UNIVERSITY OF EDUCATION, WINNEBA

THE EFFECT OF COMPUTER SIMULATION ON THE PERFORMANCE OF STUDENTS IN THE CONCEPT OF DIGESTION

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THE EFFECT OF COMPUTER SIMULATION ON THE PERFORMANCE OF SECOND YEAR HOME ECONOMICS STUDENTS' IN DIGESTION

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DECLARATION

Candidate's Declaration

I, **Banse, Issaka Somaila** hereby declare that this dissertation, with the exception of quotations and references contained in published works which have all been identified and acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

Signature: …… **Date: ……**

Supervisor's Declaration

This thesis has been read and approved as meeting the requirements of the School of Research and Graduate Studies, University of Education, Winneba.

Signature: …… **Date: ……**

E. K OPPONG (PhD)
(Principal Supervisor)

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DEDICATION

This dissertation is dedicated to my late parents Mr. Sumaila Banse and Mad Ayishetu Bara, who though illiterates made my education their topmost priority. This is also dedicated to my sweet wife Latifa and lovely kids Layan, Aydin and Qanit.

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LIST OF ABBREVIATIONS

TRT	Treatment
Grp	Group
GES	Ghana Education Service
GETFUND	Ghana Education Trust Fund
MOE	Ministry of Education
NGO(s)	Non-Governmental Organization(s)
SHS	Senior High School
WAEC	West Africa Examination Council
WASSCE	West Africa Senior Secondary Certificate Examination
SSS	Senior Secondary School
P-value	probability value (calculated probability)
Pg	Page

ABSTRACT

The aim of this study was to investigate the effect of computer simulations instructional packages on the performance of students' learning of the topic, digestion. The study used the entry point, post-test and exit point quasi experimental design method in a mixed sex Senior High School. The study used all fifty (50) students of SHS 2 Home Economics 1 and forty eight (48) students of SHS 2 Home Economics 2 at Odorgonno Senior High School in Accra, Ghana. A post-test consisting of ten multiple-choice, five true or false, five fill in blank spaces and a five short theory test items on digestion was given to two treatment groups. Descriptive and paired t-test statistics were used for answering the research hypothesis. The classroom interactions of students of the two treatment groups were observed to find out how their attitudes towards computer simulation and its effectiveness improved their performance. The assigned codes of classroom interaction were also subjected to further analysis using simple percentages. The results indicate that the performance and content knowledge in digestion among both groups after the post-intervention and exiting point improved as compared to the entry point mean scores. Computer simulation did prove to be superior to the traditional teaching approaches. The findings seem to suggest that computer simulation holds great promise for the teaching and learning of science concepts. It has therefore been recommended that computer simulation strategies be incorporated in the teaching of biology as it has a positive effect on the attitudes of students. As a result, there is a need for teachers and teacher educational institutions to reinforce the use of computer simulations in the teaching and learning science.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter deals with the background, statement of the problem and purpose of the study. The research questions that guided the study, research hypotheses and the null hypotheses that were formulated and tested in the study are discussed. It further discusses the significance, limitations and delimitations of the study.

1.1 Background to the Study

Hands-on evidence gathered by the researcher, a biology teacher, and WAEC chief examiners' reports at (SHS) have shown clearly that most students perform poorly in biology. Research into the poor performance by students has shown that students do not understand the concepts taught in biology. Their poor performance could be due to the fact that the subject is taught abstractly, which makes some of the concepts seem complex and confusing, and therefore difficult for students.

Some biology concepts that have been perceived as difficult by students have been investigated by a number of researchers. Johnstone and Mahmoud (1980) noted that water transport in plants and genetics are among the most difficult biology topics to be learnt by secondary school and university students. According to Çimer (2012), many concepts or topics in biology, including water transport in plants, protein synthesis, respiration, photosynthesis, Mendelian genetics and the central nervous system are perceived to be difficult by secondary school students. Other concepts like photosynthesis, respiration and protein synthesis are seen as difficult by some teachers (Tekkaya, Özkan & Sungur, 2001). The perceived difficulty seen by some teachers towards some concepts could partly be due to the teachers' lack of specific research-

based information on how to teach such topics which could otherwise serve as a tool in alleviating pupils' difficulties in learning the aforesaid topics (Musonda, 2013).

Impacting knowledge involves the use of appropriate teaching techniques. Teaching techniques have been seen as the different ways in which a teacher presents information to be learned (Erinosho, 2009). Quite remarkably, regular poor academic performance by the majority of students is fundamentally linked to the application of ineffective teaching methods by teachers to impact knowledge to learners (Adunola, 2011 cited in Ganyaupfu, 2013). Until today, questions about the effectiveness of teaching methods on student learning have consistently raised considerable interest in the thematic field of educational research (Hightower, 2011).

According to constructivists, learning science requires one to determine learners' existing cognitive structures and building new understanding through modification or restructuring (Glynn and Duit, 1995 cited in Cimer, Cimer and Ursavas, 2011). Thus, revealing learners' existing knowledge and understanding will pave the way to plan curriculum and instruction that challenges and further develops their cognitive structures. However, it has been observed that teaching with analogies tend to be more effective when explaining scientific concepts because they allow the learner to predict the basis of establishing causal relationships as key scientific skills (Hancock & Onsman, 2005).

Of increasing concern among educational institutions is the problem of maintaining the quality of education in the face of increased student numbers and continuing funding cuts. These concerns, coupled with the advent of readily accessible and relatively cost effective computer technology, has seen a marked increase in the use of computer-based education delivery (Pamula, Pamula, Wigmore & Wheldrake (n.d).

Computer simulation which is an ICT based teaching and learning method is one of the effective teaching methods that facilitate students‘ learning in Science (Elangovan & Ismail, 2013).

Several researches have shown that using computer simulation has positive effect on students‘ performance compared to traditional methods. For instance, Rey (2010) found that computer simulation reduced time spent on learning and improved learners‘ retention. Akpan and Strayer (2010) found that students who used computer simulation to dissect frogs outperformed those who dissected a frog conventionally. Riess and Mischo (2010) designed a computer simulated scenario on the topic _œcosystem forest‘, and found that those students exposed to computer simulation showed significant increase in their mean scores than their counterparts taught with the conventional method. Wekeba (2006) found that students taught cell-theory in biology with computer–based instruction simulation (CBIS) program performed better and had better perception towards the cell division topic in school biology than those taught with the traditional teaching method.

Observing the demeanour of students of Odorgonno Senior High School during biology lessons shows clearly that there is apathy towards the subject. Ample evidence is shown in the school‘s performance in the 2013 West Africa Senior Secondary Certificate Examination in Biology where only 3.39% obtained grade A1 and 24.11% obtained grade F9. Interactions with these students show that they do not understand many of the topics in biology as they are too abstract.

1.2 Statement of the Problem

Technological development has made computer one the most available essential gadgets. The integration of computer and ICT into the educational systems globally indicate the influence of the changes and developments in the society.

Successive governments in Ghana and other bodies have made conscious efforts in making computer be accessible to students in Ghana. All these are aimed at ensuring that Ghanaian students just as their counterparts globally, get access to quality education. Despite the initiatives, it has not translated positively to the achievement in students in their academic pursuits. This situation certainly does not favour Ghana's quest for scientific and technological human resource which is the bedrock of any development oriented country seeking world class economic status.

Onwukwe (2010) believes that the achievement of students at their full potentials could be a function of appropriate lesson delivery techniques and students' own attitudes as well as conceptual understanding of principles. Most researches have looked at socio-economic situation, educational background of parents, and gender related issues among others as possible factors that affect students' performance in biology (Akinyemi & Orukota, 1995; Yidana, 2004). This is why this study sought to find out the role that the use of computer simulation as a teaching method could play in the teaching and learning of digestion on the performance of students and its impact on their performance in the subject.

As Ghana seeks to incorporate ICT in its educational system, it is imperative that the effects of the usage of variety of computer assisted instructions are explored. This will encourage stakeholders in education and policy makers to suggest and adopt the instructional modes in ICT technology that will bring have positive effects on both

teachers and students. Therefore, it is very necessary that a study is conducted to look at the effectiveness of computer simulation as against the conventional approach of teaching. This study seeks to fill this gap.

1.3 Objectives of the Study

The study sought to

1. Find out whether any relationship existed between students‘ learning skills and their achievement in digestion using computer simulation as an interventional tool.
2. Identify the students‘ attitude towards the learning of digestion.
3. Determine the performance of digestion after the use of an interventional tool like computer simulation.
4. Determine the effect of the integration of computer simulation in the teaching and learning of digestion on the performance of students.

1.4 Research Questions

In this study, answers will be sought for the following research questions:

1. What is the relationship between students‘ learning skills and their achievement in digestion?
2. What is the effect computer simulation on students‘ attitude in teaching and learning?
3. What is the effect of computer simulation use on the performance of students in the concept of digestion?

1.5 Hypothesis

Hypotheses were tested for research question 1, 2 and 3

H_A1 There is significant difference in students‘ learning skills and their achievement in digestion?

H_A2: There is significant difference in attitudes of SHS students exposed to computer simulations instructional approach and those exposed to the traditional instructional approach in the teaching and learning of biology.

H_A3: There is significant difference in the performance of students exposed to the computer simulations instructional approach and those exposed to the traditional instructional approach to the teaching and learning of science.

H_01: There is no significant difference in the students‘ learning skills and their achievement in digestion?

H_02: There is no statistically significant difference in the attitudes of SHS students exposed to the computer simulations instructional approach and those exposed to the traditional instructional approach to the teaching and learning of biology.

H_03: There is no significant difference in performance of students exposed to the computer simulations instructional approach and those exposed to the traditional instructional approach to the teaching and learning of science.

1.6 The Significance of the Study

The study investigated the effect of using computer simulations on second year Home Economics students of Odorgonno SHS performance in digestion. It is hoped that the study will transform the teaching of biology from the traditional instructional approach of lecture, discussion, demonstration and illustration to a more practical approach.

Furthermore, it is hoped this study would serve as a reference document for the colleagues, other researchers and other stakeholders involved in science education and education in general making imperative instructional changes in science education at the senior high level. Colleague teachers will also have the empirical evidence to request budgetary allocations from the head of institutions that could be used for the procurement of the appropriate ICT facilities and software programmes to improve science (particularly biology) education in Ghanaian schools.

It is hoped this will be a document that will be a reference material that will guide teachers in adopting the right teaching techniques and strategies in teaching biology and integrated science at the second cycle level as well as the basic schools to make teaching and learning relevant and interesting. Other researchers who wish to conduct research studies into the effectiveness of the incorporation of computer simulations instructional packages in the teaching and learning of biology would find this study useful**.**

1.7 Scope of the Study

The study investigates the effect of computer simulation on the performance of SHS 2 Home Economics students in the concept of digestion at Odorgonno Senior High School**.**

1.8 Delimitations of the Study

The study was limited to Odorgonno Senior High School in the Ga Central Municipality of the Greater Accra Region of Ghana. In the selected school, only SHS 2 Home Economics students offering biology as an elective subject were considered. The study did not cover every part of the Greater Accra Region, and the results of this

study cannot be generalized of views of students in other senior high schools in parts of the region.

1.9 The Organizational Plan of the Study

The study is organized into five chapters. Chapter 1 constitutes the study background and problem definition as well as its purpose and research questions. Relevant literature review is presented in Chapter 2. The literature review is based on the subheadings related to the study. The research design and methodology are described in Chapter 3. Results and discussions of data are presented in Chapter 4. The summary of findings, discussions, recommendations and suggestions for further studies into the problem, based on the findings of this study are discussed in Chapter 5.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

The review of literature centres on work done by researchers in related fields of this study. The topical issues reviewed in the literature among others include the theoretical framework and conceptual frameworks of the study, which among others discusses the theories of known psychologists like Jean Piaget and Lev Vygotsky. Furthermore, the literature discusses the attitude of traditional non science students' (students not offering general science as elective) towards teaching and learning of biology. Students' difficulty with some biology concepts and digestion in particular is also addressed in the literature. Also reviewed are the concept of technology use in teaching and learning of biology, computer simulations, the use of computer simulations in biology teaching and learning and constructive learning in biology teaching. Finally, classroom interaction is also reviewed.

2.1 Theoretical Framework of the Study

The backbone of the theory of this research is fashioned out of the constructivist epistemology which has influenced teaching and learning of science, mathematics and many more academic disciplines. References are made to the works of Jerome Bruner, John Dewey and especially Jean Piaget's theory of cognitive development and Lev Vygotsky's social constructivism theory. By his words, Hein (1991) said that learning does not mean understanding the _true' nature of things, nor is it remembering dimly perceived perfect ideas, but rather a personal and social construction of meaning out of the bewildering array of sensations which have no order or structure besides the

explanations which we fabricate for them. According to constructivism, learning science requires determining learners‘ existing cognitive structures and building new understanding through modifying or restructuring (Glynn & Duit, 1995 cited in Cimer et al., 2011). Thus, revealing learners‘ existing knowledge and understanding them will pave the way to plan curriculum and instruction that challenges and further develops their cognitive structures.

Piaget‘s (1954) theory of cognitive development has far reaching implications for curriculum development, planning, implementation, evaluation and instructional management in schools (Simatwa, 2010). In Piaget‘s view, cognitive development is a progressive reorganization of mental processes as a result of biological maturation and environmental experience. In his theory, Piaget asserts that children construct an understanding of the world around them and then experience discrepancies between what they already know and what they discover in their environment. Piaget believes intelligence is an adaptation, and in order to grasp its relation to life in general it is necessary to state precisely the relations that exist between the organism and the environment. The relevance of Piaget's theory is the adaptation of instruction to the learner's developmental level and the teacher's role in facilitating learning by providing a variety of experiences to enable learners to explore and experiment, thereby encouraging new understandings. Another implication for instruction is the use of concrete "hands on" experiences to help children learn (Wood, Smith & Grossniklaus, 2001).

Piaget (1952), identified knowledge gain as having building blocks which he termed as schemas. He defined a schema as a cohesive, repeatable action sequence possessing component actions that are tightly interconnected and governed by a core meaning. In

his view, developing one's mental processes, involves increases in the number and complexity of the schemata that a person had learned. Piaget believed that new-born babies even before they have had much opportunity to experience the world have a small number of innate schemas. The neonatal schemas which are genetically programmed into each individual are the cognitive structures underlying innate reflexes.

According to Piaget (1954), children's cognitive development toward formal thought could be enhanced through three important cognitive processes of assimilation, accommodation and equilibration (or reorganization). Assimilation is using an existing schema to deal with a new object or situation. In his view, Piaget (1954) opines that when children assimilate, they perceive new objects and events according to their existing schemata, mental models or cognitive structures. During assimilation, people translate incoming information into a form they can understand. It is about modifying experiences and information to fit in with our pre-existing beliefs (Cherry, 2012). Piaget (1954), believes mental models formed by children from their prior knowledge and experience control how they incorporate new experiences and new information into their minds.

Accommodation happens when the existing schema (knowledge) does not work, and needs to be changed to deal with a new object or situation. It is about modifying existing schemas to fit new situations (Piaget, 1954). Accommodation involves altering existing schemas, or ideas, as a result of new information or new experiences (Cherry, 2012). New schemas may also be developed during this process. Accommodation refers to the process of changing internal mental structures to provide consistency with external reality (Bhattacharya & Han, 2001). As children

exercise existing mental structures in particular environmental situations, accommodation-motivating disequilibrium results and the children construct new mental structures to resolve the disequilibrium (Piaget, 1954). The state of disequilibrium and contradiction arising between the existing schemata and the more sophisticated mode of thought adopted by the new experience therefore, has to be resolved via equilibrium process (Yeboah, 2012).

Equilibration is the force which moves development along. Piaget (1954) believes that cognitive development does not progress at a steady rate, but rather in leaps and bounds. Equilibration refers to the biological drive to produce an optimal state of equilibrium between people's cognitive structures and their environment (Duncan, 1995). Equilibration involves both assimilation and accommodation stages of development and people conduct themselves with certain logical internal mental structures that allow them to adequately make sense of the world (Bhattacharya & Han, 2001). According to McLeod (2009), equilibrium occurs when a child's schemas can deal with most new information through assimilation. In his view Piaget (1952) believes students are actively involved in the construction of their own knowledge and knowledge is constructed through action. Children therefore must continually reconstruct their own understanding of phenomena through active reflection on objects and events till they eventually achieve an adult‘s perspective. Therefore children learn best when they are allowed to construct a personal understanding based on experiencing things and reflecting on those experiences.

Piaget and his cohorts believe all knowledge is constructed from a base of prior knowledge. However, social constructivist developed from the ideas of Lev Vygotsky; emphasizes the importance of society, culture, and language (Palmer,

2005). According to Vygotsky (1978), knowledge is socially constructed and learning takes place in particular social and cultural contexts. In Vygostsky's view the social interaction provides children with ways of interpreting the physical and social world, and students thus become enculturated into ways of thinking that are common practices in that specific community. Much learning therefore occurs when children interact with more competent individuals such as adults and teachers. To Vygotsky, children are capable of constructing their own knowledge through collaboration, direction or help of an expert or a more capable peer as children are socially engaged in constructing their own knowledge. Vygotsky believes that the development of the mind is the interweaving of biological development of the human body and the appropriation of the cultural/ideal/material heritage which exists in the present to coordinate people with each other and the physical world (Cole & Wertsch, 1996).

Vygotsky's (1978) Zone of Proximal Development (ZPD) which is the distance between a child's ~~"~~actual developmental level as determined by independent problem solving" and the higher level of ~~"~~potential development as determined through problem solving" under adult guidance or in collaboration with more capable peers emphasises his belief that learning is fundamentally a socially mediated activity. Vygotsky argued that instruction should be tied more closely to the level of potential development than to the level of actual development.

Both theories by Piaget and Vygotsky emphasise making knowledge meaningful and helping learners organize and relate new information to existing knowledge in memory (Ertmer & Newby, 2013). According to Kim (2001), social constructivism is based on specific assumptions about reality, learning and knowledge. To understand and apply models of instruction that are rooted in the perspectives of social

constructivists, it is important to know the premises that underlie them. Social constructivist teaching approaches can include reciprocal teaching, peer collaboration, cognitive apprenticeships, problem-based instruction, web quests, anchored instruction and other methods that involve learning with others **(**Shunk, 2000 cited in Amineh & Asl, 2015**)**.

Computer simulations give students the opportunity to observe a real world experience and interact with it (Sahin, 2006), simulate laboratories that are impractical, expensive, impossible, or too dangerous to run (Strauss and Kinzie, 1994), provide open-ended experiences for students **(**Sadler, McIntyre, Jackson & Cannon, 1999 cited in Sahin, 2006), provide tools for scientific inquiry (Dwyer & Lopez, 2001) and problem solving experiences (Howse, 1998). In the words of Alessi and Trollip (1991), simulation is a powerful technique that teaches about some aspect of the world by imitating or replicating it. According to the study, students are not only motivated by simulations, but learn by interacting with them in a manner similar to the way they would react in real situations. In almost every instance, a simulation also simplifies reality by omitting or changing details. In this simplified world, the student solves problems, learns procedures, comes to understand the characteristics of phenomena and how to control them, or learns what actions to take in different situations.

As constructivists call for hands-on activities limiting the teachers‘ manipulation of teaching and learning, computer simulation is seen as a right technique in teaching and learning as it is compatible with the constructivists‘ view of education (Thomas & Milligan, 2004). Computer simulations enhances effective teaching and learning as it emphasises on the role of students‘ interactions in enhancing a wide range of school

outcomes, including academic achievements, cognitive processes, meta-cognitive skills, motivation toward learning, self-esteem and social development (Newberry, 1999).

2.2 Conceptual Framework of the Study

Teachers guiding students‘ in science learning is grounded in the approach of understanding learning. Learning according to Lave and Wenger (1991) is the gradual participation in the social and historical organized practices of a community which brings a permanent change in behaviour. Learning is equal to memorising and the ability to reproduce what usually taught in a school test setting (Rossum and Hamer, 2010).

Vygotsky (1978) believes learner participating in the disciplinary practices of science enhances understanding as it draws attention to how classroom activities are organized and support students‘ engagement in the central practices of science. According to Roth and Bowen (1993) teachers‘ teaching strategies, decisions about what activity to be used and how to use it as well as guidance in the classroom has a direct impact on students understanding.

It has been observed that computer simulations have the potential of simplifying difficult and mind burgling concepts. Egunjobi (2014), Cheng, Cheng and Chen (2012); and Cholmsky (2003) have all reported the positive impact of computer simulations on learners‘ understanding and their participation in class activities. Computer simulation has put a new whole spin on science education reform act, redefining the role of teachers and reshaping the classroom learning experience (Akpan, 2002). To Sahin (2006), computer simulations offer inquiry environments and cognitive tools to scaffold learning and apply problem-solving skills. Computer

simulations are good tools to improve students‘ construction of hypothesis, graphic interpretation and prediction skills.

In a constructivist learning environment, learners are motivated to learn how to learn by giving them the training to take initiative for their own learning experiences. Motivation, according to Palmer (2005) has been recognized as an important factor in the construction of knowledge and the process of conceptual change. A constructivist learning environment plays an important part in achieving meaningful and retentive learning since it allows students to improve their problem solving, creative thinking and critical thinking skills (Ongowo, 2013). Computer simulations instructional packages provide students with experiences to enhance conceptual development, which leads to increased understanding of difficult concepts.

2.3 Students' Attitude and Achievements in Biology

Biological sciences invoke human interest to find the hidden truth with a scholarly aggressiveness and therefore have an important cultural and educational role (Özcan, 2003). The purpose of science according to Liras (1994) is to discover the laws that govern the natural world and increase our understanding of it. It is widely believed that biology is the science of the twenty-first century. There have been several developments which form an important base for both medicine and health issues. In recent years biology has become a very important subject as many issues such as biodiversity, genetically modified organisms, reproductive technologies, the prolongation of life (Reiss, 1998) are all biology based. All these developments, in the view of Jarman and McClune (2001) meet human needs and so are present times have been considered as _the Age of Biology‘.

To be able to judge about scientific issues someone has to possess an understanding of ideas and procedural understanding. Accordingly, biology education should be simplified and clarified to all biology students. Development of biological literacy in learners is among the aims of biology education (Roberts, 2001). Biologically literate individuals can have ideas and judge without any bias on pertinent issues on healthcare, environmental protection, pollution and controversial issues such as cloning and genetically modified organisms (GMO). Development of biological literacy must certainly be the most important aim of biology education. Biology knowledge such as critical thinking, looking for scientific resolutions to problems, scientific self-concept, skills of using equipment properly and the skills of experimental techniques should be gained by students through biology education. In line with this, Roberts and Gott (1999) noted that biology education should prepare some learners to become working biologists.

As a point considered in this study, to attain a value component and its effective utility of biology knowledge, appropriate perception on the subject matter is valuable (Li, Lee & Solmon 2007). Biology classes are the most important contexts for learning biology (Koksal & Cimen, 2008). Students‘ affective perceptions are the most important factors for quality of learning due to their effects on mental preparation and understanding. According to Angell (2015), perception is the consciousness of particular material things present to the sense. It is like a sensation, something of an abstraction because we are always aware of it in the background of consciousness, of sense activities other than those we speak of as being perceived, especially those connected with the internal operations of our own organism. In the view of Thompson, Naccarato, and Parker (1989), perception is the process of receiving information about and making sense of the world around us. It entails

determining which information to notice, how to categorize this information, and how to interpret it within the framework of our existing knowledge.

The prime aim of educators is to provide a better education to the youth for a better future. This type of education involves motivating students and involving them in the learning process. The most imperative goal of today's education according to Marchaim (2001) is to develop individuals that will be creative, innovative and be able to use their skills in shaping their lives. The focus of science education is therefore to enable learners to understand the nature of science and to think like scientists (Roberts, 2001). It is incumbent on the part of science educators to make science teaching be meaningful, understandable and worthy of learning (Özcan, 2003).

According to Mucherah (2008) and Myint and Goh (2001), classroom environments perceived by students as conducive tend to enhance the development of positive attitude towards a subject matter and hence, better achievement in it. Though classroom environment studies have been carried out in developed countries like United States of America (USA), Australia, New Zealand and some countries in Asia such as Taiwan, Turkey, and Singapore (Fraser, 2000), very little is reported on how SSS science students perceive their Biology classroom environment in Africa (Mucherah, 2008). Ampiah, (2006), has reported on Ghanaian SSS science students' perceptions of their science laboratory learning environments. However, little is known about how Ghanaian SSS elective science students perceive their biology classroom environments.

Attitude towards science has been a factor in determining the success of science education as it has been established that there is a clear positive correlation between

attitudes towards science and science achievement (Özcan, 2003). In her study, Wood (2002) found out that the amount of effort put forth by high school students can be predicted by science related attitudes and concluded that improving a student‘s attitude toward a subject can help that student achieve higher success and achievement in school. Attitude towards science has been seen to be gender based (Weinburgh & Englehard 1994). In the works of Johnson, 1981; Simpson and Oliver, 1985 cited in Özcan (2003), it has been established that males have more positive attitudes toward science than females. However, females have more positive attitudes toward biology whereas males have more positive attitudes toward physics and chemistry Schibeci (1984). Meanwhile Weinburgh and Englehard (1994) showed that female students have more positive attitude s toward biology activities than males and Tekkaya, Özkan, and Sungur (2001) claimed boys perceive biology topics easier than girls. They attributed the reasons of this situation to socialization factors and classroom experiences leading to low self-esteem and passive dependent behaviour among girls (Çakıroğlu, 1999; Shamai, 1996 cited in Özcan, 2003). In a study conducted in South Africa, Amponsah (2013) looked at gender differences in learning environment and student attitudes in high school chemistry classrooms in South Africa. There is the difficulty in obtaining materials on the attitudes of students towards biology in Ghanaian schools. Otami, Ampiah and Anthony-Krueger (2012) where interested in factors influencing elective science students‘ perception of their Biology classroom environment in low and high academic achieving schools in the Central Region of Ghana. They established that the key perception has got to do with the attitudes of the students towards science.

In the view of Özcan (2003), positive attitude is imperative in learners‘ achievement, so it has been established that misconceptions and their sources are crucial to improve

meaningful learning consequently to increase achievement in biology. These, misinformation transmitted by teachers, misapplication of content taught in school, misapplication of scientific terminology, wrong descriptions of the observations of the demonstrated phenomenon in school, inadequacy of curriculum, textbook errors and presentation of science topics in isolation (Çapa, 2000).

Students may also come to school with established knowledge about the physical, biological, and social worlds based upon their own ideas and explanations that may or may not be correct. Some misconceptions may change as students develop their ability to think abstractly, while others persist well into adulthood (Britannica, 2013). It behoves on educators in identifying naive conceptions learners frequently have, often with the object of replacing these conceptions with correct or _expert' understandings (Teixeira, 2000 cited in Reeve and Bell, 2009).

2.4 Students' Difficulty with Biology Concepts.

For decades now, students' difficulties in learning biology concepts have been investigated by several researchers worldwide (Johnstone & Mahmoud, 1980; Seymour & Longdon, 1991; Jennison & Reiss, 1991; Lazarowitz & Penso, 1992; Çimer, 2012). In a study, Sert-Çibik, Diken, and Darçin (2008) concluded that biology is a more interrelated science field with respect to concepts. Students have problems learning some biology concepts meaningfully and have resorted to memorize these concepts. Sert-Çibik Diken, and Darçin (2008) further cited concepts of photosynthesis and plant respiration to buttress his point.

Biology topics including water transport in plants, protein synthesis, respiration and photosynthesis, gaseous exchange, energy, cells, mitosis and meiosis, organs, physiological processes, hormonal regulation, oxygen transport, genetics, Mendelian

genetics, genetic engineering, and the central nervous system can be perceived as difficult to learn by secondary school students (Çimer, 2012). In a study conducted in Turkey, Tekkaya, Özkan and Sungur (2001) found that mitosis, meiosis, respiration, photosynthesis, excretory system, nervous system and Mendelian genetics are some biology topics that students find difficult to learn.

Yeboah (2012) found photosynthesis as one of the biology concepts students have difficulties in understanding. Stating it simply, Diki (2013) said that biology is a subject that is difficult to learn and its difficulty affects student achievement. He further noted that the difficulty of the subject makes students less motivated to learn it and as a result, it is difficult for them to achieve a good result of their studies. Mavrikaki, Koumparou, Kyriakoudi, Papacharalampous and Trimandili (2012), found in another study that the difficulty may be attributed to the fact that biology is taught as an independent and isolated subject in secondary school with a curriculum, which is so overloaded.

Some other reasons for the learning difficulties have been attributed to the nature of the topic, teachers‘ style of teaching, students‘ learning and studying habits, students‘ negative feelings and attitudes towards the topic and lack of resources (Çimer, 2012). In furtherance, Çimer (2012) attributed the difficulty to the nature of science itself and its teaching methods. He asserted that the teacher style of teaching has been seen as a source of the problem. Biology teachers usually prefer to employ mainly traditional teaching approaches and techniques and as such biology lessons are mainly run in a teacher-centered manner transferring the knowledge that they find and what is written in the textbook without conducting student-centered teaching activities (Çimer, 2012). However, Lazarowitz and Penso (1992), believe that biological level of organization

and the abstract level of concepts make learning biology difficult. In the view of Diki (2013) one other student difficulty is caused by their inability to describe the concepts of biology and the needed skills to learn biology. Inadequate textbooks and reading materials have also been identified as sources of some of these difficulties (Dikmenli, Çardak, & Öztas 2009). This is amplified by Gyasi (2013) who said that science education without readable and appropriate textbooks is comparable to democracy without appropriate constitution or farming without functional farm implements.

To arrest this problem, the panacea is the teacher (Kubika-Sebitosi, 2007) and the teaching methods (2010). Mavrikaki, Koumparou, Kyriakoudi, Papacharalampous & Trimandili (2012), suggests teacher-centered pedagogy should be abandoned in favour of a more student-centered one. Teachers‘ competencies and knowledge in both biology as a subject and its teaching are crucial for enhancing students‘ learning (Çimer, 2012). Educators are not only to provide learning support material, but also the skill that will help students to overcome their own problem (Diki, 2013). Teachers should be aware of alternative conceptions existing in literature related to biological subjects, discuss them with pupils convincing them why alternative conceptions are not scientifically valid and should be refused and then assist pupils in the process of eliminating misconceptions, namely turning them into information having scientific validity (Dikmenli et al, 2009). Teachers should also make biology lessons interesting and attractive for students to learn more effectively (Çimer, 2012) by employing the use of appropriate methods of teaching with supporting materials, like models, graphs and videos. Laboratory activities could also be used to overcome these difficulties (Diki, 2013).

Biology learning and the development of science process skills are integrated activities. On these grounds, it is better to require students to acquire competence in basic science process skills. Most of the topics taught in biology emphasize activity-centred learning. Therefore students should be involved in considerable hands on activities during biology lessons in order to develop the appropriate process skills (Nworgu & Otum, 2013).

2.5 Technology Use in Teaching and Learning of Biology

When man started using computer, perhaps no one could imagine about the future and the use of computers (Türkmen, (n.d)). There is however, a tendency that societies seem to use the new technological advances in their daily lives. Nowadays, in many counties, societies seem to show a change from industrial society to information society. The ability to work with information and communication technologies (ICT) is recognized as one of the key competencies necessary for success in life and competition in the labour market (Eurydice, 2002 cited in Šorgo, Verčkovnik and Kocijančič 2010). One of the results of these changes is mainly based on using computers in every aspect of our lives. Education, also, is an important part of today‘s society.

Computer has many functions, one of which is to assist in classroom instruction as it is possible to use computer to deliver instruction in the classroom either partially or totally (Udo & Etiubon, 2011). Information Communication Technology (ICT) based learning intervention can either be used to enhance practical investigation or as a virtual alternative to real practical work where a simulation supports exploration of the investigation model through a computerized representation of the phenomena under study (Wodi & Dokubo 2006). According to Olele (2008), interesting and well-

designed programmes motivate students and encourage them to spend more time on tasks to master concepts taught.

Many researchers have worked on computer usage in the learning of science and other disciplines. Serin (2011), investigated the effects of computer-based instruction on the achievements and problem solving skills of students in science and technology students. He opined that with the rapid development of information and communication technology, the use of computers in education has become inevitable. As the use of technology in education provides students with a more suitable environment to learn, it serves to create interest and a learning centred-atmosphere, and helps increase their motivation. Computer-based instruction enables learners to progress at their own pace and provide them with appropriate alternative ways of learning by itemizing the learning process (Senemoğlu, 2003). By this way, the major motive of science education which is to teach children science concepts in a meaningful way and enable them to learn how they can make use of these concepts in their daily lives (Çepni, Taş, & Köse, 2006) becomes a reality (Serin, 2011). Science education is concerned with the learning and teaching of science content and practices. It therefore requires pedagogical content knowledge, that amalgamates content and pedagogy that is uniquely the province of teachers; their own special form of professional understanding (Shulman, 1987 cited in Niebert & Gropengiesser, 2013).

In this era of science and technology there is a great need to improve quality of education specifically of science education. This can be possible by bringing fundamental changes through innovative techniques through which teachers can provide student-centered learning environment that can make learning processes

interesting and understandable to the young learners (Khurshid & Ansari, 2012). The expectations of society, according to Bell & Bell (2003), are the demand for ICT skills and raising the quality of education in the schools with the support of ICT. In line with this many scholars, teachers and teacher-trainers have recognized the potential of ICT to enhance teaching and learning and as an effect the number of published articles about the use of ICT in school work is enormous (Bell & Bell, 2003).

Due to advent of educational technology, teaching and learning activities have become interesting as students willingly learn, by playing and enjoying during these activities (İşman, 2005). The value of computer in teaching and learning should not be lost as the children can continue to play with it without ever getting bored (Christakis, Ebel, Rivara, & Zimmerman, 2004). It is documented that the use of computer in teaching and learning attracts students (Serin, 2011) as the use of the audio-visual devices and animations with instructional materials results in enjoyable and productive learning process. The use of computers in learning concretises abstract concepts (Akpınar, 2005).

In investigating Information and Communication Technologies (ICT) in biology teaching in Slovenian Secondary Schools, Šorgo (2011) reported that many scholars, teachers and teacher-trainers have recognized the potential of ICT to enhance teaching and learning. The introduction of ICT in biology lessons is very relevant as it does not only raise the level of knowledge but students‘ attitudes toward biology as well (Kubiatko & Halakova, 2009).

Though Çetin (2007), saw no significant difference between the computer based instruction (CBI) and traditional teaching methods, Liao (2007) found out that CBI

had a positive effect on individuals. Both Geban (1995) and Santally, Boojawon and Senteni (2004) believe CBI enable students to increase their motivation and achievements and develop positive. Hançer & Yalçın, (2009) and (Lin, 2009) have revealed that CBI serves to establish more effective learning situations than traditional teaching methods which involve teacher presentation, question and answer techniques, and discussions.

However, it must be noted that with the use computers in education, a lot of terms have come into and gone out of use in education (Owusu et al., 2010). Notwithstanding this it is imperative to employ the use of computer based instructions in the teaching and learning processes as CBI technology triggers active participation and enables students to make their own meaning (Serin, 2011).

2.6 Computer Simulations in Biology Teaching

According to Khurshid and Ansari (2012) an enormous amount has been written in the last two decades about research on how people learn. Students actively learn by observing and performing activities, the process of learning is far more accelerated when a practical implementation is associated and the learner is benefited with the applied knowledge and skills and it also involves trial and error at times during self-exploration (Khurshid and Ansari 2012). Science is founded on principles of observation, measurement, and hypothesis testing and experimental design with the last two principles being of outermost importance in advancing the understanding of how organisms function and interact with one another and their environment (Stafford, Goodenough & Davies, 2010). However, teaching experimental design is problematic (Hiebert, 2007) as it links independent and dependent variables (Underwood, 1997). To enhance scientific knowledge, experimental design skill

needs to be mastered rather than a body of knowledge to be taught (Stafford, Goodenough and Davies, 2010).

Computer simulation has been recognized as a better tool in teaching science as it gives students the opportunity to observe a real world experience and interact with it (Sahin, 2006). In describing computer simulation in educational context, Alessi and Trollip (1991) said that a simulation is a powerful technique that teaches about some aspect of the world by imitating or replicating it. Rey (2010), holds the view that computer simulation enhances students‘ performance than the conventional teaching method. Students are not only motivated by simulations, but learn by interacting with them in a manner similar to the way they would react in real situations. In almost every instance, simulation also simplifies reality by omitting or changing details. In this simplified world, the student solves problems, learns procedures, comes to understand the characteristics of phenomena and how to control them, or learns what actions to take in different situations.

Computer simulations have been widely used in the fields of teaching and learning. Egunjobi (2014) investigated its effects on students‘ academic performance in secondary school practical geography in Nigeria. He found out that there are a significant difference between the students‘ academic performance of those exposed to computer simulations and those exposed to conventional method. However, there are no significant difference in academic performance of male and female students exposed to computer simulation and those exposed to conventional method in practical geography. In physics, Quarcoo-Nelson, Buabeng & Osafo (2012) found that SHS students taught with audio-visual aids achieved better results than the SHS students taught with only the traditional lecture method. This affirms Sangodoyin‘s

(2010) assertion that the use of graphics and animation in computer presentation enhances male and female students‘ performance in biology (Yusuf & Afolabi, 2011).

In their study in evaluating the effect of computer simulations on secondary biology instruction Efe and Efe (2010), found out that using computer simulations to teach topics on cells helps students to visualise the ways in which cell parts function much more effectively than from the traditional learning environments. Using a simulation model allows students to examine results of changing feeding and management conditions quickly without causing any damage to real-life operations (Johnson, Maas, Calvert & Baldwin, 2007). In the view of Gambari Yaki, & Olowe, (2013) using computer simulation package in teaching an abstract biological concept such as the digestive system could greatly improve students understanding in digestion. However, Mills (2001) findings revealed that computer simulation was found to be as effective as classroom for fact based learning, but not as effective for topics requiring critical thinking or mathematical problem solving. In addition, the time required by learners to use computer simulation was higher overall than conventional classroom instruction. Hancer and Tüzeman (2008), are of the opinion that computer simulation is more efficient than the traditional methods concerning the increase of academic achievement of pupils in the realization of lessons. Akcay, Feyzioglu & Tuysuz, (2003), are of the opinion that computer based learning (CBL), strengthens students‘ motivation and educational processes.

Notwithstanding the numerous benefits of computer simulations in teaching and learning, teachers seldom use it. Drakulić i sar, 2011cited in Županec, Miljanović and Pribićević (2013) sites one of the reasons for it under usage as lack of computer equipment in biology cabinets, a small amount of published educational software and

insufficient training of biology teachers in the use of computers in teaching. This has limited the use of computer as an aid to teaching and learning in most schools in Africa restricting its use to very few privately owned schools and public schools where the children of the affluent attend (Adegoke, 2011 cited in Gambari et al., 2013). Thus, much remains to be empirically researched on the effect of computer simulation in biology education. It is against this background that this study investigates the effect of computer simulations on students understanding in the concept of digestive system in biology. Aside this how computer simulation affects students attitude and how this change in attitude can be translated to the learning of other biology concepts and science as a whole is also examined.

2.7 Constructive Learning in Biology Teaching.

The primary purpose of teaching at any level of education is to facilitate the process of knowledge transmission. Teachers therefore should apply appropriate teaching methods that best suit specific objectives and level exit outcomes (Ganyaupfu, 2013). According to Adunola (2011) poor academic performance by the majority of students is fundamentally linked to application of ineffective teaching methods by teachers to impact knowledge to learners. Science educators believe that achievement of students at their full potentials could be a function of appropriate lesson delivery techniques of the teachers (Onwukwe, 2010). Impacting knowledge involves the use of appropriate techniques. Teaching techniques are the different ways in which a teacher presents information to be learned (Erinosho, 2009). The choice of a teaching method depends on what fits into ones educational philosophy, classroom demographics, subject area(s) and school mission statement.

According to constructivism, learning science requires determining learners‘ existing cognitive structures and building new understanding through modifying or restructuring of existing knowledge (Glynn and Duit, 1995 cited in Cimer et al 2011). Thus, revealing learners‘ existing knowledge and understanding will pave the way to plan curriculum and instruction that challenges and further develops their cognitive structures. One of the primary goals of using constructivist teaching is that students learn how to learn by giving them the training to take initiative for their own learning experiences (Siemens, 2004). They therefore assume that learners are not empty vessels to be filled with knowledge; instead they are actively attempting to create meaning. According to Palmer (2005), when students are learning about science they use their existing knowledge, beliefs, interests, and goals to interpret any new information and this may result in their ideas becoming modified or revised. In this way, learning proceeds as each individual‘s conceptual schemes are progressively ―reconstructed" as he or she becomes exposed to new experiences and ideas (Driver, 1989).

According to Afolabi and Akinbobola (2009), in constructivist learning environment, learners construct knowledge out of their experiences which are associated with pedagogical approaches that promote active learning. Ongowo (2013), claims constructivist learning environments place much premium on students‘ prior knowledge which is also referred to as alternative framework or alternative conception. Neo and Neo (2009) believe that a constructivist learning environment plays an important part in achieving meaningful and retentive learning since it allows students to improve their problem solving, creative thinking and critical thinking skills. As intimated by Ausubell (1968), the most important single factor influencing learning is what the learner already knows.

Constructivist approaches to teaching is preferred to other forms of teaching as it is learner centred and tend to be aligned with an established and widely espoused theory of knowing and learning (Rowe, 2006). The role of the teacher in this set up in the view of McInerney and McInerney (2006) is to provide opportunities for individual learners to acquire knowledge and construct meaning through their own activities, and through discussion, reflection and the sharing of ideas with other learners with minimal corrective intervention. Constructivist teachers cooperate with students in mutual reciprocity of respect and engagement meeting their needs to promote peer interaction and responsibility (Betsy, 2003).

Inquiry-based science teaching has, at its foundation, the goal of producing students who are scientifically literate. Metacognition is one of the most important elements of scientific literacy as it is the means to increase the effectiveness of inquiry-based science education recognizing and participating in science as a discipline (Seraphin, Philippoff, Kaupp, & Vallin, 2012). Misconceptions about the scientific process could be attributed in part to the misrepresentation of the discipline of science by teachers, whose understanding of science often does not include mastery of the scientific habits of mind considered necessary by science experts (Zembal- Saul, Munford, Crawford, Friedrichsen, & Land, 2002).

In the traditional teaching and learning of science, teachers do not incorporate inquiry-based scientific practices and multidirectional knowledge construction in teaching. Teaching is not seen as a complex endeavour that requires significant effort, practice, and attention that even teachers with adequate experience practicing scientific habits of mind in the context of science research can struggle to include scientific practices into their classroom teaching (Hammer, Carson & Riley, 1999). At

secondary level, science teachers often adhere closely to the linear scientific method espoused in many science textbooks (i.e. question, hypothesis, experiment, results, and conclusion). As a result, teachers tend to perpetuate the epistemic belief that scientific knowledge is generated in a single, fixed manner. Students, in turn, tend to believe that scientific knowledge is –fixed, unchanging, absolute truth" rather than a –dynamic entity that will continue to evolve over time" (Ormrod, 2011). Correspondingly, students think the process of doing science is –memorizing procedures and formulas" to find a –single right answer" (Ormrod, 2011 cited in Seraphin et al, 2012**).** The end result is that students continue to struggle to navigate the scientific process effectively. To be more aware of their thinking both teachers and students need to understand the complex nature of the scientific process and participate in the discipline of science solving.

In his perspective Sidhu (2013), believes biology is not the search for truth but rather a process that assists us to make sense of our world. Therefore applying constructivist perspective, will present an active, social process of making sense of experiences, as opposed to what we now call –school biology." Zareen, Kayani and Kayani (2014) believe constructivism has been found to be a good description of learning and recommends that to make higher secondary biology instruction successful constructivist instruction must be incorporated into direct instruction where appropriate in teaching biology as it focuses more on the learner and his/her learning needs. Sidhu (2013) concludes by saying that constructivist teaching is an enjoyable activity. He further asserts that just as teachers have to learn how to teach from a constructivist point of view, so too must students learn how to learn. Therefore, educating students to be effective learners is an important priority in establishing environments conducive to effective learning of biology.

2.9 Class Interaction

Communication is an outward extension of thoughts. It helps in the process of arranging thoughts, linking one idea to another (Behnam & Puriran 2009). The principal medium through which patterns of interaction are built is language. Transmission of information to establish transfer of knowledge to effect change in some way requires the negotiation of meaning through interaction. Language, in relationship to the social construction of life in classrooms, refers to the oral and written discourse norms, expectations, and strategies that members establish through their daily interactions (Widdowson, 1984). According to Behnam and Puriran (2009), the language-of the- classroom is a group of constructed phenomena, a negotiated system of meaning, and a set of conventions for interacting, participating and communicating information and knowledge within a particular classroom. In education, the use of language in the classroom is imperative as education itself is propagated basically through the medium of language.

Classroom interaction refers to any interaction which takes place between the teacher and learners and amongst learners themselves (Aldabbus 2008). The use of direct classroom interaction over the years has enhanced imperative information gathered about the nature of effective teaching (Brophy & Good, 1986; Good & Brophy, 2000). It has also been established that classroom communications have a significant impact on student outcomes (Wang, Haertel, & Walberg, 1993) and directly affect students' achievement (Good & Brophy, 2000). It should be noted that when students' are granted the opportunity to participate actively in the classroom communication it contributes to one of the most important predictors of student achievement (Berliner & Biddle, 1995).

Flanders Interaction Analysis Categories System (FIACS) by Flanders (1970) was developed to help teachers develop and control their teaching behaviour, to explain the variations which occur in the chain of classroom events and their relationships with classroom communications and educational outcomes (Hai & Bee, 2006). In the view of Gorard (2000) teachers who were perceived as effective engaged largely in accepting students' feeling and ideas, used more praise and encouragement in their classroom communication. Among the objectives of classroom interaction is to involve remedial strategies in reconstructing of our whole concept of teaching methodology (Shahi, 2010).

Comparatively, classroom interaction is considered better than traditional training method as it has been used as a training tool as well as a tool to measure teachers‘ classroom behaviour patterns in various studies. It has also been established through other studies that the use of interaction analysis helps to modify teacher's classroom behaviour (Shahi, 2010). A report by World Conference on Education indicates that a multi-method research designs that include classroom observations should be used in implementing educational reforms (WCEFA, 1990).

FIACS, a major tool in measuring classroom interactions has a lot of limitations that can affect teacher effectiveness. Among these include its failure to include non-verbal behaviours and no provision for student-student interaction as the system is limited in the whole area of student participation (Evans, 1970). It strengths, however include

1. It describes rather than to evaluate teaching-learning situations.
2. It permits the preservation sequence of events of an on-going classroom interaction as it evolves.
3. The system is relatively easy to learn and to use.

4. The categories and procedures are defined in such a way that independent observers after a period of training, are able to reach a high level of inter coder agreement.
5. The system is not restricted to any particular subject area or grade level.

In Ghana, observational data have been used to further the dialogue about educational quality in ways that has led to policy changes. In addition to describing the reality of a school or classroom, observational data can be used in several other ways. When gathered in conjunction with performance testing, classroom observations can add to the interpretive power of the statistical analysis. Observational data of individual children can guide the statistical analysis by suggesting relationships to be examined or can be incorporated into the statistical analysis to explain behaviours related to achievement gains (Chesterfield (n.d)).

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter deals with the methods that were used in planning and collecting the data needed for this project. It covers the areas of research design, population for the study, the sample and sampling technique. The validity and reliability of the research instruments are discussed in this chapter. The data collection procedures and the data analysis procedures are also outlined in this chapter.

3.1 The Research Design

The study is an action research. An action research is a process of studying a school situation to understand and improve the quality of the educative process (Johnson, 2012 cited in Hine, 2013). It enables researchers to develop a systematic, inquiring approach toward their own practices (Frabutt et al., 2008 cited in Hine, 2013). According to Mills (2011), action research may help increase the effectiveness of the work being engaged in. It helps to get beyond just accepting the status quo and resists the quick fixes that rarely work as promised. It involves the examination of educational practices systematically and carefully using the techniques of research.

Action research specifically refers to a disciplined inquiry done with the intention of being informed in order to modify an existing practice(s) in the future. This research is carried out within the context of the teacher‘s environment including the students and the school and it deals with educational matters at hand. This research can be described as consisting of different research methodologies which pursue action and understanding at the same time. This grant educators opportunities to reflect on and assess teaching.

Characteristically, action research is practical problem-solving as well as expanding scientific knowledge. It is participatory as it is a research in which people work towards the improvement of their own practices. Its collaborative nature allows all those concerned and interested in change to participate.

As a research, it has dependent and independent variables. The dependent variable in this study was students' achievement in Biology and the independent variable was realistic simulation-based teaching method. The term preceding the onset of this study, the topics Skeleton and Nutrition were taught using the traditional lecture methods and the score of the students at the end of the lessons tests and of the term's examination served as their entry point. Digestion was taught using computer simulation. A post achievement test was given to the two intact classes after they had learnt the topic Digestion.

The researcher used two different computer simulations instructional packages. The first was _Learn about Digestive System_Human Digestion System Animation 1 & 2' adopted by Mexus Education and uploaded from www.ikenstore.com. Mexus Education is an educational solutions provider based in Mumbai, India. This package deals with all the processes of ingestion, digestion, absorption and egestion; the organs involved and the accessory organs.

3.2 Population

The target population for the study was all students at Odorgonno SHS located in the Ga Central Municipality in the Greater Accra Region. The school was chosen because the researcher has been teaching in the school for three academic years and is familiar with the academic environment in the school. It is also due to the fact that the school has a well-equipped computer laboratory with one hundred (100) well-functioning computers with uninterrupted internet connectivity. This made it possible for all the students try their hands on the computer simulations instructional packages that were used. Another reason was the willingness of the head of the school and elective biology teachers to participate in the study.

3.3 Sample and Sampling Procedures

The sample that was used for this study was made up of two intact SHS 2 Home Economics classes of the selected school. All the students of the classes offered Biology, General Knowledge in Art and Management in Living as their elective subjects with Food and Nutrition or Textiles alternating as their fourth elective subject. Purposive sampling technique was used as the study involved all the students in the classes selected. Purposive sampling was used as the samples that were chosen were likely to be knowledgeable and informative about the phenomenon the researcher was investigating (McMillan & Schumacher, 2001). As asserted by Crossman (2013), purposive sampling commonly called a judgmental sample, is one that is selected based on the knowledge of a population and the purpose of the study. Purposive sampling can be very useful for situations where you need to reach a targeted sample quickly and where sampling for proportionality is not the main concern.

Fifty (50) of students of SHS 2 Home Economics 1 and forty eight (48) students of SHS 2 Home Economics 2 intact classes were sampled for the research. Second year (SHS 2) students were used in the study because digestion is taught during the second year of the SHS biology programme.

3.4 Research Instruments

The instruments that were used for the study were entry point, post intervention test and observation systematic classroom interaction. Thus the researcher employed the use of both quantitative and qualitative methods of collecting data. According to Hohmann (2006), quantitative research method is developed in the natural sciences and used in the study of natural phenomena as it is an excellent way of finalizing results and proving or disproving a hypothesis.

Classroom interaction was used as it is considered as an important tool in lesson delivery. It is believed that there is no intellectual and thinking skills development among students who are given no or very little time for active participation and interaction (Inamullah, Naseer ud din & Hussain 2008). Classroom interaction provides objective data, systematic record on the learning behaviour of the learners which may be helpful in giving definite interactions and guidance to the teacher for the improvement of his teaching.

3.4.1 Post-Test

The test instruments used were named the entry point (the score of tests after the lessons on the topics Skeleton and Nutrition) and Students‘ Achievement in Digestion Test” – SADT (Appendix A) and terminating point (end of term examination). The instruments were used in collecting quantitative data from all participants. The SADT

consisted of twenty five (25) items which were made up of three sections (A, B, C and D).

Preceding Section A of the test instrument was a portion that briefly stated the purpose of the test and also asked participants to provide personal data, such as, name, gender and class of participants. This portion also contained general instructions on how to answer the items in all the three sections of the test instruments. Additionally, each section of SADT began with specific instructions regarding how to respond to items in that section.

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

Section B was made up of five (5) true/false items, which appeared as items 11 to 15 on the SADT. Each of the five true/false items had a statement about an aspect of the concept of Digestion followed by _True‘ or _False‘. Participants were required to circle _True‘ if they agreed with the statement or _False‘ if they disagreed with it. Each correct option chosen was awarded one mark, giving a total score of five (5) marks.

Section C on the other hand was made up of five (5) questions and appeared as items 16 to 20. Items 16-20 each had a statement about an aspect of the concept of Digestion and a blank space which was at the beginning, the middle or at the end. Participants were required to provide the correct word(s) in the space that was

provided for each item. Each correct option chosen was awarded one mark, giving a total score of three (5) marks.

Section D was short essay or short- answer items on SADT. Items 21-23 had no sub-questions. However, item 24 and 25 on the SADT had two (2) sub-questions each, 24(i) and 24(ii) and 25(i) and 25(ii) respectively. The maximum mark obtained by each participant in 21 and 22 was 6 (3 marks per a question). The maximum mark for each participant in item 23 was 4. For items 24 and 25, the maximum mark obtained by each participant was 10 (3 marks for item 24 (i) and 25 (i) and 2 marks for item 24 (ii) and 25 (ii)). All participants' responses to one short essay or short-answer items was scored before scoring participants responses to another short essay or short-answer items. This helped to keep one frame of reference and one set of criteria in mind while scoring responses to a particular short answer item by all participants. It also prevented carrying over impressions formed while scoring the responses of a participant to a particular item to the participant's next response(s). This was to ensure uniformity in the scoring of all items. A marking scheme was prepared for the marking and scoring of the SADT (Appendix B). Items in section D had a maximum score of 20 marks. The SADT therefore, had an overall total score of 40 marks. The marks were however expressed as 70% to ensure uniformity in comparing it with the entry point.

3.4.2 Classroom Interaction

Research on whole-class interaction gained momentum in the late 1960s, in response to the belief that the educational process is as important a focus as the learning outcome (Shomoossi, Amouzadeh, & Ketabi, 2008). Classroom interaction is a means of undertaking research into what occurs in classrooms by attempting systematically

to observe and keep records of classroom events (Johnson & Johnson, 1998 cited in Behnam & Pouriran 2009). It has been used as a technique in the study of many aspects of teaching activities. It uses a system of categories to encode and quantify classroom behaviour of teacher and students. The use of direct classroom observation over the last century has resulted in the accumulation of an impressive body of information about the nature of effective teaching (Good & Brophy, 2000 cited in Hai & Bee 2006).

Students' opportunity to participate actively in the classroom communication contributes to one of the most important predictors of student achievement (Berliner & Biddle, 1995 cited in Behnam & Pouriran 2009). The relative effectiveness of classroom interaction techniques and students‘ participation is necessary because of the need to discover what is happening in special world of the classroom with a view to achieve the best interaction pattern and students holistic intellectual development (Chika & Onwioduokit, 2012)|. However, students' opportunity to participate in the classroom communication may vary with different verbal behaviours of teachers, with their achievement and attitude (Allington, 1991; Good & Weinstein, 1986 cited in Behnam & Pouriran 2009).

The researcher employed Science Interaction Categories (SIC), originally developed by Ogunniyi (1981) and used by Kalu and Ali (2004) which is an adaptation of the Flanders Interaction Analysis Categories System (FIACS). This instrument was developed by Flanders (1970) and has been used extensively in various studies regarding classroom interaction (Inamullah et al 2008). The Flanders system is primarily concerned with the emotional climate of the classroom resulting from verbal

interactions between the teacher and the learners. The system involves the categorization of verbal classroom interaction into ten categories by an observer.

SIC was used to code and analyze the interaction patterns during biology lessons in the selected classes used for the study. It was designed to measure teacher and student behaviours in interaction patterns classroom. The original SIC by Ogunniyi (1981) has 15 categories – 9 teacher behaviours and 6 of student behaviours. These 15 categories were further modified by the researcher to suit the purpose of the study. The SIC used consisted of 7 categories student behaviours and no category for measuring teacher‘s behaviour as it was aimed at investigating how students responded to the intervention. In the final analysis, SIC, as used in the study, had the following 7 categories of behaviours for students:

1. Responds to questions (from teacher and colleagues)
2. Questions
3. Initiates talk (to seek clarification from teacher or other colleagues)
4. Experiments
5. Writes and/or draws
6. Non-productive activities, and
7. Pupil-pupil interaction.

For each of the students‘ categories, numbers (codes) ranging from 1 to 5 was assigned. Each code represented the behaviour in each of the observed student.

The number codes indicated the following behaviours

1. Uninterested
2. Confused
3. Interested but does not participate

4. Interested and participates fully
5. Formulates his ideas.

The 7 categories student behaviours and codes were develop into a coding sheet as shown in table 1. The observers (coders) ticked the code corresponding to the behaviour they observe in the student(s).

Table 1: Coding sheet for class interaction observation

	CODES				
OBSERVED BEHAVIOUR	1	2	3	4	5
1.Responds to questions					
2. Questions					
3. Initiates talk					
4. Experiments					
5. Reads, writes and or draws					
6. Non-productive activities					
7. Pupil-pupil interaction.					

3.5 Validity of Research Instruments

Validity determines whether the research truly measured that which was intended to be measured or how truthful the research results were (Golafshani, 2003). To ensure that participants‘ scores from the SADT made sense, were meaningful, and enabled good conclusions to be drawn from the sample studied (Creswell, 2008); the test instrument was presented to my supervisor to seek for his suggestions and to correct any errors. Three SHS elective biology teachers with considerable teaching experience were also contacted for their comments and suggestions in order to correct the errors that were associated with items on the SADT.

3.6 Reliability of Research Instruments

Reliability according to Kimberlin, Almut and Winterstein (2008) evaluates the stability of measures administered at different times to the same individuals or using the same standard or the equivalence of sets of items from the same test or of different observers scoring a behaviour or event using the same instrument. As asserted by Chen (2007), a test item is a unit of measurement with a stimulus and a prescriptive form of answering; and it is intended to yield a response from an examinee from which performance in some psychological construct (such as knowledge, ability, predisposition, or trait) may be inferred.

To ensure that the research instruments produced scores that were stable and consistent and to avoid any ambiguities in the test items (Creswell, 2008), the SADT was pilot tested using all of twenty five (25) SHS 2 Elective Biology students in Amasaman Senior High School in Ga West Municipality in the Greater Accra Region of Ghana. Data from the pilot testing was statistically analyzed to determine the reliability of the test instruments using Test Item Difficulty. The item statistics helped to determine those items that were good and those that needed improvement or deletion from the question bank (Mitra, Nagaraja, Ponnudurai & Judson, 2009). Analysed results yielded P-value of 0.56 (56%). Boopathiraj and Chellamani (2013) opine that optimum difficulty level is 0.50 for maximum discrimination between high and low achievers. P-values above 0.90 are very easy items and might be a concept not worth testing whiles P-values below 0.20 indicate difficult items and should be reviewed for possible confusing language or re-instruction of the contents.

To measure the inter rater reliability of the coding scheme, two extracts of 10 minutes each from the original data transcription were given to two science teachers to code

the data using Sinclair and Coulthard's system 1975 cited in Aldabbus, (2008) . A comparison was then made between their codings and those made by the researcher. The inter-observer reliability was established to be 0.90 after a two week in-school training session (towards the end of the first term preceding data collection) on how to use the SIC to code classroom interaction behaviours during biology lessons.

3.7 Data Collection Procedure

The researcher employed the services of two independent observers to observe the classroom interactions. Tests, quizzes, class exercises and assignments given to students were collected and analyzed at a regular to reveal potential difficulties. The results of the entry point (previous terms examination score) and post-test were used as data for the study.

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

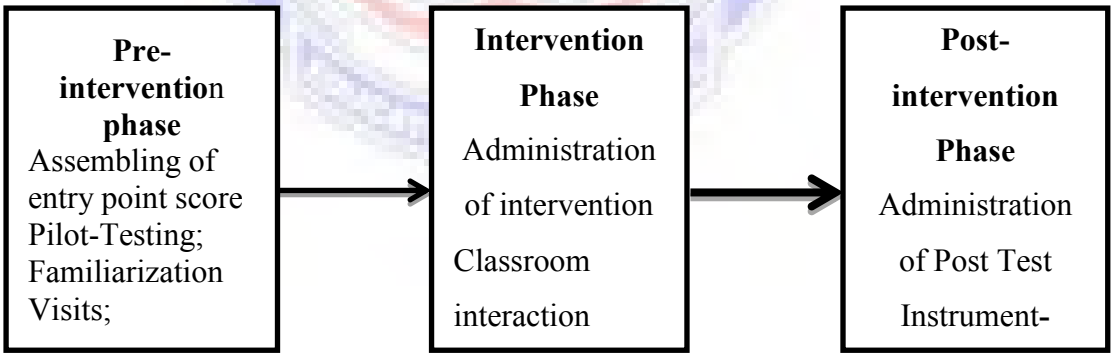

Fig. 3: The Process of Data Collection

3.7.1 Pre- Intervention Phase

This phase lasted for only two weeks. The researcher gathered the biology examination scores of the biology sample for previous term. He then calculated the mean score for each of the intact classes. Two familiarization visits were made to

Amasaman Senior High Technical School. The first visit was for the introduction of the researcher to the head of Amasaman Senior High Technical School and also to seek permission to conduct the Pilot-test in the school. It was also for discussion with respective subject teachers about the study and to solicit their cooperation and assistance for the study.

The second visit to the school was to conduct the pilot test. The researcher administered a pilot-test of the SADT on one intact second year Home Economics class which offered Elective Biology in Amasaman Senior High School in the Ga West Municipality Assembly in the Greater Accra Region of Ghana.

3.7.2 Intervention Phase

The intervention phase of the study lasted for three (3) weeks in the second term of the 2014/2015 academic year in the Ghanaian SHS calendar. In total, eighteen (18) periods of forty (40) minutes each were used.

The two intact classes were taught section three (3) unit two (2) of the SHS3 Elective Biology syllabus, which dealt with Nutrition, using the computer simulation package _Digestive system 1&2' which was adopted from Mexus Education, Mumbai, India and _How your body digest different kinds of food by John Kistes. The students were assigned to a computer each. They were then put in groups of five to compare notes, discuss the lesson outcome and work on assignments. The objectives and the modalities of the teaching strategy were specified and operational guides were produced before the commencement of the treatment.

The simulation techniques used were developed by a computer programmer. The programme allowed learners to see step by step the chemical breakdown of carbohydrate from starch through maltose to glucose. It also enabled learners to see

how protein and lipids are broken down to produce amino acids and glycerol or fatty acids respectively. This package was not time bounded so it enabled learners to progress at their own pace. The programme did not use timed pauses.

The package used text, graphics and animation to explain concepts. The text and the graphics were the predominant features used in the presentation of the lesson. As a classroom package, the researcher made available any support the students requested for. A hard copy of the simulation package used is presented for perusal.

The digestion tutorial used by the computer-based learning group

WELCOME TO THE DIGESTION TUTORIALS

DEVELOPED BY

ISSAKA SOMAILA BANSE

(MPHIL STUDENT)

DEPARTMENT OF SCIENCE EDUCATION

UNIVERSITY OF EDUCATION, WINNEBA

DIGESTION OF FOOD

Digestion of food in the mouth

- Amylase (Ptyalin) digests starch (carbohydrate) into maltose.
- Lipid and protein remain undigested.

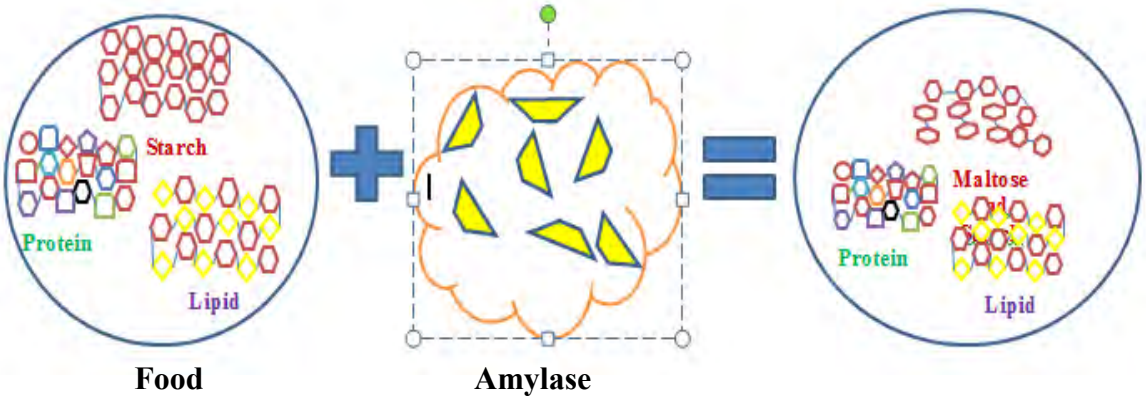

Fig. 4: Amylase action on cooked starch in the mouth.

QUESTION: Explain the process of reabsorption of water in the large intestines.

1. Explain the following as applied to digestion

   a. Ingestion b. digestion c. absorption d. assimilation e. egestion

2. Explain the importance of fibre in diet
3. List the collective names of the enzymes involved in the digestion of carbohydrate, protein and lipids
4. What is the role of liver in digestion?
5. Two Aydin a two year old boy ate rice and egg stew. Explain what happens to the food from his mouth to the anus.
6. Layan a lovely girl was passing watery stool and the doctor told the parents the girl was having indigestion. What might have caused that?

3.8 Method of Data Analysis

The study collected both quantitative and qualitative data and employed quantitative and qualitative methods of data analyses. Data obtained from participants in both classes on the entry point and the SADT were analysed statistically using independent-measures t-Test. The independent-measures t-Test was used to investigate whether any differences exist between mean scores on their entry point and the SADT. This was done to answer the research questions by either rejecting or maintaining the null hypotheses formulated for the study.

The selected coders observed the classroom interaction of students in each of the sampled classes during each of the three continuous periods of biology lesson in the scheduled three weeks period of the treatment phase. In all they observed each intact class for 120 minutes each week out of 240 minutes (6 periods). Each class was observed for 360 minutes (9 periods) out of 720 minutes (18 periods) for the three

weeks duration. To obtain authentic and unbiased data, the students were not informed they were being observed. This was achieved because the teachers that were chosen teach biology who sit in and participate in lessons of other biology teachers. This is common a practice among biology teachers in the school. Their presence during the treatment phase was therefore seen as a normal trend among the biology teachers in the school.

For each session, ten (10) different students were observed by the two coders meaning five (5) students per a coder. The students were observed by the by the coders for the entirety of each of the lesson. In all 30 (60%) out of 51 students in SHS 2 Home Economics 1and 30 out of 48 students 2 Home Economics 2 were observed. In total, 60 out of 98 students representing 61.22% of the sampled classes were observed.

The codes for each of the student‘s category were converted into simple percentages. The percentage scored for each category for all the students was used to estimate the classroom interaction behaviour of the population during the treatment phase.

CHAPTER FOUR

ANALYSIS OF DATA AND DISCUSSION OF FINDINGS

4.0 Overview

This chapter describes the details of the quantitative and the qualitative studies employed in the study. The findings from the investigation into the effect of computer simulation on students‘ performance in digestion and their attitude towards biology are discussed in relation to the three research questions. The research questions are discussed with the use of quantitative t-test statistical tool, and qualitative descriptive analysis of the entry point results (end of term examination) post-test mean scores, the terminating point (end of term examination) as well as the data of classroom observation. The findings of the study are discussed based on the research questions of the study. It presents the results and the analysis of the quantitative and qualitative data generated from participants in the two treatment groups on the entry point, SADT, terminating point and the classroom observation. The first part presents the analysis of the data, while the discussion of the findings of the study is dealt with in the second part.

Findings Related to the Research Questions.

Analysis with Respect to Research Question One (1)

4.2 Research Question One (1)

RQ 1: What is the relationship between students‘ learning skills and their achievement in digestion?

The means score, standard deviation, t-value and p-value of the entry point and terminating point for Treatment Group 1 were determined. The mean scores, standard

deviation, t-value and p-value in the entry point and terminating point of Treatment Group 1 showed significant variations (Table 2).

Table 2: Determination of Significant Differences in the Performance of Treatment Group 1 in Entry point and Terminating Point

Groups Compared	Test	Mean	*SD*	*t* – value	*p* – value
Treatment Gp. 1	Terminating point	45.16	7.49	9.74	1.94E-13*
Treatment Gp. 1	Entry-point	39.96	7.22		

a = not significant at 0.05; p > 0.05 * = significant at 0.05; p < 0.0

Descriptive statistics components means and standard deviations were computed and used to determine the difference in performance of the Treatment Group 1 in the Entry Point and Terminating Point. The mean score for the Entry Point was 39.96 (SD=7.22) while that for Terminating Point was 45.16 (*SD* = 7.49).

To determine the performance of students' in the entry point and terminating point, the means score, standard deviation, t-value and p-value for Treatment Group 1 were determined. The mean scores, standard deviation, t-value and p-value of the performance in the entry point and terminating point in Treatment Group 1 showed significant variations (Table 3).

Table 3: Determination of Significant Differences in the Performance of Treatment Group 1 in Post Test and Terminating Point

Groups Compared	Test	Mean	*SD*	*t* – value	*p* – value
Treatment Gp. 1	Terminating point	45.16	7.49	4.0763	8.19E-05*
Treatment Gp. 1	Post-test	42.80	7.85		

a = not significant at 0.05; p > 0.05 * = significant at 0.05; p < 0.05

Descriptive statistics components means and standard deviations were computed and used to determine the difference in performance of the Treatment Group 1 in the Post Test and Terminating Point. The mean score for the Post-test was 42.80 (SD=7.85) while that for Terminating Point was 45.16 (*SD* = 7.49).

The means score, standard deviation, t-value and p-value of the entry point and terminating point for Treatment Group 2 were determined. The mean scores, standard deviation, t-value and p-value in the entry point and terminating point of Treatment Group 2 showed significant variations (Table 4).

Table 4: Determination of Significant Differences in the Performance of Treatment Group 2 in Entry point and Terminating Point

Groups Compared	Test	Mean	*SD*	*t* - value	*p* – value
Treatment Gp. 2	Terminating point	47.21	6.18	8.2263	5.86E-11*
Treatment Gp. 2	Entry-point	39.81	5.68		

a = not significant at 0.05; p > 0.05 * = significant at 0.05; p < 0.05

Descriptive statistics components means and standard deviations were computed and used to determine the difference in performance of Treatment Group 2 in the Entry-point and Terminating Point. The mean score for the Entry-point was 39.81 (SD=5.68) while that for Terminating Point was 47.21 (SD = 6.18).

To determine the performance of students‘ in the entry point and terminating point, the means score, standard deviation, t-value and p-value for Treatment Group 2 were determined. The mean scores, standard deviation, t-value and p-value of the performance in the entry point and terminating point in Treatment Group 2 showed significant variations (Table 5).

Table 5: Determination of Significant Differences in the Performance of Treatment Group 2 in Post Test and Terminating Point

Groups Compared	Test	Mean	*SD*	*t* – value	*p* – value
Treatment Gp. 2	Terminating point	47.21	6.18	7.8471	2.16E-10*
Treatment Gp. 2	Post-test	43.56	7.81		

a = not significant at 0.05; p > 0.05 * = significant at 0.05; p < 0.05

Descriptive statistics components means and standard deviations were computed and used to determine the difference in performance of the Treatment Group 2 in the Post-test and Terminating Point. The mean score for the Post-test was 43.56 (SD=7.81) while that for Terminating Point was 47.21 (SD = 6.18).

Testing of Hypothesis with Respect to Research Question One

To determine whether the difference in performance in the pre-intervention and post intervention periods of the treatment groups were statistically significant, research question one was formulated into a null hypothesis and tested.

The hypothesized research question 1:

H_0 *1* There is no significant difference in the students' learning skills and their achievement in digestion?

The first hypothesis sought to indicate that there was no significant difference in over all mean scores achieved by Treatment Groups 1 and 2. Independent-measures t-Test analysis of the entry point test and terminating point and the post-test and terminating point scores of participants in Treatment Group 1 indicated that the difference was statistically significant. The calculated t-value (t = 9.74; p = 1.94E-13) and (t=8.2263; p=5.86E-11) for entry point test and terminating point and the post-test and terminating point respectively.

Independent-measures t-Test analysis of the entry point test and terminating point and the post-test and terminating point scores of participants in Treatment Group 2 indicated that the difference was statistically significant. The calculated t-value (t = 8.2263; p = 5.86E-11) and (t=7.8471; p=2.16E-10) for entry point test and terminating point and the post-test and terminating point respectively.

This means that the achievements in digestion using computer simulations instructional teaching approach and the overall performance in the end of term examination in Treatment Groups 1 and 2 were statistically significant. With this subtle evidence, it was concluded that there was a statistically significant difference in the students‘ learning skills and their achievement in biology. The first null hypothesis ($H_0$1) was therefore rejected.

Analysis with Respect to Research Question Two

4.2 Research Question Two (2)

1. RQ 2: What is the effect computer simulation on students‘ attitude in teaching and learning?

To determine the students‘ attitude towards the use of computer simulation in teaching, students of Treatment Group 1 and 2 were observed and expressed in simple percentages. Results of ―Response to Questions‖ in Treatments Groups 1 and 2 presented in Table 6 show that most students responded to questions during the observed periods.

Table 6: Number of students and Assigned codes (by Coders) on Response to Questions of Treatment Group 1 and 2

CODES	*TRT Grp 1*	Percentage (%)	*TRT Grp 2*	Percentage (%)
1	3	10.00	2	6.67
2	6	20.00	5	16.67
3	2	6.67	1	3.33
4	16	53.33	15	50.00
5	3	10.00	7	23.33

On the students of treatment groups attitude towards response to questions, only 3 students (10.00%) of TRT Grp 1 and 2 (6.67%) of TRT Grp were uninterested whilst 6 students (20.00%) of TRT Group 1 and 5 students (16.67%) of TRT Grp 2 were confused when responding to questions. Two (2) students (6.67%) of TRT Grp 1 and 1 student (3.33%) of TRT Grp 2 looked interested in responding to questions but they never participated. Sixteen (16) students (53.33%) of TRT Grp 1 and 15 students (50.00%) of TRT Grp 2 participated fully whilst 3 students (10.00%) of TRT Grp 1 and 7 students (23.33%) of TRT Grp 2 tried to formulate their own ideas in responding to questions. Majority of the participants 19 (63.33%) and 22 (73.33%) of TRT Grp 1 and 2 respectively exhibited good attitudes by participating fully and formulating their own ideas in responding to questions.

Results of –Questioning" in Treatments Groups 1 and 2 presented in Table 7 show that most students participated in asking questions during the observed periods.

Table 7: Number of students and Assigned codes (by Coders) on Questionings of Treatment Group 1 and 2

CODES	TRT Grp 1	Percentage (%)	TRT Grp 2	Percentage (%)
1	4	13.33	3	10.00
2	6	20.00	5	16.67
3	5	16.67	6	20.00
4	11	36.67	10	33.33
5	4	13.33	6	20.00

Students of the treatment groups attitude towards asking questions showed that, only 4 students (13.33%) of TRT Grp 1 and 3 (10.00%) of TRT Grp 2 where uninterested whilst 6 students (20.00%) of TRT Group 1 and 5 students (16.67%) of TRT Grp 2 were confused when asking questions to seek clarifications. Five (5) students (16.67%) of TRT Grp 1 and 6 students (20.00%) of TRT Grp 2 looked interested in asking questions but they never asked any question. Eleven (11) students (36.67%) of TRT Grp 1 and 10 students (50.00%) of TRT Grp 2 participated fully in asking questions whilst 4 students (13.33%) of TRT Grp 1 and 6 students (20.00%) of TRT Grp 2 formulated their own ideas and asked question to ascertain if their idea is relevant to the objective of the topic. Majority of the participants 15(50.00%) and 16 (53.33%) of TRT Grp 1 and 2 respectively exhibited good attitudes by participating fully and formulating their ideas when asking questions.

Results of "Initiation of talking by Students" in Treatments Groups 1 and 2 presented in Table 8 show that most students participated in talking to seek clarification or communicate his/her understanding to the teacher or a colleague during the observed periods.

Table 8: Number of students and Assigned codes (by Coders) on initiation of talking by students of Treatment Group 1 and 2

CODES	TRT Grp 1	Percentage (%)	TRT Grp 2	Percentage (%)
1	6	20.00	7	23.33
2	-	-	-	-
3	2	6.67	8	26.67
4	22	73.33	15	50.00
5	-	-	-	-

Six (6) students (20.00%) of TRT Grp 1 and 7 students (23.33%) of TRT Grp 2 were uninterested in initiating talking in the class. Two (2) students (6.67%) of TRT Grp 1 and 8 students (26.67%) of TRT Grp 2 looked interested in talking in class but never initiated any talking in class whilst 22 (73.33) and 15 (50.00) students in both TRT Grp 1 and Grp 2 were seen initiating conversation with colleagues, the researcher or the coders.

Results of "Experimentation" in Treatments Groups 1 and 2 presented in Table 9 show that most students participated in Experimentation to communicate their understanding in practical demonstration during the observed periods.

Table 9: Number of students and Assigned codes (by Coders) on Experimentation of Treatment Group 1 and 2

CODES	TRT Grp 1	Percentage (%)	TRT Grp 2	Percentage (%)
1	1	3.33	-	-
2	4	13.33	3	10.00
3	6	20.00	4	13.33
4	14	46.67	17	56.67
5	5	16.67	6	20.00

Only 1students (3.33%) of TRT Grp 1 was uninterested in experimenting his idea(s). Four (4) students (13.33%) of TRT Group 1 and 3 students (10.00%) of TRT Grp 2 were confused in experimentation. Six (6) students (20.00%) of TRT Grp 1 and 4 students (13.33%) of TRT Grp 2 looked interested in doing experiment but they did not take part in the experiment. Fourteen (14) students (46.67%) of TRT Grp 1 and 17 students (56.67%) of TRT Grp 2 participated fully in the experiments whilst 5 students (16.67%) of TRT Grp 1 and 6 students (20.00%) of TRT Grp 2 formulated their new ideas when doing the experiments. Majority of the participants 19 (63.33%) and 23 (76.67%) of TRT Grp 1 and 2 respectively exhibited good attitudes by participating fully and formulating their ideas when doing the experiments.

Results of –Ability to Writes and/or Draws" in Treatments Groups 1 and 2 presented in Table 10 show that most students participated by writing or drawing to communicate their understanding in of the concept during the observed periods.

Table 10: Number of students and Assigned codes (by Coders) on their ability to Writes and/or Draws of Treatment Group 1 and 2

CODES	TRT Grp 1	Percentage (%)	TRT Grp 2	Percentage (%)
1	4	13.33	3	10.00
2	3	10.00	3	10.00
3	7	23.33	4	13.33
4	11	36.67	8	26.67
5	5	16.67	12	40.00

Four (4) students (13.33%) of TRT Grp 1 and 3 students (10.00%) of TRT Grp 2 were uninterested in reading, writing or drawing. Three (3) students (10.00%) of both TRT Group 1 and TRT Grp 2 were confused in explaining their ideas writing or drawing. Seven (23.33%) of TRT Grp 1 and 4 students (13.33%) of TRT Grp 2 looked

interested in at least writing or drawing but they neither wrote nor drew anything. Eleven (11) students (36.67%) of TRT Grp 1 and 8 students (26.67%) of TRT Grp 2 participated fully in representing their ideas in writing and/or drawing whilst 5 students (16.67%) of TRT Grp 1 and 12 students (40.00%) of TRT Grp 2 formulated their new and relevant ideas in writing and/or drawing. Most of the participants 16 (53.33%) and 20 (66.67%) of TRT Grp 1 and 2 respectively showed their interest in the computer simulation instructional approach by participating fully and formulating in writing and/or drawing.

Results of "Non-productive Activities" in Treatments Groups 1 and 2 presented in Table 11 show that few students participated in non-productive activities during the observed periods.

Table 11: Number of students and Assigned codes (by Coders) on their involvement in Non-productive activities of Treatment Group 1 and 2

CODES	TRT Grp 1	Percentage (%)	TRT Grp 2	Percentage (%)
1	24	80.00	21	70.00
2	-	-	-	-
3	2	6.67	5	16.67
4	4	13.33	4	13.33
5	-	-	-	-

On students' involvement in non-productive activities 24 students (80.00%) of TRT Grp 1 and 21 students (70.00%) of TRT Grp 2 were uninterested in in it during the implementation of the intervention. Two (2) students (6.67%) of TRT Grp 1 and 5 students (16.67%) of TRT Grp 2 looked interested in in getting involved but they never got into any non-productive activities. Four (4) students (13.33%) in both TRT

Grp 1 and Grp 2 fully were in involved in non-productive activities such as sleeping, surfing the social media.

Results of –Student-student Interaction" in Treatments Groups 1 and 2 presented in Table 12 show that most students interacted among themselves to communicate their understanding or seek clarification from their colleagues in of the concept during the observed periods

Table 12: Number of students and Assigned codes (by Coders) on student-student interaction of Treatment Group 1 and 2

CODES	TRT Grp 1	Percentage (%)	TRT Grp 2	Percentage (%)
1	9	30.00	2	2.67
2	-	-	-	-
3	6	20.00	4	13.33
4	10	33.33	14	46.67
5	5	16.67	10	33.33

Nine (9) students (30.00%) of TRT Grp 1 and 2 students (2.67%) of TRT Grp 2 were uninterested in interacting with their colleagues to share ideas whilst 6 students (20.00%) of TRT Grp 1 and 4 students (13.33%) of TRT Grp 2 looked interested in interacting with their colleagues but they did not get involved in any observable interaction with their colleagues. Ten (10) students (33.33%) of TRT Grp 1 and 14 students (46.67%) of TRT Grp 2 were visibly seen interacting with their colleagues to share information whilst 5 students (16.67%) of TRT Grp 1 and 10 students (33.33%) of TRT Grp 2 were seen trying to outdo each other in the creation of new ideas.

Testing of Hypothesis with Respect to Research Question Two

To determine whether there is significant difference in the attitudes students exposed to computer simulations instructional approach and those exposed to the traditional

instructional approach in the teaching and learning of biology, research question 2 was formulated into a null hypothesis and tested.

The hypothesized research question 2:

H_02: There is no statistically significant difference in the attitudes of SHS students exposed to the computer simulations instructional approach and those exposed to the traditional instructional approach to the teaching and learning of biology.

The second hypothesis sought to portray that there was no significant difference in the attitudes of SHS students exposed to the computer simulation instructional approach and those exposed to the traditional instructional approach to the teaching and learning of biology. Codes assigned to 30 students in Treatment Groups 1 and 2, were examined and analysed in simple percentages terms. A total of 18 students (60.00%) of TRT Grp 1 and 19 students (63.33%) of TRT Grp 2 showed good attitudes towards responding to questions, questioning, experimentation and putting their ideas in writing and/or drawing by participating and formulating ideas. However, 3 students (10.00%) of TRT Grp 1 and 2 students (6.67%) of TRT Grp 2 showed negative attitudes towards responding to questions, questioning, experimentation and putting their ideas in writing and/or drawing by participating and formulating ideas by remaining uninterested. Whilst 9 students (30) each TRT Grp1 and 2 remain indifferent towards responding to questions, questioning, experimentation and putting their ideas in writing and/or drawing by being confused or interested by not participating.

For involvement in non-productive activities, 24 students (80.00%) of TRT Grp 1 and 21 students of TRT Grp 2 showed good attitude by being uninterested. However, 6 students (20.00%) of TRT Grp 1 and 9 students (30.00%) of TRT Grp 2 showed bad

attitude by being interested in engagement in non-productive activities though only 4 students (13.33%) of both TRT Grp 1 and 2 participated whilst 2 students (6.67%) and 5 students (16.67%) showed interest but never got involved in any non-productive activity(s).

This means that majority of the students exhibited good attitudes towards positive behaviours in teaching and learning of digestion using computer simulation teaching approach. As asserted by Efe and Efe (2011), using computer simulations to teach cell topics helps students to visualise the ways in which cell parts function. It is therefore concluded that student groups taught using computer simulations develop good attitude in the teaching and learning of biology. The second null hypothesis (H_0 2) was therefore rejected.

4.3 Research Question Three (3)

RQ 3: What is the effect of computer simulation use on the performance of students in the concept of digestion?

Descriptive statistics specifically means and standard deviations, were computed and used to determine the differences in performance in the entry point and that of the post-test instrument – SADT of the two experimental groups. The mean score of the entry point for 2 Home Economics 1 was 36.96 (SD = 7.30) while that for 2 Home Economics 2 was 39.81 (SD = 5.68). The mean scores for the two sampled populations after both had been exposed to the computer simulations instructional approach were 42.80 (SD = 7.92) and 43.56 (SD = 7.81) respectively. These results shown in Table 1.0 revealed that all the treatment groups performed better after the implementation of the intervention.

To determine the performance of students' in the entry point and post-test the means score, standard deviation, t-value and p-value for Treatment Group 2 were determined. The mean scores, standard deviation, t-value and p-value of the performance in the entry point and terminating point in Treatment Group 2 showed significant variations (Table 13).

Table 13: Determination of Significant Differences between Treatment Groups 1 and 2 in entry point and post-test

Groups Compared	Test	Mean	*SD*	*t* – value	*p* – value
Treatment Gp. 1	Post-test	42.80	7.92	2.0255	0.0244
	Entry point	36.96	7.30		
Treatment Gp. 2	Post-test	43.56	7.81	2.7834	0.0038*
	Entry point	39.81	5.68		

a = not significant at 0.05; $p > 0.05$ * = significant at 0.05; $p < 0.05$

Testing of Hypothesis with Respect to Research Question Three

To determine whether the difference in performance between the experimental groups and control group were statistically significant, research question three was formulated into a null hypothesis and tested.

The hypothesized research question 3:

Ho3: There is no significant difference in performance of students exposed to the computer simulations instructional approach and those exposed to the traditional instructional approach to the teaching and learning of science**.**

Independent-measures t-test analysis established that there is statistically significant difference in performance between the entry point and the post test results in both Treatment Groups 1 and 2. As established in Table 1 for Treatment Group 1, the calculated t-value (t=2.0255; p=0.0244) and for Treatment Group 2 the calculated t-

value (t=2.7834; p=0.0038). This analysis clearly showed that there is a statistically significant difference in the performance of students when exposed to computer simulation instructional approach and when exposed to the traditional instructional approach in teaching and learning of digestion. This demonstrates that computer simulations instructional approach is imperative in teaching and learning as it enhanced a better understanding of the concept of digestion than the traditional instructional approach. Based on this evidence, it was concluded that there was a statistically significant difference in performance and that computer simulations instructional approach has a positive effect on the performance of students in the teaching and learning of biology. The third null hypothesis (H_0 3) was therefore rejected.

4.4 Discussion of Findings

The study was aimed at finding the effect of computer simulations instructional approach on the performance of SHS 2 Home Economics students in the topic digestion. It produced results that clearly established a link between computer simulation instructional package digestion and students‘ performance at the SHS level. Findings based on the analysed data have been presented earlier in this chapter. Further elaboration of the findings with the related research questions that guided the study have been discussed here.

The results of hypothesis one revealed that there is a significant difference in the performance of students in the entry point and the post-test of both TRT Grp 1 and TRT Grp 2. This established the fact that SHS 2 Home Economics students when exposed to the computer simulations instructional approach performed better than when exposed to the traditional instructional approach to the teaching and learning of

science. These results collaborated with the findings of Rey (2010), Akpan & Strayer (2010), Riess & Mischo (2010) and Wekeba (2006) who found out that computer simulation improves students‘ performance than the traditional teaching method. The findings also agreed with that of Yaki‘s (2006) who asserted that students taught biology using computer simulation instructional models performed better than those taught using traditional teaching methods. The importance of computer simulation is asserted by Alassi and Trollip (1991) who describe simulations in educational context as a powerful technique that teaches about some aspect of the world by imitating or replicating it. The higher performances observed in both TRT Grp 1 and TRT Grp 2 could be attributed to the novel nature of computer simulation in the teaching and learning which captivated the attention of the students.

Findings from the analysis of research question two indicate that, the participants had better attitudes towards good behaviours that enhanced good environment for effective teaching and learning. It can therefore uphold the fact that computer based education is more effective than traditional methods on students‘ attitude. This finding is consistent with previous studies of Akcay, Feyzioglu, & Tuysuz, (2003) which asserts that students prefer learning with computer simulation than other learning procedures; while learning with the computer simulation, they felt challenged to do their best work; with the effort they put into it, they were satisfied with what they learned while learning with the computer simulation. The findings of this research back Yu-Hsin, Ju-Tzu and Deng-Jyi‘s (2012) assertion that with computer simulation instructions model the learning achievement of students with different learning styles shows significant growth.

The results of hypothesis three of the study opposed with the null hypothesis that there is no significant difference in over all mean scores achieved by student groups taught using computer simulations and by methods of lecture in the teaching and learning of digestion. This situation is collaborated by the mean scores and standard deviations performance of the participants in the Entry points and Terminating points of TRT Grp 1 and 2. With the t-Test analysis of Entry point and Terminating point scores of TRT Grp 1(M=39.96; SD=7.22 and M=45.16; SD=7.49 respectively) and that of TRT Grp 2(M=39.81; SD=5.68 and M=47.21;SD=6.18) and the Independent – measures t–Test analysis it was that difference between the means of participants in TRT Grp 1and 2 in the Entry point and Terminating point was statistically significant (t = 9.74; p = 1.94E-13 and t=8.2263; p=5.86E-11). The t-Test analysis of the SADT and the terminating point scores of TRT Grp1 (M=42.80; SD=7.85 and M=45.16; SD=7.49) and that of TRT Grp 2 (M=43.56; SD=7.18 and M=47.21; SD=6.18) and the Independent – measures t– Test analysis indicated that difference between the means of participants in TRT Grp 1 and 2 in the SADT and Terminating point was statistically significant [t = 4.0763; p = 8.19E-05 and t=7.8471; p=2.16E-10].

The differences in the mean scores indicated that the use of computer simulation instructional approach increased students‘ performance. This negates the assertion of Türkmen (n.d) who claimed that students cannot feel the real hands-on experiments experience when computer simulation instructional approach is used in teaching and learning and contradicts the conclusion of Mills (2001). He also asserts that computer simulation instructional approach is perceived as impersonal but only machine by students. However, the analysed data confirms the findings of Hançer and Tüzeman (2008), that computer simulation is more efficient than the traditional methods concerning the increase of academic achievement of pupils.

These findings of this study suggest that with the effective usage of computer simulation in teaching strategy in science education, students‘ performance will improve and that they will develop good attitude towards the teaching and learning of science. It is therefore, concluded that computer simulations instructional packages should be administered in cooperative learning settings to maximize their effects on students‘ achievements

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter of the study discusses the summary of findings and significant ideas, conclusions and educational implications of the study for science teaching and for further studies. In furtherance, the recommendations drawn out of the research study are also discussed here.

5.1 Summary of Findings

The study investigated the effect of computer simulations on students‘ performance among students at the SHS level. It explored the SHS elective biology usage of computer simulation in learning biology specifically digestion in man. Second year Home Economics students in Odorgonno SHS were used for the study. Purposive sampling was used to select the students as the study involved all the students in the classes selected. Self-administered post intervention test, school administered end of term examination and coders assisted observation systematic classroom interaction were used as instruments for the study. The data collected were analyzed using both qualitative and quantitative methods. Descriptive statistics was used to find the extent to which computer simulations affect SHS students‘ performance in teaching and learning biology. Independent samples t-test and simple percentages were used to find the influence that computer simulations have on students‘ performance at the SHS level. The major findings are summarized as follows:

The quantitative analysis of the findings of the research questions using appropriate statistical tools, are reviewed as follows.

Research Question one (1)

The relationship between students' learning skills and their achievement in digestion

The mean difference in the performances of students in the Entry Point and SADT and the Entry Point and Terminating Point respectively in both TRT Grp 1 and TRT Grp 2 were statistically significant. However, the difference in the mean scores of the SADT and Terminating Point was not statistically significant though there was a marginal increase in the mean with respect to the Terminating Point. This shows that students' learning skills has a positive effect on the performances of students. This means it has a positive everlasting effect on students' performance score. This shows that with the use of computer simulations both group of students' developed good learning skills. This resulted in the students' general improved performance. This indicates that computer simulations instructional package has a greater advantage of enhancing students understanding and retention of biological concepts as it develops students learning skills.

Research Question Two (2)

The effect computer simulation on students' attitude in teaching and learning

The findings from the coding in the classroom observation suggest that most students in TRT Grp 1 and TRT Grp 2 support the view that the integration of computer simulation is pedagogically useful in:

1. Generating students' interests in the teaching and learning of science.
2. Appealing to a variety of learning styles of students.
3. The acquisition of basic quick revision skills in science education needed to succeed in further studies.
4. Reducing the rote memorisation and recitation of mnemonics as well as

acronyms in science concept. This then reduces _the chew, pour and forget‘ syndrome among students.

However, not all students developed good attitudes to all the behaviours that were observed. This means computer simulations is not the only panacea in meeting the academic needs of students.

Research Question three (3)

The effect of computer simulation use on the performance of students in the concept of digestion

Results of this study indicated that both TRT Grp 1 and TRT Grp 2 performed better in the SADT than the Entry Point. However, the difference in their performances in the SADT and Entry Point was statistically significant. Conversely, whilst a good number of the low-scoring students improved their performances others showed no improvement. This indicates that the computer simulations instructional package have an overwhelming positive impact on students‘ conceptual understanding of digestion.

5.2 Conclusions

The findings of this study tend to suggest that computer simulations instructional package when efficiently used as a teaching technique could enhance the performance of students as it elicits their interests. The possibility of computer simulation becoming a success however depends on teachers‘ improved competence with the use of computer and its accessories. The post-test and terminating mean scores of the students especially the low achieving students increased tremendously clearly depicting the effectiveness of computer simulations enhancing conceptual and meaningful understanding among all ability.

In furtherance, from the result of this study, it can be concluded that the probability of achieving gender equality in science education, rests largely on the use of an appropriate teaching strategy. Even though the effect of gender on the use of the computer simulation packages in the teaching and learning processes was not an objective of this study. Computer simulation is seen as one perfect technique as the sample population used in the study is made up of over 90% females even though the effect of gender on the use of the computer simulation instructional package in the teaching and learning processes was not an objective of this study. This is because computer simulation brings about concretisation of meaning that promotes conceptual understanding in students with different ability levels which is not limited to any ability level or sex.

5.3 Recommendations

In view of the findings and conclusions drawn in this study, the following recommendations are made:

1. Biology teachers should learn and use computer simulation instructional strategy as a means of assisting their students to improving their performance in biology. Appropriate computer simulations packages should therefore, be developed or adopted for use in the Ghanaian school systems.
2. In view of the immense versatility of computer simulations it should be incorporated into teacher education programmes in order to equip biology student teachers with adequate instructional strategies that could make them effective teachers. Biology teachers should develop their computer competence to put them in a good position to make good use of computer assist instructions in their lesson delivery .

3. Heads of schools and timetable planners in various schools should ensure that biology teachers conduct at least two of the weekly periods in the computer laboratories and use the computers in their lesson deliveries. Schools that do not have computer laboratories should arrange with neighbour schools to use their facility.
4. Curriculum planners and developers should be encouraged to introduce innovative instructional strategies, including computer simulations instructional approach in the elective biology course to enforce biology teachers to incorporate computer simulations packages in their lesson delivery to motivate students in order to enhance students‘ performance in biology.
5. The Ministry of Education (MoE), GES, Teacher Unions, GAST, NGOs and all other stakeholders involved in science education should organise regular workshops and in-service training sessions for biology teachers on the effective use of computer simulations instructional packages to improve teaching and learning of biology.

5.4 Suggestions for Further Studies

The educational implications of the findings of this study calls for further research in the area of pedagogical integration and enforcement of computer simulations in all biology concepts at the SHS level. The following are recommended for further research:

1 It is suggested that the study be replicated using computer simulations instructional packages on other challenging biology concepts, such as, krebs cycle, glycolysis, nervous system, genetic, endocrine system water transport in plants, protein synthesis, etc.

2 Additionally, it is suggested that the study be replicated with samples being Elective Science students to provide a basis for more generalisation of the conclusions drawn from the findings of the study about the effectiveness of computer simulations instructional packages in the teaching and learning of digestion.

3 Similar studies should be conducted using content analysis to investigate the effect of computer simulations in teacher education programmes in Ghana especially, those offering the sciences to verify if they duly suit all levels of the sciences instruction.

4 Finally, similar empirical studies should be carried out on the use of computer simulations instructional packages on other science subjects and at different levels of science education to provide sound basis for the integration of computer simulations instructional packages in science education in Ghanaian schools.

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APPENDIX A

UNIVERSITY OF EDUCATION, WINNEBA

SCIENCE EDUCATION DEPARTMENT

POSTTEST DATA COLLECTING INSTRUMENT - STUDENTS'

ACHIEVEMENT IN DIGESTION TEST (SADT)

Name of Participant: ……..

Gender of Participant: …… Class of Participant: ……..…...

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

SECTION A

MULTIPLE CHOICE QUESTIONS

INSTRUCTIONS: The following questions are followed by four (4) options lettered A to D**.**

1. All of the following are organs of the digestive system except the
   - A) Liver
   - B) Duodenum
   - C) Mouth
   - D) Stomach
2. Which term describes the wave of muscular contraction that moves material through the Oesophagus?
   - A) Segmentation
   - B) Pendular motility
   - C) Peristalsis
   - D) Haustral churning

3. Which digestive organ mechanically and chemically transforms a food bolus into chyme?
   A) Oesophagus
   B) Stomach
   C) Small intestine
   D) Large intestine

4. Production of bile is one of several important functions of the
   A) Gallbladder
   B) Liver
   C) Pancreas
   D) Small intestine

5. Which sequence lists the regions of the large intestine in order, from the end of the ileum to the anus?
   A) Ceacum, rectum, anal canal, colon
   B) Colon, rectum, anal canal, cecum
   C) Ceacum, colon, rectum, anal canal
   D) Colon, cecum, rectum, anal canal

6. Where does most nutrient absorption occur?
   A) In the stomach
   B) In the duodenum
   C) In the jejunum
   D) In the ileum

7. The hormones produced by the cells of the intestinal glands include
   A) Biliverdin and bilirubin
   B) Secretin and cholecystokinin
   C) Enterokinase and aminopeptidase
   D) Pepsinogen and gastrin

8. The villi in the small intestine provide
   A) Increased surface area for the absorption of nutrient molecules
   B) Attachments for mesenteries suspended from the dorsal body wall
   C) Initiation of enterogastric reflexes that accelerate digestion
   D) Intestinal contractions that churn and swirl the intestinal chime

9. In which of the following does the process of deamination occur?

A) Kidney

B) Pancreas

C) Spleen

D) Liver

10. Which one of the following processes refers to the breaking up of lipids into droplets?

A) Assimilation

B) Absorption

C) Deamination

D) Peristalsis

SECTION B

INSTRUCTION: The following statements are either True or False. State whether each of the statements is TRUE or FALSE. Write True or False to indicate your answer in the space provided.

11. Production of bile is one of several important functions of the gallbladder (……)

12. Any enzyme can digest any food substance (……)

13. Liver is not an accessory organ in digestion (……..)

14. Digestion ends in the small intestines (……)

15. The gastric juice also contains an acid (……)

SECTION C

INSTRUCTION: Each question has a blank space. Fill in the blank space with the correct answer.

16. …… is the movement of digestion products, electrolytes, vitamins, and water across the digestive tract epithelium and into the underlying blood and lymphatic vessels
17. Bile is stored in the ……..…… in concentrated form
18. The digestive fluids that mix with chyme in the stomach are secreted by……
19. The enzyme responsible for digestion of protein are …… and ……..
20. The alkaline constituent pancreatic juice is……

SECTION D

ESSAY QUESTIONS

INSTRUCTION: Answer all questions. Write the correct answers on the sheet provided. Be precise in your answer.

21. Name **three** organs of the digestive system.

22. Mention **thre**e characteristics of enzymes.

23. State **two** benefits of including fibre (roughage) in the diet.

24. (i) In correct order, list **three** enzymes that digest the three macronutrients

(ii) Can one survive on a diet which contained no carbohydrate?

25. (i) State **three** adaptive features of the villus.

(ii) List the end products of digestion of lipids.

APPENDIX B

MARKING GUIDE FOR POSTTEST (SAPT) ITEMS

SECTION A

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

1×10=10 marks

SECTION B

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

1×5=5 marks

SECTION C

16. Absorption

17. Gall bladder

18. Stomach walls

19. Trypsin and Pepsin

20. NaOH

1×5=5 marks

SECTION D

21. Buccal cavity (mouth), Oesophagus, stomach, small intestine and large intestine.

Any 3×1=3 marks

22.

- Enzymes speed up chemical reactions
- Enzymes are required in minute amounts
- Enzymes are specific
- Reversible — can catalyse the reaction in both directions
- Denatured by high temperature and change in pH
- Rate of action affected by temperature and pH

Any 3×1=3 marks

23.

- Helps in weight management
- Lowers cholesterol levels
- Helps to control blood sugar level
- Promotes a healthier bowel function

Any 2×2=4 marks

24. (i)

Macronutrient	**Digestive Enzyme**
Carbohydrate	Amylase
Protein	Protease
Lipid	Lipase

$^1/_2$×3= 1$^1/_2$ marks **$^1/_2$×3= 1$^1/_2$ marks**

NOTE: Macronutrient and specific enzyme must match to score 1 mark. If macronutrient is right but enzyme is wrong score ½ mark for macronutrient.

(ii) It is possible since the will utilize protein and fats as a source of energy. However, this can lead to long-term complications and increased mortality from diseases of the heart, kidney, gastrointestinal tract, e.t.c.

2 marks

25. (i)

- It has a large surface area, for efficient organ of absorption.
- It has a good blood supply for easy transportation of after absorbed food.
- The walls of the villus is thin for efficient diffusion of end product of digestion
- Presence of lacteal in the villus for the transport of glycerol and fatty acids- towards the blood system.

Any 3×1= 3 marks

(ii) Fatty acids and glycerol.

2×1= 3 marks