UNIVERSITY OF EDUCATION, WINNEBA

EFFECT OF COMPUTER SIMULATION ON JHS TWO STUDENTS' PERFORMANCE IN SCIENCE IN UNIVERSITY PRACTICE SCHOOL, WINNEBA

CHRISTINE DODOO

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A Thesis in the Department of SCIENCE EDUCATION, Faculty of SCIENCE EDUCATION, Submitted to the School of Graduate Studies, University of Education, Winneba in Partial Fulfillment of the Requirements for Award of the Master of Philosophy (SCIENCE EDUCATION) Degree.

JULY, 2015

DECLARATION

STUDENTS' DECLARATION

I, CHRISTINE DODOO, declare that this thesis, with exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another master degree elsewhere.

SIGNATURE ……………………………

DATE ……………………………….

SUPERVISORS' DECLARATION

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

NAME OF SUPERVISOR: Prof. K.D Taale

SIGNATURE:………………………………………

DATE……………………………..

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DEDICATION

I dedicate this piece of work to my lovely mother, Lilian Esinu Apau for her support throughout the writing of this thesis. Also to my children Belinda, Richard, Bernadine and their father Dr. Yao Yekple for enduring my absence during my study times on campus.

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ABSTRACT

Students in University Practice North Campus JHS in Effutu Municipal were not motivated by the methods of teaching adopted by their Integrated Science teachers. This study therefore exploited the use of computer simulation to improve upon teaching and learning of Integrated Science among students. It was an Action Research where quasi-experimental design was adopted. Three research questions were raised to direct the study. The sample size of eighty-eight (88) was made up of all JHS 2 students of University Practice North Campus School. Convenience sampling technique was adopted in the selection of the students to form the sample for the study. Five class tests, an observational checklist and opinionnaire were used for data collection. The descriptive statistical method was used in data analysis. It was found out that students performed poorly in Integrated Science when they were taught lessons using traditional method and they also had negative attitude towards teaching and learning of Integrated Science when traditional method was used to teach them. The results revealed that, students understood the selected topics better when they were taught lessons using computer simulations. The study revealed further that the use of the computer simulation had improved students' performance and enhanced their attitude in teaching and learning of Integrated Science. The implication for teaching and learning was that computer simulation support system made science classroom more realistic as students were actively involved; since students observed things in their natural forms. Therefore Integrated Science teachers should be equipped with the ICT skills to enable them to use computer simulations to teach more topics in Integrated Science. This would enhance teaching and learning of Integrated Science at the JHS level.

CHAPTER ONE

INTRODUCTION

1.1. Overview

This chapter covers background to the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the study, limitations, delimitations, operational definition of terms and general layout of the report.

1.2. Background to the Study

Integration of Information and Communication Technology (ICT) in education has been an important concern in many countries, most especially, developing countries as it brings about development in those countries. Ghana as a developing country is also making frantic efforts by making ICT a core subject in the school curriculum to improve upon teaching and learning at all levels of education and to equip students with the necessary skills in ICT for national development. The inclusion of ICT in the school curriculum is also geared towards the improvement on the teaching and learning of science at all levels of education. This was evident in the year 1995 when the Ministry of Education and the Ghana Education Service established the Science Resource Center Projects in one hundred and ten (110) Senior Secondary Schools spread throughout the country (GES, 2004). These centers were well stocked with equipment and apparatus in order to enhance the teaching and learning of science in these schools as well as satellite schools around them. Through empowering of science teachers (In-service Training), syllabus for teaching science at all levels had undergone so many reviews in order to improve upon its teaching and learning contents and to motivate students in learning science.

The integration of ICT into education has been assumed as the potential of the new technological tools to revolutionise an outmoded educational system. Anderson and Weert (2002) attested to the fact that ICT plays a critical role in improving educational systems in many countries. In these countries, stakeholders in educational policy redesigned and reconstructed their educational systems based on the new educational paradigms so that both teachers and students develop the necessary knowledge and skills in this digital age. Hence, most countries around the world are focusing on approaches to integrate ICT in teaching and learning to improve on the quality of education (Anderson & Weert, 2002).

According to Acquah (2013), in Ghana, students' dismal performances at both basic and secondary level in science have been a great source of concern to parents and stakeholders in education. Many factors like general lack of interest in the subject by both teachers and students and inadequate teacher preparation (Djangmah, 2010 ; Osei- Kwabena, 2011) and inappropriate teaching methods (Little, 2010) among others, have been blamed for students' poor performance in basic school science (Ogunmade, 2005; Ampiah, 2010).

There are so many methods of teaching science in schools. There is the traditional method which involves the use of models, charts, diagrams, and handling of objects. According to Little (2010), the traditional approach to teaching subjects especially science becomes unmotivational to many students which leads to their development of negative attitudes toward science. There is also the technological method which includes computer simulations.

Simulation is the use of a powerful tool, the computer, to emulate or replicate an object in a real or imagined world. Many potential benefits have been claimed for the use of computer simulation in teaching science. For instance, Akpan and Andre (1999) stated that computer simulation, as with any technology, has ultimate objective of enhancing learning in the classroom. It is against this background that, the researcher deems it important to find out how the use of computer simulation can help to improve students' performance and attitudes in learning of selected topics in integrated science in University Practice North Campus Junior High School in the Effutu Municipality.

1.2. Statement of the Problem

In science education, classroom simulations provide an opportunity to apply the scientific method to the solution of problems by providing learners with a rich and variable learning environment in which they can master skills and content, develop understanding of concepts, inquire, explore various cause-and- effect relationships, develop strategic thinking, and quickly test multiple hypotheses (Hsu & Thomas, 2002). Similarly, as suggested by Coburn, Kelman, and Weiner (2011) simulation offers a bridge between concrete and abstract reasoning. According to Shaw, Okey and Waugh(2000), simulations provide a realistic cause-and-effect environment in which students can quickly, safely, and efficiently investigate to learn.

Even though much effort has been made to improve upon the teaching and learning of science in schools, it seems there is still more room for improvement and advancement.

Anamuah-Mensah, Mereku and Ghartey-Ampiah (2007) reported that performance in science at JHS 2 level in Ghana remains among the lowest in Africa and the world. Students in JHS are not motivated by the traditional methods of teaching adopted by their Integrated Science teachers. Personal interaction with some JHS two students revealed that when teachers use charts, models, and diagrams to explain some concepts in science, such as photosynthesis, blood circulation, digestion, and respiration in humans, they seem not to understand them well. Some even said they wish to see for example how blood actually flows in the body of humans. Other students also were of the view that they were tired of looking on charts from chalkboards and sitting down for long time reading information from fat books. This seems to support the fact that teachers in the Effutu Municipality in the Central Region of Ghana especially teachers at the Junior High Schools continue to use the traditional methods of teaching science which involve chalk and talk method. For example, the use of charts and diagrams on chalkboards and trying to explain them. Most teachers also resort to show and tell method of teaching science which involves showing models and giving explanations of how such models work. However, this method of teaching employed by teachers seems to make the teaching and learning of science at times boring to both teachers and learners. This also appears to minimise students' understanding of some science concepts. Furthermore, students are denied relevant aspects of science that are most fun and interesting, and many of them think of science as a body of knowledge that is difficult to understand. Majority of them therefore, prefer using computers for their lessons which is an indication that most science teachers ignore the use of computers to teach some relevant aspects of science despite its potential benefits in teaching and learning hence students' lack of interest in the subject and this seems to bring about poor performance in the subject. ICT facilities in schools can therefore be exploited to improve upon teaching and learning of Integrated Science in schools.

1.4. Purpose of the Study

This study was used to determine the effects of computer simulations on JHS two students' performance and attitude during the teaching of selected topics in Integrated Science at the University Practice School, North Campus.

1.5. Objectives of the Study

The objectives of the study were to:

1. Examine the extent to which computer simulation enhances JHS two students' understanding of some selected topics in integrated science.
2. Improve upon JHS two students' attitude towards the learning of selected topics in integrated science.
3. Assess students' performance by using computer simulation to teach some selected topics in integrated science to JHS two students in University Practice North Campus Junior High School, Winneba.

1.6. Research Questions

The following research questions were raised to guide the study:

1. How does computer simulation enhance students' understanding of some selected concepts in Integrated Science?

2. In what ways will the use of computer simulations in teaching selected topics improve upon Junior High School two students' attitude towards the learning of selected topics in Integrated Science?
3. How will the use of computer simulation influence JHS 2 students' performance in selected topics in integrated Science?

1.7. Significance of the Study

The results of this study helped to identify how the use of computer simulation enhanced JHS two students' clearer understanding of selected concepts in integrated science in University Practice Junior High School, Winneba. This will enable the school system to encourage its use in teaching other contents in the school curriculum. Also the results of the study helped to identify how the use of computer simulation in teaching selected topics in integrated science to JHS 2 students influenced their performances in integrated science. This will enable the school authorities to organise in-service training for integrated science teachers in the Schools to equip them with skills for the use of computer simulation in teaching concepts in integrated science in the school.

Additionally, the results of the study also brought to light how the use of computer simulations in teaching selected topics improved upon JHS two students' attitude in learning integrated science in University Practice School, Winneba. This would also enable the school authorities to give some form of in-service training to integrated science teachers in the school on the use of computers to improve their method of teaching.

Finally, the results of the study would add to existing literature on computer stimulation for other researchers interested in similar issues in education.

1.8 Limitation of the Study

Students were asked to write their opinions on the simulation lessons at the end of the study. However, students should have been interviewed in order to get more information from them.

1.9. Delimitations of the Study

This study focused on only JHS two students of University Practice North Campus School because it is an Action Research with an attention to a particular class where that specific problem is identified. Moreover, JHS two students are in transition to form three and they are considered because the topics such as the circulatory system, respiratory system, digestive system, photosynthesis among others, are found in their syllabus (Curriculum Research and Development Division, 2012).

1.10. General Layout of the Report

The research work is organised in five chapters. Chapter one is the Introduction which covers the background of the study, the statement of the problem, purpose of the study, the objectives of the study, research questions, significance of the study, limitations of the study, delimitations of the study and operational definition of terms. Chapter two covers the Literature Reviewed for the study. Chapter three covers the Methodology which includes: the population, sample size, sampling techniques, instrumentation, procedure for data collection and data analysis. Chapter four deals with the Results, Findings and Discussion of results of the study and chapter five covers the Summary, Conclusion and Recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1. Overview

This chapter presents the literature reviewed for the study. The review first covered the theoretical frame work, the conceptual framework and followed by the review on the key themes raised in the research questions such as:

- Ways in which the use of computer simulation enhances students' understanding of concepts in integrated science.
- The use of computer simulations in teaching and learning of science to improve upon students' attitudes in learning integrated science.
- Ways in which the use of computer simulation in teaching science influence the performances of students.

Theoretical Framework

The theoretical framework is based on activity based learning theory. John Dewey is viewed by many educational philosophers as the initiator and promoter of activity-based learning in the early part of 20th century (Prawat, 2000). According to Prawat (2000), Dewey was advocating this approach in learning pertaining to children and the key to the activity-based approach is the learner's engagement in situations that appeal to their curiosity and interest. According to Tilya (2003) activity-based or hands-on learning is defined in a variety of ways expressing relatively similar meanings. Lumpe and Oliver (1991, p.345) defined activity based science as "any science lab activity that allows the pupil to handle, manipulate or observe a scientific process". Activity based learning (ABL) theory is a cognitive learning theory which is considered as constructivist learning theory (Hein, 1990). Activity-based learning (ABL) as defined by Prince (2004) is a learning method in which students are engaged in the learning processes. Geller and Dios (1998) viewed activity-based/hands-on learning as any activity oriented toward instructional techniques/methods that enhance learning and comprehension, with an emphasis on learning by doing. Suydam, Marilyn and Higgins (1977) also defined activity –based learning as the learning process in which student is actively involved in doing or in seeing something done. In Activity-based learning (ABL) teaching method, as stated by Prince (2004) students actively participate in the learning experience rather than sit as passive listeners. According to Edward (2001), learning activities if based on 'real life experience' help learners to transform knowledge or information into their personal knowledge which they can apply in different situations. Prince (2004) is of the view that, active learning method is different from traditional method of teaching on two points. First, active role of students and second, collaboration among students. According to Churchill (2003), ABL helps learners to construct mental models that allow for 'higher-order' performance such as applied problem solving and transfer of information and skills.

In ABL the learner examines learning requirements and thinks how to solve a problem in hand. The students do not learn about the content. Rather they learn about the process to solve the problem. As they go towards the solution of the problem, they also learn about the content (Churchill, 2003). According to Stoblein (2009), activity based learning is a successful teaching model in the field of medicine, engineering and science but it has recently found its way to business schools. He further posits that, at its core, this approach provides a way to integrate learning within students' knowledge and by exposing them to a variety of activities, helps them learn how to learn. He again stated that, due to the high degree of interaction in ABL, essential instructor skills involve facilitating, motivation, enabling and coaching rather than simply presenting facts and figures didactically. Cohen (1990) spelt out that, the success of ABL is to make students feel responsible for their learning and support their own individual development.

Based on the deduction made from the activity-based approach to learning, learners are active participants with the goal being to bring them into the process of their education. Activity-based learning takes students beyond the role of passive listener and note taker and allows them to take some direction and initiative during the class. It engages them in in-depth investigations with objects, materials, phenomena, and ideas and allows them to draw meaning and understanding from those experiences. It has the potential to enable students to become critical thinkers, to apply both what they have learned and the process of learning to various life situations. Tilya (2003) supported the fact that, Science activity-based learning can then be any educational experience that actively involves students in manipulating objects or ideas to gain knowledge or understanding. In this study activity based learning is considered to be any student-centered, experiential approach to science education that focuses on science inquiry in a cooperative, problem solving learning environment.

Beichner (1995) argued that, when the activities involved using computer technology, thorough software integration into the instruction is a must, as it enables teachers to supply a variety of ways for students to become involved with content, essentially establishing an environment for learning. The more hands-on experience and mentally engaging tasks presented to students, the better they grasp the material.

2.3. Conceptual Framework

In educational preparation of JHS Two students of University Practice North-Campus Junior High School, Winneba by using computer simulation to improve upon their learning and to enable them develop good attitudes (interest and motivation), there are certain concepts that help in how they link to achieve these benefits. These concepts are computer simulations and activity based learning. According to Tilya (2003), the reality simulated could be natural, man-made or imaginary. By manipulating variables of the representations and studying the effects, students can gain a better understanding of the complex system represented by the variables. Simulations can aid visualisation of abstract ideas. Driver and Scanlon (1988) and Linn and Hsi (2000) contend that simulations aid students in explicit reasoning and in visualising the consequences of their thinking. The visualisation can occur in individual or group settings.

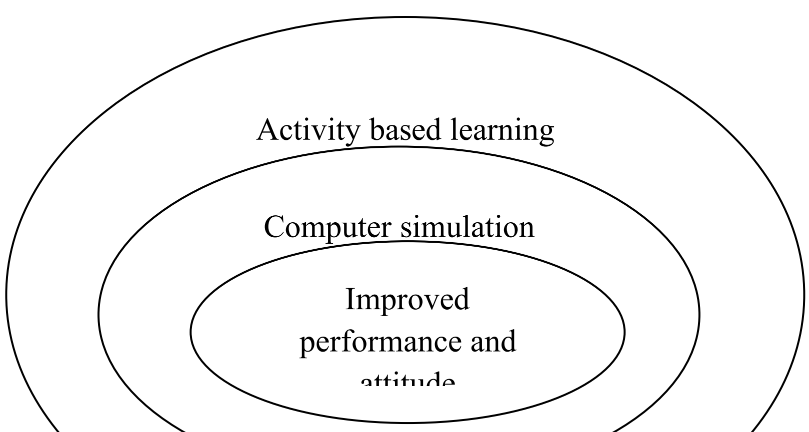

Figure 1: Diagrammatic Representation of Conceptual Framework

Figure 1 shows the conceptual framework for the study. In the diagram, activity based learning which is a broad method of teaching is and learning involves putting the learner at the center of the learning process. This means students' participate actively in the learning process with the goal to bring them into the process of their education. Varieties of such activities that can be performed by students are to handle, manipulate or observe a scientific process. The observation of the scientific process can be through computer simulations. The computer simulation is the learning tool derived from software. Its use can stimulate and enable students at any level of education develop a clearer understanding of certain concepts such as digestion of food in humans, circulation of blood in humans among others. A clearer understanding of concepts through computer simulations therefore leads to students' improved performances and positive attitudes as prerequisites for the study of integrated science.

2.4. Enhancement of Computer Simulation on students' understanding of Concepts in Science.

Traditional instruction can be successfully enhanced by using computer simulations. An effective way of using simulations is as preparation for laboratory activities since improved visualizations do not necessarily translate into better learning. In most researches, the impact of classroom scenarios and teacher guidance are ignored. Computer simulations have become a useful part of teaching science and particularly in developing understanding of concepts in science. Simulation of a system therefore, represents the running of the system's model which can be used to explore and gain new insights into new concepts or perspectives and to make it easy for the understanding of learners (Michael, 2000).

Lee (1999) defined computer simulations as interactive software programmes in which individuals explore new situations and complex relationships of dynamic variables that model real life. Simulations can be categorized into various types depending on the school of thought. Alessi and Trollip (1999) described simulations in educational context that, a simulation is a powerful technique that teaches about some aspect of the world by imitating or replicating it. 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. Alessi and Trollip (1999) categorised simulations into the following four different types: physical simulation, procedural simulation, situational simulation, and process simulation. These are explained as follows:

Physical simulation

This is where a physical object, such as a frog, is displayed on the computer screen, giving the student an opportunity to dissect it and learn about it, or when a student is learning how to operate a piece of laboratory apparatus which might be used in an experiment. In Physical simulation, each programme has an underlying computer model of a system (a city, the earth, a farm, an electronic circuit, a microprocessor etc). For example, circuits for physical science show children how to build and understand electrical parts. The programme offers students the opportunity to study various types of circuits and gives them instructions so they can explore the effects of manipulating portions of these circuits.

Procedural simulation

This occurs when a simulated machine operates so that the student learns the skills and actions needed to operate it; or when the student follows procedures to determine a solution, as when a student is asked to diagnose a patient's disease and prescribe appropriate treatment. That is procedural simulations teach a sequence of actions to accomplish some goal. Procedural simulation typically contain simulated physical object. However, the simulation of the physical object is necessary to meet a procedural requirement that is to allow engagement in the procedure. For example it allows learner dissect frogs and perform other experiments.

Situational simulation

Situational simulation is a special type of procedural simulations. Learners are encouraged to explore alternatives and see their effects. This normally gives the student the chance to explore the effects of different methods to a situation, or to play different roles in it. Usually in situational simulations, the student is always part and parcel of the simulation, taking one of the major assigned roles. Situational simulation deals with behaviours and attitudes of people or organizations in different situations rather than with skilled performance.

Process simulation

It is also called iterative or block simulation. It is similar to the physical simulation but instead of continuously manipulating the simulation, the learner runs the simulation over and over, selecting values for various parameters and observing the phenomenon that occurs without intervention. Process simulation is different from other simulations in that the student neither acts as a participant (as in situational simulations) nor constantly manipulates the simulation (as in physical or procedural simulations) but instead, selects values of various parameters at the onset and then watches the process to occur without intervention. Furthermore, in process simulation time is not included as a variable. That is whether the real phenomenon occurs very quickly or very slowly, the learner manipulates parameters, runs the simulation and sees the immediate results. For example, an introductory genetics simulation on the mating of cats selected by colour, pattern and tail presence.

Additionally, Gredler (1992) also categorised simulations into two different types. These are experiential simulations, the first category which provide students with a psychological reality in which students play roles within that reality by executing their responsibilities and carrying out complex problem-solving in that knowledge domain. Experiential simulations are intended to assist students in situations that are either too expensive or too dangerous to experience in a real world. Four major types of experiential simulations are data management, diagnostic, crisis management, and social-process simulations (Gredler, 1992). According to Gredler (1992), experiential simulations are assumed to provide opportunities for students to develop their cognitive strategies because the exercises require that students organize and manage their own thinking and learning. A second type of simulation is a symbolic simulation, which is dynamic in nature and represents the behaviour of a system, or phenomena, on a set of interacting processes. The students' role in symbolic simulation is that of principal investigator as students construct their own learning experiences.

2.5. Advantages of using Computer Simulations

The ever-increasing technological opportunities allow teachers today to teach in a way that was once hard to imagine but how does this technology affect students' understanding? There is a general consensus among researchers about the advantages of technology, especially in science. Technology in science offers benefits for inquiry-based learning, providing support for communication and expression and the ability to present interaction with information in a variety of formats (Kozma, 1999).

In an evaluation of technology use in project-based learning, one group of researchers (Blumenfeld, 1994) named six contributions that technology can make to the learning process:

(1) Providing access to information

(2) Allowing active, manipulative representations

(3) Enhancing interest and motivations

(4) Diagnosing and correcting errors

(5) Structuring the process with tactical and strategic support

(6) Managing complexity and aiding production.

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. In their description, Alessi and Trollip (1999) emphasised on that a simulation simplifies reality by omitting or changing detail. This point of view goes back to Sahin (2006) who claimed simulations as an instructional tool used to eliminate undesirable components of real situations in order to reach predetermined learning outcomes. According to Grabe and Grabe (1996), simplification allows learners to focus on critical information or skills and make learning easier. This perspective for the use of simulations is very appropriate for accomplishing simplified behavioural and cognitive tasks. On the other hand, scholars from constructivist pedagogy described educational simulations as a simulated real life scenario displayed on the computer (Wilson, Jonassen, & Cole, 1993), in which the student plays an authentic role carrying out complex tasks (Harper, Squires, & McDougall, 2000). From this point of view, simulations should reflect the complexity of the real life so that students struggle and learn higher order cognitive skills such as inquiry, which is viewed as essential for science learning (Sahin, 2006). These simulations take learners in such an environment that they conduct several integrated tasks so that they learn complex skills in authentic problems or inquiries such as the Nardoo, and BioWorld (Lajoie, Lavigne, Guerrera & Munsie, 2001)

Computer simulations addressed many of the factors recognised as influencing student attitudes in science, such as motivation, cooperative learning, hands-on activities and students' involvement in learning. Through simulations, students are given responsibility over their own learning and are provided with an interactive learning experience, allowing them to visualise problems and solutions (Zacharias, 2003). In addition to positively influencing student attitudes toward science, simulations can aid in students' understanding of abstract concepts. Lee (1999) agreed that because of their ability to present dynamic information and to visualize complex concepts, simulations are among those types of computer applications that educators view as especially promising for the learning of complex scenarios, problem-solving tasks, and the study of phenomena that are not visible to the human eye. While the amount of research studies on use of technology in education is astounding, current research into computer simulations in science is tailored to specific programmes and disciplines.

A review of recent studies of computer simulation usage shows cautious optimism and unlimited potential. Roschelle (2000) compiled a number of isolated computer simulation studies from individual classrooms and schools, using these studies to inform their work about how students' learning is changing as a result of computer-based technologies. The researcher once again addressed the similarities between what has been proven successful in traditional instruction (immediate feedback, high student engagement, connections to real-world contexts) and what is provided through computer simulations (Roschelle, 2000). Most involved in educational reform agreed that students should be actively engaged in the learning progress (Roschelle, 2000) and new curricula holds students accountable for analyzing information, communicating effectively and designing solutions.

Roschelle (2000) argues that computer-based technologies are extremely useful for this type of learning, pointing to the use of science programme "Microcomputer-Based Laboratory" which allows students to instantaneously graph data and observe the results of their experiment, instead of spending time gathering data and plotting points on a graph, students can immediately start interpreting their results. Computer simulations also allow for immediate feedback and interaction, something that is not always possible in the traditional classroom setting. Roschelle (2000) points out three ways computer simulations support the need for feedback: (1) providing immediate feedback and interaction for students, (2) engaging students so that the teacher can work with other students (3) analyzing student performance and providing targeted instruction. Simulations are now being used in science classes to help students understand scientific concepts, not simply how to solve a calculation.

Research has shown that simulations, especially the visualisation and interactions involved, have helped students grasp more abstract and complex concepts (Leonard, 1992). Trundle (2010) stated that classroom teachers do not always have time to do nature-based instruction, in this case, computer simulations allow teachers to speed up instruction, which means students gather the same amount of data in a shorter period of time. It is faster, easier and much less frustrating. Technology can help students learn and understand scientific concepts in a way that may be easier for teachers and just as effective for students.

The pursuit of computer simulations in an educational context is worthwhile for several reasons. Simulations potentially offer students opportunities to explore physical or biological situations that may be impossible, too expensive, difficult, or time-consuming to accomplish with actual laboratory or real-life experiences. Even if real-life exploration is feasible, such experimentation can be supplemented by simulations that offer students the opportunity to explore a wider range of variables more rapidly. Such simulated experiences potentially can be used to confront alternative conceptions, produce disequilibration and with appropriate scaffold instruction, lead students to a new accommodation (Piaget, 1983). In addition to being safe, convenient and controllable, simulations may encourage students to participate actively in learning activities.

> Huppert, Yaakobi, and Lazarovvitz (1998) have noted that "in computer simulations, students have opportunities to receive supplemental contact with the variables tested in real experiences or dangerous ones. Students can be active during the simulated experiments by identifying the study problem, writing in their notebooks their hypotheses, planning and performing the simulated experiments, gathering results, recording data in their notebooks, plotting these data back in the computer, and using the data for drawing tables and graphs." (p. 232).

River and Vockell (1987) also found in their study that computer simulations enhanced students' active involvement in the learning process, and facilitated their practice and mastery of concepts and principles; clearly computer simulation helped students to meet their learning objectives or goals. Michael (2000) pointed out that simulation programmes such as Electronic Workbench, Lego CAD, and Car Builder are helping students learn about events, processes and activities that either replicate or mimic the real world.

According to Michael (2000), computer simulation can afford learners numerous advantages. For example, computer simulations can (1) provide the students with the opportunity to engage in activities that may otherwise be unattainable, (2) enhance academic performance and the learning achievement levels of students and (3) be equally as effective as real-life hands-on laboratory experiences. Dickerson, Huang and Russell (2001) conducted a study to examine the use of computer simulations as a pedagogical tool for teaching computer science with the emphasis that, simulations should be used across the curriculum rather than only in isolated instances. They discussed some advantages of using simulations as follows:

1. Students can gain a better understanding of the underlying concepts of a system, task, or algorithm by studying it through simulation. For example, one of the best ways for one to really understand an algorithm is to implement it. In building a simulation for some computational process, students are pushed to think at the level of individual steps and specific parameters. This helps ensure that they recognize and understand not only the overall concepts but also the subtle details of the algorithm or computational process.

2. Computer simulations often provide a useful abstraction of the components of a system. The parts of a large system interact with each other in many ways. A student trying to understand the workings of the whole system can easily get confused following the myriad, often implementation-specific relationships among components. Simulations can be beneficial by facilitating focused examination of individual parts. As students learn the specific roles of individual parts, they become better prepared to grasp how those parts come together.

3. Existing simulations help students gain a better sense of how systems operate. Any large system will probably have a number of parameter variables that influence its operation. Students running simulations can test how different input parameters affect the system's performance. Furthermore, they can usually run these simulations at their own pace. This allows them to see the effect of each step and to spend more time on steps that are less clear.

4. Computer simulations are themselves used in many important real world applications. Some examples include the modeling and predicting of: weather conditions, chemical reactions, vehicle dynamics, biological processes, and economic systems. "In addition to imitating processes to see how they behave under different conditions, simulations are also used to test new theories.

Computer simulated instruction gives students the opportunity to observe a real world experience and interact with it. In science classrooms, simulation can play an important role in creating virtual experiments and inquiry. Problem based simulations allow students to monitor experiments, test new models and improve their intuitive understanding of complex phenomena (Alessi & Trollip, 1999). Simulations are also potentially useful for stimulating labs that are impractical, expensive, impossible, or too dangerous to run (Strauss & Kinzie, 1994). Simulations can contribute to conceptual change (Windthil, 2000); provide open-ended experiences for students (Lio & Bright, 1991); provide tools for scientific inquiry (Mintz, 2001) and problem-solving experiences (Woodward, Carnine & Gersten, 2004). An appropriate way for simulations in science education is to use them as a supplementary material (Edelson, 1999). Trundle (2010) examined the benefits of computer simulations in a first-year general chemistry course. He found that the combination of simulations and laboratory offers advantages in time so that the laboratory portion can be reduced in length and students using the simulations have a slightly better knowledge of the practical aspects directly related to laboratory work.

Additionally, in some situations, simulations are the only tools to use like experimenting with dangerous objects. According to Mintz (2001), computerized simulation as an inquiry tool, one of the most promising computer applications in science instruction is the use of simulations for teaching material, which cannot be taught by conventional laboratory experimentation but can a simulation be as effective as a conventional laboratory or replace it? The answer would be that it depends on the concept or the situation. Gordin and Pea (1996) compared the effectiveness of computer-simulated experiences with hands-on laboratory experiences for teaching the concept of volume displacement to Junior High School students. They found that computer simulated experiences were as effective as hands-on laboratory experiences. This suggests that it may be possible to use a computer simulated experiment in place of a laboratory experience in the teaching of some concepts such as the volume displacement and obtain comparable results. This may suggest that computer simulations may be used to replace those laboratory activities that require cognitive interactions with the content rather than psychomotor interactions that do not require much physical (e.g., taste, smell, touch) interactions.

2.6. Problems associated with using Computer Simulations

While computer simulations bring positive effects to science classroom and laboratories, they may also cause some problems. In this case, it cannot be stated exactly as disadvantages of using simulations but as kind of problems that arise when the simulations are used in science classrooms and laboratories. One of the problems is that to use computer simulations in biology and other science courses, both students and teachers should believe in the effectiveness of computer usage, but some of the teachers and students seem to be reluctant to use this new technology. Generally, science teachers mainly rely on textbooks and other supplementary resources, such as laboratory manuals, and text books. Also, some of the students and teachers do not have enough information on how computer simulations can be applied effectively. Therefore, they need to have computer usage background (Kameg, 2010).

Another problem in computer simulation applications, especially in laboratory classes is that, students cannot feel the real hands-on experiments. It is known that if students' sensory organs, such as hearing, seeing, and touching, participate in learning activities, student learning achievement should be much better than other types of teaching. On the other hand, computer simulations cannot give some of these feelings, like touching. In this case, computer simulations are somehow perceived as impersonal but only as machine by students (Edelson, 1999). Another point in computer simulations according to Fifield and Peifer (1994) is the educational fitness for the student learning environments and needs. Some simulation programmes lack well preparation because sometimes students cannot understand how to use very complex simulations and simulation programmes may not fit for the learning age of students. For example as stated by Michael (2000), if a simulation programme is prepared for college level introductory biology with computer-based multimedia courses, it posses problem when it is used in a high school biology course and it may not be proper for high school students. Simulations have distinct disadvantages compared with other modalities. Because simulations are often used with problem-based learning methods, they stimulate learners to immerse themselves in a problematic situation and experiment with different approaches (Heinich, Molenda, Russel & Smaldino , 2002). This type of learning may require significantly more time than other methods of instruction. Research has shown that, without appropriate coaching, scaffolding (Duffy & Cunningham, 1996), feedback and debriefing (Leemkuil, Jong & Ootes, 2003), the learner gains little from the discovery learning simulation than it can facilitate (Mintz, 2001). In addition, research has indicated that, in the absence of reflection and debriefing, students tend to interact with a simulation as merely a game (Leemkuil, Jong & Ootes, 2003). Some constructivists argue that educational simulations “oversimplify the complexities of real-life situations,” giving the learner an imprecise understanding of a real life problem or system (Heinich, Molenda, Russel, & Smaldino , 2002). Simulations cannot provide prompts and feedback to learners of different characteristics (Lee, Guo, & Ho, 2008).

Simulations lack the presence of real objects. Corter, Esche, Chassapis, Ma and Nickerson (2011) indicated that "remote and simulated labs may allow the students to "see" or remotely operate the apparatus, but some students may need to touch and interact with the apparatus personally to understand at a deep level what is going on" (p. 20). They further suggested that these laboratories lack social component as most students work individually while collecting data. On realism, Edward (1997) argued that simulations lack hands- on experience no matter how sophisticated the display model is and further questioned that the "flight simulation also can be realistic but who would want to fly with the pilot who had never previously been in the air"? (p.55). Simulations lack realism (Garrett & Callear, 2001) and Eskrootchi and Oskrochi (2010) concluded that often they fail due to their complex nature and difficulty in understanding. Finally, development of educational simulations may involve extensive planning and require significant investment of time, labour and financial resources.

2.7. Improvement of Computer Simulations on students' attitude in Science

Researchers have long discussed whether students' interests towards learning science can influence whether students consider science as a career (Papanastasious & Zembylas, 2004). Anamuah-Mensah, Mereku and Ghartey-Ampiah (2007) stated that, one of the goals of science education in Ghana is the development of a positive attitude of science and science-related subjects in students. Several studies (e.g. Lee & Burkam, 1996; Simpson & Olive, 1990) have found out that students' attitudes or interests toward learning of science correlated with science achievement and participation in advanced science courses and (Tekbiyik, Birincikonur & Pirasa, 2008) during teaching process computer assisted applications aid the consolidation of attitudes and the restructuring of the knowledge by students themselves. It is also well known that, students' interests and attitudes toward a subject as well as their learning environment impact school achievement. Children with positive attitudes toward science are more likely to be found in classrooms that have high levels of involvement, teacher support, and use of innovative teaching strategies (Myers & Fouts, 1992).

According to Wood (2009), in one study a school system chose to experiment with a new approach in teaching biology in order to try to create more positive attitudes towards science and science instruction. The study enabled students to use microcomputers in order to expand, enrich, reconstruct, and supplement the laboratory and lecture components of the traditional biology course. Through microcomputer use, students were able to do experiments that were impossible or impractical to carry out in any other way. In particular the authors wanted to investigate whether there were differences in attitudes towards science and the science course between students exposed to a computer-simulated programme and students in a traditional biology course. Researchers found that students who engaged in the computer-simulated programme scored higher on two science attitude inventories. Overall, the study showed that computer use in the classroom can improve attitudes of high school biology students. In addition, the computer programme in the study demonstrated promise in relation to helping make science attitudes more positive in students through the use of technological advances (Hounshell & Hill, 1989).

However, many studies performed about the effects of computer assisted instruction on students' attitudes do not agree whether it makes positive changes in interests towards science and science lessons (Francisa, Katzb, Susan & Jonesc, 2000; Mitra, 1998). Although Selwyn (1999), Ertepınar, Demircioglu, Geba, and Yavuzet (1998) reported that computer assisted instruction improves a positive attitude towards science, Shaw and Marlow (1999) found that computer assisted instruction does not show a positive effect on students' attitude. This is supported by Wood (2009) who showed that, there was no significant difference between science related attitudes before and after the programme. Shrigleys (1990) believes that science attitude scores are correlated with science behaviours in the classroom. Wood (2009) further stated that, improving a student's attitude towards a subject can help that student achieve higher success and achievement in school.

2.7.1. Motivation

According to Haddad and Jurich (2003), the famous astronomer Carl Sagan used to say that all children start out as scientists full of curiosity and questions about the world, but schools eventually destroy their curiosity. The first and probably the challenging task in an effective teaching and learning process is to motivate students to learn. Every teacher desires students who are motivated to learn. Students who are motivated to learn participate in learning activities, stay engaged in a learning task, and show a commitment to learning. These characteristics help students to create goals and beliefs that play an essential part in maintaining a long-term relationship with learning (McCown, Driscoll, & Roop, 1996). For mathematics and science teachers, this task can be even more daunting, since their subjects are highly abstract, complex, and appear disconnected from the students' reality.

Motivation is an essential aspect of teaching and learning. A teacher can plan a lesson that is perfectly sequenced and well presented yet fail to teach and students end up being bored and restless during periods of passive learning. Research findings from developed countries indicate that the use of media resources plays a major part in motivating students to learn (Heinich, Molenda, Russel & Smaldino , 2002). Once students are motivated they will learn from any media if it is completely used and adapted to their needs. They become stimulated when they are actively and emotionally involved in their own learning (Ellington, Percival & Race, 1993). Doeer, Arleb Ack, and O' Neil (2013) suggested there is a need to design activities in order to motivate students to make sense of meaningful situations. According to Akinsola and Animasahun (2007), learning has to be experiential, motivational and engaging.

A major constraint in using simulations is their effect on cognitive domain. Liu and Su (2011) found that simulations loaded with multimedia features like audio, video and different formats of information increase the cognitive workload thereby affecting learning. Lee (1999) concluded that computer based simulations produced different cognitive impact on learners depending on their prior knowledge and gender (Edward, 1997) making them unsuitable for some learners. Furthermore, the students were overwhelmed and confused by the excessive information processing while working with simulations (Dunleavy, Dede & Mitchell, 2009). Motivation has also been regarded by experienced and inexperienced teachers alike as a prerequisite for effective learning, and the greatest challenge that many teachers face is to make their students want to learn (Petty, 2004). Therefore, the teacher needs to provide motivational activities or strategies to hold the learners' attention and sustain it throughout the lesson. Research findings from developed countries indicate that the use of media resources plays a major part in motivating students to learn (Carol, 1997; Heinich, Molenda, Russel, & Smaldino , 2002; McCallun, 2000). Once the students are motivated, they will learn from any media if it is completely used and adapted to their needs, and students become stimulated when they are actively and emotionally involved in their own learning.

The purpose of an educational simulation is to motivate the learner to engage in problem solving, hypothesis testing, experiential learning, schema construction, and development of mental models (Rudduck & Flutter, 2001; Duffy & Cunningham, 1996). A study by Carol (1997) noted specifically that the use of computers in teaching and learning provide motivational activities. One of the reasons for the massive expansion of the introduction of computers in teaching and learning was because of its capability to motivate children by producing a graphic representation that they can control. By introducing computers into the education system, the aim of the educators was to enable the learners to learn by doing, make them want to learn, create, manipulate and evoke experiences that are vivid to enhance learning (Ellington, Percival, & Race, 1993). Heinich, Molenda, Russel and Smaldino (2002) are of the view that, one of the reasons for the massive expansion of the use of computers in schools is that of motivating students to learn effectively. According to Heinich, Molenda, Russel and Smaldino (2002) motivation is an internal state that leads people to choose to pursue certain goals and experiences.

Many researchers (Christman, Budgett & Lucking , 1997) have discussed the use of computers in teaching and learning and have found out that motivational factors are indisputably important in education. Heinich, Molenda, Russel and Smaldino (2002) also reported that "various emotional factors have been found to influence what we pay attention to, how long we pay attention, how much effort we invest in learning and how feeling may interfere with learning. Teachers need also to be aware that promotion of motivation depends upon two kinds of motivation: that is intrinsic and extrinsic motivation. Heinich, Molenda, Russel and Smaldino (2002) reported that intrinsic motivation is generally more effective. Students who are intrinsically motivated will work harder to learn more because of their personal interest in the materials because the learner derives pleasure in performing activity. It arises out of direct interest in the materials to be learnt.

Intrinsic rewards include a feeling of a job well done, and a feeling of satisfaction. Alessi and Trollip (1999) added that intrinsic motivation is the thing inherent in the instruction that motivate students if they consider it to be fun. Alessi and Trollip (1999) suggested a number of ways that could enhance intrinsic motivation such as use of game technique; use of audio, visual and audio visual technique increase students intensity of work, attention and encourage deeper cognitive processing. Carol (1997), Christman, Budgett and Lucking (1997), have suggested that the computer can be an ideal medium for developing such motivation. The motivational function of the computer has been considered an important factor in many computer based instructional programmes (Furlong, Barton, Miles, Whiting & Whitty 2000). These studies show that intrinsic features of the computer such as immediate feedback, animation, sound, active interaction and individualization are more likely than any other media to motivate students to learn.

A study by Koumi (1994) found out that computers were good motivators that heightened students' interest and enjoyment and were also seen to have a positive effect upon the status of the subject. Carol (1997) also reported that several heads of department in her study noted the benefits of technology in terms of pupils' motivation gained from the use of computers. The integration of computers in the curriculum can help to heighten students' motivation to learn and introduce them to variety of new learning experiences. Motivation can also do much to increase students' interest thereby helping them to learn difficult subjects like science and mathematics (Azita, 1999). For example in science, Haddad and Jurich (2003) reported that simulation is often used to stimulate students' interests in a topic in order to promote active learning of problem solving and the study process. This can be emotionally stimulating as well as being intellectually rewarding and can encourage them to learn more. It is due to the capabilities of computer technology as a teaching and learning resource capable of motivating students to learn effectively that led developing countries like Kenya to introduce computers in public secondary schools.

A research conducted by Odera (2011) revealed that majority of heads of departments (HODs) of an institution reported that computer motivates students to learn various subjects. They indicated that once the learners are motivated they concentrate and learn effectively so computer arouses learner's curiosity and creative thinking. Furthermore, computer teachers were asked to identify what they felt to be the main impact of computer on motivating students' learning. They were also asked to state whether they could think of specific examples when students' learning was motivated and stimulated or enhanced by computer programmes. It was reported that, in response, the majority of the interviewees noted that students were motivated to learn when they use computer technology. One of the teachers reported that "*there is no sleeping during computer class, a sign that they appreciate their use of computers and what they learn from them. It increases students desire to learn. They are normally very happy and this enables them to learn even more on their subject areas* (Odera, 2011, p. 9)

Guided computer simulation activities can be used as an educational alternative to help motivate students into self-discovery and develop their reasoning skills. The laboratory activity can then focus on the actual transfer of knowledge. This strategy helps improve the effectiveness and efficiency of the teaching and learning process (Gokhale, 2011). King-Dow (2011) also stated that, ICT-integrated chemistry texts not only increase students' learning motivation and interest but also upgrade their performance and improve their study attitudes at the same time, as well as leading to more intimate communicative interactions between teachers and students. According to Bialo and Sivin-kachala (1996), during the 1970s, studies demonstrated that using computer technology could motivate students, enhance instruction for special needs students, improve students' attitudes toward learning, and motivate teachers and free them from some routine instructional tasks.

2.7.2. Interest of Students

Rodrigues (1997) reported that there are many researches carried out on investigation of the use of simulations in science education. On increasing students' interest in the topic taught during the lesson, it was reported in the related literature that computer software are more effective than other methods used for the same purpose (Geben, Askar & Ozkan, 1992 ; Hounshell & Hill, 1989). Similarly the use of computer animations is reported to increase students' interest towards lessons (Andolore, Bellamonte & Sperandeo-Mineo, 1997; Rodrigues, 1997).

According to Zhao and Zhao (2009), performance of computer simulation software helps to promote students' interest in learning, to solve difficulties in study, to encourage students to bring forth new ideas, to improve their comprehensive ability and to achieve ideal teaching effect. Heinich, Molenda, Russel and Smaldino (2002) also reported that "various emotional factors have been found to influence what we pay attention to, how long we pay attention, how much effort we invest in learning and how feeling may interfere with learning. Many students do not perform well in school subjects due to lack of interest and end- up dropping out of school. Therefore, if teachers can create an enduring fascination for the subjects under discussion, then students can learn more effectively. For example in science, Andre and Haselhuhn (1995) reported that simulation is often used to stimulate students' interests in a topic in order to promote active learning of problem solving and the study process. This can be emotionally stimulating as well as being intellectually rewarding and can encourage them to learn more.

The task of multi-media is creating study environment and arousing students' study motivation. It is a cognitive tool for students to actively learn and explore (Zhao & Zhu, 2008). According to Chen, Chen and Gao (2013), multimedia technology should be used reasonably according to students' cognitive ability. And it can inspire the students' studying interest and innovation consciousness when properly designed. If the position and function of all elements of teaching can be located, we will make good use of multimedia. A study conducted by Odera (2011) on whether the use of computer in teaching and learning increase their desire and make them want to learn, the response from the learners showed that majority of them (85%) agreed that computers heighten students' interest and make them want to learn on their own. Johnson (1996) also noted that computers were good motivators that heighten students' interest and enjoyment that had positive effect on the subject they learn. The only vehicle that could be used to achieve and sustain this goal is a worthwhile curriculum which would be ICT- oriented. ICT deals with the handling of information using all kinds of electronic devices (Becker, 1991). These electronic systems can be used for broadcasting, telecommunications and all forms of computer-mediated communication. ICT - centered education covers the use of computers, online self-learning packages, interactive CDs, satellites and all types of Information Technology (IT), hardware and software (Akudolu & Adebay , 2002). Reviewing science education curriculum would demand the integration of such technology as, electronic classroom, computer tutorial lessons so as to enable students learn at their own pace, virtual fieldtrip, video conferencing system, electronic laboratory, television programme and Internet Relay Chat (IRC).

Technologies if integrated into science education curriculum have the potentials and promises to motivate students to learn, arouse and sustain their interest in learning. Acquah (2013) revealed that today's science teaching and learning have become more activity oriented and more student centered. Problem solving is a primary characteristic and the learner does not just read about science but he does science. Science has become a basic required subject for all students. It has become interdisciplinary aiming at achieving scientific literacy among communities. Scientific literacy according to Acquah (2013) refers to the knowledge and understanding of events and happenings in the environment. It refers to being literate about natural phenomena. Given to this revelation, integration of ICT to science education curriculum becomes imminent. In support of this, Albirini (2006) opined that ICT greatly facilitate the acquisition and absorption of knowledge, offering developing nations unprecedented opportunities for business and quality education. Becker (1991) pointed out that one of the reasons for integrating ICT into school curriculum is to prepare the current generation of learners for a workplace where ICT, particularly computers, internet and related technologies are becoming more and more ubiquitous. Enhancing science teacher's competencies in teaching ICT influences the roles of teachers in the modern classroom.

Teachers are no longer the custodians of knowledge but facilitators and guides, thereby promoting child-centered method of teaching. Zhao and Zhao (2009) stipulated that, performance of computer simulation software helps to promote students' interest in learning, to solve difficulties in study, to encourage students to bring forth new ideas, to improve their comprehensive ability and to achieve ideal teaching effect. Some studies showed that computer assisted instruction was more effective than the other methods in increasing students' interests in science lessons (Geben, Aşkar & Özkan, 1992; Hounshell & Hill, 1989).

2.8. Influence of Computer Simulations on students' performance

Looking specifically at studies dealing with computer simulations in science, it can be found that, the picture is not clear. Okey and Shaw (1995) indicated that when computer simulations and laboratory work were compared to traditional instruction in middle grade science, the simulation groups showed significant improvement on definition, attributes and values subscales, but not on rule determination. Sperry (2004) also found that there was no significant difference in critical thinking scores between computer simulation treatment and traditional classroom instruction for high school biology students. Hummel and Batty (2009) found no significant difference in achievement between the computer simulation treatment and the traditional instruction in a high school chemistry course.

Traditional instruction may take twice as long as Computer Assisted Instructions; however, in the area of physics and physical science it was also found to have mixed results.

Trundle (2010) studying Junior High physical science students found no significant difference in achievement between the computer simulation group and the traditional instruction group. In contrast to these studies, Boblike and Lunneta (2010) found that the computer simulation instruction groups had significantly better achievement scores than the control groups receiving traditional instruction in high school physics. It is not very clear why the research provides conflicting results on the effectiveness of computer simulation, but Okey (1990) speculates that it may be due to a peaking out effect. A meta-analysis was performed to synthesize existing research comparing the effects of computer simulation instruction to traditional instruction on students' achievement in Taiwan. The results of this study suggested that the effects of Computer Simulation Instruction are positive as compared with those of traditional instruction in Taiwan. While many educators have put and are putting tremendous effort into devising new ways of using computer technology in the classroom, with the clear expectation that such technology will dramatically increase students' academic achievement, the results of this study can provide classroom teachers with a cumulative bank of research-based evidence for the positive effects of computer simulation instruction on students learning. The analyses of the studied variables, however, provided no consistent evidence that there are no learning benefits to be gained from employing different media in instruction (Hopkins & Tylinski, 2001).

Chou (1998) and Serpell (2002) also noted the significantly greater effectiveness of computer simulation instruction as compared to traditional instruction. Johnson and Stewart (1990) reported that by using genetics construction kits as part of a strategic computer simulation, undergraduate and high school students learned to "solve" genetics programmes and to build accurate and rich mental models of genetic knowledge. However, Parker (1995) and Tannehill (1998) have found no significant differences between computer simulation instruction and traditional instruction. Hopkins and Tylinski (2001) even reported an opposite finding: the significantly greater effectiveness of traditional instruction.

Two review studies regarding the effectiveness of computer simulation have also been analyzed. A review conducted by Lee (1999) concluded that although simulations were more effective in the development of attitudes than lectures, it appeared that the claims of improved cognitive development and learning retention were not readily supported. Lee's (1999) review used a meta-analytic approach: He collected 19 studies and yielded 51 effect sizes. The study found that the overall mean effect size for academic achievement was

0 .41; meaning about 66% of the students in computer simulation classes outperformed the average students from the control groups. On the other hand, the overall effect size for attitude was -0.04, meaning control groups performed slightly better than computer simulation classes. Obviously, the results of these two reviews were inconsistent. It is assumed that these conflicting results may be due to the different sources used by the two review studies or their different methodologies.

According to Christman, Budgett and Lucking (1997) even though there are a lot of studies on the effect of Computer Assisted Instructions (CAI) on students' academic achievement, there are few in science education. Akudalu (2002) investigated how effective CAI was on student achievement in secondary and college science education when compared to traditional instruction. She found the overall effect size as 0.273 from 42 studies yielding 108 effect sizes between the years 1970 and 1999. The results of the study also indicated that some study characteristics, such as student-to-computer ratio, CAI mode, and duration of treatment were significantly related to the effectiveness of CAI. Christman, Budgett and

Lucking (1997) examined the effects of CAI on students' achievement in differing science and demographic areas. They combined 11 studies on CAI in science. Brant, Hooper and Sugrue (1991) studied a meta-analysis of U.S. research published from 1980 to 2004 on the effect of specific science teaching strategies on student achievement. The major implication of their research is that they have generated empirical evidence supporting the effectiveness of alternative teaching strategies in science. Jimoyiannis and Komis (2001) examined the effect of the computer simulations on students to understand the orbital movements, by using basic concepts related with kinematics, in a study made in physics teaching.

As a result of this study, it is seen that teaching basic concepts of kinematics through simulations has brought about successful results and has contributed highly to learning process. In a study in which the influence of computer based physics activities on students' acquisitions is searched on the subject of Simple Harmonic Motion, it is concluded that the teaching realized by the simulation programme with an applied dynamic system is more successful than the teaching implemented by traditional methods (Karamustafaoglu, Aydin & Ozmen, 2005).

Some studies have been performed about whether the computer simulation experiments or traditional laboratory experiments are effective on the students' successes about science subjects. Some parts of this studies showed that the computer simulation experiments are more effective (Redish, 1997). But Brown and Mclntare (1993) couldn't find a meaningful difference between computer simulation experiments and traditional laboratory experiments. A study conducted by Lord and Harland (1998) showed that a significant difference was not determined between the effect of laboratory based learning on student success and the effect of computer (simulation) based learning. Thus, as a result of research for the student's academic success it can be said that computer (simulation) based physics learning is as effective as laboratory based physics learning. A study conducted by Chen and Howard (2010) supports the significant role of simulation in transmission of knowledge for educational purposes. It was found that participation in the live simulation may have influenced students' attitude toward science over time. Students' normality of scientists was one of the science-related attitudes that showed significant change. This result is confirmed by prior research into realistic simulations showing the relevance of science and change in how students perceive scientists (Jarvis, 2005). The result obtained by Ezeudu and Ezinwanne (2013) after conducting research showed that students taught using simulation got a higher mean score than those taught with the conventional method. It then means that students in the experimental group achieved better than those in the control group. This is confirmed by the test of hypothesis which revealed that there is significant difference in the mean achievement scores of students taught using simulation and those taught with the conventional method. This is in agreement with the work of Paricer (1998), Akinsola (2003) and Poripo (2008), which indicated that simulation used in teaching and learning promote better understanding of the concepts. Gokhale (2011) also attested to the fact that, computer assisted instruction has various effects on students such as academic achievement, attitudes toward course. Students' attitudes are one of the key factors in learning science. Learning process is important in improving of positive attitudes. The development of positive attitudes toward science (George, 2006) can motivate student interest in science education and science-related careers. Based on the results of a study conducted by Gokhale (2011), it can be concluded that effective integration of computer simulation into traditional lecture-laboratory activities enhances the performance of the students.

2.9. Summary of Literature Review

The literature reviewed started with the theoretical framework which informed the entry point of perspectives that underlined issues influencing the use of computer simulation in teaching selected topics in integrated science to JHS two students. The main variables of the review focused on use of computer simulation, improvement in students' attitude in learning science and the performances of students using computer simulation. The evidence provided on these various sub-headings together with the empirical studies showed that the effective use of computer simulation had influenced students' attitude and performance in learning topics in integrated science. The literature reviewed revealed that the use of computer simulations in science education increases students' interest in learning and understanding of concepts in integrated science. The literature reviewed also indicated that there are some computer softwares that are more effective than other methods used for the same purpose in teaching integrated science. Similarly the use of computer animations is reported to increase students' interest towards lessons. The literature reviewed indicated that computer simulation software helps to promote students' interest in learning, to solve difficulties in study, to encourage students to bring forth new ideas, to improve their comprehensive ability and to achieve ideal teaching effects. Computer simulation is often used to stimulate students' interests in a topic in order to promote active learning of problem solving and the study process. This can be emotionally stimulating as well as being intellectually rewarding and can encourage students to learn more.

CHAPTER THREE

METHODOLOGY

3.1. Overview

This chapter presented the research methodology employed in the study. It discussed the research design which was post-test only non-equivalent group of quasi-experimental design. It further explained how the population and sample were selected and then gave reasons for the choice of a particular sampling technique. Other areas covered included instruments used for data collection, validity and reliability of the research instruments and how the data collected were analysed to determine the effectiveness of the teaching approaches used.

3.2. Research Design

The study adopted post-test only non-equivalent group of the quasi experimental design using action research approach with the focus on determining the effects of computer simulation on Junior High School form two students' performance and attitude in selected topics in integrated science in University Practice North Campus School. According to

Fraenkel and Wallen (2003), quasi experimental design is considered sufficiently rigorous and appropriate for experimental and quasi experimental studies. The quasi-experimental approach enabled the use of the intact classes and justified the use of post-test and non – equivalent group approaches adopted. Flick (2006) stated that since quasi-experimental designs are used when randomisation is impractical and/or unethical, they are typically easier to set up than true experimental designs, which require random assignment of subjects. He further stated that utilising quasi-experimental designs minimises threats to external validity as natural environments do not suffer the same problems of artificiality as compared to a well-controlled laboratory setting. Shuttleworth (2008) also supported this idea by stating that the posttest-only non-equivalent control group design of the quasi-experimental research design involves selecting groups upon which a variable is tested without any random pre-selection processes.

There are many ways to conduct research in order to improve on quality teaching and learning in the classroom (Morley, 1992). Each of these ways is used in various professional fields, including psychology, sociology, social work, medicine, nursing, education and so on. However, the field of education often uses action research, an interactive method of collecting information that is used to explore topics of teaching, curriculum development, children's learning and behaviour in the classroom (Morley, 1992). According to Max and Chisholm (1993) action research is very popular in the field of education because there is always room for improvement when it comes to teaching and educating others. There are all types of method of teaching in the classroom, but action research works very well because the cycle offers opportunity for continued reflection. In all professional fields, the goal of action research is to improve processes. Action research is also beneficial in areas of teaching practice that need to be explored or settings in which continued improvement is the focus especially in teaching and learning. These authors further posit that action research is 'learning by doing' in which a group of people identify a problem, do something to resolve it, see how successful their efforts were, and if not satisfied, try again. While this is the essence of the approach, there are other key attributes of action research that differentiate it from common problem-solving activities that we all engage in every day. Action research, aims to contribute both to the practical concerns of people in an immediate problematic situation and to further the goals of social science simultaneously. That is there is a dual commitment in action research to study a system and concurrently to collaborate with members of the system in changing it in what is together regarded as a desirable direction. Accomplishing this twin goal requires the active collaboration of researcher and client and that it stresses the importance of co-learning as a primary aspect of the research process.

This study was carried out in three major phases: pre-intervention, implementation of intervention and post-intervention activities. In this study, the researcher downloaded some simulation videos from the internet on digestive system, circulatory system, photosynthesis and respiratory system. These simulation videos were carefully selected by taking into consideration the content of the JHS Integrated Science Syllabus containing the selected topics. These simulation videos were installed on the twenty (20) school laptop computers. Outlined of activities were as follows:

Activity 1: Introduction of the topics

Activity 2: Distribution of laptops to students

Activity 3: Guiding of students to open files containing the simulation videos

Activity 4: Watching of the simulation videos by the students

Activity 5: Monitoring of the learning by the teacher

Activity 6: Teacher discussed concepts from the simulation videos with students

Activity 7: Conclusion

Activity 8: Evaluation

Students were put into groups of two (2). Each group was provided with a laptop computer containing the simulation videos. This was done during the intervention stage. Class test was conducted at the post intervention stage to assess the effectiveness of the simulation videos on students' academic performance.

3.3. Accessible Population

All JHS 2 students in the University of Education, Winneba, North Campus Practice School formed the accessible population for the study.

3.4. Sample size

This was made up of all JHS 2 students in the University of Education, Winneba (North-Campus) Practice School. A total of 88 students were involved in the study. This comprised of 29 students each from JHS 2A and 2B, and 30 from 2C. Table 1 shows gender distribution of respondents.

3.5. Sampling Technique

To select the sample size for the study, the convenient sampling technique was used to select the JHS two students of the University of Education, Winneba (North-Campus) Practice School. The convenient sampling technique was used because the researcher teaches science in form two classes in the school and the topics under study are also found in the form two syllabus. So conveniently, it was appropriate to involve the students in the study. According to Fraenkel and Wallen (2003) convenience sampling is a group of individuals who (conveniently) are available for study.

3.6. Research Instruments

A semi-structured observation, post-test and opinionnaire were used to collect data. Observational checklist which spelt out some behaviours to be observed during the implementation of the intervention was used. Post-test only was conducted for students at the end of the implementation of the intervention based on those selected topics from the Integrated Science syllabus taught using the computer simulations. Students were also asked to write their opinions at the end of the computer simulation lessons. According to Denscombe (2008) observation does not rely on what students do, what they say or what they think. It is more than that. Instead, it draws on the direct evidence of the eye to witness events first hand. It is based on the premise that, for certain purposes, it is best to observe what actually happens. Bell (2008) also believes observation is useful in determining what people actually do or how they actually behave in their contexts. Post-test was given to students to provide their answers. Since the research was aimed at the use of computer simulations and its influence on students' performance and attitude in the learning process in Integrated Science, it was appropriate to use observation, posttest only and opinionnaire for data collection.

3.7.1. Observation

A semi-structured systematic observation guide (observational checklist) was developed and used. This observational checklist was developed in such a way that it contained some attributes of attitudes and their responses. The trained Integrated Science teachers or observers ticked the appropriate response when a particular behaviour was exhibited. The responses were (Item1-11) 'very often', 'often', 'sometimes' 'never' and (Item 12-18) were 'Very high', 'high', 'low' and 'lowest'. According to Denscombe (2008), observation can be categorized into two types: systematic or structured observation and participant or unstructured observation. Systematic observation generates numerical data which can be subjected to statistical analysis (Cohen, Manion & Morrison, 2008). These authors further posit that, the numerical data can be gathered by noting the number, frequency or timing of particular events. Denscombe (2008) also pointed out that 'participant observation, as a method, enables researchers to infiltrate situations, sometimes as an undercover operation, to understand the culture and processes of the groups being investigated' (p.206). Participant observation is also useful for gaining an understanding of the physical, social, cultural and economic contexts in which study participants live, and peoples' behaviours and activities, what they do, how frequently and with whom. The observational checklist was designed to track students' attitudes to lessons during the intervention. The observational checklist consisted of 18 items (Appendix E).

3.7.2. Post-test

Teacher made test based on the simulation videos was administered to the students at post intervention stage. This was done to assess students' academic achievements and the effectiveness of the simulation lessons after successful treatment of the selected topics. The test was made up of three sections. Section A consisted of multiple-choice items; section B required students to label some diagrams and also answer some essay type items; and section C contained some essay type items only. The scripts were marked and scored and immediate feedback was given to the students (Class test; Appendix A, B, C and D).

3.7.3. Opinionnaire

All the students (sample) were asked to write their opinions about the simulation lessons at the end of the implementation of the intervention. According to Denscombe (1999) Opinion is what a person says on certain aspects of the issue under considerations. It is an outward expression of an attitude held by an individual. Payne (1994) stated that opinionnaire are generally of two types. These are closed or precategorised type and the open or free response type. This author further posits that it is recommended that the open ended form of opinionnaire should be adopted for most uses unless a very large of respondents is involved. The open ended opinionnaire was therefore adopted for the study. Students were required to write their opinions at the end of the simulation lesson in order to assess the effectiveness of the lessons on academic achievements.

3.8. Validity

The goal of a good research is to have results that are reliable and valid (Creswell, 2005). Validity is concerned with whether the findings are really about what they appear to be about (Robson, 2003). Leedy and Ormrod (2002) noted that validity remains important within any research that needs to ensure that people's lives, experiences, and views are represented accurately. To determine this, test items, observation checklists and opinionnaire were submitted to the supervisors for expert judgment. Further corrections were made based on suggestions by the supervisors.

3.9. Reliability

Reliability according to Cohen, Manion and Morrison (2008), means that scores from an instrument are stable and consistent; scores should nearly be the same when researchers administer the instrument multiple times and also scores need to be consistent. To ensure reliability, the items in the instruments were designed to cover the key areas raised in the research questions. Item difficulty Index was used to determine difficulty level of test items. Additionally, Kappa Coefficient reliability was calculated to determine the scoring agreement on observation items since this was scored by two different science teachers (two ratters) in the school during the implementation of the intervention.

3.9.1. Kappa Statistic Reliability

Kappa statistic reliability is about calculating the scoring agreement between two raters or between one rater scoring the items on two or more occasions. Sim and Wright (2005) stated that, two types of reliabillity exist. These are 1) agreement made by two or more clinicians (Interrater reliability). And 2) agreement between ratings made by the same clinicians on two or more occassions (intrarater reliability). Kappa (K) statistic reliability is commonly used among clinicians to examine interrater or intrarater reliability inrelation to clinical diagnoses or classifications. Even though the Kappa statistic reliability is commonly used among clinicians, it is adopted and used for the present study because it is about two raters (two integrated science teachers) who used the observational checklist to trap students attitude during simulation lessons. In this case, it is interrater reliability. It is therefore appropriate to use Kappa (K) statistic reliability to find out the scoring agreement between the two integrated science teachers (raters). According to Sim and Wright (2005), if clinicians agree purely by chance, they are not really agreeing and Kappa is such a measure of true agreement. Kappa statistical reliability calculation for this study revealed that the observational checklist was reliable (Appendix G).

According to Sim and Wright (2005), the range of possible values of Kappa is from -1 to 1, though it usually falls between 0 and 1. Unity represents perfect agreement, indication that, the ratters agreed in their classifications of every case. Zero indicates an agreement not better than that expected by chance as if the ratters had simply guessed every rating. A negative Kappa would indicate agreement worse than that expected by chance. However, Fleiss (1981) proposed benchmark scale for interpreting the magnitude of Kappa Coefficient as follows; < 0.40 = Poor, 0.40-0.75 = Intermediate to good and > 0.75 = Excellent. So, from the calculations, Kappa reliability of 0.80 means the scorings made by the two raters (two integrated science teachers from the school) were excellent and therefore reliable (Refer to Appendix G).

3.9.2. Item Difficult Index (P)

The item difficulty index (P) is determined by calculating the proportion of examinees that, answer the item correctly (Fossey, 2013).

The formula for item difficulty index is $P = \frac{Np}{N}$

Where Np = Number of test takers in the total group who passed the item.

N = Total number of test takers in the group

The calculation of the item difficult index (P) in this research is important because, it helps to find out if the test items are too difficult or too easy so that it can be maintained or discarded. Fossey (2013) spelt out some importance of calculating item difficulty. These are:

1. Item analysis is especially valuable in improving item which will be used again in later tests.
2. It can also be used to eliminate ambiguous or misleading items in a single test administration.
3. Item analysis is valuable for increasing instructors' skills in test construction.

4. It can help to identify specific area of course content which need greater emphasis or clarity.

According to Fossey (2013), the item difficulty index (P) has a range of 0.00 to 1.00. If no one answers the item correctly, the P value would be 0.00. An item that everyone answers correctly would have a P value of 1.00. This means, the higher the P value, the easier the item and the lower the P value, the difficulty the items. According to Office of Educational Assessment (2005) the following general guidelines can be used to interpret reliability coefficients for classroom examinations. Reliability value of 0.90-1.00 = Excellent Reliability, 0.80-0.90 = Very Good Reliability, 0.70-0.80= Good Reliability, 0.60-0.70 = Somehow Low Reliability, 0.50-0.60 = Suggests Need for revision of test and 0.50 or below = Questionable Reliability. However, all the four sets of test items for the present study were reliable (Refer to Appendix H).

Pilot Testing of the instrument

Pilot test was conducted at University Practice Junior High School (North-Campus), Winneba in the Effutu Munucipality in the Central Region of Ghana. The purpose of this activity was to find out the effectiveness of the instrument. This was carried out on seventy (70) first year students to identify and correct some lapses in the intervention and data collected processes before the real intervention was done.

3.10. Procedure for data collection

Research instruments were used to collect data. The data collection procedure was divided into three phases. These were pre-intervention, intervention and the post-intervention phase.

Pre-intervention phase

The researcher informed the head teacher about the research work she wanted to carry out in the school in order to solicit his cooperation and assistance. Permission was therefore asked from him to use the school laptop computers for the study. Downloaded simulation videos were installed on the school laptops (20 in number) and was pilot tested on JHS 1 students in the school. They were seventy (70) in number. This was done to find out the effectiveness of the instruments.

Intervention phase

This was where simulation videos were used to teach students. It lasted for eight weeks. The simulation videos were carefully selected based on the selected topics from JHS 2 two Integrated Science syllabus. Some science concepts were identified from the simulation videos and the researcher discussed them with students. At that point, students were asked to pause the simulation videos for discussion after which they continued to play it. Students also asked the researcher questions when necessary. The Researcher monitored students activities and intervene when necessary.

Computer simulation

According to Allesi and Trollip (1999) the purpose of simulations is to help learners built their own mental models of the phenomenon or procedures and provide them opportunities to explore practice test and improve those models safely and efficiently. Allesi and Trollip (1999) categorised simulations into the following four different types: physical simulation, procedural simulation, situational simulation, and process simulation. These are explained as follows:

Physical simulation

This is where a physical object, such as a frog, is displayed on the computer screen, giving the student an opportunity to dissect it and learn about it, or when a student is learning how to operate a piece of laboratory apparatus which might be used in an experiment. In physical simulation, each programme has an underlying computer model of a system (a city, the earth, a farm, an electronic circuit, a microprocessor etc). For example, circuits for physical science show children how to build and understand electrical parts. The programme offers students the opportunity to study various types of circuits and gives them instructions so they can explore the effects of manipulating portions of these circuits.

Procedural simulation

This occurs when a simulated machine operates so that the student learns the skills and actions needed to operate it; or when the student follows procedures to determine a solution, as when a student is asked to diagnose a patient's disease and prescribe appropriate treatment. That is procedural simulations teach a sequence of actions to accomplish some goal. Procedural simulation typically contain simulated physical object. However, the simulation of the physical object is necessary to meet a procedural requirement that is to allow engagement in the procedure. For example it allows learner dissect frogs and perform other experiments.

Situational simulation

Situational simulation is a special type of procedural simulations. Learners are encouraged to explore alternatives and see their effects. This normally gives the student the chance to explore the effects of different methods to a situation, or to play different roles in it. Usually in situational simulations, the student is always part and parcel of the simulation, taking one of the major assigned roles. Situational simulation deals with behaviours and attitudes of people or organizations in different situations rather than with skilled performance.

Process simulation

It is also called iterative or block simulation. It is similar to the physical simulation but instead of continuously manipulating the simulation, the learner runs the simulation over and over, selecting values for various parameters and observing the phenomenon that occurs without intervention. Process simulation is different from other simulations in that the student neither acts as a participant (as in situational simulations) nor constantly manipulates the simulation (as in physical or procedural simulations) but instead, selects values of various parameters at the onset and then watches the process to occur without intervention. Furthermore, in process simulation time is not included as a variable. That is whether the real phenomenon occurs very quickly or very slowly, the learner manipulates parameters, runs the simulation and sees the immediate results. For example, an introductory genetics simulation on the mating of cats selected by colour, pattern and tail presence. This study therefore adopted process simulation. This was to help students observe and learn about digestive system of human, circulatory system of human, photosynthesis and respiratory system of humans in a real world experience and interact with them.

Implementation of the computer simulation video

This involved five activities. The activities were explained as follows:

*Activity 1***:** *Introduction*

Students' relevance previous knowledge was reviewed by the researcher through question and answers. This was done in order to evaluate the level of support the students will need as they interact with the new lesson for easy assimilation of the new material.

Activity 2: Conduction of the simulation lessons

Students were put into groups of two (2) by the researcher. The school laptop computers containing the simulation video files were distributed to the students by the researcher. Students were guided on how to open the appropriate video files. Students then watched the simulation videos and noted some key points down into their notebooks. However, at a point in time the researcher asked students to pause the simulation videos for some science concepts like diffusion of food nutrients in the ileum through the villi into the bloodstreams, movement of water and mineral salt from the soil through the xylem tissues to the leafs (osmosis and diffusion respectively) and pressure with which the heart pumped blood to be discussed. Students were also allowed to ask questions for clarification of points when necessary.

Activity 3: Monitoring and intervening

While the students watched the simulation videos, the researcher moved round to assist them when necessary. Some of the students asked the researcher some questions for clarification based on the simulation videos. At a point in time, the researcher also asked students questions based on the simulation videos just to put students on track and also to stimulate them on the learning tasks. The researcher moved round to assist groups and individuals as well when the need arose.

Activity 4: Evaluation

Students' attitude checklist and class tests were used to evaluate students based on the tasks. In order to evaluate students' understanding of some science concepts, questions were administered to them to answer. The researcher specifically set these questions to test students' understanding of some science concepts involved in the study. Another set of questions were also given to students to answer. This was to asses students understanding for that matter their performance. Each student answered the questions independently. They were not allowed to help each other during the writing of the class test.

Activity 5: Marking and scoring

Each individual students'class test collected were marked and scored. These scores were put together for each student.

Activity 6: Provision of feedback

Students were provided with feedback on the class test taken. This was done to correct mistakes made by students and also to motivate them to learn task with seriousness.

Observational Checklist on students' Attitude

In order to track students' attitude towards simulation lessons, an observational checklist was developed and used. Two Integrated Science teachers from the school were trained to use the observational checklist during simulation lessons. When 70% to 100% of the students exhibit a particular behaviour, it was indicated as 'Very often' (Item 1-11) or 'Very high' (Item 12-18). When 51% to 69% of the students exhibit the behaviour then it was indicated as 'Often' (Item1-11) or 'High' (Item 12-18). When 1% to 50% of the students put up the behaviour then it was scored as 'sometimes' (Item1-11) but if the behaviour did not occur at all, then it was scored as 'never'. When 0% to 10% of the students put up the behaviour, then it was scored as 'lowest' and when 11% to 50% of the behaviour occurred, then it was scored as 'Low' (Item 12-18). The observational checklist was used by the two Integrated Science teachers each during twelve (12) different simulation lessons. Data collected were coded as (Very often or Very high= 4, Often or High = 3, Sometimes or Low = 2 and Never or Lowest = 1) and analysed.

Opinionnaire

This was developed and used by the researcher in order to solicit their opinions based on the simulation lessons. So, at the end of the intervention process, students were asked to write their opinions on the simulation lessons they had. This was collected and read through by the researcher. Students' opinions were therefore categorized and analysed.

Post-intervention Test

Data collection lasted for eight weeks. At the end of each week, post-test was administered on students. The post-tests were based on digestive system, circulatory system, photosynthesis and respiratory system. Each test was made up of three sections. Section A consisted of multiple –choice items. Section B was some diagrams for students to label and some essay type items and Section C was only essay type items. The test items were administered in their respective classrooms. The students' scripts were marked and scored. This was to assess the effectiveness of the simulation lesson on students' academic performance.

3.11. Data Analysis

3.11.1. Analysis of Observation Data

In the analysis of the observational data, students' attitude scores on the observational checklists was compiled and presented in tables by the use of the SPSS Version 16.0. The tables (Table 6 and 7) spelt out frequency of attitude on the observational checklist (Appendix E) as well as their percentages. In the analysis of observation data 1-11, responses involving 'very often' and 'often' were combined as one entity, 'never' and 'sometimes' remained separately for discussion purposes. However, in the analysis of observation data 12-18, responses involving 'very high' and 'high' were combined as one entity and 'low' and 'lowest' were also combined as one entity in the discussion. Students' mean attitude scores from the table were also calculated and presented by the use of SPSS versions 16.0 to obtain the frequency distributions of the percentages and to give the interpretation of the scores. Each of the statements on the observational checklist was analysed using descriptive statistical method. In the analysis, the statements were supported with some of the comments written by students and pictures taken during simulation lessons.

3.11.2. Post-test Data Analysis

Reports were presented on the simulation lessons and analysed based on the progress of the students from Lesson to Lesson. The activities carried out, the interactions and the progression of the lessons were all grounded in the report. Discussions of the findings here were made based on the research questions one and three.

3.11.3. Analysis of Opinionnaire Data

Opinions written by students were read through carefully and coded into meaningful categories. Statements that emerged were categorised accordingly and the descriptive statistical method was used in the analysis.

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF DATA

4.1. Overview

The Data analysis of the results from the data collected were presented in this chapter. Analysis of the results was done along the three research questions posed. Reports on five Lessons were written and each of these Lessons was based on the teaching and learning activities that went on in the classroom. Opinions written by respondents were also used to support the findings from the data. Pictures taken during the observation section were also used to support expressions made from the data.

4.2. Report on Lesson 1

Topic: Digestive system in humans

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

1. Identify parts of the digestive system in humans and state their functions
2. Describe the changes that occur to different food substances as they pass through the alimentary canal.
3. Describe what happens to the end products of digestion in humans.
4. Describe how undigested food substances are eliminated from the body.
5. Draw and label digestive structure of humans.

Relevant Previous Knowledge: The researcher introduced the lesson by revising students' previous knowledge by asking them to mention some foods in which each kind of food substance can be found.

Students' response:

Food	Food Substance Obtained
Cassava, maize, sweet potatoes	Carbohydrates
Soya beans , fish	Proteins
Groundnut, palm fruit	Fats and oil

Activity 1: Identification of parts of the digestive system in humans and their functions.

The students were put into groups of two (2). Each group was given one laptop computer. Students were instructed to boot the computers and open a file named digestive system 1 from the desktop. They were instructed to watch the simulation video on digestive system 1 by critically listening and observing the parts of the digestive system of humans. They were also asked to take notice of the spellings of the parts of the digestive system. The students were instructed to listen and observe carefully the functions of the parts of the digestive system. They were guided to pause the simulation lesson for discussion with the researcher when the need arose. The students repeated the simulation videos by writing down some salient points into their notebooks.

Findings 1: The students were able to identify parts of the digestive system in humans and stated their functions as follows:

Buccal cavity (mouth): Contains teeth and tongue. Teeth break down solid food into smaller pieces. Tongue rolls the chewed food into a bolus before it is swallowed. Carbohydrate digestion begins in the mouth.

Gullet or Oesophagus: It is a muscular tube through which food (bolus) passes before it gets to the stomach. The lining of the oesophagus secretes mucus to lubricate the ball of food.

Stomach: It is a sac-like structure that receives chewed food from the buccal cavity. The walls of the stomach contain gastric gland. The gastric gland secretes gastric juice. The gastric juice contains hydrochloric acid and protein digesting system enzyme called proteases. These are pepsin and renin. Protein digestion begins in the stomach.

Small intestine: It consists of the duodenum and the ileum. It is in the small intestine that absorption of digested food occurs.

Pancreas: It produces a juice called pancreatic juice. Pancreatic juice contains three digestive enzymes namely pancreatic amylase, trypsin and lipase. Pancreas also secretes a hormone known as insulin that helps in the conversion of excess sugar to glycogen for storage in the liver.

Large intestine: It consists of the colon and rectum. It is here that undigested food substances are stored. It also absorbs water.

Gall bladder: It stores the bile that is produced by the liver.

Liver: It produces bile. Bile is not an enzyme but salt to break up fats into smaller droplets for easy digestion by enzymes.

Anus: It serves as an opening allowing undigested material to be removed from the body.

The skills acquired were manipulating, listening, observing and communicating skills. Students demonstrated these skills. The activity was carried out by the use of computer simulation videos.

Activity 2: Changes that occur to different food substances as they pass through the alimentary canal.

The students were instructed to observe the changes that occur to different food substances as they pass through the alimentary canal. The students were asked to pause the simulation videos at a point in time for discussion of the changes that occur to different food substances as they pass through the alimentary canal by the researcher. They were asked to write down some salient points from the discussion. They watched the simulation video over again to observe the changes critically.

Finding 2: Students observed the changes that occurred to different food substances as they pass through the alimentary canal. This was illustrated by students as follows:

Digestion in the buccal cavity (mouth)

- Digestion of carbohydrate (starch) begins in the mouth
- The food is chewed by the teeth into smaller pieces
- This makes it easier for digestive enzymes to act on it
- As the saliva mixes with the food, the enzyme salivary amylase breaks down the starch in the food to maltose
- The saliva makes the food soft and the tongue rolls it into bolus.
- The food is then swallowed
- The oesophagus contracts and relaxes as it pushes the food along
- This process is called peristalsis.

Digestion in the stomach

- Digestion of protein begins in the stomach
- Gastric gland in the wall of the stomach secretes gastric juice
- Gastric juice contains hydrochloric acid and two main proteases, pepsin and rennin

Digestion in the small intestine (duodenum)

- The duodenum is the first part of the small intestine
- The agents (organs) of digestion comes from the liver and the pancreas

Digestion in the small intestine (ileum)

- The ileum is the second part of the small intestine
- It is in this part of the small intestine that digestion of food is completed
- The walls of the small intestine secrete variety of enzymes called succus entericus onto the food
- The enzymes are maltase, lactase, sucrose and erepsin
- Maltase converts all maltose to glucose
- Erepsin converts all peptides to amino acids
- Sucrase converts all sucrose (sugar cane) to glucose and fructose
- Lactase converts lactose (milk sugar) to glucose and galactose
- The food is now converted into a watery emulsion called chyle
- It is from this that the products of digestion are absorbed.
- The skills acquired were observing, listening, manipulating, descriptive and communicating skills. These skills were demonstrated by the students. The activity was carried out by using computer simulation videos.

Activity3: Describing what happens to the end products of digestion in humans

Students were asked to observe from the simulation video what happens to the end products of digestion in humans. They were instructed by the researcher to pause the simulation video for discussion when necessary. Students wrote down salient points into their notebooks.

Finding 3: The students identified the end products of digestion as follows:

Food substance	**End product**
Carbohydrate (starch)	Glucose
Protein	Amino acids

Fats and oil	Fatty Acid and Glycerol

They described the absorption of the end products as follows:

- Absorption of the end products of digestion (glucose, amino acid, fatty acid and glycerol) took place in the ileum.
- Absorption occurred by simple diffusion
- The ileum is well adapted to perform this function
- The skills acquired were manipulating, observing, listening and communicating skills. The activity was carried out by watching the simulation videos on digestive system of humans.

Activity 4: Describing how undigested food substances are eliminated from the body

The students were asked to listen and observe the removal of undigested food substances from the body by watching the simulation video. The researcher discussed the process with students as they pause the simulation video.

Finding 4: Description of how undigested food substances are eliminated from the body.

Some water is absorbed from the mixture by the walls of the large intestine and the undigested food becomes semi-solid. This forms the faeces and is released from the rectum to the anus at regular intervals, together with gases produced as a result of digestion. The removal of waste undigested food substances from the body in the form of faeces is called egestion or defaecation.

Activity 5: Drawing and labelling of human digestive system

Students were asked to draw and label human digestive system. The students made individual drawings and labelled the parts of human digestive system.

Finding 5: Majority of the students were unable to draw neat and clear diagrams. The outlines of their diagrams were woolly and wavy. Also, the guidelines were provided with arrows. Again, some of the guidelines were crossing each other and some of their labelling were vertical and diagonal instead of horizontal. According to Asabere- Ameyaw and Haruna (2007) these are not accepted in biological drawings. The skills acquired were observing, communicating, listening, manipulating, drawing and labelling skills. The activity was carried out by watching the simulation videos.

Evaluation questions and students' responses

1. Label the parts of digestive system of humans.

Expected students' response: students labelled the parts as mouth, salivary gland, oesophagus, stomach, pancreas, gall bladder, duodenum, ileum, colon, rectum, and anus.

2. State functions of the parts labelled in question (1) above.

Expected students' response: Buccal cavity (mouth): Contains teeth and tongue. Teeth break down solid food into smaller pieces. Tongue rolls the chewed food into a bolus before it is swallowed. Carbohydrate digestion begins in the mouth.

Gullet or Oesophagus: It is a muscular tube through which food (bolus) passes before it gets to the stomach. The lining of the oesophagus secretes mucus to lubricate the ball of food.

Stomach: It is a sac-like structure that receives chewed food from the buccal cavity. The walls of the stomach contain gastric gland. The gastric gland secretes gastric juice. The gastric juice contains hydrochloric acid and protein digesting system enzyme called proteases. These are pepsin and rennin. Protein digestion begins in the stomach.

Small intestine: It consists of the duodenum and the ileum. It is in the small intestine that absorption of digested food occurs.

Pancreas: It produces a juice called pancreatic juice. Pancreatic juice contains three digestive enzymes namely pancreatic amylase, trypsin and lipase. Pancreas also secretes a hormone known as insulin that helps in the conversion of excess sugar to glycogen for storage in the liver.

Large intestine: It consists of the colon and rectum. It is here that undigested food substances are stored. It also absorbs water.

Gall bladder: It stores the bile that is produced by the liver.

Liver: It produces bile. Bile is not an enzyme but salt to break up fats into smaller droplets for easy digestion by enzymes.

Anus: It serves as an opening allowing undigested material to be removed from the body.

Summary of Findings from Lesson 1

Majority of the students were able to identify parts of the digestive in human and stated their functions. The following skills were acquired by the students in the lesson:

1. Manipulating skill which was acquired when the students booted the computer and opened appropriate file containing the simulation videos. This skill was also displayed when students pause the simulation video for the discussion to take place.

2. Observing skill was acquired when students watched the simulation video during the Lesson to identify and state the functions of the parts of the digestive system in human.
3. Listening skill was acquired when parts of the digestive system was pronounced in the simulation video. It was also acquired during the watching of the simulation video.
4. Communicating skills was displayed when the students followed the Researchers' instruction to open the appropriate files containing the simulation video from the computer. This was also shown by students during the discussion they had with the researcher during the lesson.

4.3. Report on lesson 2

Topic: Circulatory system in humans

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

1. List and describe the parts of the circulatory system.
2. Describe the heartbeat in humans

Relevant Previous Knowledge: Students were asked to describe what happens to the end products of digestion in humans.

Students' response: There is absorption of the end products of digestion (glucose, amino acid, fatty acid and glycerol) in the ileum. The absorption occurs by simple diffusion into the bloodstreams.

Activity 1: Description of the parts of the circulatory system in humans.

The students were put into groups of two (2). Each group was given a laptop computer by the researcher. They were asked to boot the computers and open the file (circulatory system 1) containing the simulation videos on circulatory system of humans. They were instructed by the researcher to watch and listen carefully to the parts of the circulatory system as it was described in the simulation video. They were asked to listen to the pronunciations of the parts and also their correct spellings. At a point in time, they were asked to pause the simulation video for discussion to be made. The students repeated the simulation videos by writing down some key points in to their notebooks.

Finding 1: The students were able to describe the parts of the circulatory system in humans as follows: Parts of the circulatory system of humans are Blood, Heart and Blood vessels.

Blood: Blood is fluid substance that circulates in the arteries and veins of the body. In humans and other higher animals like dogs, it is red in colour. This is because it contains a red pigment called haemoglobin. The human blood consists of a liquid part called blood plasma and a solid part called blood cells.

The Human Heart: The heart is a pear-shaped organ found in the thoracic cavity (chest region) between the lungs. It is made up of muscles. The heart consists of four mascular walled parts called chambers. These are left ventricle, right ventricle, left auricle (atrium) and right auricle (atrium). Walls of the ventricles are thicker than walls of the auricles. The auricles pump blood short distance into the ventricles. The heart is connected to blood vessels. Major blood vessels include aorta, pulmonary artery, pulmonary vein, anterior and posterior vena cava.

Blood vessels: Blood vessels are channels through which blood flows around the body. They form a complex network of tubes throughout the body. The function of the blood vessels is to transport blood throughout the body. The types of blood vessels are arteries, capillaries and veins. The skills acquired were manipulating, listening, observing and communicating skills. Students demonstrated these skills during the simulation lesson. The activity was carried out by the use of the computer simulation videos.

Activity 2: Describing the heartbeat in humans.

The students were asked to boot the computer and open a file containing the simulation video (heartbeat in humans). The researcher instructed them to watch the simulation video carefully. Students were asked to pause the simulation video for class discussion. The researcher went round to assist students when the need arose. Students wrote down some key points into their notebooks.

Findings 2: The students described the heartbeat in humans as follows: The pumping action of the heart to distribute blood to all parts of the body is what creates the heartbeat. The brain is the main organ that controls the rate of heartbeat. Heartbeat is considered in two stages. These are systolic phase and diastolic phase. Systolic phase occurs when the auricles and ventricles contract to pump blood to all parts of the body. Diastolic phase is a resting period during which all the heart chambers relax. The cycle then repeats. One systole and diastole make up one complete heartbeat and this lasts approximately 0.8 seconds. The human heart beats on average 72-75 times per minute. It beats over and over again, day and night. The heart beat faster to pump more blood when we run faster or during exercise. This is because the body needs more oxygen to produce energy. The skills acquired were manipulating skill, observing skill and communicating skill. Simulation videos were used.

Evaluation questions and students' responses

1. Describe the following parts of the circulatory system.

a. Blood

b. The heart

c. Blood vessels

Expected students' response: *Blood:* Blood is fluid substance that circulates in the arteries and veins of the body. In humans and other higher animals like dogs, it is red in colour. This is because it contains a red pigment called haemoglobin. The human blood consists of a liquid part called blood plasma and a solid part called blood cells.

The Human Heart: The heart is a pear-shaped organ found in the thoracic cavity (chest region) between the lungs. It is made up of muscles. The heart consists of four mascular walled parts called chambers. These are left ventricle, right ventricle, left auricle (atrium) and right auricle (atrium). Walls of the ventricles are thicker than walls of the auricles. The auricles pump blood short distance into the ventricles. The heart is connected to blood vessels. Major blood vessels include aorta, pulmonary artery, pulmonary vein, anterior and posterior vena cava.

Blood vessels: Blood vessels are channels through which blood flows around the body. They form a complex network of tubes throughout the body. The function of the blood vessels is to transport blood throughout the body. The types of blood vessels are arteries, capillaries and veins.

2. **Describe how the heartbeat occurs in humans**

Expected students' response: The pumping action of the heart to distribute blood to all parts of the body is what creates the heartbeat. The brain is the main organ that controls the rate of heartbeat. Heartbeat is considered in two stages. These are systolic phase and diastolic phase. Systolic phase occurs when the auricles and ventricles contracts to pump blood to all parts of the body. Diastolic phase is a resting period during which all the heart chambers relax. The cycle then repeats. One systole and diastole make up one complete heartbeat and this lasts approximately 0.8 seconds. The human heart beats on average 72-75 times per minute. It beats over and over again, day and night. The heart beat faster to pump more blood when we run faster or during exercise. This is because the body needs more oxygen to produce energy.

Summary of Findings from lesson 2

Majority of the students were able to describe the blood, the heart and blood vessels as part of the circulatory system. The following skills were demonstrated by the students in this lesson:

1. Manipulating skill was demonstrated when students booted the computer and opened the appropriate file containing the simulation video on circulatory system. It was also displayed by students when they paused the simulation video for discussion with the researcher.
2. Observing skill was displayed when students watched the simulation videos which described parts of the circulatory system and also the heartbeat in humans.
3. Communicating skill was demonstrated when the researcher discussed aspects of the simulation videos with students. This was displayed again when students discussed issues under the simulation topics during the lesson.
4. Descriptive skill was displayed when students described how the heartbeat occurred in humans.

4.4. Report on lesson 3

Topic: Circulatory system in humans.

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

1. State the functions of each type of blood vessels.
2. Compare the differences between arteries and veins.
3. Describe how blood circulation occurs in humans

Relevant Previous Knowledge: Students were asked to state the types of blood vessels in humans.

Students' response: Arteries, veins and capillaries.

Activity 1: Functions of each type of blood vessels in humans.

The students were put into groups of two (2). Each group was provided with a laptop computer. The researcher instructed the students to open the file (circulatory system 3) containing the simulation video on circulatory system in humans. They were instructed to observe and listen critically to the types of blood vessels and their functions. The researcher asked students to pause the simulation video for discussion when it became necessary. Students wrote down some key points from the simulation video into their notebooks.

Findings 1: The students stated and explained the functions of each type of blood vessels as follows:

Functions of arteries

- Transport blood away from the heart
- Transport oxygenated blood only (except pulmonary artery that transports de oxygenated blood).

Functions of veins

- Veins transport blood to the heart
- They transport deoxygenated blood only (except pulmonary vein that transport oxygenated blood.

Functions of capillaries

- They allow exchange of materials (oxygen, carbon dioxide, water and salts between the blood and the surrounding body tissues.
- They supply tissues with oxygen, water and nutrients carried by the blood and remove waste substances such as carbon dioxide from the surrounding cells.

The skills acquired were manipulating, listening, observing and communicating skills. These skills were demonstrated by the students during the simulation lesson.

Activity 2: Differences between arteries and veins

The students were instructed to open the appropriate file (arteries and veins) containing the simulation video. They were asked to watch the simulation video by identifying the differences between arteries and veins. The researcher asked students to pause the simulation video for discussion at some point in time when it became necessary. Students were instructed to write down key points into their notebooks.

Findings 2: Students described the differences between arteries and veins as follows:

Differences between arteries and veins

Arteries	Veins
1. Transport blood away from the heart 2.Carry oxygenated blood 3.Have relatively narrow lumen 4.Have relatively more muscle and elastic tissues 5.Transport blood under high pressure 6.Have thick walls 7.Do not have valves	1. Transport blood towards the heart 2.Carry de oxygenated blood 3.Have relatively wide lumen 4. Have relatively less muscle and elastic tissues 5.Transport blood under low pressure 6. Have thin walls 7.Have valves

The skills acquired by students during this simulation lesson are manipulating skill, observing skill, listening skill and communicating skill.

Activity 3: Describing how blood circulation occurs in humans

Students were asked to observe from the simulation video how blood is circulated in human body. They were instructed by the researcher to pause the simulation video for discussion when the need arose. Students wrote down key point into their notebooks.

Finding 3: Students described how blood circulation occurs in humans as follows:

- During breathing in, atmospheric oxygen is taken into the capillaries of the lungs.
- Oxygen in the capillaries of the lungs combines with haemoglobin of the red blood cell to form oxyhaemoglobin.
- At the same time, food nutrients such as glucose and amino acids are absorbed into the bloodstream through the small intestines. The blood becomes oxygenated.
- Oxygenated blood from the lungs enters the left auricle (atrium) of the heart through the pulmonary vein.
- The left atrium contracts and the blood now move to the left ventricle through biscuspid valve.
- Left ventricle contracts and pumps the oxygenated blood into the aorta.
- Blood from the aorta is sent to all parts of the body.

- The blood now becomes deoxygenated and it flows into the vena cava, into the right atrium, then to the right ventricle and finally the lungs for oxygenation and the cycle is repeated. The skills acquired by students during this simulation lesson are observing skill, communicating skill, listening skill, descriptive skill, comparing skill and manipulating skill.

Evaluation questions and students' responses

1. State the functions of each type of blood vessels.

Expected students' response: *Functions of arteries*

- Transport blood away from the heart
- Transport oxygenated blood only (except pulmonary artery that transports de oxygenated blood).

Functions of veins

- Veins transport blood to the heart.
- They transport deoxygenated blood only (except pulmonary vein that transport oxygenated blood.

Functions of capillaries

- They allow exchange of materials (oxygen, carbon dioxide, water and salts between the blood and the surrounding body tissues.

- They supply tissues with oxygen, water and nutrients carried by the blood and remove waste substances such as carbon dioxide from the surrounding cells.

2. Describe how blood circulation occurs in humans.

   - *Expected students' response:* During breathing in, atmospheric oxygen is taken into the capillaries of the lungs.

- Oxygen in the capillaries of the lungs combines with haemoglobin of the red blood cell to form oxyhaemoglobin.
- At the same time, food nutrients such as glucose and amino acids are absorbed into the bloodstream through the small intestines. The blood becomes oxygenated.
- Oxygenated blood from the lungs enters the left auricle (atrium) of the heart through the pulmonary vein
- The left atrium contracts and the blood now move to the left ventricle through biscuspid valve.
- Left ventricle contracts and pumps the oxygenated blood into the aorta.
- Blood from the aorta is sent to all parts of the body

The blood now becomes deoxygenated and it flows into the vena cava, into the right atrium, then to the right ventricle and finally the lungs for oxygenation and the cycle is repeated.

Summary of Findings from lesson 3.

Majority of the students stated the functions of each type of blood vessels in humans. Majority of them were also able to describe how blood circulation occurs in humans.

4.5. Report on lesson 4

Topic: Photosynthesis

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

1. Describe the process of photosynthesis
2. Describe the internal structure of a leaf
3. State the functions of the leaf.

Relevant Previous Knowledge: Students were asked to mention the primary source of energy in the ecosystem.

Students' response: sun

Activity 1: Describing the process of photosynthesis

The students were put into groups of two (2). Each group was given a laptop computer by the researcher. Students were instructed to boot their computers and open a file (photosynthesis) containing the simulation video from the desktop. They were asked to observe and listen critically to the process of photosynthesis from the simulation video. At a point in time, students were asked to pause the simulation video for discussion to be done on some aspects of the simulation video. Students also paused simulation video to write down some key points into their notebooks.

Finding 1: The students described the process of photosynthesis as follows:

- The part of the plant where photosynthesis occurs is the leaf.

- The leaf contains chlorophyll and stomata.
- Chlorophyll is the green colouring matter in the leaf. It is used by plants to trap energy from sunlight.
- The stomata are tiny pores occurring in the surface of the leaf. They allow carbon dioxide from the atmosphere to enter the leaf.
- The roots of plants absorb and transport water and dissolved mineral salts from the soil through the stem to the leaf.
- The raw materials namely carbon dioxide, water and dissolved mineral salt are now available to the plant.
- They are converted into sugar by the leaf using the energy acquired from the sun.
- During the process, oxygen is produced as by-product.
- Later, some of the sugar produced is converted to starch as plant food
- They are stored as tubers as in cassava, fruits as in pawpaw and mango or in the leaf as in cabbage and lettuce
- The plant uses the rest of the sugar it makes in the following ways:

1. To generate energy through respiration

2. To make protein with the addition of nitrogen and sulphur from the mineral salts

3. To make fats and oil

4. To make cellulose to build new cells. The skills acquired by students were observing skills, manipulating skills, descriptive skill and communicating skills. These skills were demonstrated during the simulation lessons.

Activity 2. Describing the internal structure of the leaf

The researcher mentioned the name of the file (photosynthesis 1) to students to open from the desktop of the laptops. Students were instructed to watch the simulation video and observe the process critically. Students were asked to pause the simulation video for discussion. Students wrote down some key points in their notebooks.

Finding 2: Students described the internal structure of a leaf as follows:

Internal structure of a leaf and its function

Internal structure of a leaf	Function
1. Upper and lower epidermis	Protect the inner layer of cells of a leaf
2. Stomata	They are tiny pores that are present in the epidermis of a leaf. It is through the stomata that water vapour and other gases such as oxygen and carbon dioxide get to the plant
3. Guard cells	These are cells that surround the stomata. They control the opening and closing of stomata
4. Palisade and Mesophyll cells	These are cells that contain chloroplasts. Chloroplasts contain chlorophyll. It is in these cells that photosynthesis occurs

- Xylem cells are cells in the leaf, stem and leaf that transport water and dissolved mineral salts from the soil to the leaf of plants.
- Phloem cells are cells in the leaf, stem and root that carry the food that is made in the leaf to other parts of the plant. The skills acquired were manipulating skills, observing skills and communicating skills.

Activity 3. Stating functions of the leaf

The students were directed by the researcher to open the file (photosynthesis 2) containing the simulation video. The researcher instructed them to watch the simulation video by paying attention to the functions of the leaf. Students were asked to pause the simulation video for discussion to be done with the researcher. Key points were written down by the students into their notebooks.

Finding 3: Students stated the functions of the leaf as:

1. The leaf manufactures food for the plant
2. Respiration (gaseous exchange) takes place through the stomata of leaf
3. Transpiration takes place through the stomata of leaf
4. Leaves of some plants can reproduce vegetatively (e.g Bryophyllum). The skills acquired by the students from this lesson were manipulating skills, communicating skills and observing skills.

Evaluation questions and students' response

1. Describe the process of photosynthesis.

Expected students' response: Students described the process of photosynthesis as follows:

- The part of the plant where photosynthesis occurs is the leaf.
- The leaf contains chlorophyll and stomata
- Chlorophyll is the green colouring matter in the leaf. It is used by plants to trap energy from sunlight.
- The stomata are tiny pores occurring in the surface of the leaf. They allow carbon dioxide from the atmosphere to enter the leaf.

- The roots of plants absorb and transport water and dissolved mineral salts from the soil through the stem to the leaf.
- The raw materials namely carbon dioxide, water and dissolved mineral salt are now available to the plant.
- They are converted into sugar by the leaf using the energy acquired from the sun.
- During the process, oxygen is produced as by-product.
- Later, some of the sugar produced is converted to starch as plant food
- They are stored as tubers as in cassava, fruits as in pawpaw and mango or in the leaf as in cabbage and lettuce

2. State the functions of the leaf

Expected students' response:

1. The leaf manufactures food for the plant
2. Respiration (gaseous exchange) takes place through the stomata of leaf
3. Transpiration takes place through the stomata of leaf
4. Leaves of some plants can reproduce vegetatively (e.g Bryophyllum). The skills acquired by the students from this lesson were manipulating skills, communicating skills and observing skills.

Summary of Findings from lesson 4

Majority of the students were able to describe the process of photosynthesis. Again, majority of them stated the functions of the leaf correctly.

4.6. Report on lesson 5

Topic: Respiration system in humans

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

1. State the roles of the parts of the human respiratory system
2. Explain the process of breathing
3. Draw and label human respiratory system

Relevant Previous Knowledge: Students were asked to mention the organ through which air passes into the human body.

Students' response: Nostril/Nose

Activity 1: Stating the role of the parts of human respiratory system

The students were put into groups of two (2). Each group was provided with a laptop computer. They were instructed to open a file (respiratory system) containing the simulation video from the desktop. Students were asked to watch the simulation video by observing critically the role of each part of the human respiratory system. During the lesson students were asked to pause the simulation video for discussion to be done with the researcher. They noted key points down into their notebooks.

Finding 1: The students stated the role of the parts of human respiratory system as:

Nostril

- It allows the passage of air

- It has hair-like structure that filter out larger dust particles from the incoming air stream. The filtering prevents air bone bacteria, virus and other substances that are potential in causing infection from entering the lungs.
- It also contains mucus which moistens and then warms the incoming air. This is to protect the structure in the respiratory system.

Trachea

- Air from the larynx enters the trachea
- It contains mucus and cilia to trap dust particles and bacteria in the air.
- It also warms and moistens the air
- The trachea split into two short tubes called bronchi

Bronchus

- It allows the passage of air
- Its cells are lined with cilia and mucus that trap dust particles and also moistens the air
- It splits into numerous smaller branches called bronchioles.

Bronchiole

- It allows the passage of air
- Contains cilia and mucus that trap dust particles
- It ends in a bunch of tiny air sacs called alveoli (alveolus) from which gaseous exchange occurs.

Alveoli

- Air from bronchioles enter the alveoli
- The alveoli have moist surfaces
- Their walls are very thin and elastic and are richly supplied with blood capillaries
- They have very large surface area, which enhances gaseous exchange
- They contain white blood cells that ingest any bacteria and foreign matter that pass down the respiratory bronchioles to reach the alveolar lining. The skills acquired by students during the simulation lesson were manipulating skills, observing skills and communicating skills.

Activity 2: Explaining the process of breathing

Students were instructed to open a file (respiratory 2) from the desktop of the laptops. They were asked to observe the process of breathing in humans from the simulation video. Students were asked to pause the simulation video at a point in time to have discussion with the researcher. After that they continued to watch the simulation video to the end.

Finding 2: Students explained the process of breathing as follows:

Breathing consists of two processes. These are

1. Breathing in or inspiration or inhalation
2. Breathing out or expiration or exhalation

Breathing in

- During breathing in, the intercostal muscles of the ribs contract which cause the ribs and sternum to move up and out.
- This result in the increase of the volume of the thorax (chest cavity)

- Air pressure around the lungs therefore decreases
- At the same time, muscles of the diaphragm contract, causing it to become flattened.
- The volume of thorax increases further and air pressure in the lungs decreases
- Because of this, atmospheric air pressure forces air into the alveoli of the lungs through the nostril, pharynx, trachea, bronchi and bronchioles.

Breathing out:

- During breathing out, all the processes are reversed
- First, the intercostals muscles relax and the ribs and sternum move down and in
- These movements reduce the volume of the thorax and increase air pressure around the lungs
- At the same time, muscles of the diaphragm relax causing it to become dome-shaped
- The volume of thorax decreases further and air pressure in the lungs increases
- As a result, air is forced out of the lungs from the alveoli, bronchioles, bronchi, pharynx and nostrils. The skills acquired by students were manipulating skill, observing skill and communicating skill.

Activity 3: Drawing and labelling of human respiratory system

Students were asked to draw and label human respiratory system. The students made individual drawings and labelled the parts of human respiratory system.

Finding 3: Majority of the students were able to draw neat and clear diagrams. The outlines of their diagrams were not woolly and wavy. Also, the guidelines were not provided with arrows. In addition, the guidelines were not crossing each other and all of their labelling were neither vertical nor diagonal instead, they were all horizontal. The skills acquired were manipulating skill, observing skill, communicating skill, drawing and labelling skill.

Evaluation questions and students' responses

1. Draw and label human respiratory system

Expected students' response: Students drew and labelled the parts as nostril, trachea, lung, bronchus, bronchiole, rib, alveolus, diaphragm and intercostals muscle. Students provided title of the diagrams drawn.

2. State the role of the following human respiratory system labelled in question (1) above.

a. Bronchus
b. Alveoli
c. Trachea
d. Nostril

Expected students' response: Students stated the role of the above parts of the human respiratory system listed above as follows:

Bronchus

- It allows the passage of air
- Its cells are lined with cilia and mucus that trap dust particles and also moistens the air

- It splits into numerous smaller branches called bronchioles.

Alveoli

- Air from bronchioles enter the alveoli
- The alveoli have moist surfaces
- Their walls are very thin and elastic and are richly supplied with blood capillaries
- They have very large surface area, which enhances gaseous exchange

Trachea

- Air from the larynx enters the trachea
- It contains mucus and cilia to trap dust particles and bacteria in the air.
- It also warms and moistens the air
- The trachea split into two short tubes called bronchi

Nostril

- It allows the passage of air
- It has hair-like structure that filter out larger dust particles from the incoming air stream. The filtering prevents air bone bacteria, virus and other substances that are potential in causing infection from entering the lungs.
- It also contains mucus which moistens and then warms the incoming air. This is to protect the structure in the respiratory system.

Summary of Findings from lesson 5

Majority of the students were able to state the roles of the parts of the human respiratory system. Additionally, majority of them were able to explain the process of breathing in humans. This was displayed by students because they understood lessons taught using the simulation videos.

Discussion

4.7. Research question 1

How does Computer Simulation enhance students' understanding of selected concepts in Integrated Science?

From the interaction the researcher had with the students before the introduction of the simulation lessons, it was discovered that students did not understand some selected topics taught them using traditional method in teaching and learning Integrated Science. Most especially topics that were abstract in nature such as circulatory system in human, digestive system in human, photosynthesis and respiratory system in human. It was evident that most of the students were unable to describe some biological processes that occur in humans because most of them said they were complex to learn when traditional method was used in teaching and learning of these topics. This led to inactive involvement of students during the teaching and learning of these topics. In answering this question, the information gathered was based on conceptual understanding of biological concepts taught students using the simulation videos. Also, classroom interactions that occurred within the five lessons were analysed.

In lesson 1, manipulating, observing and communicating skills were acquired by the students. Majority of the students were able to describe the changes that occur to different food substances as they pass through the alimentary canal. During the discussion, almost all the students described correctly what happens to the end products of digestion in humans. In doing so, communicating skill and descriptive skill were acquired. Majority of them were able to pause the simulation video and wrote down some key points in their notebooks. By doing so, manipulating skill was acquired. Majority of the students described how undigested food substances were eliminated from the human body.

In lesson 2, almost all the students were able to describe how the heartbeat occurs in humans. In the lesson, manipulating, observing, descriptive and communicating skills were acquired by the students. It was found out that, students' descriptive, observing and manipulating skills had improved. With the descriptive skill, almost all the students were able to describe how the heartbeat occurs in humans. During the class discussion, majority of the students explained the concept of pressure under which the heart pumped the blood. With the observing skills, all the students observed that pumping action of the heart to distribute blood to all parts of the body was what created the heartbeat. Also, they observed that, the systolic phase occurs when the auricles and ventricles contract to pump blood to all parts of the body; and the diastolic phase is a resting period during which all the heart chambers relaxed.

In lesson 3, manipulating, observing, descriptive and communicating skills were acquired by the students. The manipulating skill was acquired when students opened appropriate files containing the simulation video from the desktops of the laptops and also when they were able to pause simulation videos for discussion with the researcher and also during the period they paused the simulation video to write down key points in their notebooks. With the observing skills all the students observed that, oxygenated blood from the lungs enters the left auricle (atrium) of the heart through the pulmonary vein. They also observed that, the left atrium contracts and the blood now moves to the left ventricle through the biscuspid valve. The students explained that, in the tissues, exchange of materials occurs by simple diffusion. They discovered that, oxygen in the blood together with other useful substances (glucose, amino acids etc) are released to the cells and carbon dioxide, urea and salts from the cells enter the blood. The students observing, manipulating and descriptive skills had improved drastically. All the students became aware that, deoxygenated blood flows into the vena cava, into the right atrium, then to the right ventricle and finally to the lungs for oxygenation and the cycle is repeated. They all discovered that this type of circulation in humans is called double circulation. Majority of the students described correctly how blood circulation occurs in human body.

In lesson 4, manipulating, observing, descriptive and communicating were the skills acquired by students. With the manipulating skill, all the students were able to open, pause and close all simulation videos. They paused simulation videos to write down key points in their notebooks. With the descriptive skill, almost all the students were able to describe the process of photosynthesis. They discovered that, the leaf contains chlorophyll and stomata. Students noticed that, the roots of plants absorbed and transported water and dissolved mineral salts for photosynthesis to occur. They found out that, during the process of photosynthesis, oxygen was produced as by-product and some of the sugar produced was converted to starch as plants food. Students communicating skills had improved during the discussion held with the researcher. All the students observed the internal structure (upper and lower epidermis, stomata, guard cells, palisade and mesophyll cells) of a leaf. Students became aware that, the leaf manufactures food for the plant, gaseous exchange takes place through the stomata of the leaf, transpiration takes place through the stomata of the leaf, leaves of some plants can reproduce vegetatively (e. g Bryophyllum).

In lesson 5, manipulating, observing, descriptive, communicating, drawing and labeling skills were acquired by the students. With manipulating skill, students were able to open, pause and stop simulation videos. They were also able to shutdown the computers at the end of the simulation lessons. With the observing skill, all the students observed the human respiratory structure and the process of breathing in humans. Students discovered that during breathing in, the intercostals muscles of the ribs contracts which cause the ribs and sternum to move up and out. Also during breathing out, the intercostals muscle relax and the ribs and sternum move down and in. The students found that, the volume of thorax decreased further and air pressure in the lungs increases during breathing out. They again discovered that, the volume of thorax increases further and air pressure in the lungs decreases during breathing in. The students' drawings this time had improved drastically as they avoided woolly and wavy outlines and guidelines without arrow heads. All labeling were horizontal not vertical or diagonal this time. Guidelines did not cross each other. The students drew the human respiratory structure and labeled the following parts: Trachea, alveolus, bronchus, bronchioles, diaphragm, lungs and ribs.

Based on the quality of responses provided by the students during the simulation lesson, it is clear that computer simulation support system had improved the students' understanding of concepts in digestive system of humans, circulatory system of humans, photosynthesis and respiratory system of humans. Students' comments confirmed this as follows:

Students: *We really understood the digestive system taught using the computer simulations and we will not forget it (opinion of students). Refer to Appendix F.*

Students: *Circulatory system was an exciting topic and we understood it very well. We were surprised that the heart beats 100000 times a day (opinion of 86 (97.7%) students). Refer to Appendix F.*

Students: *We really enjoyed watching the video on photosynthesis.* Some of them even expressed their views that, *we were taught this topic in our former schools but did not understand it.* They confirmed that upon watching the simulation video, *we understood it and never shall we forget it (opinions of students). Refer to Appendix F*

Students: *Respiratory song from the respiratory video helped us to learn and understand the topic very well.* Some even expressed their opinion that *when any question was asked on the topic, we just sang the respiratory song and that enabled us to answer any of the questions on respiratory system (opinions of students).*

These opinions seems to be in agreement with the works of Paricer (1998), Akinsola (2003), and Poripo (2008), who indicated that simulation used in teaching and learning promote better understanding of concepts. This was also consistent with the findings of Dickerson, Huang and Russell (2001) who are of the same view that students can gain a better understanding of the underlying concepts of a system, task, or algorithm by studying it through simulation. Similarly, Liu and Su (2011) found out that simulations loaded with multimedia features like audio, video and different formats of information increase the cognitive workload thereby affecting learning.

4.8. Research Question 2

In what ways will the use of Computer Simulations in teaching and learning selected topics improve upon Junior High School two students' attitudes in Integrated Science in University Practice North Campus School?

In order to answer this research question, results from observational checklist which was used to trap students' attitude in class during computer simulation lesson was used. Table 1 shows the result of the frequency distribution and their corresponding percentages of the various attitudes that were anchored on a four point scale ranging from 'very often', 'often', 'never' and 'sometimes'. Very often and often were combined to be one item, while never and sometimes were considered as separate entities. This was used for items 1-11. Table 2 also shows the result of the frequency distributions and their corresponding percentages of the various attitudes which were anchored on a four point scale ranging from 'very high', 'high', 'low' and 'lowest'. For easy analysis, both very high and high were combined as one entity and also, low and lowest were also combined as one entity.

Table 1: Students' attitudes (Items 1-11) during the teaching and learning of Simulation Lessons

Statement	Frequencies	%Frequencies	
	Often	Never	Sometimes
1. Fighting over computers for simulation lessons	3(12.5%)	10 (41.6%)	11(45.8%)
2. Struggle for space for simulation lessons	-	13 (54.1%)	11(45.8%)
3. Fidgeting with irrelevant materials unrelated to topic understudy	-	24 (100%)	-
4.Talking in class on issues unrelated to topic under study	1(4.16%)	23 (95.8%)	-
5. Asking questions for clarifications in order to know more on topic understudy	23(95.8%)	-	1(4.16%)
6.Students ask permission to go out	-	24 (100%)	-
7.Sleeping or dozing while in class	-	24 (100%)	-
8. Students-students interaction in class	23(95.8%)	-	1(4.16%)
9. Students- teacher interaction in class	22(91.6%)	-	2(8.33%)
10. Punctuality with which students attend class	24 (100%)	-	-
11.At the end of the lesson, students were rushing to the teacher for an interaction	22(91.6%)	-	2(8.33%)

4.9. Discussion of results from Table 1 on students' attitudes (Items 1-11) during the teaching and learning of Simulation Lessons.

The results from Table 1 revealed that, on item 1 which was on whether students fight over computers for simulations lessons or not, only 3(12.5%) of the students were observed often behaving that way. 10 (41.6%) of such attitudes never occurred and 11(45.8%) of such attitudes sometimes occurred. The results reflected this because, students did not have a computer laboratory and they were using laptops which were charged somewhere and brought to be used for the simulations lessons in the classrooms. Therefore, students were asked to sit at their places in the classroom as the instructor distributed the laptops to them. This was done to avoid students causing damage to the laptops if they were asked to pick them themselves.

On item 2 which was on students struggling for space for simulation lessons, the data revealed that, 11(45.8%) of the attitude sometimes occur, 13(54.1%) never occur and 0(0%) of the attitude often occur. This may occur because, the computer simulation lessons took place in their various classrooms, so students just resume their normal sitting positions for the simulation lessons. Considering item 3 which is on students fidgeting with irrelevant materials unrelated to topic understudy, 24(100%) of such attitude never occurred in class. This means none of the students never put up such attitude in class. This probably may be due to how interesting the simulation videos were. So, students' attention was captured during teaching and learning of simulation lessons. These are comments from students:

> **Students:** *The video was very interesting and we have never watched such simulation videos in our lives. The video had made us to like science very much and we wish all the teachers use the laptops to teach us. (Opinions by students). Refer to Appendix F*

This is also a kind of intrinsic motivation provided for students to learn. The statement appears to support the work of the following authors. Alessi and Trollip (1999) suggested a number of ways that could enhance intrinsic motivation such as: use of game technique; use of audio, visual and audio- visual technique increase students intensity of work, attention and encourage deeper cognitive processing. Carol (1997), Christman, Budgett and Lucking (1997), have suggested that the computer can be an ideal medium for developing such motivation. The motivational function of the computer has been considered an important factor in many computer based instructional programmes (Furlong, Barton, Miles, Whiting & Whitty 2000). These studies show that intrinsic features of the computer such as immediate feedback, animation, sound, active interaction and individualization are more likely than any other media to motivate students to learn.

Considering item 4, which is on students talking in class (on issues unrelated to topic under study), only 1 (4.16%) of such attitude occured and 23(95.8%) of such attitude never occur among the students. This result may reveal how motivated students were during simulation lessons. Confirmation from students is as follows:

Students: *We wish the simulation lessons continue because it had helped us understood some topics we find difficult. We really loved science class because of the simulation lessons (Opinions of students). Refer to Appendix F*

A study by Carol (1997), noted specifically that the use of computers in teaching and learning provide motivational activities. This statement appears to support that of the students. With reference to item 5 which spelt out whether students ask questions for clarification in order to know more on topic under study or not, majority 23 (95.8%) of such attitude was often observed among students whiles only 1 (4.16%) of such attitude sometimes occur. This may be due to some interesting issues that they have watched from the simulation video which they want further clarification on. Again, it can be deduced from the result that, the simulation lessons have motivated students and arouse their interest during the learning process. That is why majority of them were asking questions for clarifications in order to know more on the study. Students commented as follows:

Students: *The simulation lessons were very interesting and we enjoyed it a lot (Opinion of students).*

Haddad and Jurich (2003) reported that simulation is often used to stimulate students' interests in a topic in order to promote active learning of problem solving and the study process. This can be emotionally stimulating as well as being intellectually rewarding and can encourage them to learn more. This statement seems to support that of students. Item 6, which is on students asking permission to go out or not, all students 24(100%) out of the total number of 24(100%) never show up such attitude during simulation lessons. This may be due to the motivation and interest students have towards teaching and learning of science through simulation lessons. This statement manifested from comments written by students:

Students: *What a fantastic lesson. We really enjoyed learning these topics through computer simulation (opinions of students).*

The findings of the following authors seems to support students opinions. Heinich, Molenda, Russel and Smaldino (2002) stated that various emotional factors have been found to influence what we pay attention to, how long we pay attention, how much effort we invest in learning and how feeling may interfere with learning. A study by Koumi (1994) found out that computers were good motivators that heightened students' interest and enjoyment and were also seen to have a positive effect upon the status of the subject. Carol (1997) also reported that several heads of department (HODs) in her study noted the benefits of technology in terms of pupils' motivation gained from the use of computers. The integration of computers in the curriculum can help to heighten students' motivation to learn and introduce them to variety of new learning experiences. Similarly, Azita (1999) noted that motivation can also do much to increase students' interest thereby helping them to learn difficult subjects like science and mathematics.

Taking into consideration item 7 on students sleeping or dozing while in simulation class, none of the student was seen putting up such an attitude. From Table 1, 24(100%) of such attitude never occur among students. This demonstrated how interesting the simulation lesson was and how motivated students are in the teaching and learning process. Comment from students supported this:

Students: *Simulation lessons were always lively and interesting so we do not get bored (Opinion of students).*

Figure 2: Interest shown by student during simulation lesson.

A research conducted by Odera (2011) revealed that majority of HODs reported that computer motivates students to learn various subjects. They indicated that once the learners are motivated they concentrate and learn effectively so computer arouses learner's curiosity and creative thinking. Furthermore, computer teachers were asked to identify what they felt to be the main impact of computer on motivating students' learning. They were also asked to state whether they could think of specific examples when students' learning was motivated and stimulated or enhanced by computer programmes. It was reported that, in response, the majority of the interviewees noted that students are motivated to learn when they use computer technology. One of the teachers reported that "*there is no sleeping during computer class, a sign that they appreciate their use of computers and what they learn from them. It increases students desire to learn. They are normally very happy and this enables them to learn even more on their subject areas.* This appears to be in line with the students comments.

With reference to item 8, there was very high number of students 23(95.8%) who were seen interacting with each other during simulation lessons. This observation may be due to students discussing interesting and unclear aspect of the simulation video since students sit in twos for simulation lessons. Students expressed their opinions as follows:

> **Students:** *During the simulation lessons, we have heard that, some plants eat insects and we discussed that among ourselves.*

The idea of Zhao and Zhao (2009) seems to support that of students that, performance of computer simulation software helps to promote students' interest in learning and also encourage students to bring forth new ideas. Only 1 (4.16%) of such attitude was seen sometimes occurring among students. This may reveal some learning styles of some students who always want to learn alone but not in a group. A study conducted by Odera (2011) on whether the use of computer in teaching and learning increases students desire and make them want to learn, the response from the learners showed that majority of them (85%) agreed that computers heighten students' interest and make them want to learn on their own. With this notwithstanding, Kozma (1999) is of the view that, technology in science offers benefits for inquiry-based learning, providing support for communication and expression and the ability to present interaction with information in a variety of formats. The result from Table 1 on item 9 which was to find out whether there was student-teacher interaction in class or not, 22(91.6%) of the attitude occur most often while only 2(8.33%) of such attitude sometimes occur. This may be as a result of students asking for all kinds of assistance from the teacher such as asking for the steps involved in opening appropriate folder even though the teacher might have done that earlier on. It could also be some students having problem with the volume of their laptops hence they may call for assistance from the teacher. Some students who cannot wait to the end of the simulation lesson may be seen asking the teacher interesting questions from the video as lesson is ongoing. Few of the students who sometimes had interaction with the teacher during simulation lessons may be that, they had much knowledge on how they could use the laptops and if there was any discussion they wanted to have with the teacher, they would like to do that, at the end of the lesson so that they could concentrate on watching of the simulation lesson. Students commented as follows:

> **Students:** *Apart from acquiring knowledge in science, we have also learnt new ICT skills from the teacher as she operated the simulation video from our laptops. Again, because the simulation lesson was so much interesting, we do not want to discuss a lot of issues with the teacher during the lesson but rather after the lesson.*

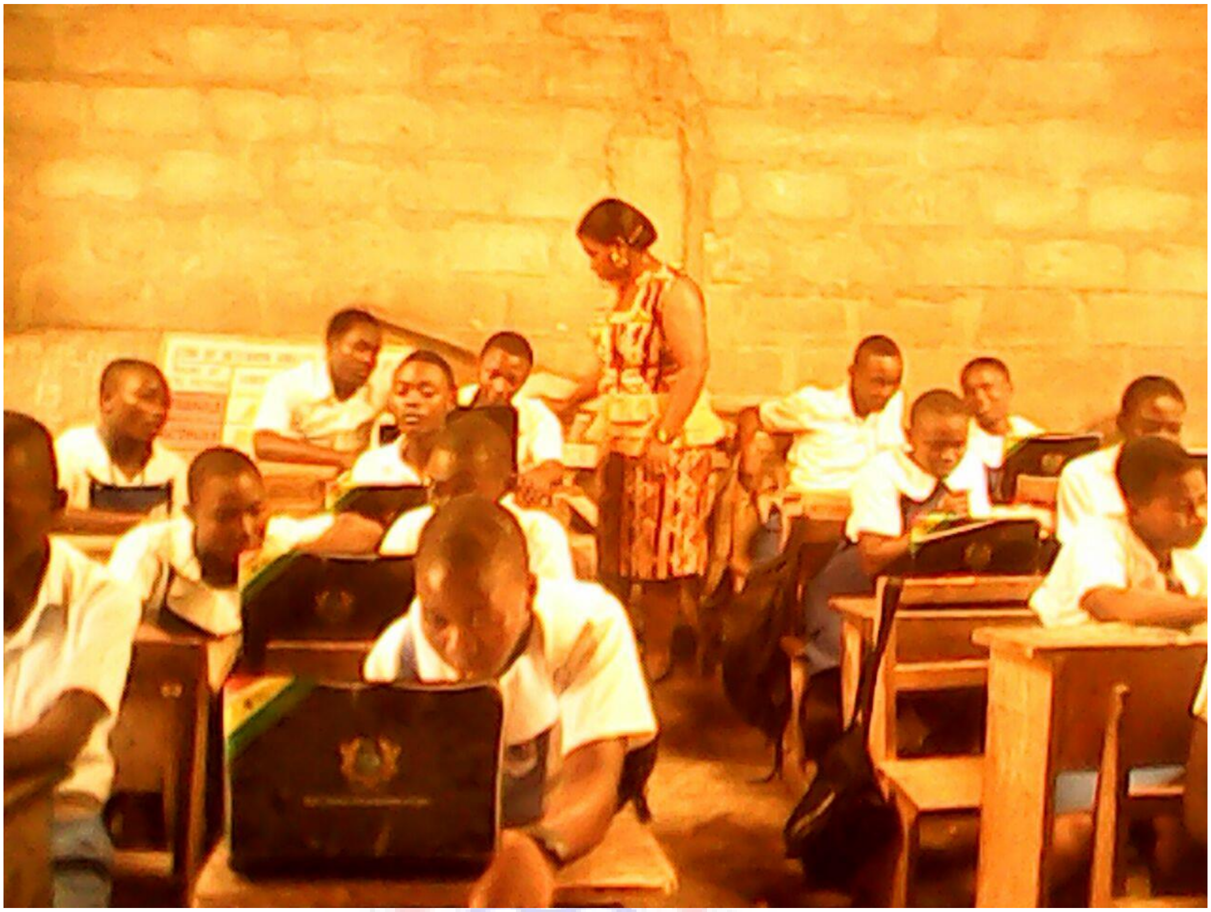

Figure 3: Teacher interacting with students during simulation lessons

Finding out punctuality with which students attend simulation classes which is item 10 from Table 1, it was noticed that all students 24(100%) were very punctual in attending simulation classes. This shows the maximum interest students have in the simulation lessons so, they do not want to miss classes at all. Most students commented this way:

> **Students**: *Anytime we have science on the teaching timetable, we become happy and we would not like to miss classes at all because of the simulation lessons (Opinion of students). Refer to Appendix F*

Johnson (1996) agreed to the fact that, computers were good motivators that heighten students' interest and enjoyment that had positive effect on the subject they learn. This seems to conform to students opinions.

Figure 4: Students present during simulation lessons.

On item 11 which was to find out whether students were rushing to the teacher for an interaction at the end of the simulation lessons, it was shown that, 22(91.6%) of such attitude occur whiles only 2(8.3%) of such attitude was observed to occur sometimes. This may reveal how excited majority of the students were at the end of the simulation lessons. Probably, some of the students wanted to ask how they could get some of these simulation videos to watch at home. Few of the students who sometimes showed this behaviour may reflect those timid students in every classroom who wish to have an interaction with the teacher but could not do that because of their timidity. So they may prefer asking their colleagues for the information they had from the teacher.

Table 2 shows attitude of students from items 12-18 during teaching and learning of simulation lessons.

Table 2: Students' attitudes (Items 12-18) during the teaching and learning of Simulation Lessons.

Statement	Frequencies High	Frequencies Low
12. Show interest in the simulation lesson	24 (100%)	-
13. Reluctant to shut down computers after lessons	17 (70.8%)	7 (29.1%)
14. Response to questions posed by teacher or colleague students	23 (95.8%)	1 (29.1%)
15. Regularity with which students attend classes	24 (100%)	-
16. Average number of students who are usually present in class	24 (100%)	-
17. Students were impatient for the end of the lesson	6 (25%)	18 (75%)
18. Students were enthused at the end of the lesson	24 (100%)	-

4.10. Discussion of results from Table 2 on attitude of students (Items 12-18) on Computer Simulation Lessons.

Twenty-four (100%) of the observations were made on item 12 which was on whether students show interest in the simulation lessons or not. This is an indication that, all students were so much interested in the simulation lessons. Even students from the other classes also showed some interest by standing by the window to watch simulation lessons. Students commented as follows:

Students: *Simulation lessons were really interesting and we enjoyed them so much (Opinion of students). Refer to Appendix F.*

The following authors ideas seems to portray that of the students. Geben, Aşkar, and Özkan (1992), Hounshell and Hill (1989) stipulated that, computer assisted instruction was more effective than the other methods in increasing students' interests in science lessons. Additionally, Zhao and Zhao (2009) stipulated that, performance of computer simulation software helps to promote students' interest in learning.

Figure 5: Students paying attention during simulation lessons

Observation of students about item 13 which was on reluctance of students to shut down computers after lessons, 20 (83.3%) of such observations were high whiles 4(16.6%) were low. This observation was deduced from the fact that, because students were so much interested in the simulation lessons, they did not want to shut down computers at the end of the simulation lessons. Four (16.6%) of such observation reflected the obedient students. Even though they may be so much interested in the simulation video, they shut down just to obey the teacher. Students' opinions supported this statement as follows:

Students: *Simulation lessons were fantastic and we wish to watch them over and over again.*

Figure 6: Students were reluctant to shut down laptops (computers) after simulation lessons

Considering response to questions posed by teacher or colleague students which was item 14 from Table 2, there was high observation 23(95.8%) made on students. This may imply that, often times, students' respond to questions posed by the teacher or colleague students because they may be so much excited during simulation lessons and also, they may have understood the concepts from the simulation video. This may however portray a change in their attitude during teaching and learning of integrated science.

A study conducted by River and Vockell (1987) seems to confirm this idea that, computer simulations enhanced students' active involvement in the learning process. On the other hand, only 1(4.16%) of such attitude was observed to be low. This may indicate some students who may know an answer but refuse to say it in class but may perform very well in a class test or an examination if they are asked to answer the questions through writing. On item15 from the table which was on regularity with which students attend classes, it was seen that, all the students 24 (100%) were present throughout the simulation lessons. This was because they did not want to miss any aspect of the simulation lessons. This again means that, their interest rate was very high. None of the students absented themselves during any of the simulation lessons.

Students expressed their views through writing as follows:

> **Students**: *We had a very good experience and interesting lessons which were unique in our lives.*

This seems to confirm the result of item 16 which was about average number of students who were usually present in class. It was shown from the table that, all 24 (100%) students were present in class throughout the simulation lessons. The reason may be due to the keen interest they had in the simulation lessons. Hounshell and Hill (1989) similarly noticed that, computer programme in their study demonstrated promise in relation to helping make science attitudes more positive in students through the use of technological advances.

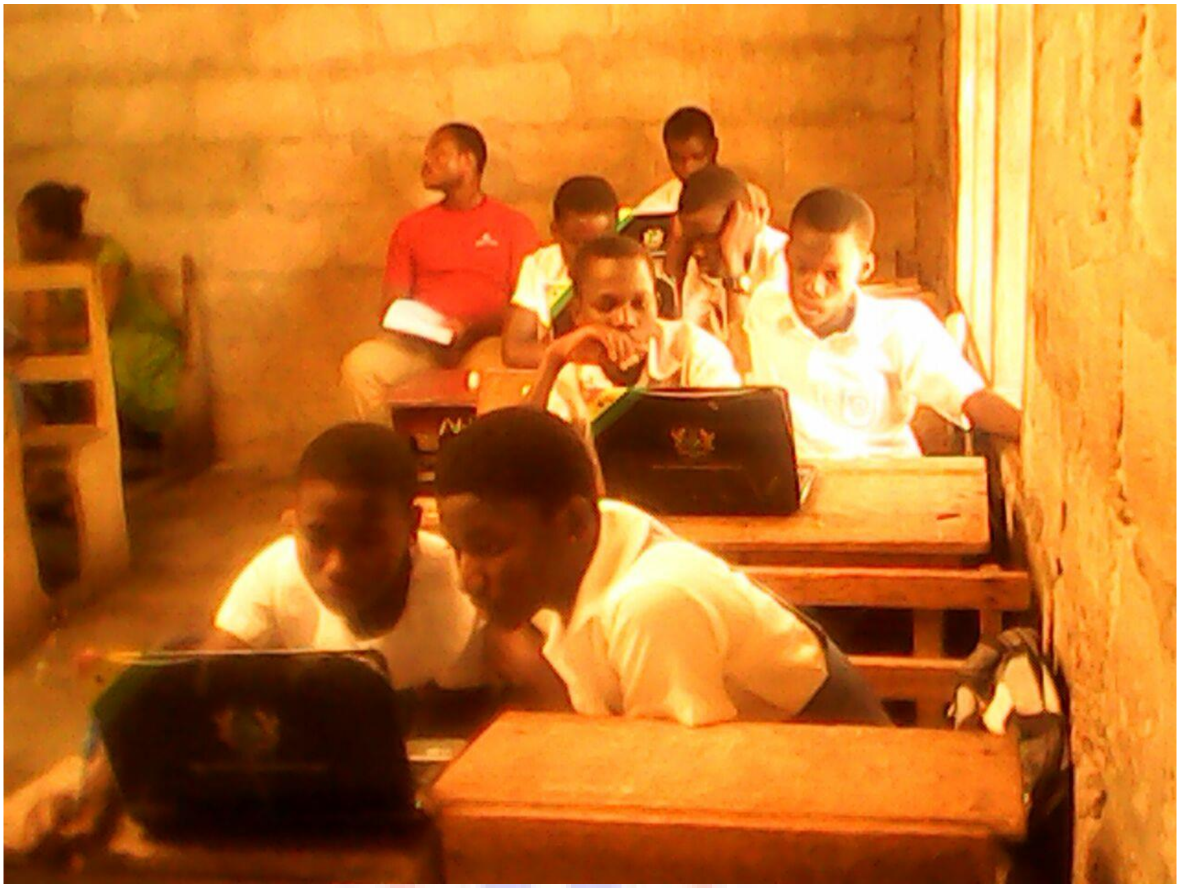

Figure 7: Students and two observers (teachers) present during simulation lesson

Considering the result from Table 2 on item 17 which stated whether students were impatient to the end of the lesson or not, 20 (83.3%) of such attitude was low. This means that, majority of the students were patient for the end of the simulation lessons. This is because they seem to have a positive attitude towards the simulation lessons. Only 4 (16.6%) were seen to be impatient for the end of the simulation lessons. This result again may reflect on the attitude of hyperactive students in a class who wanted to leave their seat because they have low attention span.

With reference to item 18 which is the last item on the observational checklist which was on whether students were enthused at the end of the lesson or not, the result from Table 2 indicated that, all the students 24(100%) were enthused at the end of the simulation lessons. This reflected back on the punctuality and regularity with which students attended simulation classes. Additionally, it was also reflected on the high interest of students in the simulation lessons. Even the two integrated science teachers who were scoring the observational checklist were so much overwhelmed about the simulation lessons. Students commented on this statement as follows:

> **Students:** *The teacher had done a great job. We had recommended her for best teacher award. The simulation lessons were interesting and enjoyable and we were always excited during simulation lessons (Opinions of students). Refer to Appendix F*

The use of computer simulation therefore had positive effect on students' attitude towards the study of selected topics in Integrated Science.

Figure 8: Enthusiastic students at the end of a simulation lesson

Furthermore, the introduction of the simulation lesson, the students' attendance to class and participation in class was unsatisfactory. However during and after the implementation of the intervention the Researcher observed that, the students were now regular in class, participate actively in lessons and jot down points in their notebooks. In lesson 4, the students were very excited when they discovered some plants called carnivorous plants which eat insects. This and other exciting scenarios motivated them to have interest in the simulation lessons and even feel reluctant to shut down the computers after closing. This confirmed that computer simulation had positive effects on students' attitude towards Integrated Science.

4.11. Research Question 3

How will the use of Computer Simulation in teaching selected topics in Integrated Science to JHS 2 students have influence on their performance?

This research question was answered by the academic performance of the students in responding to questions asked and acquisition of skills during the five lessons. It was noticed that students' responses and acquisition of skills progressively improved from Lesson 1 to Lesson 5. In Lesson 1, majority of the students were not able to draw neat and clear diagram of digestive structure of humans. Also few of the students could not boot the computers to open the appropriate files containing the simulation videos. Some were not able to pause and stop the simulation videos. Few of the students could not describe perfectly the changes that occur to different food substances as they pass through the alimentary canal. These observations were made in Lesson 1 but as time went on and approaches were improved and intensified the students' responses and acquisition of skills increased lesson by lesson. In Lesson 2 students were able to open, pause and stop simulation videos. The students' descriptive and communicating skills in Lesson 2 had improved compared with their performance in Lesson 1. With reference to Lesson 3, majority of the students were able to compare the differences between arteries and veins and how blood circulation occurs in humans. Most of the students had improved on their descriptive and communicating skills as compared to their performance in Lesson 2. Considering Lesson 4 and 5 almost all the students were able to draw and label correctly the respiratory structure of humans. Almost all the students were able to explain the process of breathing in humans. Therefore, there was really an improvement in performance over Lesson 1, 2 and 3. In the course of the lessons, students' responses, reasoning abilities, use of appropriate terminologies and explanation of phenomena increased progressively from Lesson 1 to 5. Almost all the students showed better knowledge in the selected topics (digestive system in humans, circulatory system in humans, photosynthesis and respiratory system in humans). This increased in academic performance of students showed that computer simulation is effective for teaching and learning of some topics in Integrated Science. This result is consistent with the findings of Gokhale (2011), who stated that effective integration of computer simulation into traditional lecture-lab activities enhances the academic performance of the students. The following authors' ideas also seem to support the findings of this study. Boblike and Lunneta (2010) found that the computer simulation instruction groups had significantly better achievement scores than the control groups receiving traditional instruction in high school physics. Again, Chou (1998) and Serpell (2002) also noted the significantly greater effectiveness of computer simulation instruction as compared to traditional instruction.

4.12. Discussion of students' opinions (Opinionnaire) at the end of Simulation Lessons

Students opinions written at the end of the simulation lessons were categorized under the following themes which were related to the research questions raised in the study. These are: Students understanding of simulation lessons and attitude of students at the end of the simulation lessons.

Students' opinions on understanding of Simulation Lessons

Students' understood simulation lessons on digestive system of humans, circulatory system of humans, respiratory system of human and photosynthesis. This seems to reflect on students' responses and excellent performances in the various class tests. Students therefore expressed their opinions as follows:

Students: *We really understood the digestive system taught using the computer simulations and we will not forget it (opinion of students). Refer to Appendix F.*

Students: *Circulatory system was an exciting topic and we understood it very well. We were surprised that the heart beat 100000 times a day (opinion of students). Refer to Appendix F.*

Students: *We really enjoyed watching the video on photosynthesis. We were taught this topic in our former schools but did not understand it. We confirmed that upon watching the simulation video, we understood it and never shall we forget it (opinions of students). Refer to Appendix F*

Students: *The respiratory song from the respiratory video helped us to learn and understood the topic very well. Any question that was asked on the topic, we just sang the respiratory song and that enabled us to answer any of the questions on respiratory system (opinions of students).*

Students' opinions on their attitudes at the end of Simulation Lessons.

Students' poor attitudes towards teaching and learning of science had improved at the end of the simulation lessons**.** Opinions expressed by students at the end of the simulation lessons seem to support this idea. They commented as follows:

Students: *The video was very interesting. We have never watched such simulation videos in our lives. The video had made us like science very much and we wish all the teachers use the laptops to teach us. (Opinions by students). Refer to Appendix F.*

Students: *We wish the simulation lessons continue because it had helped us to understand some topics we find difficult. They again stated that, we really love science class because of the simulation lessons (Opinions of students). Refer to Appendix F*

Students: *The simulation lessons were very interesting and we enjoyed it a lot (Opinion of students).*

Students: *What a fantastic lesson. We really enjoyed learning these topics through computer simulation s(opinions of students).*

Students: *We had a very good experience and interesting lessons which were unique in our lives.*

Students: *During simulation lessons, we pay much attention since we enjoyed the videos because interpretations of some diagrams were easy to comprehend (Students opinions).*

Students: *Anytime we had science on the teaching timetable, we became happy and would not like to miss classes at all because of the simulation lessons (Opinion of students). Refer to Appendix F*

Students performed well by the use of computer simulation to teach some selected topics in Integrated Science.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1. Overview

This chapter presents the summary of findings, conclusions and recommendations**.**

5.2. Summary of Findings

The following were the major findings that emerged from the study:

1. The students were able to identify parts of the digestive system in humans and stated their functions.
2. Majority of the students were able to describe the blood, the heart and blood vessels as part of the circulatory system.
3. The students were able to describe the parts of the circulatory system in humans.
4. Almost all of the students stated the functions of each type of blood vessels in humans. Majority of them were also able to describe how blood circulation occurs in humans.
5. Majority of the students were able to describe the process of photosynthesis. Again, majority of them stated the functions of the leaf correctly.
6. They were able to state the roles of the parts of the human respiratory system.
7. Additionally, majority of them were able to explain the process of breathing in humans. This was displayed by students because they understood lessons taught them using the simulation videos.
8. The students acquired the following science process skills: manipulating, observing, comparing, communicating, drawing and labeling.
9. The students' attendance to class and involvement in lessons had improved

Findings on research question one revealed that the use of computer simulation enhances students' understanding of concepts in Integrated Science since it enables students to observe things in their natural forms regarding human circulatory systems, digestive systems among others.

Data analysis for research question two also revealed that students developed positive attitudes towards the learning of concepts in integrated science through the use of computer simulation since it increased their motivation in teaching and learning of Integrated Science.

It was also established from research question three that the use of computer simulation influenced students' academic performance in understanding concepts in Integrated Science.

5.3. Conclusion

This study concluded that, computer simulations had positive effects on students by enhancing their understanding of concepts in Integrated Science. Most especially concepts which were abstract in nature. Some of these concepts were digestive system in human, circulatory system in human, photosynthesis and respiratory system in human. Students also supported this idea by stating that, they understood these concepts better when they were taught lessons using computer simulations. Again, students have shown positive attitude towards computer simulation lessons. Among these attitudes were, students were very punctual and regular during simulation lessons. Their attention span was also very high and at the end of the simulation lessons, students' enthusiasm was very high. Students performed better when they were taught the following topics using computer simulation: Digestive system, circulatory system, photosynthesis and respiratory system.

The various findings on the use of computer simulations in the teaching and learning of those abstract concepts in Integrated Science cannot be overlooked since understanding of concepts in their natural forms, development of positive attitudes, and enhancement of students performances are core issues in motivating students in science subjects.

5.4. Recommendations

Based on the findings of the study, the following recommendations were made:

- Planning of lessons enables teachers to acquire teaching equipment so teachers may take cue from the way the lessons were planned in this work.
- In-service training programmes should be organized for integrated science teachers in University Practice North Campus Junior High School to equip them with the necessary skills that would enable them use the computer and software to teach concepts in integrated science. To achieve this there is the need for Government or the District Assembly to support the school by providing them with enough computers.
- Computer laboratory should be provided for the school to enable Integrated Science teachers to use them to teach concepts in integrated science to students which would eventually lead to students developing positive attitudes towards the learning of science.
- Since computer simulation influences students' performance in learning and understanding concepts in Integrated Science, teachers in the school system need to be equipped with Information Communication and Technology (ICT) skills in order to become conversant with using them in teaching not only science but all other subjects that would enhance students' academic performances.

5.5. Suggestions for Further Research

This study was delimited to only one school in the Effutu Municipality of the Central Region of Ghana. Further research is therefore, needed in other schools in the Municipality and other schools in other Municipalities in Ghana to determine the effect of computer simulation on students' performance and attitudes in Integrated Science and how teachers are conversant in using computer in teaching other related subjects.

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APPENDIX A

CLASS TEST 1 (HUMAN DIGESTIVE SYSTEM)

Answer all questions (Section A)

Answer the following questions on simulation of digestive system 2

1. Which body system breaksdown food?
a. Circulatory system b. Digestive system c. Respiratory system d. Nervous system
2. The digestive truck is about ....cm long
a. 900 b. 600 c. 300 d. 150
3. Where does the food particles mix with stomach acids and enzymes
a. Liver b. Oesophagus c. Stomach d. Small intestine

Answer the following questions on simulation of digestive system 1

4. The food pipe is also called
a. Large intestine b. Small intestine c. Oesophagus d. pancreas
5. Most of the food digestion happens in the ....
a. Small intestine b. Stomach c. Rectum d. Large intestine
6. Water is absorbed in the ....
a. Small intestine b. Stomach c. Liver d. Large intestine

Answer the following questions on simulation of digestive system 3

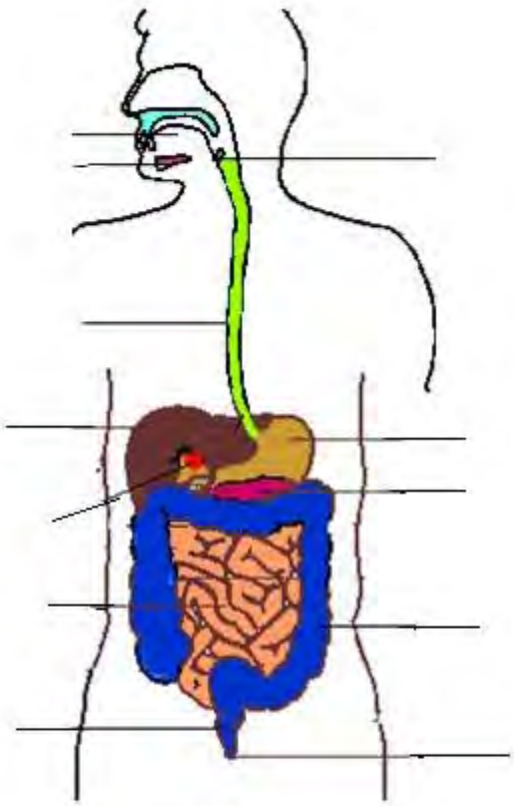
7. The digestive system consists of alimentary canal and associate organs.
a. True b. False
8. In the region of the crown of the teeth, the dentine is covered with ....
a. Gum b. Pulp cavity c. Enamel d. Neck
9. The longest part of the alimentary canal is
a. Oesophagus b. Large intestine c. Stomach d. Small intestine
10. The inner mucosa of small intestine is raised into millions of minute fingerlike projections called..
a. Villi b. fibre c. Long tube d. Duodenum

Answer the following questions on simulation of digestive system exercise

11. What is the name of the part coloured blue?
12. Which part is coloured light green?
13. Which part is coloured orange?
14. Which part is coloured pink?

Section B

1. Label the parts of digestive system of humans



2. State the functions of the parts labeled in question (1) above.
3. Describe the changes that occur to different food substances as they pass through the alimentary canal.
4. Describe what happens to the end products of digestion in humans.

Section C

1. Describe how undigested food substances are eliminated from the body.
2. Draw and label digestive structure of humans.

APPENDIX B

CLASS TEST 2 (CIRCULATORY SYSTEM)

Answer all questions (Section A)

Answer the following questions on simulation of circulatory system 1

1. The heart pumps......................................of blood every minute.
   a. 10 litres b. 5 litres c. 100 litres d. 50 litres
2. The heart beats .... times in one day
   a. 10 000 b. 10 c. 100000 d. 1000

3. Contraction of the heart is called...............................

a. systole b. Diastole c. Pumping d. Beats

4. Relaxation of the heart is called...................................

a. systole b. Diastole c. Pumping d. beats

Answer the following questions on simulation of circulatory system3

5. Which number represents the right atrium?......................................

6. Which number represents the left ventricle?.....................................

7. Which number pumps blood to the body? ....

8. Which number pumps blood to the lungs? ....

Tick the correct name that represents the following numbers from the simulation diagram?

9. Number 9

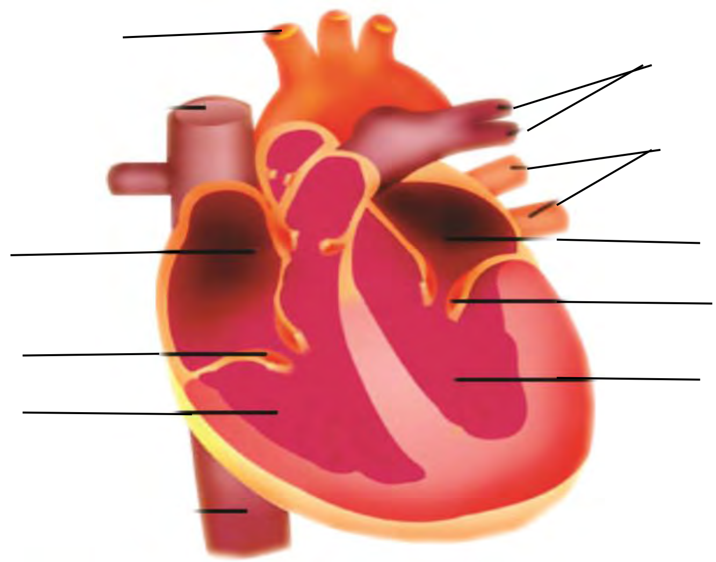
a. Right ventricle b. Left ventricle c. Right atrium d. Left atrium

10. Number 10

a. Aorta b. Pulmonary vein c. Left atrium d. Vena cava

Section B

1. Label the parts of the heart



2. Describe the following parts of the circulatory system in humans
a. Blood
b. The heart
c. Blood vessels

Section C

a. Describe how blood is circulated in human body
b. Describe how the heartbeat occurs in humans
c. State the functions of each type of blood vessels in humans.

APPENDIX C

CLASS TEST 3 (PHOTOSYNTHESIS)

Answer all questions (Section A)

Answer the following question from simulation diagram on photosynthesis 1

1. Which cells are shown in the leaf?

a. Mesophyll cells b. Plant cell c. Animal cell d. Lenticels

2. Some plants eat animals

a. True b. False

3. What is the name of the green blocks in the inner parts of the leaf?

a. Leaf b. Sun c. Root d. Chloroplast

4. From the simulated diagram, mushrooms also prepare their own food.

a. True b. False

Answer the following questions from simulation diagram on photosynthesis 2

5. What is the name of the inside of the plant coloured yellow?

a. Phloem b. Xylem c. Leave d. Stem

6. What is the function of the inside of the plant coloured yellow?

a. Transport water b. Transport nutrients c. Carry sunlight d. Carry chloroplasts

7. Which substance is coloured blue and travelled along the path coloured yellow?

a. Nutrients b. Sunlight c. Carbon dioxide d. Water

8. What substance is described as holes like windows in plant leaves?

a. Sunlight b. Carbon dioxide c. Stomata d. Photosynthesis

9. From the diagram, photo is...

a. Mixing b. Taking of photograph c. Colouring d. Light

10. From the diagram, synthesis is...

A. Cooking b. Mixing c. Light d. Taking of photograph

Section B

Answer all questions

1. State the requirements needed for plants to prepare food
2. Write down the word equation representing photosynthesis from the simulation diagram

Section C

1. Describe how photosynthesis occurs in plants
2. State the functions of the leaf.

APPENDIX D

CLASS TEST 4 (RESPIRATORY SYSTEM)

Answer all questions (Section A)

Answer the following questions from simulation of respiratory system 1

1. What is the primary function of the respiratory system?
a. Gas exchange b. Respiration c. Oxygen d. Carbon dioxide
2. From the simulation, inspiration means ....
a. Breathing out b. breathing in c. breathing carbon dioxide d. Breathing through the mouth
3. From the simulation, expiration means...............................
a. Breathing out b. Breathing in c. Breathing carbon dioxide d. Breathing through the mouth

Answer the following questions from simulation of respiratory system 2

4. Human trade off carbon dioxide for oxygen made by trees
a. True b. False
5. Human body give..............................to blood and blood to organs
a. Carbon dioxide b. Oxygen c. Blood d. Water
6. Human body needs lot of..........................to function and leave behind carbon dioxide a. Air b. Carbon dioxide c. Oxygen d. Ribs
7. From the simulation, which organ performs the first process?
a. Epiglottis and Pharynx b. Mouth and Nose c. Pharynx and Nose

d. Mouth and Pharynx

8. What is the name of the tube that is used for food, liquid and air?
a. Alveoli b. Cilia c. Nose d. Pharynx
9. The arrow coloured blue represents the flow of........
a. Oxygen b. Blood c. Carbon dioxide d. Air
10. The arrow coloured red represent the flow of......
a. Blood b. Carbon dioxide c. Oxygen d. Trachea

Section B

Answer all questions

Answer the following questions from simulation of respiratory system 1

1. State four functions of the respiratory system stated in the simulation.

Section C

1. Draw and label human respiratory structure.
2. State the role of the following parts of the human respiratory structure labeled in question (1) above.

a. Bronchus
b. Alveolus
c. Trachea
d. Nostril

APPENDIX E

OBSERVATIONAL CHECKLIST

Students attitude score on the observational checklist during implementation of intervention

Topic...

Class..

Date...

Item	Description of Students Attitude	Rate students attitude during intervention			
		Very Often	Often	Never	Sometimes
1	Fighting over computers for simulation lessons				
2	Struggle for space for simulation lessons				
3	Fidgeting with irrelevant materials unrelated to topic understudy				
4	Talking in class (on issues unrelated to topic under study)				
5	Asking question for clarification in order to know more on topic under study				
6	Students ask permission to go out				
7	Sleeping or dozing while in class				
8	Student-student interaction in class				
9	Student-teacher interaction in class				
10	Punctuality with which students attend class				
11	At the end of the lesson, students were rushing to the teacher for an interaction				

	Description of Students Attitude	Very High	High	Low	Lowest
12	Show interest in the simulation lesson				
13	Reluctant to shut down computers after lesson				
14	Response to questions posed by teacher or colleague students				
15	Regularity with which students attend classes				
16	Average number of students who are usually present in class				
17	Students were impatient for the end of the lesson				
18	Students were enthused at the end of the lesson				

APPENDIX F

OPINIONS OF STUDENTS ON SIMULATION LESSONS

Emmanuel Ebo Bortsie 23rd febuary

Science Report Simulation.

The video that I watched about photosynthesis, Digestion and circulatory system was very nice because how the food pass through the mouth, the teeth breaks down into smaller particles and pass through the oesophagus and then enters the stomach, I wish I will always watch that video every day when we have Science. At first I didn't know that Some plant chew insects for photosynthesis but when I watch the video I saw that Some plant chew insects for their photo-synthesis. Photo also stands for light and Synthesis means mixing. Some plant also use oxygen, water and carbondioxide for photosynthesis. The video was very intresting that I have not watch that thing Since class one to form two, the video have let me like Science very much. I wish all the teachers will use the Laptop to teach everyday.

AMONOO JUSTICE
MALE
TWO A
15TH FEBRUARY, 2015

Write your views on the simulation.

To begin this, I really enjoyed the simulation class. Infacts, it was the best of all the activities in class. We have been always listening to our teachers but this time we watched as well as listening. ~~In~~ for ~~inst~~ instance, if I watch something, ~~and~~ I understand it more than listening.
All I will say is I really enjoyed it.

Sylvia Mensah
2A

Report about the science simulation lesson.

I was very happy when our madam told us that ~~we~~ will ~~use~~ the laptop for our lesson.

On the laptop we watch about so many kinds of science simulation such as circulatory system, digestive system and Photosynthesis.

But the ~~one~~ I enjoy most is the circulatory system, it talk about the heart and how it work. I was very ~~surpri supries~~ suprise that the heart beat 100,000 a day, I was so excited. I will be glad if we use the laptop for learning it very interesting. And us for this lesson we will remember it always because we watch it like television so we will never forget it. I may conclude that this lesson is very very interesting.

Silas Koomson (Form 2A)

To write my view about the science simulation makes me genius, because I have gotten the opportunity tell you happy I am, what makes happy ~~and~~ and how the science simulation have help me.

My overview about the science simulation is that, the science simulation have helped me alot. In my former school we treated these topics but the understanding did not come because it was in the form rote copying and talking. So when i watch the simulation, i get the understanding.

It was realy good, eventhough we have been using laptops for practicals, the teacher collect us some money for Taxi but yours you made it free, you did not collect any money, Eventhough it was your. The fuel you used cost about twenty cedis ~~for~~ but still you did no collect any money, you printed the papers also free for us, and that make me even happ.

I think you have ~~done~~ done a great job keep it up and think you even deserve to be given award as the best teacher. I need more simulation to watch so i ~~wish~~ we could use all the rest period to watch simulations.

APPENDIX G

CALCULATION OF KAPPA STATISTICAL RELIABILITY

$$K = \frac{Po - Pc}{1 - Pc}$$

Where K= Kappa coefficient

Po = The proportion of observed agreements.

Pc = The proportion of agreement expected by chance

Data on scoring agreement by two integrated science teachers from observational checklist during computer simulation lessons.

	Rater 2 Agree	Disagree	Total
Rater 1 Agree	a (10)	b (1)	**g1(11)**
Disagree	c (1)	d (8)	**g2(9)**
Total	**n1(11)**	**n2 (9)**	

Since there are 20 items which the two raters considered, the total number is 20.

From table 2,

a = Number of attitude on which ratter 1 agreed.

b = Number of attitude on which ratter 1 disagreed.

c = Number of attitude on which ratter 2 disagreed.

d = Number of attitude on which ratter 2 agreed.

n = Total number of attitude considered by each ratter

n1= Total number of attitude on which ratter 2 agreed on

n2 = Total number of attitude on which ratter 2 disagreed on

g1 = Total number of attitude on which rater 1 agreed on

g2 = Total number of attitude on which ratter 1 disagreed on

$$Po = \frac{a+d}{n} = \frac{10+8}{20} = 0.9$$

$$Pc = \frac{\frac{(n1\times g1)}{n} + \frac{(n2\times g2)}{n}}{n} \qquad Pc = \frac{\frac{(11\times 11)}{20} + \frac{(9\times 9)}{20}}{20} = \frac{(6.05+4.05)}{20} = 0.505$$

$$K = \frac{(Po-Pc)}{1-Pc} = \frac{(0.9-0.505)}{1-0.505} = 0.80$$

APPENDIX H

CALCULATION OF ITEM DIFFICULTY INDEX (P) OF CLASS TEST 1.
Table 3: Item Difficult level of class test 1 (Digestive system)

Number of Items	Number of students who passed Items	Total number of students	Item difficulty index (P)
1	75	88	0.85
2	80	88	0.90
3	76	88	0.86
4	82	88	0.93
5	84	88	0.95
6	79	88	0.88
7	87	88	0.98
8	86	88	0.97
9	87	88	0.98
10	87	88	0.98
Total 10			

Appendix H shows the item difficult level of class test 1 on digestive system. There is an indication that, items 1, 3 and 6 with P values of 0.85, 0.86 and 0.88 respectively were very good test items in terms of reliability whiles items 2,4,5,7,8,9 and 10 with P values of 0.90, 0.93, 0.95, 0.98, 0.97, 0.98 and 0.98 respectively were excellent test items in terms of reliability. The appendix H revealed that, students find item 1 the most difficult item with P value of 0.85 and most easiest items were items 7, 9 and 10 with P value of 0.98 each. It can be deduced from appendix H that, all the 10 objective questions on class test 1 were appropriate for the students.

APPENDIX I
CALCULATION OF ITEM DIFFICULTY INDEX (P) OF CLASS TEST 2.

Table 4: Item Difficult level of class test 2 (Circulatory system)

Number of Items	Number of students who passed items	Total number of students	Item Difficulty Index (P)
1	86	88	0.97
2	87	88	0.98
3	88	88	1.00
4	83	88	0.94
5	88	88	1.00
6	79	88	0.89
7	85	88	0.96
8	88	88	1.00
9	86	88	0.97
10	88	88	1.00
Total 10			

Appendix I shows the item difficult level of class test 2 on circulatory system. This indicated that, items 1, 2, 3, 4, 5, 7, 8, 9 and 10 with P values of 0.97, 0.98, 1.00, 0.94, 1.00, 0.96, 1.00, 0.97 and 1.00 respectively were excellent test items in terms of reliability whiles item 6 with P value of 0.89 was very good item in terms of reliability. It can be found out that, the easiest items for students were items 3, 5, 8 and 10 with P value of 1.00 each and the difficult item for students was item 6 with P value of 0.89. The result therefore, shows that, all the objective items on class test 2 were reliable.

APPENDIX J

CALCULATION OF ITEM DIFFICULTY INDEX (P) OF CLASS TEST 3.

Item Difficult level of class test 3 (Photosynthesis)

Number of Items	Number of Students who passed Items	Total number of Students	Item Difficulty Index (P)
1	88	88	1.00
2	87	88	0.98
3	78	88	0.88
4	76	88	0.86
5	80	88	0.90
6	84	88	0.95
7	79	88	0.89
8	86	88	0.97
9	84	88	0.95
10	86	88	0.97
Total	**10**		

Appendix J shows the item difficult level of class test 3 on photosynthesis. There is an indication that, items 1, 2, 5, 6, 8, 9 and 10 with P values of 1.00, 0.98, 0.90, 0.95, 0.97, 0.95 and 0.97 respectively were excellent test items with regard to reliability whiles items 3, 4, and 7 with P values of 0.88, 0.86 and 0.89 respectively were very good test items with reference to reliability. The most difficult item in the class test 3 was item 4 with the least P value of 0.86 and most easiest item for students was item 1 with P value of 1.00. This means all students answered item 1 correctly. All the objective questions on class test 3 were reliable.

APPENDIX K

CALCULATION OF ITEM DIFFICULTY INDEX (P) OF CLASS TEST 3.

Item Difficult level of class test 4 (Respiratory System)

Number of Items	Number of Items passed by students	Total number of students	Item Difficulty Index (P)
1	86	88	0.97
2	87	88	0.98
3	80	88	0.90
4	88	88	1.00
5	85	88	0.96
6	86	88	0.97
7	82	88	0.93
8	88	88	1.00
9	79	88	0.89
10	84	88	0.95
Total 10			

Appendix K shows the difficult level class test 4 on respiratory system. It can be deduced that, items 1, 2, 3, 4, 5, 6, 7, 8 and 10 with P values of 0.97, 0.98, 0.90, 1.00, 0.96, 0.97, 0.93, 1.00 and 0.95 respectively were excellent with regard to reliability while item 9 with P value 0.89 was very good item with regard to reliability. Items 4 and 8 were very easy for students. So, none of them had it wrong. The difficult item for student s was item 9 with the least P value of 0.89. It can be said that, the objective test items in class test 4 were reliable.

APPENDIX L

OPPINIONNAIRE

Write your opinions on the simulation lessons.