UNIVERSITY OF EDUCATION, WINNEBA

ENHANCING STUDENTS' RETENTION OF CELL DIVISION THROUGH COMPUTER SIMULATIONS IN ADANWOMASE SENIOR HIGH SCHOOL

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DECLARATION

I, BERNICE BOATENG ACHEAMPONG, declare that this Thesis, with the 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 degree elsewhere..

SIGNATURE: ……………………………

DATE: ……………………………………

SUPERVISOR'S DECLARATION

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

NAME OF SUPERVISOR: DR. JOSEPH NANA ANNAN

SIGNATURE : …………………......................…………

DATE : ………………………………………………….

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DEDICATION

I dedicate this work to the Almighty God; I also dedicate it to my family; Mr. Kwasi Boateng Acheampong, Mrs. Christiana Boateng Acheampong, Judith Osei-Wusu, Grace Boateng Acheampong, Ebenezer Boateng Acheampong, and Emmanuel Boateng Acheampong.

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ABSTRACT

Integrated science is one of the core subjects offered in the Ghanaian Senior High School. Most of the concepts included in Science are abstract and therefore students find it difficult to understand the concepts.

Cell division is one of the most problematic and difficult concepts that students learn in the Science syllabus. Questions on cell cycle, Mitosis and Meiosis in Cell Division are very popular in the West African Certificate examination.Analysis of the Science paper using the Chief examiner's report has revealed that students have misunderstandings on the main concepts of cell division topic such as mitosis and meiosis. These learning problems in Cell division arise from improper teaching and learning method that emphasized mainly on teacher centered learning and encourages rote learning among students.

Computer simulation which is one of the learning strategies that stimulates and enhances students thinking ability was employed in this study to teach the concept of cell division in Adanwomase Senior High School.

A total of 62 students from two different form one classes were used for this study. A pre-test on cell division was administered to the two classes. A t-test analysis of the pre-test revealed a significant difference between the scores for the two classes. Thirty of them were subjected to lessons prepared on the concepts of cell division using computer simulations because they had the least scores. The other 32 were taught the concepts using the traditional lecture method because they had the highest scores in the pre-test. A post- test was then administered after the interventions.

Results from the post-tests were gathered and also subjected to statistical analysis using paired and unpaired t-test. After the study it was realized that there was a significant difference between science achievements of students who were taught with both the computer simulations and the traditional lecture method. However, those who were taught with computer simulations had a significantly scores in the post-test.

CHAPTER ONE

INTRODUCTION

Overview

This chapter deals with the background to the study, the statement of the problem, diagnosis of the study, purpose of the study, research questions, significance of the study, and delimitation of the study.

1.1 Background of the study

Cell and cell division is one of the important topics in Integrated Science, however the concepts: cell cycle, mitosis and meiosis are very complex to be learned by students.

The perceived nature of Science as being a difficult subject makes students shun or avoid the subject. In effect, many students, more especially, girls have lost interest and the enthusiasm to study Science in Senior High Schools due to the old and traditional ways of teaching the subject (Donnellan, 2003; Anamuah-Mensah, 2004). However, if students are made to see science as a means of enriching personal life and improving national economy by making the surroundings more interesting and comprehensible, then there must be a change in the way science is taught in schools and this will also require a change in the teachers' perception of the context and method they use.

In recent times, there seem to be public outcry on the declining standard of Science Education in the country. There is obviously a problem with the method of teaching Science in Senior High Schools all over the nation and therefore an urgent need to investigate the problem and propose solutions to solve it (Anamuah-Mensah, 2004).

With a greater percentage of the national budget spent on quality and expansion of secondary education, one would have expected the performance at this level of Science education to have been improved. The case is however contrary as exemplified by results of students in the West African Secondary School Certificate Examination (WASSCE). Reports from the chief examiner of the West African Examination Council, 2008 confirmed that many students have poor knowledge in Integrated Science. Students who answer questions on cell division perform abysmal. Most teachers also confirmed that students find it difficult to grasp the concept of cell division. From the examiner's report, it seems students are not involved in teaching of the concept and therefore students need to be active learners to keep the brain working and integrating new information. However, the lecture method which most often does not involve students seems to be the most prominent strategy employed by most science teachers in the various Senior High Schools in Ghana. The result is that, the learners generally are less apt to ask questions in class, and thus shun the study of the subject. The lecture method has not been of much help to students in their study of Science in Senior High Schools in Ghana.

Computer simulation according to Wekesa (2003) improves the teachers 'repertoire' by enhancing and expanding the educational environment particularly in areas considered difficult or dangerous. Computer simulation has the ability to shift learning to more hands-on and visual imagery interaction that is often lacking in traditional teacher based classroom. It natures confidence, initiative and enhances cognition, psychomotor and effective behavior.

1.2 Statement of the problem

Over the years, the performance of students in Integrated Science in the WASSCE has been very poor in the country (WAEC, 2008). This has affected most students' ability to have tertiary education since a credit in the subject is a requirement to the tertiary institutions. This is not an exception to students of Adanwomase Senior High School. One of the topics that students perform poorly in Integrated Science is Cell division because students cannot retain the concept. This has necessitated the need to find solution to the problem.

1.3 Purpose of the study

The purpose of the study was to use computer simulations to enhance form one students' retention of cell division in Integrated Science of Adanwomase Senior High School.

1.4 Objectives of the Study

The study sought to:

- Use computer simulations to improve form one students of Adanwomase Senior High retention of the five stages involved in cell division.
- Find out students' perception on the use of computer simulations in the learning of cell division.
- Use computer simulations to improve the academic performance of form one students of Adanwomase Senior High School in the Ashanti Region in the study of Integrated Science.

1.5 Research questions

The following research questions guided the study:

1. Is there any difference in achievement of students taught with Computer Simulations and those taught with the Lecture method?
2. Is there any difference in students' perception in the use of Computer Simulations and the lecture method in the learning of Cell Division?

The hypothesis for the research is as follows:

H_{0A}: There is no significant difference in the achievement of students taught with Computer Simulations and those taught with the Lecture method.

H_{0B}: There is no difference in the perception of students in the use of Computer simulations and the Lecture method in learning Cell Division.

1.6 Significance of the Study

This study would help clarify the misconception students have in the study of Cell division in particular. The findings and recommendations of this study would be of much benefit to students which will go a long way to improve their academic performance both in internal and external examinations. Again, the educational implication is that, the use of simulations in teaching could show positive results among students in the school, they have the potential of replacing the traditional lecture method of instruction, as the benefits of this instructional approach are becoming motivating factors for improving the teaching and learning of Integrated Science.

Teachers on the other hand will be able to sustain their students' interest in the teaching of cell and cell division and other science concepts. The study would make stakeholders in the educational sector to be conscious of the need and usefulness in adopting different instructional teaching strategies in teaching and learning in Ghanaian schools.

Finally, the present study inevitably contributes to the existing literature on methodologies for teaching Integrated Science in the Second Cycle Institutions and moreover, serves as reference material for the effective teaching of Integrated Science. With respect to curriculum development, the present study serves as reference. The study will also go a long way to help curriculum developers to strategize the curriculum such that different strategies of teaching will be included in it.

1.7 Delimitation

Ashanti region of Ghana has a large number of Senior High Schools; however, this study was conducted only in Adanwomase Senior High School because of the researcher's involvement with the school as an Integrated Science teacher.

Also, due to the limited duration of the programme, only two form one class were used from Adanwomase Senior High School.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

The purpose of this section is to provide a comprehensive, critical review of the literature on the impact of computer simulations on science teaching and learning.

2.1Theoretical Review

The design of the computer mediated scheme (CMS) module was guided by the dual-coding theory of the cognitive paradigm. According to this theory, information in memory is represented by both images and verbal codes. Park and Hopkins as cited in Lewalter (2003) argue that there is a 'referential connection' that links verbal and non-verbal cues into a complete associative network to potentially allow such operations as imaging to words and naming to pictures. Therefore, something is more likely to be remembered if coded both verbally and visually because representatives of one form reinforces the other (Tennyson & Rash, 1988).

2.2 Teaching styles

Teaching style is explained as the manner in which a teacher effectively and efficiently interacts within the classroom environment to bring about quality learning of a subject among students. Woods (1995) categorized teaching styles as discipline-centered, teacher-centered, and student-centered.

In teacher-centered model, the teacher is considered as an authoritative expert, the main source of knowledge, and the focal point of all activity. In this teaching model, students are passive recipients of the information. According to Lackey (1997), lecture obviously reflects teacher-centered style and requires a passive role for students. In summary, the teacher-centered style is traditional and requires lecture.

In student-centered model, on the other hand, instruction focuses on the student and his/her cognitive development. The teacher's goal is to help students grasp the development of knowledge as a process rather than a product. In student-centered style, activities such as group discussions and group or individual reports are used (Lackey, 1997). This style is individualized to provide accommodation to students' cognitive, affective, behavioral and physical needs during the teaching and learning process (Shreves, 1998). The student-centered style therefore refers to individualized teaching approach.

In discipline-centered model, the course has a fixed structure. Here, teachers appear to place subject matter knowledge as the central focus of their beliefs and actions instead of placing teaching or students at the center. Programmed learning materials, printed study guides, prepared curricular materials, and research papers can be used (Lackey, 1997). Discipline-centered teaching strategies tend to be teacher-centered, but also include hands on activities, laboratories, demonstrations, group work and discussion. Therefore, this technique creates students with positive learning environment to clarify their understanding and present their ideas (Patricia, et.al., 1999). In short, discipline-centered teaching style has characteristics of both teacher-centered style and student-centered style. Hence, using discipline-centered style as transitional style may be acceptable.

2.3 Learning styles

Koul (1984) described learning styles as the way students prefer to process new information including strategies that are consistently adopted to learn. Although there are many theories on thinking and learning, it is largely accepted that students learn in different ways (Fleming

2001). Bigge and Shermis (1999) and Schunk (1996) concluded that teaching styles should match with students' learning styles.

2.4 Computer Simulations

Most concepts are very abstract in nature and its retention becomes difficult for students. For example being able to have your students vary the force of gravity and determine the effects on an object's motion, explore nuclear fission at the molecular level and discover whether the daughter atoms are always the same and again move tectonic plates while investigating the differences between divergent and convergent boundaries is something very difficult in most traditional classroom setting.

Computer simulations make these types of interactive, authentic, meaningful learning opportunities possible. Learners can observe, explore, recreate, and receive immediate feedback about real objects, phenomena, and processes that would otherwise be too complex, time-consuming, or dangerous.

Scientific discovery learning is a highly self-directed and constructivist form of learning. A computer simulation is a type of computer-based environment that is very suited for discovery learning, the main task of the learner being to infer, through experimentation, characteristics of the model underlying the simulation.

In the field of learning and instruction we now see an impressive influence of the so-called "constructivist" approach. In this approach a strong emphasis is placed on the learner as an active agent in the knowledge acquisition process. As in the objectivistic tradition, where developments were followed and encouraged by the computer-based learning environments, such as programmed instruction, tutorials, and drill and practice programmes (Alessi & Trollip, 1985), also within the constructivist approach we find computer learning environments that help to advance developments.

Computer simulations are computer-generated dynamic models that present theoretical or simplified models of real-world components, phenomena, or processes. They can include animations, visualizations, and interactive laboratory experiences.

Thompson, Simonson and Hargrave (1996) defined simulation as a representation or model of an event, object, or some phenomenon. In science education a computer simulation according to Akpan and Andre (1999) is the use of the computer to simulate dynamic systems of objects in a real or imagined world. The use of a computer to represent the dynamic responses of one system by the behaviour of another system modeled after it. A simulation uses a mathematical description, or model, of a real system in the form of a computer program. This model is composed of equations that duplicate the functional relationships within the real system. When the program is run, the resulting mathematical dynamics form an analog of the behaviour of the real system, with the results presented in the form of data. A simulation can also take the form of a computer-graphics image that represents dynamic processes in an animated sequence.

Computer simulations are used to study the dynamic behaviour of objects or systems in response to conditions that cannot be easily or safely applied in real life. For example, a nuclear blast can be described by a mathematical model that incorporates such variables as heat, velocity, and radioactive emissions. Additional mathematical equations can then be used to adjust the model to changes in certain variables, such as the amount of fissionable material that produced the blast. Simulations are especially useful in enabling observers to measure and predict how the functioning of an entire system may be affected by altering individual components within that system.

The simpler simulations performed by personal computers consist mainly of business models and geometric models. The former includes spreadsheet, financial and statistical software programs that are used in business analysis and planning. Geometric models are used for numerous applications that require simple mathematical modeling of objects, such as buildings, industrial parts, and the molecular structures of chemicals. More advanced simulations, such as those that emulate weather patterns or the behaviour of macroeconomic systems, are usually performed on powerful workstations or on mainframe computers. In engineering computer models of newly designed structures undergo simulated tests to determine their responses to stress and other physical variables. Simulations of river systems can be manipulated to determine the potential effects of dams and irrigation networks before any actual construction has taken place. Other examples of computer simulations include estimating the competitive responses of companies in a particular market and reproducing the movement and flight of space vehicles.

2.5 The role of computer simulations in science education

Smetana and Bell (2012) reported that researchers studying the use of simulations in the classroom have reported positive findings overall. The literature indicates that simulations can be effective in developing content knowledge and process skills, as well as in promoting more complicated goals such as inquiry and conceptual change. Gains in student understanding and achievement have been reported in general science process skills and across specific subject areas, including physics, chemistry, biology, and Earth and space science.

Although conventional instructional materials such as textbooks present two-dimensional representations, simulations can offer three-dimensional manipulative that bring the subject matter to life. Visualization results in the development of mental constructs that allow one to think about, describe, and explain objects, phenomena, and processes in a more true-to-life form. These are just the habits of mind scientists rely upon in their daily work. For example, after comparing simulated and hands-on dissection labs, Akpan and Andre (2000) concluded, “The flexibility of these kinds of environments makes learning right and wrong answers less important than learning to solve problems and make decisions.

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, 1985)

Simulations can enable students to develop familiarity with an activity before they engage in it. As an example, with Froguts students can use an interactive computer program to proceed fully through a frog dissection before attempting dissection of an actual frog. Students who use simulations report that they feel more confident in their skills when later working with real materials (Ronan & Elihu, 2000).

2.6 The nature of simulations

Alessi and Trollip (1985) categorized simulations into the following four different types:

(1) Physical simulations, in which 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;

(2) Procedural simulations, in which 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;

(3) Situational simulations, which normally give 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;

(4) Process simulations, which are 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 occur without intervention.

2.7 Benefits of simulations in instruction

The use of simulations in science education can make significant contributions by providing appropriate learning opportunities to diverse learners and motivating students to learn science, both inside and outside of the school environment. Computer simulations potentially enable learners to be actively involved in the learning process, to generate and test ideas, and to see and feel things that are not feasible to do with other instructional methods. Simulations allow group cooperation, which is effective in generating new ideas, solving problems, and helping students learn from each other. Learning to work cooperatively is an important goal for children in science and all other subjects. Simulations can motivate students of different learning abilities by enabling them to interact with a given task and work with problems that bring forth meaningful results. Simulations can reduce teachers' teaching times, provide opportunities for student discussion and interaction, and thus, increase communication and reduce both social and learning differences (Akpan, 1998).

Simulation are little different from other computer Assisted Instructions (CAI) because it provides a situation that cannot be experienced to a learner (Linn, 1987).

Also, some lab exercise can be very expensive or take too much time, and may not be suitable for students, such as dissections in biology labs (Strauss & Kinzie, 1994). Moreover, according to Linn, simulation encourages students to understand a situation easily and can present dynamic representations to complex relationships. In science labs, naturally occurring events could be simulated its original taste by using computer-based simulations. However, computer simulations are not completely a better instructional tool than other instructional tools, they are more active and viable instruction approaches that can influence contend knowledge (Stevens, 1995).

2.8 Using computer simulations in combination with other instructional methods

Throughout the literature there has been consensus about the use of computer simulations as a supplement to, rather than a substitute for, other learning activities. In light of this consensus, several researchers have conducted investigations with the goal of determining how best to use the simulations in conjunction with other modes of instruction.

There is some evidence to support the use of computer simulations before traditional classroom instruction (Akpan & Andre, 2000; Brant, Hooper, & Sugrue, 1991; Winberg & Berg, 2007). For instance, Akpan and Andre (2000) compared four experimental conditions for a frog dissection: simulation before dissection (SBD), dissection before simulation (DBS), simulation only (SO), and dissection only (DO). Results indicated that students in the SO and SBD conditions improved significantly on assessments of their content knowledge from pre- to posttest, while those in the DBS and DO conditions did not. And, both the SO group and the SBD group achieved higher overall scores than either the DO group or the DBS group. The authors concluded that the introductory simulations provided a simplified environment where students could construct an experiential base to build more complex knowledge upon. Negative findings for the DBS group suggest that students may attend less to the simulation when it serves as a review. This may be particularly true for today's science classrooms, where educational technologies are more commonplace.

2.9 Cell division

Is the process by which cellular material is divided between two new daughter cells. In unicellular organisms it increases the number of individuals in the population. In multicellular organisms it is the means by which the organism grows, starting from one single cell.

In order to make new cells, all cells must undergo cell division, or cell reproduction. In prokaryotes, single-celled organisms without a nucleus, cell division occurs by binary fission. This process is very simple and includes the duplication of chromosomal DNA (DNA replication) followed by Cytokinesis or the splitting of the cell into two new cells. Binary fission results in two identical daughter cells. This is how prokaryotes, like bacteria, reproduce.

Eukaryotes are organisms with a nucleus in their cells. Many eukaryotes are also multicellular, and they usually use cell division for growth or to replace old or damaged cells. While the process of cell division is much more complicated in eukaryotes, it does have similarities to the process in prokaryotes. Just like in prokaryotes, DNA replication must occur first. Then mitosis, or the division of the nucleus, occurs. Cytokinesis, or the division of the cytoplasm, occurs just as it does in binary fission.

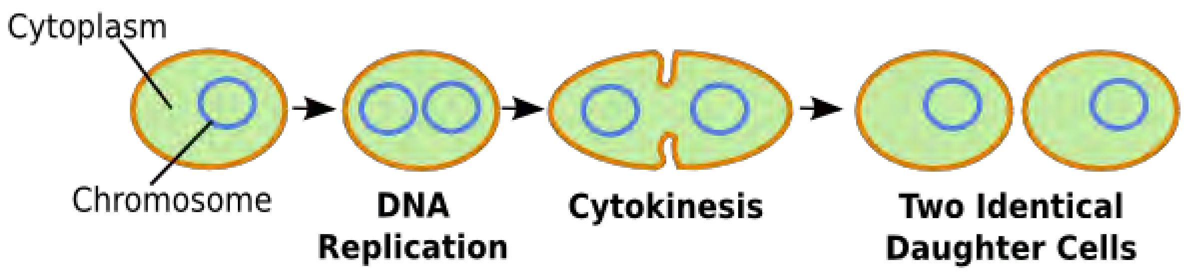

Figure 2.1 The process of Cell division (mitosis)

2.10 Mitosis

Mitosis is a process of nuclear division in eukaryotic cells that occurs when a parent cell divides to produce two identical daughter cells. During cell division, mitosis refers specifically to the separation of the duplicated genetic material carried in the nucleus. Mitosis is conventionally divided into five stages known as prophase, prometaphase, metaphase, anaphase, and telophase. While mitosis is taking place, there is no cell growth and all of the cellular energy is focused on cell division.

During prophase, the replicated pairs of chromosomes condense and compact themselves. The pairs of chromosomes that have been replicated are called sister chromatids, and they remain joined at a central point called the centromere. A large structure called the mitotic spindle also forms from long proteins called microtubules on each side, or pole, of the cell.

During prometaphase, the nuclear envelope that encloses the nucleus breaks down, and the nucleus is no longer separated from the cytoplasm. Protein formations called kinetochores form around the centromere. The mitotic spindle extends from the poles and attaches to the kinetochores.

During metaphase, the microtubules pull the sister chromatids back and forth until they align in a plane, called the equatorial plane, along the center of the cell.

During anaphase, the sister chromatids are separated simultaneously at their centromeres. The separated chromosomes are then pulled by the spindle to opposite poles of the cell. Anaphase ensures that each daughter cell receives an identical set of chromosomes.

Finally, during telophase, a nuclear membrane forms around each set of chromosomes to separate the nuclear DNA from the cytoplasm. The chromosomes begin to uncoil, which makes them diffuse and less compact. Along with telophase, the cell undergoes a separate process called Cytokinesis that divides the cytoplasm of the parental cell into two daughter cells (Nature Education, 2014).

2.11 Meiosis

Vidyasagar (2015) defines meiosis as a specialized form of cell division that produces reproductive cells, such as plant and fungal spores, sperm and egg cells.

Meiosis is a type of cell division that reduces the number of chromosomes in the parent cell by half and produces four gamete cells. This process is required to produce egg and sperm cells for sexual reproduction. During reproduction, when the sperm and egg unite to form a single cell, the number of chromosomes is restored in the offspring.

Meiosis begins with a parent cell that is diploid, meaning it has two copies of each chromosome. The parent cell undergoes one round of DNA replication followed by two separate cycles of nuclear division. The process results in four daughter cells that are haploid, which means they contain half the number of chromosomes of the diploid parent cell.

Meiosis has both similarities to and differences from mitosis, which is a cell division process in which a parent cell produces two identical daughter cells. Meiosis begins following one round of DNA replication in cells in the male or female sex organs. The process is split into meiosis I and meiosis II, and both meiotic divisions have multiple phases. Meiosis I is a type of cell division unique to germ cells, while meiosis II is similar to mitosis.

Meiosis I, the first meiotic division, begins with prophase I. During prophase I, the complex of DNA and protein known as chromatin condenses to form chromosomes. The pairs of replicated chromosomes are known as sister chromatids, and they remain joined at a central point called the centromere. A large structure called the meiotic spindle also forms from long proteins called microtubules on each side, or pole, of the cell. Between prophase I and metaphase I, the pairs of homologous chromosome form tetrads. Within the tetrad, any pair of chromatid arms can overlap and fuse in a process called crossing-over or recombination. Recombination is a process that breaks, recombines and rejoins sections of DNA to produce new combinations of genes. In metaphase I, the homologous pairs of chromosomes align on either side of the equatorial plate. Then, in anaphase I, the spindle fibers contract and pull the homologous pairs, each with two chromatids, away from each other and toward each pole of the cell. During telophase I, the chromosomes are enclosed in nuclei. The cell now undergoes a process called Cytokinesis that divides the cytoplasm of the original cell into two daughter cells. Each daughter cell is haploid and has only one set of chromosomes, or half the total number of chromosomes of the original cell.

Cells move from meiosis I to meiosis II without copying their DNA. Meiosis II is a shorter and simpler process than meiosis I (Khan, 2016). Meiosis II is a mitotic division of each of the haploid cells produced in meiosis I. During prophase II, the chromosomes condense, and a new set of spindle fibers forms. The chromosomes begin moving toward the equator of the cell. During metaphase II, the centromeres of the paired chromatids align along the equatorial plate in both cells. Then in anaphase II, the chromosomes separate at the centromeres. The spindle fibers pull the separated chromosomes toward each pole of the cell. Finally, during telophase II, the chromosomes are enclosed in nuclear membranes. Cytokinesis follows, dividing the cytoplasm of the two cells. At the conclusion of meiosis, there are four haploid daughter cells that go on to develop into either sperm or egg cells.

2.12 Importance of cell division

Organisms are made of cells. For an organism to grow, new cells must be made because there is a limit to how large a cell can become.

For single-celled organisms, cell division is the process by which individuals reproduce, and the population gets larger.

For multi-cellular organisms, cell division is the process by which a fertilized egg (a single cell) becomes eventually an adult with millions of cells. Also in multi-cellular organisms, cell division is the process by which the organism replaces lost or damaged cells.

There are three important reasons for cell division: (i) reproduction, (ii) growth and (iii) repair

1. Cell division for reproduction

Cells undergo meiosis in order to produce gametes (eggs and sperm) for sexual reproduction (Fester & Siegrief). Thus, all organisms use cell division to reproduce. There are two types of reproduction: asexual and sexual.

Asexual reproduction is the process of producing offspring from only one parent, this result in the production of offspring that are genetically identical.

Genetically identical means that every cell that is produced has identical copies of a single, identical set of chromosomes. When cells in an organism undergo division, they all produce daughter cells, (two new cells), with exactly the same DNA.

In asexual reproduction, the offspring simply goes through cell division, forming two new daughter cells, each one genetically identical to the parent cell.

The process of producing offspring by the fusion of male and female gametes, (i.e. egg and sperm), the production of offspring that have genetic information from each parent is referred to as sexual reproduction

Gametes also referred to as 'half cells' are cells that contain only half of the DNA usually found in a cell. Gametes are produced when some of the parents' cells undergo a cell division process known as meiosis.

When two gamete cells combine, the offspring inherits characteristics from both parents.

Sexual reproduction results in offspring that receive a combination of genetic material from both parents. Hence, sexual reproduction has the advantage of creating variety in offspring, which may make for better adaptation to change.

Asexual reproduction occurs from division of the parent cell without meiosis, gamete formation, or fertilization. Hence, asexual reproduction uses less time and energy than sexual reproduction. Asexual reproduction is common in single celled organisms and plants.

2. Cell division for growth

In unicellular organisms, cell division is the means of reproduction; in multicellular organisms it is a means of tissue growth and maintenance (Cuffe *et al.,* 2016).

As all organisms grow, the number of cells increases. As multi-cellular organisms grow, their cells duplicate their genetic information and divide. Cells undergo division rather than simply growing larger, this is because if the cell gets too large, it may not be able to transport materials in and wastes out efficiently, and i.e. osmosis and diffusion are no longer efficient for transporting materials in and out.

3. Cell division for repair

When part of an organism is damaged, the remaining cells divide to repair the injury.

Cell division creates new cells that replace those in the wounded or broken area to close the wound and heal.

The time taken for the process of cell renewal changes as the individual's age changes, or with changes in hormone or vitamin levels.

A human body loses ~ 30 000 – 40 000 skin cells every minute. Red blood cells in the human body are replaced every 120 days. Human body sheds dead skin cells, and replaced by new ones. Every cut, blister needs new cells to fill in the gaps.

2.13 Empirical review

Researchers have explored the effectiveness of computer simulations for supporting science teaching and learning during the past four decades. Several studies suggest that simulations can be as effective, and in many ways more effective, than traditional (i.e. lecture-based, textbook-based and/or physical hands-on) instructional practices in promoting science content knowledge, developing process skills, and facilitating conceptual change. As with any other educational tools, the effectiveness of computer simulations is dependent upon the ways in which they are used. Computer simulations are most effective when they (a) are used as supplements; (b) incorporate high-quality support structures; (c) encourage student reflection; and (d) promote cognitive dissonance. Used appropriately, computer simulations involve students in inquiry-based, authentic science explorations. Additionally, as educational technologies continue to evolve, advantages such as flexibility, safety, and efficiency deserve attention.

Campbell and Reece (2005), cell division process is a part of the cell cycle. Cells are formed when parent cell divides to become two new cells. Cell division process includes two important processes such as mitosis and meiosis. Mitosis and meiosis is a continuous process. Cell Division topic is one of the important topics in Biology and its complex concept most difficult to understand.

A study conducted by Ozcan et al (2012) shows that students' poor understanding and poor mastery level for both mitosis and meiosis concept cause difficulty in understanding of cell division concept among students and make them to have misconceptions about two important concepts. Misconceptions about biology abstract concepts affect students' achievement. Thus, the problem of misconception should be considered in the learning process of an individual.

Students have misconceptions and lack of understanding about Cell Division topic due to the use of many educational methods that require memorization of the concepts. To them, students' misconception is difficult to replace if teachers use traditional teaching methods alone

Mitosis and meiosis serve as the basis for understanding about the molecular events of mitosis and meiosis which are difficult to observe through the naked eyes. Understanding and construction of the knowledge about mitosis and meiosis concepts at the molecular level depends on the ability of the students' visualization about the chromosomes movement during mitosis and meiosis

Karamustafaog˘lu, Sevim, Mustafaog˘lu, and Epni (2003) mentioned that students' misconceptions can be reduced or avoided through interactive teaching and learning process that uses educational software program. Computer simulation is one of the educational software programmes. Simulation teaching and learning method is based on constructivist learning and support students of different learning styles such as visual, auditory and kinesthetic.

Again, Rutten, Van Joolingen and Vanderveen (2012) said that most of the research findings show that the integration of simulation in traditional teaching methods leads to positive changes in cognitive and affective do mains. A study conducted by Gelbart, Brill, and Yarden (2009) also shows that computer simulations have a positive influence on learning outcomes when compared with effects of regular teaching method without use of computer simulation for Genetic topics in Biology.

Riess and Mischo (2010) in their study identified that computer simulation based learning is effective teaching method and have positive impact on Biology students' understandings and achievements which were analyze through students' ability in answering questions regarding forest ecosystem topic with correct explanation and their score. Hence, computer simulation based teaching method supports students from different learning styles, create constructivism learning environment in which role of students in learning process is higher than the teachers and enhance students' understandings, ability of thinking and achievement.

Kiboss, Wekesa and Ndirangu (2006) said that simulation can show the dynamic nature of cell division process through animated colored graphics and involve use of various senses.

They further emphasized that learning environment designed using computer simulation for Cell Division topic in Biology is effective in improving students' understandings, knowledge and achievement and encourage students to engage actively in the learning process.

Furthermore, study of White, Kahriman, Luberice and Idleh (2010) shows that 3D visualization and simulation based teaching method is more efficient compared to traditional teaching methods for learning protein structure concept in Biology. Buckley (2000) shows that the simulation and multimedia based teaching method in Biology, promote constructivism learning environment among students and encourage students to develop their own learning goals and increase their concentration toward Biology lesson while interacting with simulation presentation. Buckley (2000) in his study use simulations and multimedia resources as Educational model to teach Blood Circulation System topic.

Kiboss, Wekesa and Ndirangu (2006) said that computer simulation based teaching and learning method for learning Cell Division topic is interactive. Dynamic characteristics of the computer presentation that combines verbal code with graphical representation and animation provides variety of interesting learning activities about the concepts that they have learned, encourage students to interact openly with teaching materials and facilitate students' understandings. Combination of graphical representation, animation and simulation in computer simulation based instructions increase the acceptance and understandings of the cell division process that they have learned in the form of illustrations. They reported that students taught with computer simulation based instruction got higher achievement than students taught with the traditional teaching method. Teacher centered teaching approach in the traditional teaching method affect students' Biology achievement. Findings from Kiboss, Wekesa and Ndirangu's study further strengthen the findings of previous studies that students perform better and score higher when taught with computer based instructional method whereas students who were taught with traditional teaching method unable to perform well. Non-realistic simulation is desktop virtual reality simulation. Application of virtual reality technology in teaching method, create more immersive and interactive virtual learning environment that can be shared by all students in a virtual community. Virtual learning environment help students to solve their learning problems and explore new concepts

Pan, Cheok, Yang Zhu and Shi (2006) reported that virtual reality is one of latest computer based technology and it increase interactivity. For example, in Biology education, students encouraging to interacting with virtual reality simulations, encouraging student engagement in an interactive learning environment and students can access remotely from any place including long distance place. Virtual reality also creates virtual learning environment that uses various senses, mo re immersive than other computer based teaching and learning methods and has a significant impacts on students' learning.

Virtual reality technology in education imp roves student's motivation and understandings. It is effective in teaching difficult topics and experiments that are difficult to understand if teach with traditional teaching method. This is because, virtual reality learning environment pro mote self-directed learning and the virtual reality based 'hands-on' activities assist students in understanding of scientific abstract concepts

Furthermore, Shim *et al*. (2003) reported that students show more interest in virtual reality simulations than teaching methods that use multimedia and students assume that virtual reality simulations are very helpful in learning science subjects especially Biology. In another study, Varma and Linn (2012) examine the use of interactive technology to support students' understandings of the greenhouse effect and global warming in Biology. They reported that, student's understandings increase after they conducted experiments using virtual visualization. The results showed that students' knowledge and understandings increase when students are actively involved in the learning process. Students' achievement shows that there was an increase in their post test scores than the pre test scores. Meir, Perry, Stal, Maruca and Klopfer

(2005) also reported that there was an increase in students' understandings and reduce students' misconceptions when students conduct experiments to learn about diffusion and osmosis concept in the virtual laboratory.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter presents the methodology adopted for the study. A detailed procedure for the design of the research for the study as well as their analysis is explained in this chapter.

3.1 Research Design

The present study was a quasi-experimental study. The study was done by dividing the sample into two groups: control group and the treatment group. Integrated Science students form one Class in Adanwomase Senior High School in the Kwabre East District of Ashanti Region were purposively selected. Students from the first class were assigned as the treatment group while students from the second class was assigned as the control group. Both groups each comprise of 62 Integrated Science students. The control group was taught with the traditional lecture method whereas the treatment group was taught with computer simulation for the Cell Division topic.

A quasi-experimental design is a quantitative approach because it involves measurement and has two variables such as dependent variable and independent variable. The dependent variable is students' achievement and the independent variables are computer simulation based teaching method and the traditional teaching method. Measurement is carried out through a set of pre-post achievement test questions. Pre achievement test and post achievement test consisted of 20 objective questions. Before control group and treatment group students followed the Cell Division topic lesson using computer simulation and traditional lecture methods, pre achievement test was given to both control group and treatment student groups. After that, the control group was taught using the traditional lecture method whereas the treatment group was taught using a computer simulation. Post achievement test was given to both control group and the treatment group after they finished learning the Cell Division topic for three weeks. The design of the present study is summarized in Figure. 3.1:

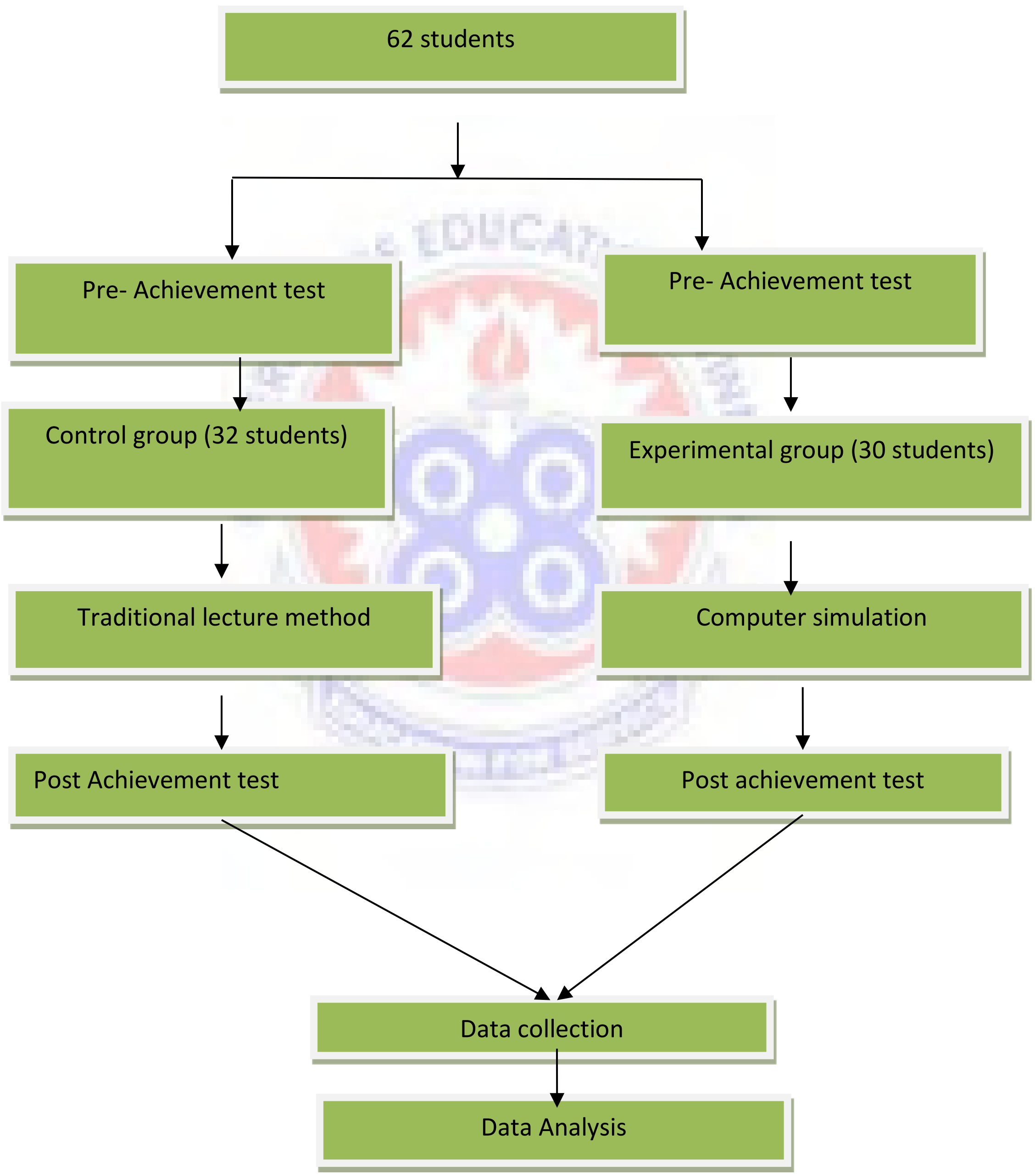

Figure 3.1 Pictorial representation of the procedure

Computer simulations were selected from existing software on the website which is freely accessible. Simulations consist of four main concepts of Cell Division topic such as cell cycle, mitosis, meiosis I and meiosis II.

Pre-achievement test data was analyzed followed by post-achievement test data. In the preliminary analysis the pre- achievement test scores were used as a covariate to adjust and control the effects of covariate (students' pre-achievement) on the dependent variable (students' post-achievement). All pre-achievement test and post-achievement test data were analyzed using SPSS Version 16.0. Descriptive statistics which is used to describe the characteristics of the variables that used in a study and it used to make inferences based on the numerical data whereas inferential statistics used to describe the relationship between the variables. Descriptive statistics that were used in present study include the number of people, percentage, the percentage difference, frequency, mean, and the mean difference. Inferential statistics that was used in present study were paired and un- paired samples t-test.

Inferential statistics and descriptive statistics were used to identify the effectiveness of two types of teaching methods (simulation and traditional teaching method) on students' achievement for Cell Division topic. In inferential statistics such as paired sample t-test, a p value less than 0.05 is significantly different and the null hypothesis rejected.

3.2 Population

The target population of this study was all SS1 Integrated Science students in Adanwomase Senior High School in the Kwabre East District in the Ashanti Region.

3.3 Sample size

A total of 62 students were selected from two form one classes (1D and 1A10) that served as the experimental group and control group respectively.

3.4 Sampling Procedure

Sampling refers to the process of selecting a portion of the population to represent the entire population (Fraenkel and Wallen, 2000; Muijs, 2004; Alhassan, 2006).

In this study, all form one Integrated Science students were used as the population.

Purposive sampling technique with the help of the pre-intervention test was used to sample a total of thirty (30) students as experimental group and another thirty–two (32) as a control group. The academic performance of 1A10 class is higher than 1D. Hence, 1A10 was chosen as the control group and 1D as the experimental group because they have a low academic performance. The purpose was to get a sample size of thirty- two (32) within the lower scores limit in the pre-intervention test as the experimental group, and the remaining thirty two with the upper and higher scores limit as the control group.

The school as well as the two classes was purposively selected on the basis of easy accessibility to the researcher.

3.5 Instrumentation

In this study, the main instruments used included a set of pre and post- treatment test items as well as students' questionnaires. A set of Tutor constructed Integrated Science Achievement Test (TCIAT) items were used as the main tool for collecting the data. The pre-test items consisted of 20 multiple choice questions on concept related to the topic.

The scores of the pre-intervention and post-intervention test items were used in the analysis to answer the research questions. The students' questionnaire items were chosen to gather the data and further buttress findings on the effectiveness of Computer Simulations as instructional strategy integration in Integrated Science education.

3.6 Scoring of the questionnaire items on students' perception about computer simulations integration

A Likert scale with five options (Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D) and Strongly Disagree (SD)) was used to score the questionnaire items on students' perception about Computer Simulations integration. The items were positively and negatively worded in order to minimize participant satisfying responses.

Likert scale was used to score the questionnaire because it looks interesting to respondents and people often enjoy completing a scale of this type (Muijs, 2004). Again, Likert scale is easier to construct, interpret and also provide the opportunity to compute frequencies and percentages as well as statistics such as the mean and standard deviation of scores. This in turn allows for a more sophisticated statistical analysis such as Analysis of Variance (ANOVA), t-test and regression analysis (Fraenkel and Wallen, 2000; Muijs, 2004). Additionally, Likert scales are often found to provide data with relatively high reliability. Variable scores were obtained by averaging the numeric values of the responses for the related items on the variable. A mean score near 5 was considered a very high level of support, between 3 and 4 a high level of support, and a score between 1 and 2 was regarded as low level of support. For the perception of the Effectiveness of Computer simulations in the instructional process, a mean score of 3.0 represents a 'neutral position'. This value representing a neutral position was used in this study to indicate a position that respondents neither agree nor disagree with a statement. A mean value of below 3.0 gave a general picture of disagreement with a statement. However, it must be noted that, a mean value above or below 3 does not imply that all respondents agreed or disagreed with a statement, but the majority were. The percentages of the participants' responses to the Likert scale items were also used to indicate the extent to which participants agreed or disagreed with the items.

Students were asked to rate how useful they found computer simulations on a 5 point Likert scale where 1 meant that students strongly disagree and 5meant that they strongly agree. Again, they were asked to rate if computer simulations reduce forgetfulness.

3.7 Data Collection Procedure

An objective test items consisting of twenty test items on a just treated sub-concept topics such as cell cycle, mitosis and meiosis etc. were administered to the sixty two form one Integrated Science students as a pre-intervention test with the assistance of science teachers. The questionnaire items on the effectiveness of computer simulations in Integrated Science instruction was administered to the experimental group after the treatment.

Procedure

Two instructional strategies were used. The experimental group received the computer simulation instructional treatment, while the control group was taught using the traditional lecture method.

The two study groups covered the same content material. Each group was met three times per week for three weeks. The content covered was extracted from the Senior High School Integrated Science curriculum. The units covered in cell division were, plant and animal cells, levels of organisation of cell in living organisms, cell cycle, mitosis, meiosis, differences between mitosis and meiosis, significance of mitosis and significance of meiosis. In the traditional teaching method, the main methods used were lecture- note-taking sessions, discussion and question and answer methods. The control group was given an introductory lesson on the first day, which included the unit objectives of the sub topics given above and some other questions which were designed to instill motivation. The succeeding days consisted of regular class discussions, informal assessments, and textbook exercises.

3.8 Data Analysis

The statistical Package of Social Sciences (SPSS) was used for the data analysis.

The data from both the pre and post-tests were analyzed using methods of descriptive and inferential statistics. The statistical procedures employed were: quantitative paired and unpaired t-test as well as descriptive statistical tool such as the mean, standard deviation etc.

The responses from the questionnaire items were analyzed through the use of descriptive explanations making use of percentages and descriptive statistics.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter presents the analysis of data collected from the two classes (1A10, 1D) that were used for the study. Sixty-two students from both classes were subjected to pre-test questions on Cell Division after which they were given an intervention (using computer simulations and the traditional Lecture method). Thereafter, a post- test was administered to the two classes.

4.1 Presentations of the results

Table 4.1 gives a summary of the results obtained by students after they had been subjected to twenty (20) objective tests before (pre) and after (post) they were taught the concept of Cell division using Computer simulations as well as the Traditional Lecture method.

Table 4.1: **Descriptive Statistics of the Pre-Test and Post-Test for the Treatment and control groups**

Instrument	Group	Sample size	Mean	Standard deviation
Treatment Group	Pre-Test	30	5.36	2.00
(Computer Simulation/ 1D)	Post-Test	30	11.50	3.28
Control Group	Pre-Test	32	6.03	1.94
(Lecture method/ 1 A10)	Post-Test	32	9.12	2.37

The pre-test of 1 D was compared to the pre-test of 1A10. The mean score of 1A10 (6.03) was higher than 1D (5.36) and therefore 1A10 was assigned as the control group and 1D as the treatment group after the pre-test. The graphical representation of this information is presented in Figure 4.1.

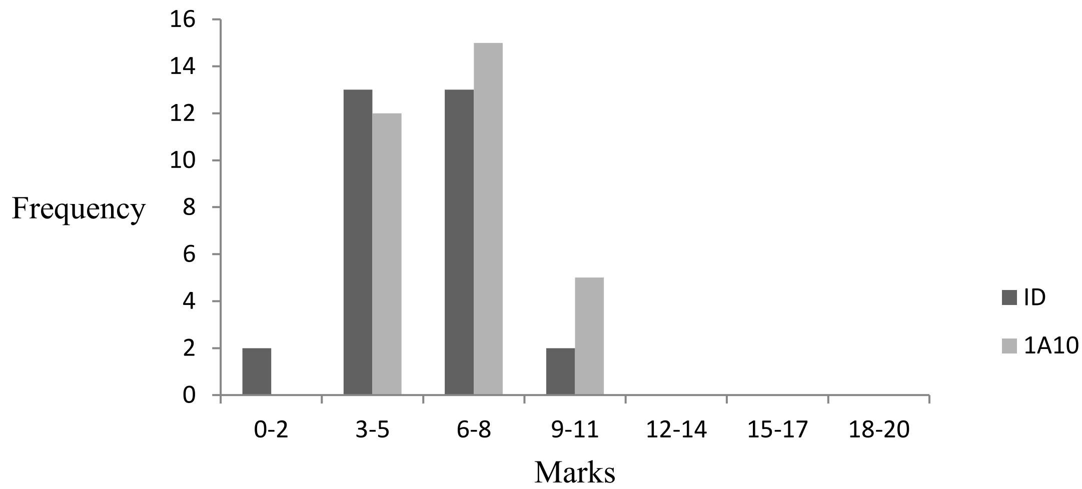

Fig 4.1: A bar chart distribution of the pre-intervention test for 1D and 1A10

The t-test analysis of the means showed a p-value (0.19) and that there was no significant difference between the means of the pre-test for 1A10 and 1D (Table 4.2).

The table below shows the t-test results of the means of the pretest for 1A10 and 1D.

Table 4.2: t- test result of the pre-test for 1D and 1A10

Test	Mean difference	Degree of freedom	p-value
Pre-tests of 1D and 1A10	0.66	60	0.19

p>0.05 no significant difference

Analysis of test results with respect to the research question one

RQ 1: Is there any difference in achievement of students taught with Computer Simulations and those taught with the Lecture method?

In order to find solution to this research question, further questions were derived which included

A. Is there any difference in the test results (pre-test and post-test) of students when they were taught with Computer simulations?
B. Is there any difference in the test results (pre and post) of students after they were taught using the Traditional lecture method?
C. Is there any difference in achievement in the post-achievement test scores between the treatment group students who learnt with computer simulation and control group students who learnt with the traditional lecture method?

RQ 1(A): Is there any difference in the test results (pre-test and post-test) of students when they were taught with Computer simulations?

This question sought to find out whether there would be a positive effect on academic achievement of students in Integrated science after using computer simulations to teach cell division.

The mean of students' post-test (11.500) in 1D was higher than their pre-intervention test (5.36) (Table 4.1)

Table 4.3 represents the difference in means of the pre test and post test results of students when they were taught using Computer simulations.

Table 4.3: t- test result of the pre-test and post-test of 1D

Test	Mean difference	Degree of freedom	p-value
Pretest and post test (1D)	6.933	29	4.83

p>0.05 no significant difference

From Table 4.3, it was observed that the p-value (4.83) for the pre-test and post-test of 1D was greater than 0.05. This means that there is no significant difference in the pre-test and post-test scores of students who were taught with computer simulations. The null hypothesis (H_{0A}) which stated that there is no significant difference in treatment group of students' achievement between pre-test and post-test was therefore maintained.

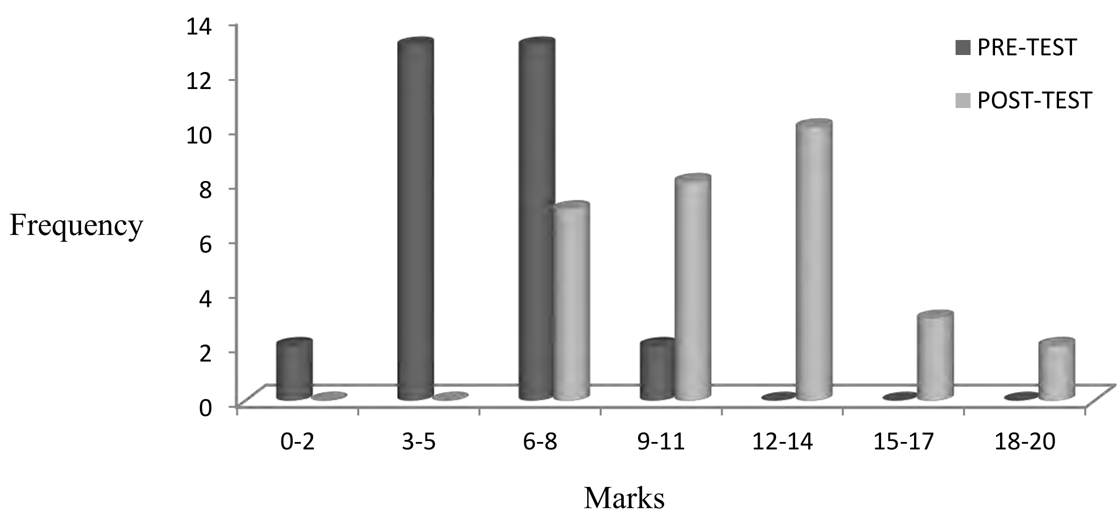

Fig 4.2: A bar chart distributrion of the pre and post-intervention test for 1D

Analysis of test results with respect to the research question one B

RQ 1(B): Is there any difference in the test results (pre and post) of students after they were taught using the Traditional lecture method?

This question sought to find out whether there would be a positive effect on academic achievement of students in Integrated science after using the traditional lecture method to teach cell division.

In response to this question, the mean score (9.12) of students' post-test in 1A10 was higher than their pre-intervention test (6.03) (Table 4.1).

The graphical representation of this information is presented in Figure 4.3.

The means of the pre-test and post-test of 1A 10 was also subjected to a t-test analysis.

Table 4.4 represents the difference in means of the pre-test and post-test results of students when they were taught using the traditional lecture method.

Table 4.4: t- test result of the pre-test and post-test of 1A10 (Traditional lecture method)

Test	Mean difference	Degree of freedom	p-value
Pretest and post test (1A10)	3.094	31	6.35

p>0.05 no significant difference

It was observed that the p-value (6.35) for the pre-test and post-test of 1A10 was greater than 0.05 (Table 4.4). This means that there is no significant difference in the mean scores of the pre-test and post-test of students who were taught with the Traditional lecture method. The null hypothesis (H_{0B}) was therefore maintained.

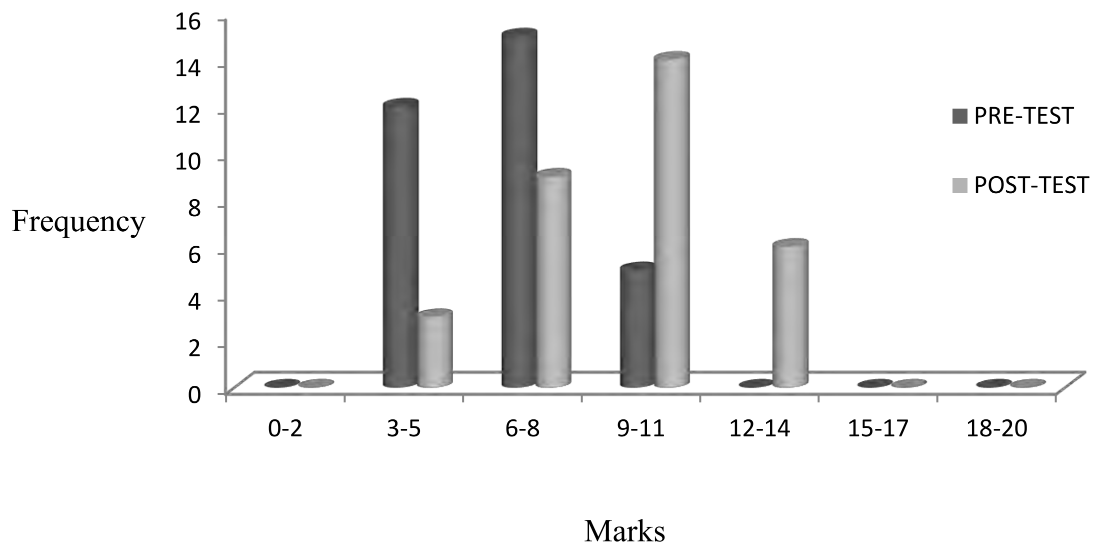

Fig 4.3: A bar chart distribution of the pre and post-intervention test for 1A10

Analysis of test results with respect to the research question one (C)

RQ 1(C): Is there any difference in achievement in the post-achievement test scores between the treatment group students who learnt with computer simulation and control group students who learnt with the traditional lecture method?

This question sought to find out which of the two teaching methods is more effective in improving academic achievement of students in Integrated science after using computer simulations and the traditional lecture methods to teach cell division.

In response to this question, the mean (11.500) of students' post-test in 1D was higher than the mean (9.12) for the post-test for the control group (Table 4.1).

The means of the post-test of 1 D and 1A 10 were subjected to unpaired t-test analysis and it was found that there was a significant difference between the two means. The result obtained is shown in Table 4.5.

Table 4.5 represents the difference in means of the post-test results of students when they were taught using Computer simulations and the traditional Lecture method.

Table 4.5 t-test result for post -tests of Treatment group (1D) and control group (1A10)

Test	Mean difference	Degree of freedom	p-value
Post-tests (1D and 1A10)	2.375	60	0.002

It was observed that the p-value (0.002) for the post-tests for both classes 1 D and 1 A10 was less than 0.05(Table 4.5). This implies that there is a significant difference in the post-achievement test of students who were taught with computer simulations and those students taught with the Traditional lecture method. The graphical information of the results is as shown in figure 4.4.

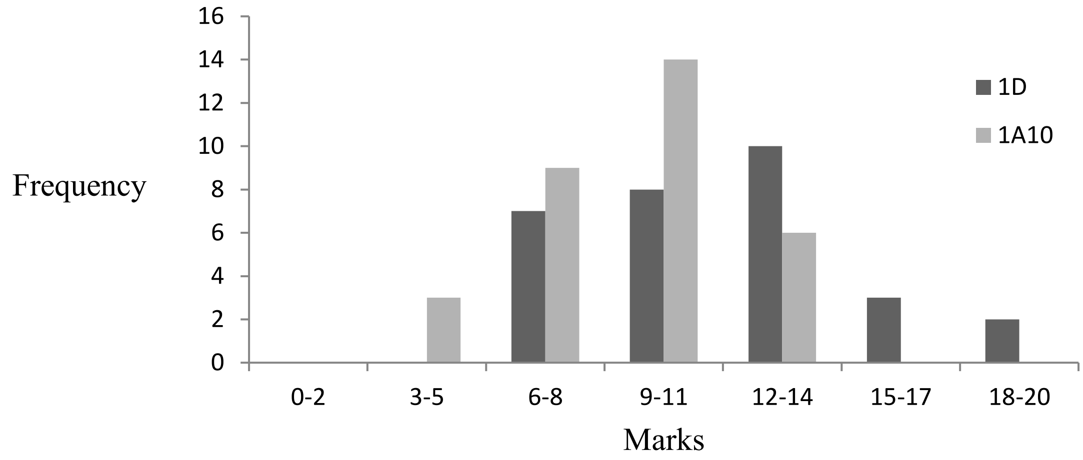

Fig 4.4: A bar chart distribution of the post-intervention test for 1D and 1A10

The null hypothesis (H_{0C}) which stated that there was no significant difference in students' post-achievement test between treatment group students (taught with Computer simulation) and the control group students (taught with the traditional lecture) method was therefore rejected and the alternative hypothesis (H_{1C}) was maintained.

From the above results from the three sub hypotheses (A, Band C) the null hypothesis for the research question one which stated that there is no significant difference in the achievement of students taught with computer simulations and those taught with the lecture method was rejected and the alternative hypothesis maintained.

Analysis of test results with respect to the research question two

RQ 2: What is the treatment group students' perception on the use of computer simulations in the learning of cell division?

This question sought to find out how students felt after the use of computer simulations to teach the Cell Division topic.

The questionnaire used to answer RQ 2 was grouped into two. One is in favor of the fact that computer simulation promotes students understanding and does away with rote learning and the second one is about computer simulation reduces forgetfulness.

It was found out that out of the thirty (30) students, twenty two (22) of them representing 73.33% strongly agreed with the fact that computer simulation promotes students learning and does away with rote learning. Eight (8) students representing 26.67% agreed with the statement above. None of the students were neutral, disagree or strongly disagreed with the statement.

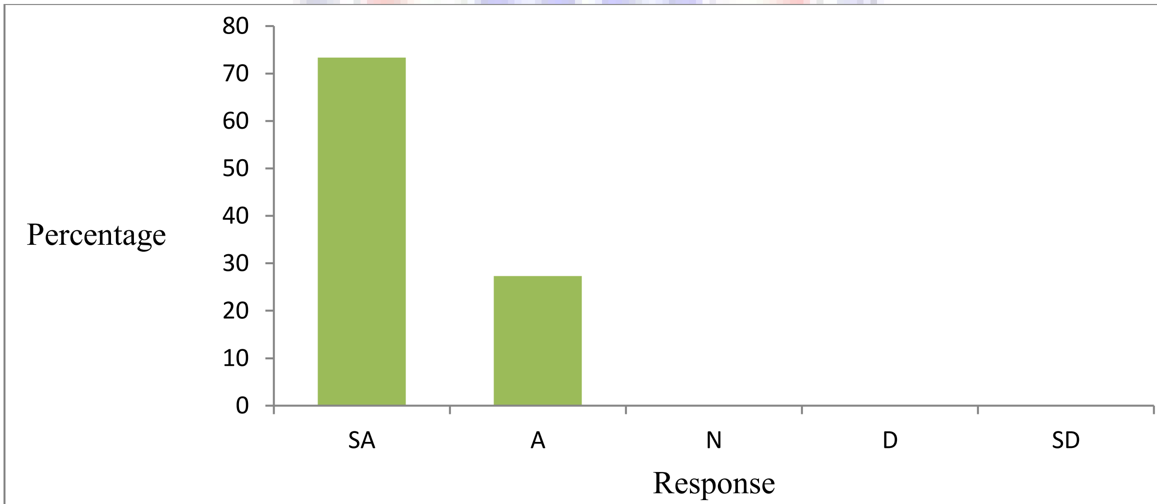

Fig 4.5: A barchart reflecting students' responses that computer simulations promote students understanding and does away with rote learning

With regards to the statement computer simulations reduce forgetfulness, twelve (12) students out of the thirty students representing 40% strongly agreed with this fact. Sixteen (16) of the students representing 53.33% agreed with the above statement. None of the students were neutral, disagreed or strongly disagreed with the statement. The bar-chart in fig.4.6 shows the percentage of students who strongly agree, agree, disagree and strongly disagree with the fact that computer simulations reduce forgetfulness.

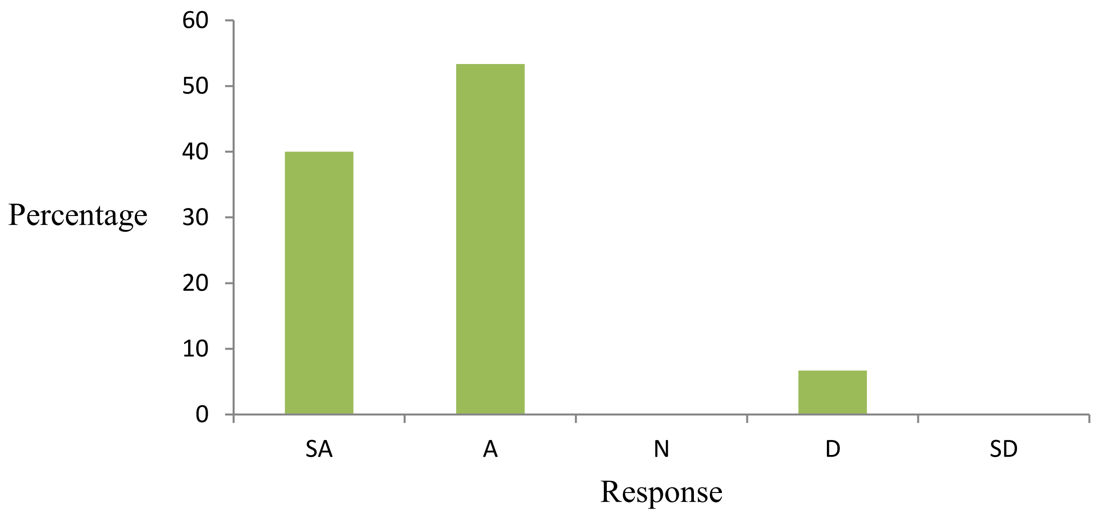

Fig 4.6: A barchart reflecting students' responses that computer simulations reduce forgetfulness

4.2. Discussion

Based on the descriptive statistics form table 4.1, both control group and treatment group got higher scores in post-achievement test than pre-achievement test. However, treatment group students who were taught with computer simulation gained a higher mean score in post achievement test than the control group students who were taught Cell division topic using traditional teaching method. The mean score differences between treatment group and control group for post achievement test is 2.375. These results showed that Computer simulation is a more effective method for the learning of Cell division than the traditional lecture method.

Paired samples t-test was used to identify the effectiveness of Computer simulations on treatment group students' achievement for Cell division topic. Paired samples t-test showed that there were no significant differences in the means of the pre-achievement test and post-achievement test of treatment group students who were taught with computer simulation. Table 4.1 and 4.2 showed that the mean score for the post-test (Mean = 11.50) is greater than the mean score of the pre-test (Mean = 5.36) for the treatment group. However, there was no significant difference between the means. Thus, the first null hypothesis (H_{0A}) which stated that there was no significant difference in treatment group of students' achievement between pre-test and post-test was therefore maintained.

H_{0B} There is no significant difference in control group students' achievement between pre-achievement test and post-achievement test using the Traditional lecture method. Paired samples t-test was used to identify the effectiveness of Traditional lecture method on control group students' achievement for Cell Division topic. Paired samples t-test showed that there no significant differences in the pre-achievement test and post-achievement test of control group students. The mean score of the post-test (9.12) was greater than the mean score (6.03) of the pre-test (Table 4.1). However, they were not significantly different from each other (Table 4.4). Thus, the second null hypothesis (H_{0B}) of this study was also maintained.

H_{0C}: There is no significant difference in students' post-achievement between treatment group students who were taught with computer simulation and control group students who were taught with traditional lecture method for Cell Division topic. Both computer simulations and the traditional lecture method had positive impacts on students' post- achievement when compared with students' pre-achievement scores. Students gained scores in their post-achievement test after they were taught with the two teaching methods. However, they were not significantly different. A t-test analysis made between the pre-test scores and the post-test scores of 1A10 and 1D showed that there is a significant difference between the means scores of the two classes. Thus, the mean post test scores of 1D (experimental group) (11.5) is significantly higher than the mean post test scores (9.12) for 1A10 (control group). Therefore, computer simulation was a more effective teaching method for the topic Cell division in Integrated science and thus the null hypothesis (H_{0C}) was rejected and the alternative hypothesis (H_{1C}) maintained.

The result from the study is supported by several studies such as study of Varma and Linn (2012), who reported that non-realistic simulation increase students' knowledge, understandings and achievement. A study conducted by Meir, *et al*. (2005) reported that non-realistic simulation enhance students' understandings as well as reduce their misconceptions about learned Biology concepts. Mikropoulos, Katsikis, Nikolou and Tsakalis (2003) also reported that teaching and learning with non-realistic simulation method encourage students to engage actively and creatively in Biology learning and promote better understandings among students about the difficult concepts through visualization.

Based on the findings of this study and other related studies in the field of students' performance in Science, both computer simulation and the traditional lecture methods can improve Science students' achievement.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter deals with the summary of the study and findings that resulted from the study. Other components of the chapter are the conclusions drawn from the study as well as educational implications of the study for teaching Integrated Science; recommendations made from the findings and suggested areas for further research.

5.1 Summary

The summary of key findings from this study is that, the intervention improved students' performance comparing students mean test scores of the pre-intervention test and the post-intervention test.

Even though both the computer simulation and the traditional lecture method improved students performance, there is also evidence of even greater significant difference in performance between the students who were taught with computer simulations and those taught with the traditional lecture method. That is, the computer simulation method improved students' performance more than the ordinary traditional lecture method.

5.2. Conclusions

Findings of this research indicate that, computer simulations and Traditional Lecture method provided some support for every student to eventually achieve an enhanced conceptual understanding of the Cell Division topic.

It can also be deduce from the study that, when the appropriate teaching and learning materials (TLMs) and methods such as Computer simulation are used to teach cell division, they bring out the best in learners and make them the discoverers of their own knowledge as far as learning is concern.

Computer simulations improved the retention of cell division among form one students of Adanwomase Senior High School.

Students had a good perception on the use of computer simulations in the learning of Cell Division.

5.3 Recommendations

Reflecting on the findings of this study, there are some recommendations made for the future study that will be carried out in the field of the effect of computer simulations on students' achievements.

In the learning of cell division topic, teachers should incorporate the use of computer simulations.

Again, teachers should be trained on the use of computer models for the learning of science.

Furthermore, the Ministry of Education should provide computers to schools to help in learning of science since students learn better with the eye.

Finally the Ghana Education Service should provide CDs and DVDs on challenging topics such as cell division for teachers.

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APPENDIX I
PRE TEST ON CELL DIVISION
DURATION: 30 MINUTES
NAME:…………………………………………………CLASS………20marks

You have been provided with 20 question items. After each question, there are four alternatives, please circle the appropriate one.

1. Homologous chromosomes move to opposite poles of a dividing cell during
   A Mitosis
   B. Meiosis I
   C. Meiosis II
   D. Fertilization

2. If a diploid cell with 18 chromosomes undergoes meiosis, the resulting gametes will each have
   A. 9 chromosomes
   B. 18 chromosomes
   C. 36 chromosomes
   D. 11 chromosomes

3. Mitosis occurs in the
   A. Gametes
   B. Chromatids
   C. Somatic cells
   D. Cytoplasm

4. After meiosis, daughter cells have
   A. Twice the number of chromosomes as the parent
   B. The same number of chromosomes as the parent
   C. One-fourth the number of chromosomes as the parent
   D. Half the number of chromosomes as the parent.

5. In mitosis, the division of the nucleus is usually followed immediately by
   A. Cytokinesis
   B. Fertilization
   C. Crossing over
   D. Duplication

6. During ……the chromatids in the nucleus become more tightly coiled, condensing into discrete chromosomes
   A. Interphase
   B. Prophase
   C. Metaphase

D. Anaphase

7. At the …………stage, paired centromeres of each chromosome separate, finally liberating the sister chromatids from each other.
   A. Interphase
   B. Prophase
   C. Metaphase
   D. Anaphase

8. The correct arrangement of mitosis is
   A. Interphase → prophase →metaphase →anaphase →telophse and Cytokinesis
   B. Prophase →telophase and cytokinesis → anaphase →interphase →metaphase
   C. Anaphase → prophase → telophase and Cytokinesis → metaphase → Interphase
   D. Metaphase → anaphase → telophase and Cytokinesis →interphase →prophase

9. Which of the following does not occur during mitosis?
   A. Packaging of the chromosomes
   B. Replication of DNA
   C. Separation of sister chromatids
   D. Spindle formation

10. The zygote and all other cells having two sets of chromosomes are called
    A. Haploid cells
    B. Diploid cells
    C. Triploid cells
    D. Somatic cells

11. Meiosis in animals occurs in the
    A. Testes
    B. Ovaries
    C. Testes and ovaries
    D. None of the above

12. Meiosis II is similar to mitosis in that
    A. Homologous chromosomes synapse
    B. DNA replicates before division
    C. Sister chromatids separate during anaphase
    D. The daughter cells are diploid

13. Meiosis results in …..daughter cells where as mitosis results in ……….daughter cells
    A. 2, 4
    B. 4, 2
    C. 1, 2

D. 2, 1

14. The random separation of homologous chromosomes is called
    A. Independent assortment
    B. Genetic recombination
    C. Crossing over
    D. Genetic variation

15. During which stage does DNA replication occur
    A. Prophase
    B. Anaphase
    C. Metaphase
    D. None of the above

16. During ……………the chromosomes are now at the equator of the spindle
    A. Interphase
    B. Prophase
    C. Metaphase
    D. Anaphase

17. How many cells are present in a human sperm cell?
    A. 23
    B. 46
    C. 15
    D. 30

18. Cytoplasmic division of a cell is called
    A. Mitosis
    B. Cytokinesis
    C. Cleavage furrowing
    D.Synapsis

19. Each duplicated chromosome prior to division will be held together at a region called the
    A. Tetrad
    B. Synapsis
    C. Centromere
    D. Chromatid

20. The haploid number of chromosomes found in the housefly is 6. The diploid number for the house fly would be
    A. 6
    B. 3
    C. 9
    D. 12

APPENDIX II

POST- TEST ON CELL DIVISION

DURATION: 30 MINUTES

NAME:………………………..………………………CLASS……….20marks

You have been provided with 20 question items. After each question, there are four alternatives, please circle the appropriate one.

1. If a diploid cell with 20 chromosomes undergoes meiosis, the resulting gametes will each have

   A. 9 chromosomes

   B. 10 chromosome

   C. 18 chromosome

   D. 20 chromosomes

2. Mitosis occurs in the

   A. Gametes

   B. Somatic cells

   C. Chromatids

   D. Cytoplasm

3. Homologous chromosomes move to opposite poles of a dividing cell during

   A. Mitosis

   B. Meiosis I

   C. Meiosis II

D. Fertilization

4. After meiosis, daughter cells have

A. Twice the number of chromosomes as the parent

B. Half the number of chromosomes as the parent.

C. The same number of chromosomes as the parent

D. One-fourth the number of chromosomes as the parent

5. In mitosis, the division of the nucleus is usually followed immediately by

A. Fertilization

B. Crossing over

C. Cytokinesis

D. Duplication

6. During ……the chromatids in the nucleus become more tightly coiled, condensing into discrete chromosomes

A. Interphase

B. Prophase

C. Metaphase

D. Anaphase

7. At the…………..stage, paired centromeres of each chromosome separate, finally liberating the sister chromatids from each other.

A. Anaphase

B. Interphase

C. Prophase

D. Metaphase

8. The correct arrangement of mitosis is

A. Interphase → prophase →metaphase →anaphase →telophse and Cytokinesis

B. Prophase →telophase and cytokinesis → anaphase →interphase →metaphase

C. Anaphase → prophase → telophase and Cytokinesis → metaphase → Interphase

D. Metaphase → anaphase → telophase and Cytokinesis →interphase →prophase

9. The zygote and all other cells having two sets of chromosomes are called

A. Haploid cells

B. Diploid cells

C. Triploid cells

D. Somatic cells

10. Meiosis in animals occurs in the

A. Testes Ovaries

C. Testes and ovaries

D. None of the above

11. Which of the following does not occur during mitosis?

A. Packaging of the chromosomes

B. Replication of DNA

C. Separation of sister chromatids

D. Spindle formation

12. Meiosis II is similar to mitosis in that

A. Homologous chromosomes synapse

B. DNA replicates before division

C. Sister chromatids separate during anaphase

D. The daughter cells are diploid

13. How many cells are present in a human egg cell?

A. 46

B. 30

C. 23

D. 15

14. Meiosis results in …..daughter cells where as mitosis results in ………..daughter Cells

A. 1,2

B. 2, 1

C. 2, 4

D. 4, 2

15. During which stage does DNA replication occur?

A. Prophase

B. Anaphase

C. Metaphase

D. None of the above

16. During …………..the chromosomes are now at the equator of the spindle

A. Interphase

B. Prophase

C. Metaphase

D. Anaphase

17. The random separation of homologous chromosomes is called

A. Independent assortment

B. Genetic recombination

C. Crossing over

D. Genetic variation

18. Cytoplasmic division of a cell is called

A. Mitosis

B. Cytokinesis

C. Cleavage furrowing

D. Synapsis

19. Each duplicated chromosome prior to division will be held together at a region called

the

A. Tetrad

B. Synapsis

C. Centromere

D. Chromatid

20. The haploid number of chromosomes found in the housefly is 6. The diploid number for the house fly would be

A. 6

B. 3

C. 9

D. 12

APPENDIX III

STUDENTS' QUESTIONNAIRE

TEACHING WITH COMPUTER SIMULATIONS

INSTRUCTIONS

This is a questionnaire to ascertain students' perception on the use of computer simulations in the learning of cell division in Integrated Science. Thank you for taking time to complete this questionnaire. Your thoughtful and truthful responses will be greatly appreciated**.** **Your individual name and any identification number are <u>not required</u> and will not any time be associated with your responses**. Your responses will be kept completely confidential and will not influence your course grade and any of your examination results anywhere.

Please read the following statements and kindly provide the information required.

A. Background information

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

1. Gender [ ] Female [ ] Male

2. Age………………years

3. At what level were you taught with computer simulations? Please tick only one level

Kindergarten level	
Junior high school level	
Senior high school level	
Other, please specify	

B. Perceptions of the effectiveness of Computer simulations on teaching and learning.

Please tick [√] the option that best reflects how you associate with each of the following statements.

Rating Scale: Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), Strongly Disagree (SD).

Statement	**SA**	**A**	**N**	**D**	**SD**
4. I was more enthusiastic and motivated during the use of computer simulations in the teaching and learning of Cell division					
5. The use of computer simulations in instruction reduced my personal interaction with my colleagues.					
6. The use of computer simulations promotes students' understanding and does away with rote learning					
7. Computer simulations can be used in Integrated Science to enhance the understanding of other concepts					
8.The use of computer simulations makes student feel more involved in the classroom					
9. The use of computer simulations reduces the personal undue forgetfulness and recitation of mnemonics during examinations.					

10.The use of computer simulations would affect my learning during my private time in a positive way					

11. Please, give any general view(s) about the Perceptions and effectiveness of computer simulations integration in the teaching and learning of science as a practice to enhance student's performance in the space below:

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

Thank you very much for your assistance and time.

APPENDIX IV

A LIKERT SCALE WITH FIVE OPTIONS.

Response intensity	Symbol	Score
Strongly Agree	SA	5
Agree	A	4
Neutral	N	3
Disagree	D	2
Strongly Disagree	SD	1

APPENDIX V

STUDENTS' RESPONSES TO QUESTIONNAIRE

Table 4.6: Percentage of students who strongly agree, agree, disagree and strongly disagree with the fact that computer simulations promote students understanding and do away with rote learning.

	SA	A	N	D	SD
Treatment Group(n=30)	22	8	0	0	0
Percentage	73.33	26.67	0	0	0

Table 4.7: Percentage of students, who strongly agree, agree, disagree and strongly disagree with the fact that computer simulations reduce forgetfulness

	SA	**A**	**N**	**D**	**SD**
Treatment Group(n=30)	12	16	0	2	0
Percentage	40.0	53.33	0	6.67	0

Strongly agree=4 points

Agree =3 points

Disagree=2points

Strongly disagree=1point

Calculating the scale for question 1

22*4= 88

8*3= 24

Total= 112/32=**3.5**

Calculating the scale for question 2

12*4= 48

16*3= 48

2*2 = 4

Total= 100/32= 3.125

A Likert scale of 3.5 means that majority of the students agree with the fact that computer simulations promote students understanding and does away with rote learning.

A Likert scale of 3.125 shows students agree with the fact that computer simulations reduce the personal undue forgetfulness and recitation of mnemonics during examination.

APPENDIX VI

RAW SCORES OBTAINED BY STUDENTS OUT OF 20 MARKS

1D TEST SCORES	
PRE-TEST	POST-TEST
3	8
6	12
6	14
5	15
9	17
4	12
4	14
6	12
6	10
5	12
4	8
9	13
2	12
6	11
0	10
4	18
5	9
6	18
3	14
7	10
5	10
7	11
8	9
6	8
7	7
8	8
5	8
4	6
7	17
4	12

1A10 TEST SCORES	
PRE-TEST	POST-TEST
6	4
6	11
3	5
6	7
5	5
6	9
6	8
3	7
10	12
6	11
5	12
4	13
5	11
5	9
7	8
9	12
4	10
9	9
6	11
6	9
4	10
6	9
8	12
4	10
7	11
8	8
10	10
6	8
3	7
9	12
5	6
6	6

APPENDIX VII

MARKING SCHEME FOR THE PRETEST

1. B	**11. C**
2. A	**12. D**
3. C	**13. B**
4. D	**14. A**
5. A	**15. D**
6. B	**16. C**
7. D	**17. A**
8. A	**18. B**
9. B	**19. C**
10. B	**20. D**

MARKING SCHEME FOR THE POST-TEST

1. B	**11. B**
2. B	**12. D**
3. C	**13. C**
4. B	**14. C**
5. C	**15. D**
6. B	**16. C**
7. A	**17. A**
8. A	**18. B**
9. B	**19. C**
10. C	**20. D**