceived barriers to successful implementation of ICT in the teaching and learning of science subjects in Nigerian* *secondary school*. Nigerian Journal of Computer Literacy. 8.1.16-31. *or individualistic*. Review of Educational Research, 1974, 44(2).

Ohlsson, S. (2009). *Meaning Change, Multiple routes, and the role of Differentiation in Conceptual Change: alternatives to resubsumption*? *Educational Psychologist,* 44 (1), 64-71, 2009.

Owusu, K. A., Monney, K. A., Appiah. J. Y and Wilmot. E. M (2010). *Effects of computer assisted instruction on performance of senior high school biology students in Ghana.* Journal of Computer and Education. 55.2. 904-910.

Ozdemir, G., & Clark, D.B. (2007). *Overview of Conceptual Change theories*. Eurasia Journal of Matematics, Science & Technology Education, 3(4), 351-361.

Ozmen, H. (2008). *The influence of computer-assisted instruction on students' conceptual understanding of chemical bonding and attitude toward chemistry*: A case for Turkey. Computers & Education, 51 (1), 423- 438. Curriculum Research and Development Division (CRDD) (2007). *Syllabus for Information and Communications Technology for Junior High School.*

Piaget, *J.* (1929). The child"s Conception of the world..London: Routledge and Kegan Paul. Research on Technology in Education, vol. 34, no. 3, pp. 285303.

Pierfy, D. (1977). *Comparative simulation game research: Stumbling blocks and stepping stones*. Simulation & Games, 8, 255-268,

Posner, G., Strike, K., Hewson, P., & Gertzog, W. (1982). *Accommodation of a scientific conception: Toward a theory of conceptual change. Science Education,* 66(2), 211-227.

Rogers, W. D., & R. Ford. (1997).*Factors that Affect Student Attitude Towards Biology*. Bioscience::Journal of College Biology Teaching, 23(2), 3–6.xxv

Rowe, H.A.H.(1993).*Learning with personal computers,* Victoria, Australia: The Australian council for Educational Researcher.

Russell, J., & S. Hollander. (1975) Ozmen, H. (2008). *The influence of computer-assisted instruction on students' conceptual understanding of chemical bonding and attitude toward chemistry:* A case for Turkey Computers & Education, 51 (1), 423- 438.

Ryan, A. W. (1991). *Meta-Analysis of achievement effects in microcomputer applications in elementary schools*. Educational Administration Quarterly, 27(2), 161–184.

Sahin, S. (2006).*Computer Simulations in Science Education*: Implications for distant Education- Turkish on line Journal for Distance Education-TOJDE,7 (4),1-15.

Seidu, A. (2007) *Modern approaches to research in Educational Administration*. Revised Edition. Kumasi; payless publication limited.

Selwyn, N.(1999). *Switching on the learning society?-questioning the role of technology in widening participation in lifelong* of Education *learning*, Journal policy14(5),523-534.

Smith J.P., diSessa,A.A., & Rosschelle, J. (1993) Teaching strategy associated with Conceptual based learning in science. Journal of learning science.3.115-163.

Smith, E. L., Blakeslee, T. D., & Anderson, C. W. (1993). Teaching strategies associated with conceptual change learning in science. *Journal of Research in Science Teaching, 30*, 111-126.

Snowman, J.(1995). *Computer-based education: more hype than help?* Mid-Western Educational Researcher, 8(1), 32–35.

Songer, C.J.,&Mintz ,J. J.(1994)*Understanding Cellular Respiration: Analysis of construal change in college Biology.* Journal of Research in Science Teaching,31(6),621-637.

Stewart,J.(1983).Students problem solving in High school. Genetics Science Education 67.523-540.

Swan, K. (2005). *A constructivist model for thinking about learning online.* In J. Bourne, & J. C. Moore (Eds.), *Elememts of Quality Online Education: Engaging Communities,* (pp. 1-19). Needham, MA: Sloan-C.

Tabassum, R. (2004). *Effects of Computer Assisted Instruction (CAI) on the secondary school students'achievement in science.* Ph.D. Thesis.Rawalpindi,Paskistan: University of Arid Agriculture. Retrived 20/09/2017.Prr.hec,gov.pk/235,pdf.

Tagoe,S.J.,& Amissah,P.A.K. (2002).Psychology of Human Development and Learning. Accra.Charis Publications.

Tekkaya, C.,Ozkan O.,&Sungur,S.(2001). *Biology concepts perceived as difficult by Turkish High School students*: Hacettepe Universitesi Egitim Fakultesi,Dergisi 21:145-150.

Thomas, G. P. (2001). *Toward effective computer use in high school science education:* where to from here? Education and Information Technologies, 6(1), 29–30.

Thorndike, E.L. (1898, 1911) Animal Intelligence and Experiment study of the associate processes in Animal Psychological Monographs #8..

Tolman,R,R.(2008). Difficulties in genetics problem solving. America Biology Teacher. 44, 525 - 527.

Tomita, M. K., (2008). *Examining the influence of formative assessment on conceptual accumulation and conceptual change.* Doctoral dissertation, Stanford University.

Van‟t Hooft,& Mark, (2008). Personal, mobile, connected: the future of learning. In:Voogt, Joke, Knezek, Gerald (Eds.), International Handbook of InformationTechnology in Primary and Secondary Education. Springer, New York,pp. 873–881 Vol.3, No.4, pp.35-45, October Published by European Centre for Research Training and Development UK (www.eajournals.org)

Voogt, J., & van den Akker, J. (2001). *Computer-assisted instruction.* In International encyclopaedia of social and behavioural sciences Elsevier Science.

Vosniadou, S. (1994). Capturing and modeling the process of conceptual change.*Learning and Instruction, 4*, 45-69.

Vosniadou, S., & Brewer, W.F. (1992). Mental models of the earth. A study of conceptual change in childhood. *Cognitive Psychology, 24*, 535-585.

Vosniadou, S., & Ioannides, C. (1998). From conceptual development to science education: A psychological point of view. *International Journal of Science Education, 20*, 1213-1230.

Vosniadou, S., (2004). Extending the conceptual change approach to mathematics learning and teaching. *Learning and Instructions*, 14, 445-451.

Vosniadou, S., Ioannides, C, Dimitrakopoulou, A., & Papademetriou, E. (2001).Designing learning environments to promote conceptual change in science. *Learning and Instruction,* 11,381-419 **.**

Vosniadou, S., Vamvakoussi, X., & Skopeliti, I. (2008). The framework theory approach to the problem of conceptual change. In S. Vosniadou (Eds.), International *Handbook of Research on conceptual Change* (pp. 3-34). New York and London: Routledge Taylor & Francis Group.

Vygotsky, L.S. (1978). Mind in Society. Cambridge, MA: Harvard University Press WAEC(2007-2013). Chief Examiners" Report.WAEC Press Ltd.

Walberg, H. J. (1969) Predicting class learning: *A generalized regression approach to the class as a social system.* American Educational Research Journal**,** 1969, ***6,*** 529-542,

Wandersee, J. H., Mintzes, J. J., & Novak, J. D. (1994). Research on alternative conceptions in science. In D. Gabel (Ed.), *Handbook of Research in Science Teaching and Learning* (pp. 177-210). New York: Macmillan..

Williams, R. (1980). *Attitude change and simulation games*. Simulation & Games, 11, 177-196. Turkish Online Journal of Educational Technology, vol .10, no. 4, pp. 195210. Retrieved Nov 14, 2011 from http://www.tojet.net/articles/10420.pdf

Woolfolk, A. (2007). *Educational Psychology* (10th Ed.). New York: Pearson Education, Inc. Rockman (cited ij Branscum)."we should start exploring ways to achieve equity using technology"(p.88).

Yin, R.K.(2003). A case study research: Design and method (3rd ed), Applied Social Research Method Series .Sages: Thousand Oaks.

Yin, Y. (2005). *The influence of formative assessment on student motivation, achievement achievement, and conceptual change.* Doctoral dissertation, Stanford University.

Yusuf,M.O &Afolabi,A.O (2010).Effect of computer assisted instruction (CAI)on Secondary School students performance inBiology.TOJET:The Turkish online Journal of Education Technology:9(1),1-8.

APPENDIX A

INTERVIEW SCHEDULE FOR STUDENTS

Semi-structured pre-treatment interview schedule for students on cell cycle. This exercise is mainly for academic purposes. You are assured that your responses to this questions will be confidential. Kindly respond to every question as honest as possible.

ITEMS

1. Please what is your age?
2. What are your elective subjects?
3. What has been your performance in Biology exercises, class tests ,midterm and end of term examinations?
4. Which of the Biology topics do you find challenging and why?
5. Have you ever studied cell cycle and cell division?
6. What have been your reactions whenever you see questions on cell cycle?
7. What has been your performance when questions on cell cycle and cell division are asked?
8. Which aspect of cell cycle do you find most challenging.
9. Kindly provide answers to the questions below.

a. Identify 2 areas in (I) plants (II) animals where mitosis occur?

b. Indicate 2 areas in(I)In plants(II)In animals where meiosis occur.

c. State the main products each of mitosis and meiosis cell division

d. Differentiate between Mitosis and Meiosis.

APPENDIX A1

POST-TREATMENT RESPONSES OF STUDENTS IN THE EXPERIMENTAL GROUP TO INTERVIEW SCHEDULE ITEMS

Iitem8. Phases of cell cycle which are: Interphase, M-phase (mitosis and cytokinesis) and the G0 phase.

9a.Areas in plants where mitosis occurs: Root tip, shoot tip, and in the bud.

Areas in animals where mitosis occurs: Skin cell, muscle cell, nerve cell and in the cartilage.

9b.Areas in plants where meiosis occurs: in pollen grain and the egg cell in the ovary of the flower.

Areas in animals where meiosis occurs: in the egg cell (ovum) of female and in the sperm cell of male.

9c. The main product of mitosis: Two genetically identical diploid (2n) cells.

The main product of meiosis: four haploid (n) cells which vary genetically.

APPENDIX B

POST-TREATMENT INTERVIEW SCHEDULE FOR THE EXPERIMENTAL GROUP

Cherish students please provide your honest opinion on the use of computer simulation and concept model in teaching you recently in the laboratory. No answer is considered right or wrong.

Your response would be treated confidentially .Thanks for your co-operation.

1. What concepts have you been learning for the past four weeks?
2. Did you like the way the topics were taught? If yes explain -if no explain
3. Have you noticed any difference in the way the concepts were taught and the way you were taught in your normal class? Explain any difference you have noticed
4. What is you"re feeling about the computer simulation?
5. Can it be reliable? If yes explain –if no explain.
6. Have the materials and the method improved your understanding of cell cycle?
7. Would you opt for the usual method or encourage the integration of computer simulation in the teaching of Biological concepts?
8. What are your suggestions to improve upon this of computer simulation?

APPENDIX C

UNIVERSITY OF EDUCATION, WINNEBA

SCIENCE EDUCATION DEPARTMENT

BIOPET (PRE-TEST) DATA COLLECTING INSTRUMENT FOR M. PHIL IN SCIENCE EDUCATION ON THE TOPIC „CELL CYCLE" LESSON DELIVERED THROUGH TRADITIONAL METHOD (WITHOUT COMPUTER SIMULATION)

Name of Participant:……………………………………………………………………

Gender:………………………………………

Class:………………………..

GENERAL INSTRUCTIONS: this test contains (20) questions put into two sections, A and B. You are kindly requested to answer all questions in the two sections

SECTION A

MULTIPLE CHOICE QUESTIONS

INSTRUCTIONS: Each question is followed by four (4) options lettered A to D. selects the correct option by circling to indicate your answer.

1. Which organelle in an animal cell forms spindle fibers during cell division?
    a. Golgi body
    b. Centriole
    c. Lysosome
    d. Vacuole
2. A normal chromosome consists of two halves called the
    a. Genes
    b. Alleles
    c. Chromatids
    d. Centromere

3. The process of cell division by meiosis takes place only in
    a. Red blood marrow
    b. Skin cells
    c. Reproductive organ
    d. Lymphocytes
4. Which of the following pair of organelles are directly involved in cell division?
    a. Centriole and golgi body
    b. Nucleus and ribosome
    c. Nucleus and centriole
    d. Centriole and mitochondrion
5. In mitosis the number of chromosome is
    a. Halved
    b. Tripled
    c. Doubled
    d. Unchanged
6. Which of the following processes is not a source of variation?
    a. Meiosis
    b. Mitosis
    c. Crossing –over
    d. Mutation
7. The correct order of the stages of mitosis is
    a. Telophase prophase metaphase anaphase
    b. Prophase metaphase anaphase telophase
    c. Prophase metaphase anaphase telophase
    d. Prophase anaphase metaphase telophase
8. The division of the nucleus is termed
    a. Cytokinesis
    b. S phase
    c. Karyokinesis
    d. Interphase
9. Chromatids move to opposite poles of the spindle during
    a. Anaphase
    b. Telophase

c. Metphase
d. Prophase

10. Which of the following does not occur during interphase?
    a. DNA replicates
    b. Organelles replicate
    c. The cell stores energy
    d. The cytoplasm divides
11. Which of the following stages is not present during mitosis?
    a. Metaphase
    b. Anaphase
    c. Interphase
    d. Prophase
12. In which of the following processes of mitosis are chromatids arranged along the equator of the spindle?
    a. Anaphase
    b. Interphase
    c. Metaphase
    d. Telophase
13. Separation of sister chromosome during meiosis occurs in
    a. Metaphase II
    b. Prophase II
    c. Anaphase II
    d. Telophase II
14. A newly developed variety of rice has a chromosome number of 12 in the zygote. What is its diploid chromosome number?
    a. 12
    b. 6
    c. 18
    d. 24
15. If a cell does not enter the s stage from G1 stage it exits from cycle and enters
    a. Metaphase
    b. M phase
    c. Interphase
    d. Go phase

SECTION B

ESSAY TYPE QUESTIONS

Instruction**:** answer all questions in this section

1. Outline three main phases into which the cell cycle is divided. (2marks)
2. Identify areas in plants and animals where mitosis and meiosis occur. (2marks)
3. What are the main products of mitosis and meiosis? (2marks)
4. (I) what is the cell cycle? (2marks)

   (II) Make a diagram to show the cell cycle. (3marks)
5. (I) Mention the 2 main processes that occur in the M- phase. (1marks)
6. (II) What is cell division?(1mark) (III) identify the two types of cell division. (2 marks)
7. I) Mention any 3 events that occur during interphase. (3marks)

   II) Mention any 3 events that occur at prophase I of meiosis but does not occur at prophase of mitosis. (3marks)
8. I) With the help of annotated diagram outline the stages of mitosis (2marks)

   II) State 2 significance of mitosis. (2marks)

[TOTAL MARKS = 40]

APPENDIX D

UNIVERSITY OF EDUCATION, WINNEBA SCIENCE EDUCATION DEPARTMENT SATCC (POST-TEST) DATA COLLECTING INSTRUMENT FOR MPHIL IN SCIENCE EDUCATION THESIS RESEARCH ON THE TOPIC "CELL CYCLE LESSON DELIVERED THROUGH COMPUTER SIMULATION

Name of participant...

Gender:…………………………………………..

Class:…………………………………

GENERAL INSTRUCTIONS: I his test contain (20) questions put into two sections, A and B. You are kindly requested to answer all questions in the two sections.

SECTION A

MULTIPLE CHOICE QUESTIONS

INSTRUCTIONS:

Each question is followed by four (4) options lettered A to D. Select the correct option by circling to indicate your answer.

1. Replication of DNA occurs in a cell during
   a. prophase of mitosis
   b. anaphase of meiosis
   c. interphase of mitosis
   d. metaphase of mitosis
2. Which of the following process marks the final stage of cell division?
   a. karyokinesis
   b. cytokinesis

c. interphase
d. gap one

3. How many chromosomes will be in a gamete if the norma! cell has 4 chromosomes?
    a. 2
    b. 4
    c. 8
    d. 1
4. If telophase fails to occur during mitosis in living cell, which of the following consequences will occur?
    a. The cell will shrink
    b. No new cells will be formed
    c. Spindie fibres will not be formed
    d. Chromatid will migrate to the poles
5. The process of cell division by meiosis takes place in
    a. Lymphocytes
    b. Reproductive cells
    c. Bone cells
    d. Red blood cells
6. Separation of sister chromatids occurs during
    a. Anaphase II
    b. Metaphase I!
    c. Telophase II
    d. Prophase II
7. In prophase we of meiosis cell division homologous pairs of chromosome lie side by side to form
    a. spindle
    b. Sister chromosome
    c. A bivalent
    d. A chiasmata

8. What name is given to process whereby homologous pairs of chromosome lie side by side
    a. Bivalency

b. Synapsis

c. Chiasma

d. Crossing over

9. In which of the following region; In plants does mitosis occur?,

a. In the stem

b. In the Leaves

c. In the root

d. In the root tip

10. Nucleolus disappears in which stage of mitosis?

a. Metaphase

b. Anaphase

c. Telophase :

d. Prophase

11. Which of the following is typical of mitotic cell division?

a. Crossing over

b. Synapsis

c. Homologous chromosomes pair up

d. Chromatid align themselves at the equator

12. The number of chromosomes found in the somatic cell of humans is

a. 92

b. 56

c. 46

d. 23

13. Meiosis takes place during

a. Growth and development

b. In somatic ceils

c. During asexual reproduction

d. During gamete formation

14. Which of the following statement about meiosis is false?

a. Chiasmata is formed

b. Bivalent are formed

c. Four daughter cells are formed

d. The process does not lead to variation

15. In meiosis the number of chromosome is

a. Doubled

b. Halved

c. Tripled

d. Remains unchanged

SECTION B

ESSAY TYPE QUESTIONS

INSTRUCTION: ANSWER ALL QUESTIONS IN THIS SECTION

1. Describe the process of Meiosis (2marks)

ii) Identify two significance of Meiosis. (5marks)

2. i. Draw to show the diagram of the cell Cycle. (4 marks)

   ii. Outline the stages of interphase and state one activity that occurs at each stage (6marks)

3. i. Explain the following terms as applied in Meiotic cell division i

   ii. Bivalent II) Synapsis III) Chiasmata IV) Homologous chromosome (6marks)

4. What happens when a cell enters the Go phase

(2marks) TOTAL MARKS=40)

APPENDIX E

MARKING SCHEME FOR BIOPET (PRETEST) ITEMS

Expected Responses for scoring test items.

SECTION A

1. B
2. C
3. C
4. C
5. D
6. B
7. B
8. C
9. A
10. D
11. C
12. C
13. C
14. A
15. D

2. In multicellular cell, mitosis produce more cells for growth.
3. It also helps to maintain genetic stability since genetically identical cells are produced, that is the two daughter cells have the same type and number of chromosome.
4. Cell replacement and regeneration :Mitosis ensures that all damaged tissues are repaired and that copies of new cells are identical to the cell being replaced,

APPENDIX F

MARKING SCHEME FOR SATCC (POSTTEST) ITEMS

Expected Responses for scoring test items.

SECTION A

1) C

2) B

3) A

4) B

5) B

6) A

7) C

8) B

9) D

10) D

11) D

12) C

13) D

14) D

15) B

3) The phases of interphase include: G1, S, and G_2

Activities occurring at each phase

G_1 (Gap 1): High amount of protein is synthesized and the cell grows to about double of its original size.ii. More organelles such as ribosomes and mitochondria are produced.DNA replication does not occur at this stage.

S (synthesis) phase: it the stage where DNA is synthesized or replicated. During this phase the amount of DNA in each cell is doubled but the number of chromosome remains the same. In animal cells, centriole duplicate in the cytoplasm. Synthesis of protein is very low at s-phase.

G_2 (gap2) phase: At this phase the cell continues to grow rapidly and synthesis more protein. Microtubules begin to reorganize to form a spindle. The cell builds up more energy to enter Mitosis.

4) Explanation of some terms associated with meiosis cell division:

I. Bivalent it is the association of replicated chromosomes having exchanged DNA strands in at least one point called chiasmata.
II. Synapsis: it the pairing of two homologous chromosome which occurs during meiosis, it leads to crossing over between two homologous chromosomes.
III. Chiasmata are the point of contact, or physical link between two non-sister chromatids belonging to homologous chromosomes. At a given chiasmata exchange of genetic materials can occur between two non-sister chromatids resulting in chromosomal crossing over.

IV. Homologous chromosomes are two sets of chromosomes having the same gene at the same loci for the expression of a trait but may have different alleles.

5. At Go (Gap zero phase) the cell example the heart cell may exit from the cycle and enters an inactive or the quiescence phase and cease to divide but rather assumes normal metabolic activities.

APPENDIX G

SAMPLE LESSON NOTES FOR TEACHING

1^{ST} & 2^{ND} WEEKENDING: 21^{ST} OCTOBER, 2017

SUBJECT: ELECTIVE BIOLOGY

SCHOOL: METHODIST SENIOR HIGH SCHOOL

CLASS: SHS FORM TWO

DAY/DURATION	**TOPIC/SUB-TOPIC/ASPECT**	**OBJECTIVES/ R.P.K**	**TEACHER-LEARNER ACTIVITIES**	**TEACHING AND LEARNING MATERIALS**	**CORE POINTS**	**EVALUATION AND REMARKS**
DAY MONDAY AND TUESDAY	**TOPIC** CELL II	**R.P.K** Students can define cell cycle 2. Students can outline the 3-phases of cell cycle.	Teacher (Tr) revises students R.P.K by brainstorming them Students responded individually			
DURATION 80MINUTES	**SUB-TOPIC** CELL AND CELL CYCLE	OBJECTIVES By the end of the lesson the student should be able to 1.Define cell division 2.Outline and explain the two types of cell division, Mitosis and Meiosis 3.State at least two significance Mitosis and Meiosis.	Tr. discusses cell division with students Students participated in the discussion Tr. Explained Mitosis and Meiosis to students. Students listened attentively and also took notes		-Cell division it the ability of a parent cell to divide And give rise to two or more daughter cells. -There are two types of cell divisions namely Mitosis and Meiosis	1.Define cell division 2.Identify the two types of cell divisions 3.Exnplain i. Mitosis ii. Meiosis 4.Statenat least two significance each of Mitois and Meiosis
	ASPECT CELL DIVISION		Tr. Discusses significance of mitosis and Meiosis with students. Students participated by		Mitosis is the division of somatic cell to give rise to two identical diploid daughter cells. The parental cells divide once to produce two genetically identical	

			contributing and asking question intermittently.		cells. Mitosis occurs in four stages namely prophase .metaphase, anaphase and telophase. --Significance of Mitosis; 1.For growth 2.For asexual reproduction in unicellular organisms such as amoeba .bacteria 3.For cell replacementtiand regeneration	
					-Meiosis is the type of celldivision which occur in reproductive cells ,in meiosis a single cell divides twice to give rise to four haploid daughter cells . It occurs in two successive stages namely meiosis I and Meiosis II.	
					-Significance of meiosis; *1, for gamete formation* *2.it brings about variation* *3.prevents doubling of chromosomes*	

		4. Name the processes that occur at the m-phase.	asking questions intermittently		division -the stages of interpose are g1,s.g2 g1; the cell grows and synthesis protein s- the cell synthesis DNA g2- more proteins are synthesized 2.organelles such as mitochondria, ribosome are form 3. the cell build up more energy to enter cell division	
	aspect cell cycle		tr. finally discussed m-phase with students learners participated in the discussion and also took notes		the two processes that occur in the m- phase are karyokinesis and cytokinesis	

APPENDIX I

Data on independent Sample t- test Analysis on students' Test.

EXPERIMENTAL AND CONTROL (PRE-TEST) I (I)

Group Statistics

	group.type	N	Mean	Std. Deviation	Std. Error Mean
marks	exp	35	18.6286	11.02693	1.86389
	control	35	18.8857	9.49232	1.60450

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
marks	Equal variances assumed	1.470	.229	-.105	68	.917	-.25714	2.45937	-5.16474	4.65045
	Equal variances not assumed			-.105	66.528	.917	-.25714	2.45937	-5.16671	4.65242

EXPERIMENTAL AND CONTROL GROUP (POST-TEST)I (II)

Group Statistics

	group. Type	N	Mean	Std. Deviation	Std. Error Mean
marks2	exp	35	33.4857	5.66398	.95739
	control	35	25.2571	7.89021	1.33369

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Marks2	Equal variances assumed	5.155	.026	5.012	68	.000	8.22857	1.64174	4.95253	11.50462
	Equal variances not assumed			5.012	61.688	.000	8.22857	1.64174	4.94645	11.51070

GENDER VARIATION I (III)

Group Statistics

	sex	N	Mean	Std. Deviation	Std. Error Mean
posttest	male	21	33.5714	4.72833	1.03181
	female	14	33.3571	7.03406	1.87993
pretest	male	21	21.1429	11.65884	2.54417
	female	14	19.5714	12.63520	3.37690

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
posttest	Equal variances assumed	.528	.473	.108	33	.915	.21429	1.98330	-3.82076	4.24933
	Equal variances not assumed			.100	20.786	.921	.21429	2.14447	-4.24819	4.67676
pretest	Equal variances assumed	1.162	.289	.378	33	.708	1.57143	4.15865	-6.8941	10.03227
	Equal variances not assumed			.372	26.415	.713	1.57143	4.22803	-7.11278	10.25563

APPENDIX J

Table 9. Frequency distribution of pretest and posttest scores of students in the control group.

Scores	0-15	16-20	21-25	26-30	31-35	36-40
Pretest	16	6	5	3	3	2
posttest	0	7	6	6	7	9

Source: Students‟ scripts.

Table10: Frequency distribution of pretest and posttest scores of students in the experimental group

Scores	0-15	16-20	21-25	26-30	31-35	36-40
Pretest	10	8	4	3	6	4
posttest	0	1	2	2	10	20

.

APPENDIX M

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF SCIENCE EDUCATION
Our ref.No.SD/M.PHIL./VOL.1/120

Your Ref. No. **15TH July, 2017**

TO WHOM IT MAY CONCERN

INTRODUCTORY LETTER

The bearer of this letter Miss.Veronica Vidzro is a Master of philosophy student in the Department of Science Education in the University of Education, Winneba. She is studying "The effect of computer simulation and concept model on selected SHS students‟ conceptual understanding of cell cycle"

Your school has been selected as part of her sampling area.

I hope you would assist her to do her thesis write- up.

Thank you.

Yours faithfully,

SIGNED

DR. VICTOR ANTWI

HEAD OF SCIENCE DEPARTMENT