UNIVERSITY OF EDUCATION, WINNEBA

USING COMPUTER ASSISTED INSTRUCTION TO IMPROVE STUDENTS' ACADEMIC PERFORMANCE IN INTEGRATED SCIENCE IN JUABOSO SENIOR HIGH SCHOOL

EBENEZER DUKU AGBEMAFLE

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EBENEZER DUKU AGBEMAFLE
200011879

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DECLARATION

STUDENT"S DECLARATION

I, Ebenezer Duku Agbemafle 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 this work was supervised in accordance with the guidelines for supervision of thesis/dissertation/project as laid down by the University of Education, Winneba.

Supervisor"s Name

PROF. K.D. TAALE

Signature :…….……

Date:……..……

DEDICATION

To my lovely brother; Mr. George Baidoo.

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I am very grateful to Prof. Kodjo Donkor Taale, my supervisor for his thorough inspection of this thesis. In fact, he guided me not only in the writing of this thesis, but also instilled in me some sense of discipline and integrity. Prof, I am thankful.

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ABSTRACT

This study sought to improve Students‟ Academic Performance in Integrated Science Using Computer Assisted Instruction in Juaboso Senior High School. The main objectives were to: Examine the effect of Computer Assited Instruction (CAI) on students‟ academic performance, explore the effect of CAI on students‟ academic performance in different levels of cognitive domain and investigate the impact of CAI on students‟ retention ability. Three research questions were answered and three null hypotheses were stated and tested at $p \leq 0.05$ levels of significant. Action research design was used for the study. In the selection of the subjects, convenience sampling was used. Thirty-seven (37) students were used for the study. Integrated Science Performance Test (ISPET) made up of 30 multiple choice questions was used to measure the academic performance of the students before and after treatment. ISPET was validated by professional Integrated Science teachers and the supervisor with respect to content, construct and criterion validity. ISPET was pilot tested in Boinzan SHS. Reliability of ISPET was calculated using the Kuder-Richardson formula 21 ($K\text{-}R_{21}$) and found to be 0.78. The data collected from the performance test were analysed using descriptive statistics (mean, standard deviation) and Inferential statistics (dependent sample t-test through SPSS). The results indicated that students‟ academic performance improved after the treatment and that, CAI really helped the students to improve their knowledge in the various cognitive domains. Findings also revealed that CAI had a positive effect on students‟ retention ability in Integrated Science. Based on these findings, it was recommended that Integrated Science teachers in the school should use CAI in teaching and learning of Integrated Science to enhance students‟ academic performance and retention ability.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter deals with the background to the study, statement of the problem, purpose of the study, research objectives, research questions, significance of the study, limitation and delimitation of the study as well as definition of terms.

1.1 Background to the Study.

The increasing importance of skilled persons; not only as users of knowledge but producers of knowledge put additional responsibilities on the educators of science (Gonen, Kocakaya, & Inan, 2006). As an instructional medium, computers are described in various forms such as computer-based learning (CBL), computer-enhanced learning (CEL), computer-based instruction (CBI), computer-aided instruction (CAI), computer-aided learning (CAL) and computer-assisted instruction (CAI). Among these, CAI has been most successful and beneficial instructional approach for boosting interest, uplifting mentality, building up students' retention capacity and boosting the students‟ academic performance (Yusuf & Afolabi, 2010). Computers provide exciting, stimulating and energising approaches to instructional process that were not even imagined for two decades back. Yet the degree to which the instructive capability of computer technology will be accepted remains to be seen (Amara, 2006).

Computer-assisted instruction (CAI) is an instructional approach where a computer is used to communicate the instructional materials and evaluate the learning outcomes. It uses a blend of graphs, texts, sounds and videos for learning process (Onasanya, Daramola, & Asuquo, 2006). CAI refers to virtually any sort of computer application

in instructional settings comprising drill and practice, simulations, instructional exercises, supplementary exercises, instructional management, database development, programming, composing using word processors and other different applications (Cotton, 2001). Gana (2013) expressed that CAI is learner-centered and activity oriented. The challenge is how to optimise its usage. Gonzalez and Birch (2000) ascertain that computer-assisted instruction has the ability to promote active learning in a wide variety of disciplines from literature to the social sciences and beyond. Educators use technology to enhance instruction and this method has been turned out to be more powerful and effective.

The advantages of CAI method according to Orjika (2012) include; ensuring the application of proven teaching methods to students; offering equal educational opportunities for students by using the same program, changing the role of the teacher from teaching capacity to that of a guide; also, when properly handled, removing fright and embarrassment on students and bringing about meaningful learning and academic performance. Research has discovered that those learners who utilise computers have extensive self-assurance, confidence and are more efficacious and propelled to learn than those learners who are subjected to learn in traditional learning environment (Wishart, 2002). CAI helps to enable learners to focus on the physical meaning of the abstract concepts, subsequently, to get a detailed understanding of the theory (Azar & Şengüleç, 2011). It has been proved empirically that CAI is an excellent approach of teaching that strengthen students‟ academic performance, stimulate their interest and decrease their exhausting and abstract nature (Gambari, 2008). Simulations provide educators with the chances to give learners an instructional tool that can enable them to transform their alternate science conceptions into precise science conceptions. Learners could detach and manipulate parameters

and in this way, they are able to build up a comprehension of the relationships among physical ideas, variables and phenomena (Arvind & Heard, 2010).

The application of CAI in science subjects would empower the exposure and ability of the learners in building skills, understanding, abilities, learning and accessibility to information in the technological world. Such ability building will boost social, mechanical significance and sustainable development of the country (Kareem, 2015). The International society for technology in education (2005) suggests that teachers who move away from traditional learning environment to new learning environment promote active learning, higher level thinking, collaborative and multisensory stimulation. In order to manage effective learning in science, there should be a learning environment where the level of the students" prior knowledge is known, real life events are discussed, students are both mentally and physically ready and cognitive change is provided. At the same time, these learning environments should provide opportunities to students to consolidate the recently-learned notions (Guvercin, 2010). To develop the students" cognitive learning and their performance in solving problems, there is a need to teach using different student-centered education methods instead of the traditional methods (Ergun, 2010). Computer assisted instructional materials are more successful in building an ideal and desirable attitude, and in capturing enthusiasm towards learning. (Azar & Sengüleç, 2011).

Somekh (2008) argues that ICT is a powerful driver for educational change if used in the right manner and helps to create a less stressful environment for both teachers and students. The benefits of using ICT are immense for teachers and students of science. For teachers, the Internet expands the instructional resources available to them (Bingimlas, 2009), while also allowing them to empower students to become active

and skillful information seekers rather than remaining passive recipients of scientific facts (Pickersgill, 2003). Teachers can make science more engaging and comprehensible to students by employing ICT in four distinct ways as categorized by Ball (2003). Namely, as a tool, as a reference source, as a means of communication and as a means for exploration. For students, ICT can support development of science process skills and conceptual understanding. Besides, it also enhances opportunities to engage in effective communication about science at several levels (Murphy, 2006). A comprehensive review of research papers concludes that students can acquire science ideas quite successfully through ICT models and simulations (Hogarth, Bennett, Lubben, Campbell & Robinson, 2006).

According to Kankaanranta (2005), the rapid development of technology has challenged learning environments to adopt CAI to support learning and teaching and in guiding children to become its diversified users. It has now become clear that ICT as a modern tool has an important role to play in the quest to accelerate the rapid development of the education sector of everyday society. Any society that ignores the importance and usefulness of ICT in its development and most especially in its educational delivery would be doing so at the peril of the quality development of its human resources needed to facilitate development. (Opoku, 2008).

Integrated science covers all the various aspects of science disciplines (Physics, Biology, and Chemistry) including Agricultural Science and Information and Communication Technology. The study of Integrated Science becomes meaningful if only the concepts taught to the learners are understood by them and can be applied by the learners in life to improve upon the quality of their lives. Records show that 71.55 % of 608 students from Second Cycle Schools in Juaboso District who took the West

African Senior School Certificate Examination in 2016 failed in Integrated Science whilst 28.45 % passed. Again, 87.44 % out of 820 students from second cycle schools in Juaboso District who took the West African Senior Secondary School Examination in 2017 failed in Integrated Science whilst 12.56 % passed (The Chief examiner"s report, WAEC, 2017).

The standard of students passing Integrated Science in Juaboso District in the Western North Region of Ghana keeps on falling. (Safo-Adu, Ngman-Wara & Esi-Quansah, 2018). Hence, the researcher decides to improve students" academic performance in Integrated Science using Computer Assisted Instruction in Juaboso Senior High School.

1.2 Statement of the Problem

Integrated Science studies involve bringing together traditionally separate subjects so that students grasp a more authentic understanding. (Nwafor & Oka, 2016). According to the Integrated Science teaching syllabus for Senior High School in Ghana, the general aims of Integrated Science should enable students to be able to:

- solve basic problems within his/her immediate environment through analysis and experimentation
- keep a proper balance of the diversity of the living and non-living things based on their interconnectedness and repeated patterns of change.
- adopt sustainable habits for managing the natural environment for humankind and society
- use appliances and gadgets effectively with clear understanding of their basic principles and underlying operations

- explore, conserve and optimize the use of energy as an important resource for the living world.
- adopt a scientific way of life based on pragmatic observation and investigation of phenomena.
- search for solutions to the problems of life recognising the interaction of science, technology and other disciplines.

To achieve these objectives, it is suggested that the teaching and learning of Integrated Science should involve the use of innovative methods in teaching; methods like discovery, problem-solving, field trip and laboratory method among others (Nwafor & Oka, 2016). These suggested methods of teaching have been utilised for many years now. However, Safo-Adu, Ngman-Wara and Esi-Quansah (2018) stated that the quality of Integrated Science teaching and learning in Senior High Schools in Ghana is not encouraging and this has reflected in the low academic performance of Ghanaian SHS students in the West African Senior School Certificate Examination (WASSCE), particularly, in Juaboso District. This status may be attributed to lack of proper teaching materials, inadequate evaluation or probably, the teaching methods used in teaching and learning of the subject. (Nwafor & Okoi, 2016). The researcher therefore sought to use Computer Assisted Instruction (CAI) as an innovative method of teaching to improve the academic performance of students in Juaboso Senior High School in the District to fill this gap.

1.3 Purpose of the Study

Using Computer Assisted Instruction to improve Students‟ Academic Performance in Integrated Science in Juaboso Senior High School was the purpose of this study.

1.4 Research Objectives

Specific objectives of the study were to;

1. Examine the effect of Computer Assisted Instruction on students‟ academic performance in teaching and learning of Integrated Science at Juaboso Senior High school.
2. Explore the effect of Computer Assisted Instruction on students‟ academic performance in different levels of cognitive domain in Integrated Science at Juaboso Senior High school.
3. Investigate the impact of Computer Assisted Instruction on the retention of students‟ academic performance in Integrated Science at the Senior High School level.

1.5 Research Questions

1. What is the effect of Computer Assisted Instruction on students‟ academic performance in teaching and learning of Integrated Science at Juaboso Senior High School?
2. What is the effect of Computer Assisted Instruction on students‟ academic performance in different level of cognitive domain in Integrated Science at Juaboso Senior High School?
3. What is the impact of Computer Assisted Instruction on the retention of students‟ academic performance in Integrated Science at Juaboso Senior High School?

1.6 Research Hypotheses

The following null hypotheses were tested in the study;

Ho 1: There is no statistically significant difference between students‟ academic performance on pre-intervention test and post-intervention test in teaching and learning of Integrated Science at Juaboso senior High School using CAI.

Ho 2: There is no statistically significant difference between students‟ academic performance in different levels of cognitive domain i.e., knowledge, comprehension, application, analysis, synthesis and evaluation on pre-intervention test and post-intervention test.

Ho 3: There is no statistically significant difference between students‟ academic performance on post intervention test and retention test in Integrated Science at Juaboso Senior High School.

1.7 Significance of the Study

It is hoped that the study will transform the teaching and learning of Integrated Science from the traditional method of lecture, discussion, demonstrations and illustration to situation where CAI would be incorporated in the teaching and learning processes at Juaboso senior High School. This will help students to develop their creativity, problem-solving abilities, informational reasoning skills, communication skills and other higher-order thinking skills. (Trucano, 2005).

Again, it is believed that the study empowers the management unit of juaboso Senior High School in procuring the appropriate computer hardware and software to help improve teaching and learning of Integrated Science.

Furthermore, this study serves as a reference document for the Ministry of Education (MoE), Ghana Education Service (GES), Curriculum Research and Development Division (CRDD) and other stakeholders associated with science education to make instructional changes in science education and empower them to push for the incorporation of appropriate Computer Assisted Instructional packages in the teaching and learning of Integrated Science in Ghanaian SHS. The MoE and GES will also have the empirical evidence to back any increased budgetary allocation that would be ear-marked for the procurement of the appropriate ICT facilities and software programs to improve Science education.

Finally, the study will be a reference material for other researchers who would wish to conduct research studies into similar issues on how well Science is taught and learnt in Senior High Schools particularly, in Juaboso Senior High School.

1.8 Delimitation of the Study

The study was delimited to Western North Region, Juaboso District.

Only one school from the Juaboso District was used for the study, therefore, the use of the outcome of this study should be with caution.

Again, the study was delimited to only third year students of Juaboso SHS school since all the selected topics for the study were in third year syllabus. The study was additionally delimited to some selected topics (Nervous System, Electronics Variation and Inheritance) in Integrated Science instead of covering all the Integrated Science topics. These topics were selected because the researcher observed that students find it difficult to answer questions relating to them.

1.9 Definition of Acronyms

CAI: Computer Assisted instructions.

CAIP : Computer Assisted Instruction Package

CBI: Computer-Based Instruction.

CBL: Computer Based Learning.

CEL: Computer-Enhanced Learning.

GES: Ghana Education Service.

ICT: Information and Communications Technology.

IMMCAI : Interaction Multimedia Computer Assisted Instruction

ISPET : Integrated Science Performance Test

MoE: Ministry of Education

SHS: Senior High School

SHSs: Senior High Schools

SPSS : Statistical Package for The Social Sciences

WAEC: West African Examination Council.

WASSCE: West African Senior Secondary Certificate Examination.

RETENTION TEST: a test conducted in two weeks after the intervention to measure how much knowledge has been retained in students‟ cognitive domain.

1.10 Organisation of the Rest of the Thesis

The second chapter of this thesis is where the literature found to be relevant to study has been presented.

The third chapter deals with the methodology used for this study: It presents the research design used for the study, population as well as the sample. It also looked at

the development of the interventions used in this research, the instrument for data collection, the data collection as well as data analysis procedures.

Chapter four of the thesis comes next. Here, the results of the study from students‟ test scores (pre-intervention test, post-intervention test and retention test) and the discussions on them are presented.

In the fifth chapter, the overview of the research problem and methodology are given. Also, summary of the key findings of the research are presented. Conclusions of the research have been drawn and recommendations as well as suggestions for further studies are presented in this chapter.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This study aimed at improving students‟ academic performance in Integrated Science using Computer Assisted Instruction in Juaboso Senior High School in the Juaboso District in Ghana. In this chapter, the researcher reviewed related literature to the study undertaken under the following sub-headings.

- Computer Assisted Instructional Packages.
- Barriers to integration of CAI in teaching and learning of Science.
- Prominence of CAI in Teaching and Learning.
- Senior High School Educational Reforms in Ghana.
- Nature of Integrated Science at Senior High School Level.
- Theoretical Framework.
- Conceptual framework
- Review of Similar Study.

2.1 Computer Assisted Instructional Packages

The rapid development of technology as noted by Kankaaranta (2005) has challenged learning environments to adopt ICT to support learning and teaching and in guiding children to become diversified users of technology. Voogt and van den Akker (2001) therefore noted that it is generally accepted that the increasing impact of ICT on our society is also influencing teaching and learning. The computer has many purposes in the classroom and it can be utilised to help a student in all areas of the curriculum (Tabassum, 2004). The role of computers in education is captured more concisely by Traynor (2003) when he stated that “computers are used not only as a means of

helping schools analyse data but computers have become a pervading tool toward optimizing student learning". The use of computers in education is steadily increasing (Tondeur, van Braak & Valcke, 2007). Teachers and school administrators use computers in different ways and that since the introduction of computer use in education in the 1960s its terminology has continuously evolved (Voogt & van den Akker, 2001). Van Braak, Tondeur and Valcke (2004) identified two different types of computers used by teachers. They found out that there is the "class use of computers" whereby teachers use computers as a tool for presentation and instructing pupils, in the other way, teachers use of computers was for administration purposes, preparing worksheets for the pupils and looking for information on the internet for lesson preparation. Tondeur, *et al.* (2007) analysed some international computer curricula to find out the aims of computer education. They found out two main aims. One of them was that, children will become digitally literate in order to be prepared for a knowledge-based society. The other aim indicated that computers should be incorporated in the curriculum. Based on these aims, Tondeu, *et al.* (2007) derived two types of computer usage in education. These are computers as a school subject and computers as an educational tool. The computers as a subject seek to emphasise learning about the computer and its uses. In this, the computer is taught as a separate and distinct subject just like Integrated Science or biology. This type of computer usage seeks to teach the student how to use the computer, the various parts and the basic functions of the computer parts and functions of the computer in general. The computer as an educational tool seeks the use of the computer in the teaching and learning process. This encompasses the various modes by which the teacher can use the computer to facilitate the teaching of his or her lessons as well as how the computer can help the students maximise their learning. The computer as an

educational tool is thus used to enhance the teaching and learning process and that it may fit into a spectrum of instructional approaches, varying from traditional to innovative (Tondeur, van Braak & Valcke, 2007). Ornstein and Levine (1993) observed that the role of the computer has been envisioned in terms of three areas of application. That is; tool application, Computer-managed instruction and Computer-assisted instruction. According to them, in the tool application, also called learning about computers (Goldberg & Sherwood, 1983; Tabassum, 2004), the computer is used as a personal assistance device. In the tool application mode, students are taught computer and its applications. Knowledge of computers may be thought of as a continuum, ranging from skills and awareness of computers at lower level to programming at higher level (Tabassum, 2004). The computer can be used in presentation in multiple forms and data analysis (Thomas, 2001). Application packages like the Statistical Package for the Social Sciences (SPSS) and Excel are used to analyse data. Voogt and van den Akker (2001) assert that data presentation packages, word processor and other applications support students in their capability to structure information and to easily present information in different formats. Students and teachers always use the internet to search for information for assignments and research. The second way that the computer can be applied in education is in a process termed computer-managed instruction (Ornstein & Levine, 1993). Ornstein and Levine (1993) defined this usage as the system control and organisation of instruction, characterized by testing, diagnostic data, learning prescriptions and thorough record keeping. With respect to this function of the computer, Thomas (2001) and Voogt and van den Akker, (2001) showed that the computer can be applied in education as microcomputer-based laboratory (MBL). The microcomputer-based laboratory includes computer program which records events automatically in

order to provide an audit trail. The computer is used as a support tool for students‟ laboratory work. It becomes much easier to repeat experiments, to measure different variables at the same time, to use a very short or very long-time ranges, to analyse data and to represent data graphically (Voogt & van den Akker, 2001).

The computer can be used in education in a process called Computer-Assisted Instruction (CAI). In the CAI mode, the computer is used in the teaching of the student (Ornstein & Levine, 1993). Goldberg and Sherwood (1983) and Tabassum (2004) call this application learning from the computer. According to Soe, Koki and Chang (2000), "learning from computers encompasses approaches to computer-assisted instruction in which the computer is used as a means for transmitting specific subject matter." In this approach, the flow of information is basically from the computer to the student. The computer presents the learning materials or activities for students to which the latter responds. During the course of the interaction, the computer retains records of the student‟s progress (Soe, Koki & Chang, 2000). Ornstein and Levine (1993) believe that CAI emphasises tutoring and or drill and practice programs and is appropriate when subject matter needs to be mastered or for practice of basic skills before advancing to higher levels of learning. Computer-assisted instruction refers to drill and practice, tutorial, or simulation activities offered either by themselves or as supplements to traditional teacher directed instruction. Cotton (1997). Voogt and van den Akker (2001) indicated that drill and practice and tutorial software programs serve as an assistant for teachers by taking over some of their tasks. Thus, in the CAI mode, the computer can more or less used to teach the students literally as in the tutorial application or it can be used to assist the teaching of the student as in drill and practice. In the drill and practice mode, it is assumed that the students have been taught previously and further practice is needed for mastery.

Tabassum (2004) indicates that the students must be familiar with certain concepts prior to working with drill and practice packages in order to understand the content. The drill and practice use of the computer emphasises individualised learning where the student moves at his or her own pace and offer the practice of basic knowledge and skills (Tabassum, 2004 and Voogt & van den Akker, 2001). There are facilities in the drill and practice software that provide feedback to the learners to keep track of their performance (Voogt & van den Akker, 2001). According to Sharp as cited by Tabassum (2004), the typical drill and practice program design includes four steps: the computer screen presents the student with questions for responses or problems to solve, the student responds, the computer informs the student whether the answer is correct or not and if the student is right, he or she is given another problem to solve, but if the student‟s response is wrong, he or she is corrected by the computer. The steps are shown diagrammatically in Figure 2.1.

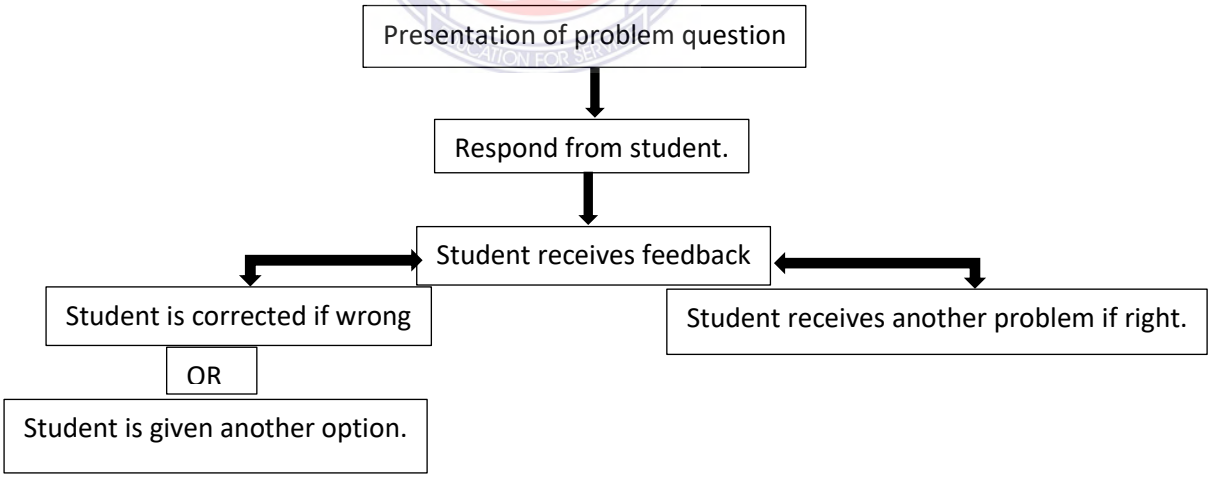


Figure 2.1: Drill and practice steps (tabassum, 2004)

In tutorials the subject matter is literally taught by the computer programme (Tabassum, 2004). Voogt and van den Akker (2001) indicated that tutorials can be used for learning new content. In this case the computer presents the material to be

learnt to the student. Explanations can be added orally. The student responds to each component of information presented by answering questions about the material and then gets immediate feedback on each response (Tabassum, 2004). There are two frames of tutorials: linear and branching (Alessi & Trollip, 2000 and Tabassum, 2004). According to Tabassum (2004), The linear tutorial presents the student with a series of frames, each of which supplies new information or reinforces the information learned in previous frames. The student has to respond to every frame in the exact order presented and there is no deviation from this presentation, but the student does have the freedom to work through the material at his or her own pace. The branching tutorial allows more flexibility in the way the material is covered. The computer decides what material to present to each student. Tutorials teach new materials whiles drill and practice helps students to remember previously learnt material (Tabassum, 2004). Aside tutorials and drill and practice, computers are used to assist the teaching and learning process in the form of simulations (Thomas, 2001). They serve as a bridge between reality and the student‟s mental model of reality (Voogt & van den Akker, 2001). According to Thorson (as cited by Tabassum 2004), “simulation is a mode of education which demands that knowledge be integrated with reality and with behaviour. Simulation activities are most often organised in the form of games. This motivates and interests the learners. Due to its very nature, learners can experiment with hazardous chemicals on the computer without the fear of being hurt. Thus in this approach, students take risks as if they were confronted with real life situations without having to suffer the consequences of failure (Tabassum, 2004). Another computer use similar to simulations is multimedia cases in that they all seek to present an approximation of the real thing. However, while simulations just give one aspect of the representation of the real thing, multimedia cases offer the

possibility to study parts of reality by presenting illustrations of real world practice that can be discussed and studied from several perspectives (Voogt & van den Akker, 2001). According to Thomas (2001) each of the applications enumerated above has potential educational value and may be seen as compatible with the broad contemporary goals of science education. This is because science education seeks to provide students with avenues to explore and inculcate the habit of investigation, reflection and analysis and the use of computer in education is capable of providing such functions. Since computer has become an integral part of the school system in this modern era, this study looked at the effect computer usage has on students‟ academic performance in teaching and learning in Ghanaian Senior High Schools as far as Integrated Science is concerned.

2.2 Barriers to integration of CAI in teaching and learning of science.

Integrating ICT into classroom learning is not as easy as it sounds. The process is indeed complex and teachers often encounter difficulties. (Mehmet, 2019). Schoepp (2005) called these difficulties "barriers" and defined them as conditions that make it difficult for a person or organisation to progress or achieve an objective. Numerous studies across contexts and cultures have identified what these barriers are among teachers, for example, mismatch between available ICT and existing curricula (Albirini, 2006); lack of institutional support (Ageel, 2011); lack of funds and budget allocation (Alwani & Soomro, 2010); insufficient training (Al-Oteawi, 2002; Taylor & Corrigan, 2007); computer anxiety, ICT efficacy and lack of confidence (Becta, 2004); teacher beliefs and attitudes (Chen, Tan, & Lim, 2012); resistance to change (Gomes, 2005); overwhelming workload and commitment (Hennessy, Ruthven & Brindley, 2005); overloaded curriculum and lack of subject-specific guidance for using ICT (Osborne & Hennessy, 2003); outdated hardware and Internet facilities

(Ozen, 2012); time constraint and unfamiliarity with new equipment (Peralta & Costa, 2007); absence of technical support (Toprakci, 2006); and readiness as well as motivation (Ward, 2003). Mumtaz, (2000) summed up three factors that impede teachers‟ ICT uptake, these factors are; the school or institution, resources and the teachers themselves.

Ertmer (1999) grouped factors related to teacher variables (attitudes, beliefs, practices, resistance, personal experience, and awareness) as intrinsic or first order barriers, while placing factors such as inadequate and or inappropriate configuration of ICT infrastructure, access, time, technical support, resources and training in the extrinsic or second order category. Chen et al. (2012) discovered that extrinsic barriers (time and curriculum constraints) tend to play a greater role than intrinsic barriers in hampering teachers‟ use of computers in the classroom. Becta (2004) summarised the research conducted in several different countries over a ten-year period (1993-2003) and proposed two categories of barriers, namely school-level barriers (such as lack of instructional time, access to resources, hardware and effective training, inappropriate organization, poor quality software and technical problems) and teacher-level barriers (such as lack of preparation time, confidence and access to ICT resources, resistance to change, negative attitudes and no perception of benefits). According to Veen (1993), teacher-level factors such as beliefs about ICT benefits and computer skills tend to outweigh school factors in influencing ICT use. Knezek and Christensen (2002) stated that teachers‟ competence with computer technology is a key factor of effective use of ICT in teaching. So, the teachers who do not have ICT competence could not integrate the ICT tools in their teaching. Some other research studies such as Albalat and Tarrago, 1995, Braak, 2001, Chu, 2000, Hodgson, 1995, Vanderlinde, Braak and Hermans, 2009 and Venezky, 2004 also agreed that effective

use of computers is reliant on the teachers‟ ICT skills as well as their intentions towards ICT use.

Divaharan and Koh (2010) also claimed that teachers‟ professional development has to concentrate on both ICT skills training and appropriate ICT integration strategies in the curriculum. Therefore, the teachers need knowledge of appropriate ICT integration approaches and ICT skills to successfully incorporate the ICT tools into their lessons. According to Schiller (2003), personal characteristics such as educational level, age, gender, educational experience, experience with the computer for educational purpose and attitude towards computers can influence the adoption of a technology. Several studies found that teaching experiences and age influence the successful use of ICT in classrooms (Wong &Li, 2008, Giordano, 2007, Hernandez-Ramos, 2005). Similar findings can be found in research carried out by Gorder (2008) which was reported that teacher experience is significantly correlated with the actual use of technology.

The study conducted by Jones (2004) discovered seven barriers affected the integration of ICT into lessons; lack of confidence among teachers during integration, lack of access resources, lack of effective training facing technical problems in use, lack of personal access during lesson preparation, age of the teachers, teaching experiences and lack of time for the integration. According to Dang (2011), the lesson preparation using ICT is time consuming because as the rule of thumb, one hour of ICT- enhanced lesson would require about three to four hours of preparation. Thus, the teachers faced problem either in preparing the lessons or in conducting the lessons within the limited time.

Moreover, the teachers need additional time to set up all the ICT tools in the classrooms. So, the teachers felt that they could accomplish the required tasks during their lesson hours instead of setting up the ICT tools. Kozma (2003) also claimed that the biggest barriers to the use of computers by teachers were the lack of time available in classes and in their own schedules for planning. According to Jones (2001), the attitudes of teachers towards technology greatly influence their adoption and integration of computers into their teaching. He also stated that, the teachers prefer to use the traditional method for teaching in their classroom because of their lack of motivation, acceptance and readiness towards the ICT integration and adoption in teaching and learning process. Kumar et al (2008) found attitude, motivation, gender, age and computer training have effects on the Actual Usage of Computers (AUC) by teachers. According to Sang et al (2009), Zhao and Cziko (2001), teachers‟ educational beliefs impact on their use of ICT. Besides, Richardson (2009) claimed that the ICT integration in teaching is still difficult for some teachers due to lack of training and practice. Jones (2004) and Keong et al (2005) determined that lack of technical support was a barrier to the successful integration of ICT in teaching. Lack of technical support discourages teachers from adopting and integrating technology in classrooms (Korte & Husing, 2007). Becta (2004) also agreed that lack of technical support available in schools and technical maintenance is the main problem in integrating ICT in classrooms. Hare (2007) also stated that lack of policy frame work, inadequate infrastructure and high cost and inadequate in-service training on ICT integration in education also inhibit the use of ICT in teaching and learning.

2.3 Prominence of CAI in teaching and learning.

Venkataiah (2004) observed that Computer-Assisted Instruction (CAI) is an interaction between a student, a computer and a software program guided by the

teacher for the purpose of enhancing learning outcomes. According to Sharifah (2003), in Malaysian schools where traditionalist pedagogical approaches prevail over other methods, the use of Information and Communications Technology (ICT) can significantly enhance the quality of teaching and students‟ learning experience, especially in science subjects. Somekh (2008) argues that ICT is a powerful driver for educational change if used in the right manner and helps to create a less stressful environment for both teachers and students. The benefits of using ICT are immense for teachers and students of science. For teachers, the Internet expands the instructional resources available to them (Bingimlas, 2009), while also allowing them to empower students to become active and skillful information seekers rather than remaining passive recipients of scientific facts (Pickersgill, 2003). Teachers can make science more engaging and comprehensible to students by employing ICT in four distinct ways as categorized by Ball (2003): as a tool, as a reference source, as a means of communication and as a means for exploration. For students, ICT can support development of science process skills and conceptual understanding, besides enhancing opportunities to engage in effective communication about science at several levels (Murphy, 2006). A comprehensive review of 557 research papers concludes that students can acquire science ideas quite successfully through ICT models and simulations (Hogarth, Bennett, Lubben, Campbell, & Robinson, 2006).

Computer Assisted Instructional Packages emphasises strongly on student-centered learning and allows students to learn at their own phases by producing their own learning tracks and outcomes which shifts away responsibility of learning from the teacher to the student (Kanapathippillai, Shamlee & Dellaportas, 2012). Computer Assisted Instructional Packages intensely increases students‟ access to information that is in line with their abilities and preferences which increase the amount of

modified instruction students receive from the immediate reaction of computer interactions and raise the self-paced and private learning environment (Arnold, 2000).

Computer learning skills often enhance the interest of students, encourage them to learn and increase students‟ centered kind of education. (Boulianne, 2014). Utilization of computer software in the classroom helps in reducing concerns associated with the traditional curriculum which often uses too much lecture orientation and conventions instead of their concentration to the context. (Saidu, Dahiru & Muhammad, 2019).

The advantages of CAI method according to Orjika (2012) include, “ensuring the application of proven teaching methods to students, offering equal educational opportunities for students by using the same program, changing the role of the teacher from teaching capacity to that of a guide, also when properly handled, removing fright and embarrassment on students and bringing about meaningful learning and academic performance” Research has discovered that those learners who utilise computers have extensive self-assurance, confidence and are more efficacious and propelled to learn than those learners who are subjected to learn in traditional learning environment (Wishart, 2002). CAI helps to enable learners to focus on the physical meaning of the abstract concepts, subsequently, to get a detailed understanding of the theory (Azar & Şengüleç, 2011, Bayrak et al., 2007, Hargunani, 2010). Investigators have additionally discovered that CAI improves learning proportion, that is, students become able to learn a similar amount of content in less time than the conventionally taught students. Besides, CAI has a significant better effect on retention of the students (Cotton, 2001). CAI can encourage the advancement of students‟ decision-making and critical thinking aptitudes, data processing skills and communication abilities. By the application of computers, students can get accessibility to extensive

learning links and expand their exposure to differing individuals and points of view (Bakac, Kartal &Akbay, 2011). According to Bayrak, 2008, Fraser et al., 2007 and Serin, 2011, exercises that help learners visualise abstract concepts will encourage their conceptual comprehension and these exercises would be consistent and harmonising to conventional teaching and could be concrete physical exercises or computer simulations and animations. Computer Assisted Simulations provide educators with the chances to give learners an instructional tool that can enable learners to transform their alternate science conceptions into precise science conceptions. Learners could detach and manipulate parameters and, in this way, help them to build up a comprehension of the relationships among physical ideas, variables and phenomena (Arvind & Heard, 2010, Bakaç, Taşoglu & Akbay, 2011, Tao & Gunstone, 1999). The application of CAI in science subjects would empower the exposure and ability of the learners in building skills, understanding, learning and accessibility to information in the technological world. Such ability building will boost social, mechanical significance and sustainable development of the country (Kareem, 2015).

Computer-based learning has the potential to facilitate development of students‟ decision-making and problem-solving skills, data-processing skills and communication capabilities. By using computer, students can gain access to expansive knowledge links and broaden their exposure to diverse people and perspectives (Bakac, Kartal & Akbay, 2011).

Nevertheless, Mills (2001) revealed that CAI was found to be as effective as classroom instruction for fact-based learning, but not as effective for topics requiring

critical thinking or mathematical problem-solving. In addition, the time required by learners to use CAI was overall higher than conventional classroom instruction.

2.4 Senior High School Educational Reforms in Ghana.

Education is the act of transferring knowledge in the form of experiences, ideas, skills, customs, and values, from one person to another or from one generation to generations. (Adu-Gyamfi, 2016).

Adu-Gyamfi (2016) defined Educational Reforms as changes and policies initiated to better educational structure or systems in a country. According to him, Ghana‟s educational system had previously been regarded as one of the most highly developed and effective in West Africa, but by the 1980s it was in near collapse and viewed as dysfunctional in relation to the goals and aspirations of the country and Since March 6, 1957 when Ghana attained independence from British colonial rule, education has been a major priority on the agenda of successive governments. It has also been subjected to series of changes, constantly in search of the model which would fit the needs of the country and the expectations of the citizens.

Formal education in Ghana dates back to the colonial period, initial attempts to introduce formal education were made by the many European merchants, especially the Danes, Dutch and English. The European merchants and Christian missionaries established schools in the mid-eighteenth century to not only eradicate the high level of illiteracy but also to propagate the gospel to the indigenous people. (Adu-Gyamfi, 2016). Several Educational Reforms have been initiated over the years aiming at finding lasting solutions to problems concerning education in Ghana. For example, the number of years a student is supposed to spend in the second cycle institution has not been permanent. During the National Redemption Council (1974) under the

leadership of Ignatius Kutu Acheampong, the second cycle institution was four years. However, the Provisional National Defense Council (1987) changed this period from four years to three years of secondary school education. On the other hand, the New Patriotic Party (2000) reversed the decision back to four years but only to be reverted to the three-year system under the National Democratic Congress administration from 2009 till present.

This issue of the number of years students spend in Senior High School Education has been a challenge for the Ghanaian educational system (Adu-Gyamfi, 2016). In 1951, when Ghana, then Gold Coast became internally self-governing and led by Kwame Nkrumah, the pre-tertiary school system was composed of up to seventeen years of education; six years of primary, four years of middle school, five years of secondary school and two years of sixth-form (Palmer, 2005).

The Accelerated Development Plan of 1951 and Education Act of 1961 is the first educational reform initiated when self-governed under the leadership of Dr. Kwame Nkrumah. (Adu-Gyamfi, 2016). According to Poku, Aawaar and Worae, (2013), The Accelerated Development Plan for Education was launched in 1951 which aimed at expanding education in all sub-sectors with a clear emphasis on the expansion of primary and middle schools. The Accelerated Development Plan laid down a revised structure for general education comprising five years of `secondary education. At the end of the five years, suitable students went on to do a two-year sixth form course that could lead to a three-year University. Students, who were not suitable to continue, completed two-years of pre-vocational classes (Adu-Gyamfi, 2016). According to Adu-Gyamfi (2016), The Accelerated Development Plan provided assistance to the expansion of secondary education, central government approximately built fifteen

(15) new secondary schools in built-up localities and technical institutions in Accra, Tarkwa, Kumasi, Sekondi-Takoradi among others to boost the Technical and Vocational sector for effective productivity, scholarships for primary, secondary and tertiary education were introduced for children from the regions of the north and from parts of Brong-Ahafo.

In 1966, the National Liberation Council (NLC) administration appointed the Kwapong Educational Review Committee which brought into the middle school system a two-year pre-vocational continuation classes based on the industrial and farming needs of the country. (Poku, Aawaar & Worae, 2013). On March 7, 1966, the government appointed a new Educational Review Committee to undertake a comprehensive review of the entire formal educational system and the structure of the education system under the NLC was such that the ten (10) years of elementary education by Nkrumah was structured to an eight (8) years basic course to prepare students for secondary schools‟ entry and a further two (2) year continuation course of middle school. The basic requirement of entry into secondary school rested on the Common Entrance Examination by students in final eighth year and made the secondary school lasted for five (5) years to prepare students for School Certificate of the West African Examinations (Adu-Gyamfi, 2016).

The National Redemption Council (NRC) led by Col. Ignatius Kutu Acheampong succeeded the Busia government. The new military-police government carried out a review of the educational system and formed the Dzobo Committee in 1973 to recommend appropriate measures to recover the situation and this led to the publication of the New Structure and Content of Education (NSCE) in 1974. This reform introduced the concept of the Junior Secondary School (JSS) and the Senior

Secondary School (SSS). The Ghana Teaching Service (GTS) later to be called the Ghana Education Service (GES) was set up in 1974 to implement various policies or reforms. The „NSCE" reduced the duration of years an individual should spend in the pre-tertiary education thus reducing the five years of senior secondary school to four years (Adu-Gyamfi, 2016).

In 1987, the Educational Reform Programme of 1987 under the leadership of Flight Lieutenant Jerry John Rawlings after he overthrew President Limann and his government was launched (wikieducator.org). According to Frempong 1996, The educational reform programme had three broad phases:

1. The implementation of nationwide establishment of Junior Secondary Schools (JSS) system from 1987 – 1990 therefore Middle School Leaving Certificate Examination was to be written by Middle Form Four for the last time in 1990. This meant that in 1987 Middle Form One was abolished and JSS One was established throughout the country.
2. The Senior Secondary School (SSS) system should be implemented from 1991 – 1993. As such, in January, 1991, the SSS programme was launched.
3. The tertiary education reform should also be implemented from 1994-1997. (Frempong,1996)

The practice of taking a Common Entrance Examination before admission to secondary level came to an end in April, 1989 when the last examination was taken, middle school leaver could enter the secondary school to the universities by spending 17 years in school and eventually enter the university. The four-year senior secondary school was reduced to 3 years (wikieducator.org). The academic year comprised of three terms for Senior Secondary Schools (SSS) whiles terminal examinations were

conducted at the end of the term. However, Senior Secondary School finalist were mandated to write the West African Senior Secondary Certificate Examination (WASSCE) (Adu-Gyamfi, 2016). Also, Senior Secondary School run a 40-week school year and students are tested using an internal continuous assessment (30% of final score) and an external examination conducted by the West African Examinations Council (70% of final score). The Senior Secondary School curriculum has Core subjects and Elective subjects. Every student takes four core subjects: English language, Mathematics, Integrated Science and Social Studies. Students also choose 3 elective subjects from 5 available programmes: Agriculture Programme, General Programme (Arts or Science option), Business Programme, Vocational Programme and Technical programme (www.tobeworldwide.org/files).

President Kuffour, in January, 2002 inaugurated a Committee of Review of Educational Reforms in Ghana. The report was reviewed by government and a White Paper was produced as „The White Paper on Educational Reforms (Ministry of Education, Youth and Sports, 2004). The proposed Educational Reform became operational in September, 2007 (the 2007/2008 academic year) (Acheampong, 2008). The new educational reform laid emphasis on the post-basic education and training as crucial to poverty reduction and to address concerns about quality and the need for new determination to restructure pre-tertiary education provision in order to focus on preparing all secondary students either for entry into tertiary institutions or for the job market through apprenticeship training in the private sector and to achieve these objectives, the senior secondary education was extended from three to four years ((Poku, Aawaar & Worae, 2013). It is worth to note that, the change in governance after the 2008 general elections saw the New Democratic Congress (NDC) barely a year in office reversing the decision made by the NPP with respect to four (4) years in

Senior High School back to three (3) years as it was under the Provincial National Democratic Council led by Flt.Lt. Jerry John Rawlings (Adu-Gyamfi, 2016).

The recent reform is the Free Senior High School Policy introduced in August, 2017 in Ghana (Opoku, 2018). According to the ministry of education, Article 25 clause 1b of the 1992 constitution states that "Secondary education in its different forms including technical and vocational education, shall be made generally available and accessible to all by every appropriate means and in particular, by the progressive introduction of free education". Goal four (4) of the United Nation"s Sustainable Development Goals (SDGs) states, "By 2030, all boys and girls complete free equitable and quality primary and secondary education leading to relevant and effective learning outcomes" (MOE, 2004). Toeing to this, in September 2017, the ministry of education under the governance of the New Patriotic Party achieved a major milestone with the implementation of the Free Senior High School program (MOE, 2018). According to Tabanja and Pajibo, (2019), the Free Senior High School has the following features;

1. Eligible to all Ghanaian youth and young adults who are placed into public second cycle institutions by the Computerised School Selection and Placement System (CSSPS).
2. The duration of the FSHS scholarship is for three (3) years.
3. The government absorbs all tuition fees of students in senior high schools.
4. The government absorbs feeding costs for all those admitted as boarding students but lunch for those who are not in boarding house.
5. To ensure equity, 30% of places in elite schools are reserved for applicants from public Junior High Schools.

6. The government provides infrastructure; buildings, furniture, teaching and learning materials, etc.

In the first year of its introduction, there was 11% increase in enrolment breaking records from previous years. Prior to increase in enrolment, the double track system was introduced after consultation with stakeholders which aimed to tackle the issue of increased student demand with limited infrastructure in many preferred senior high schools across the nation. The double track sought to create room to accommodate the increase in enrolment, reduce class size and increase contact hours (MOE, 2018). The free senior high school system also quashed away the three terms of academic calendar and replaced it with the semester system. (Tabanja & Pajibo, 2019). The then Educational Minister, Dr. Matthew Opoku Prempeh in addressing the press in 2018 said "All Senior High Schools henceforth will run the semester system even when we build all the infrastructures, all SHSs will be Semester System (modernghana.com). Figure 2.2 shows the first-time table for the double track system developed by MOE in 2018. As shown in Figure 2, the calendar of third and second-year students is reduced from three to two semesters (Green and Gold Tracks), each with 81 days, respectively. With regards to the first-year students on the double tract, those on the Green Track will spend 41 days in school while their colleagues on the Gold Track stay at home. After, the 41 days, they will vacate for those on the Gold Track who will do 81 days in each semester. Those on the Green Track will equally spend 81 days in a year albeit interspersed with vacation holidays. (Tabanja & Pajibo, 2019).

The inconsistency of the structure of Ghanaian educational system is as a result of "over politicization". Political parties after gaining power seek to provide reforms that they deem fit especially regarding their quest to provide quality education for

Ghanaians. It is significant to note that the current educational system may undergo some changes if there should be a change in governance (Adu-Gyamfi, 2016).

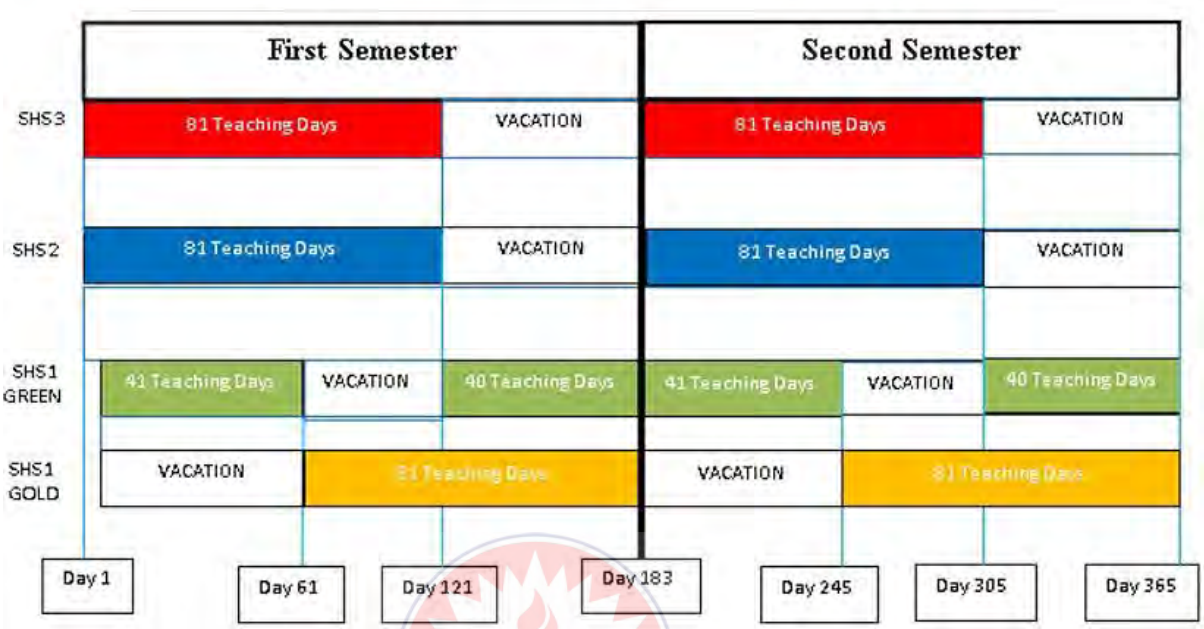


Figure 2.2: SHS Calendar for Single and Double Track Systems. Adopted from Ministry of Education, (2018).

2.5 Nature of Integrated Science at Senior High School Level

Science is a continuous process of investigation and experimentation in order to widen people‟s understanding of the natural world. It involves the gathering and recording of knowledge to find answers to the questions and challenges that life poses every day. (Baidoo, 2010). According Bassey 2002, there are many methods used to collect information and the forming of ideas but the method used by scientist should be systematic and reliable. These methods are often referred to as the scientific method. It involves identification of problem, stating the aim, formulation of hypothesis, observation, investigation, experimentation, recording and interpreting of data and evaluation. Science uses methods involving logical investigations,

experimentation and questioning that lead to reliable knowledge. The knowledge gained is stored and can be used to help further investigation and understanding to help solve scientific problems (Talabi, 2003). Marson (1998) sees science as a process of dynamic interaction of rational inquiry and active play. According to him, scientists" probe, poke, handle, observe, question, formulate theories, test ideas, make conclusions, make mistakes, revise and synthesis, communicate, disagree and discover. According to Gega, (1990), science has two structures: the conceptual and the methodological structure. The conceptual structure is made up of ideas, facts, theories and hypothesis which scientists generate as they work. The methodological structure is also known as the process of science is the method scientists use to collect data and it consists of experimentation, classification, observation, reporting and communication. Science is basically sentenced on what we can see, hear and touch. Personal opinion and speculative imaginations have no place in science. Science is purely objective and that knowledge gained can be proven. (Chalmers,1994).

Integrated science is defined as a cumulative approach of scientific study that synthesizes the perspectives of the individual disciplines and integrates them during all phases of the approach to a question or problem with the results having an influence on policy and management decisions (Gallagher et. al., 2008). Integrated science aims at collaborative efforts to examine the linkages among single-disciplinary perspectives during which new methods, concepts and approaches are often developed. Interdisciplinary research and integrated science brought to bear on complex management questions are cumulative, synthesising perspectives of individual disciplines and integrating them during all phases of work to solve scientific and resource management problems. With the increasing complexity of natural and social issues facing parks and protected areas throughout the world, it is

important for managers to recognize the benefits of utilising and employing interdisciplinary and integrated scientific approaches to solving resource manage problems. (Riper, Powell, Wagtendonk, Machlis, Galipeau, & Ruschkowski, 2012). UNICEF (1991) defined integrated science as an approach to the teaching and learning of science in which concepts and principles are presented so as to express the fundamental unity of scientific thoughts and avoid premature and undue stress on the distinctions between the various scientific fields. Willard (1995) describes it as a program which offers students experiences which help them to develop an operational understanding of the structure of science that should enrich their lives and make them more responsible citizens in the society.

Brown (2007) describes integrated science under four broad characteristic meanings:

1. The unity of all knowledge; that integrated science has a holistic view of knowledge as essentially one and undivided.
2. The conceptual unity of the sciences; that various conceptual units that make up the framework are identified;
3. A unified process of scientific enquiry. This characteristic place emphasis on the methodological distinctions and similarities among the sciences;
4. An interdisciplinary study; that the discipline is a collaborative venture between subjects and viewing of topic or theme from logically different viewpoints with the learner left to synthesize in any way he or she chooses.

Integrated science was designed based on the observation that the universe is a unified whole therefore there must be a holistic approach to its study. (Arokoyu, 2012). No wonder Rutherford and Gardner (1971) rightly said: "To some degree, the concept of integrated science teaching is based on the parallel assumptions that the universe has

an inherent unity and that science as an attempt to provide an understanding of the natural world has a unity of purpose, content and process that is far more significant than the differences in language or focus between individual sciences". For Arokoyu (2012), the introduction of integrated science as a subject in school curriculum has lent a lot of strength and support to the foundation of teaching and learning science. To him, Integrated science offers students the benefit of learning science concepts from different science disciplines in contexts which are expected to have enduring relevance to them in future. Also, students develop scientific knowledge and skills which help them to evaluate the impact of scientific and technological developments (Arokoyu,2012). Integrated Science is a subject to raise the level of scientific literacy of all students and equip them with the relevant basic scientific knowledge needed for their own living and for making valuable contributions to production in the country. It also provides opportunities for students to develop positive attitudes and values such as curiosity, creativity, open-mindedness and perseverance, concern for living things, honesty and love in our youth. (Asiaw, Asante & Oteng, 2016).

The broad aims of integrated science curriculum are to enable students to:

1. solve basic problems within his or her immediate environment through analysis and experimentation keep a proper balance of the diversity of the living and non-living things based on their interconnectedness and repeated patterns of change.
2. adopt sustainable habits for managing the natural environment for humankind and society.
3. use appliances and gadgets effectively with clear understanding of their basic principles and underlying operations

4. explore, conserve and optimize the use of energy as an important resource for the living world
5. adopt a scientific way of life based on pragmatic observation and investigation of phenomena.
6. search for solutions to the problems of life recognizing the interaction of science, technology and other disciplines. (CRDD, 2010)

According to the G.E.S syllabus for senior high schools, the content of the Senior High School Integrated Science syllabus covers the basic sciences and includes topics in Health, Agriculture and Industry. The course has been designed to offer a body of knowledge and skills to meet the requirements of everyday living and also provide adequate foundation for the study of other subjects and for those who wish to pursue further education and training in science related vocations. To enable students to appreciate the links between seemingly different scientific topics and hence help them to be able to integrate ideas from various scientific sources, the integrated science syllabus has been categorized into five main themes; Diversity of matter, Cycles, Systems, Energy and Interactions, which covers three-year period of Senior High School Education and each year‟s work embraces all the five themes (CRDD, 2010).

According to the integrated science teaching syllabus as developed by CRDD, 2010, the teaching of Integrated Science at the senior high school level has a five period per week for both theory and practical with each period consisting of forty minutes. The theoretical aspect takes three periods per week while the practical aspect is allocated to two continuous periods per week for S.H.S one, two and three. Remembering and Understanding, Application of Knowledge and Practical and Experimental Skills are the main profile dimensions for the teaching, learning and testing of Integrated

Science with their percentage weights as 20%, 40% and 40% respectively. The final Examination consists of three papers, Paper 1, Paper 2, Paper 3 and the School Based Assessment (SBA). Paper 1 consists of an objective – type test paper, Paper 2 consists of structured essay questions, while Paper 3 is made up of practical test paper. Paper 2 is a more intellectually demanding paper and is therefore weighted more than Papers 1 and 3. The weight of all the three papers and the SBA are shown in table 2.1 below.

Table 2.1: Distribution of Examination Paper Weights and Marks: adopted from integrated science syllabus, 2010.

Dimension	**Paper 1**	**Paper 2**	**Paper 3**	**SBA**	**Total Marks**	**% Weight of Dimension**
Remembering and understanding	30	20	-	10	60	20
Applying knowledge	30	70	-	20	120	40
Experimental and process skills	-	-	60	60	120	40
Total marks	60	90	60	90	50	-
% Contribution of Papers	10	25	15	50	-	100

Paper 1 is marked out of 60 marks; Paper 2 is marked out of 90marks, Paper 3 marked out of 60marks and School Based Assessment is marked out of 90, giving a total of 300 marks. You will note that Paper 1 has a contribution of 10% to the total marks; Paper 2 has a contribution of 25% to the total marks; Paper 3 has a contribution of 15%, and SBA has a contribution of 50% which is appropriately scaled down to 30%. Of the total marks of 300, 60 marks, equivalent to 20% of the total marks, are

allocated to Knowledge and Comprehension. 120 marks, equivalent to 40% of the total marks, are allocated to each of Application of Knowledge and Process or Experimental Skills. The ratio of theory to practice in integrated science is 60:40. (CRDD,2010).

To improve assessment and grading and also introduce uniformity in schools, it is recommended that schools adopt the following WASSCE grade structure for assigning grades on students‟ test results. (CRDD,2010). Base on this, Students‟ results are graded using the WASSCE grading system as shown in table 2.2 below.

Table 1.2: Integrated Science Grade structure for S.H.Ss: adopted from integrated science syllabus, 2010.

Grade	Marks (%)	Remarks
A1	80-100	Excellent
B2	70-79	Very Good
B3	60-69	Good
C4	55-59	Credit
C5	50-54	Credit
C6	45-49	Credit
D7	40-44	Pass
E8	35-39	Pass
F9	34 and below.	Fail

2.6 Theoretical Framework

The theoretical basis that guided this study was the theory of Interaction Multimedia Computer Assisted Instruction (IMMCAI) which was developed by Trirathanakul, Sombunsukho, Lertkulvanich, and Buranajant (2008) together with the cognitive theory. IMMCAI is an essential theory that promotes the development and testing the effect of Computer Assisted Instructional Packages (CAIPs) or applications,

especially in regard to teaching and learning using computer, graphic and animation, audio, logical judgement, questions and answers through direct interaction with a computer (Trirathanakul et al., 2008). This enables the instructor to plan, design and input instruction materials to the computer system for students‟ consumption, thereby reducing load of the students and serving as cost effective on the part of the teacher. It also helps in facilitating more students‟ participation, freedom, less responsibility from the instructors and can also be used to serve as instruction supplement that enriches classroom teaching, or be used as a normal classroom teaching module for drilling, simulations etc. (Saidu, Dahiru & Muhammad, 2019).

An Effective Construction of Computer Assisted Instruction based on Interaction Multimedia Computer Assisted Instruction theory (IMMCAI) developed by the School of Industrial Education and Technology of King Mongkut‟s University of Technology shows that the following steps must be followed in developing CAIPs; Topic selection, Analysis, Design, Development, Implementation and Evaluation. (Trirathanakul, Sombunsukho, Lertkulvanich, & Buranajant (2008). According to Saidu, Dahiru and Muhammad (2019), Analysis which is the first step has to do with sorting out all relevant course content and titles related to the general topic of the subject chosen from the curriculum.

In the Design stage, Strategic presentation plan in line with behaviour objectives and course flow chart are drafted. The strategic presentation covers the sequencing and presentation timeframe, length and type of explanations, hints or coaching aid arrangements for presentation as well as reinforcements. The target learner‟s knowledge level is determined and modular blocks indicating specific functional parts of the design are addressed at this level.

Development stage deals with the technical script drafting stage which establishes the actual teaching and learning content of the IMMCAI package that will guide and inspect the ideas of the topic by specialists, so as to enable optimised visualisation, animation, and audible interactive illustration.

The fourth stage, (Implementation) is concerned with authoring software selection which has to do with making package accessible and executable by the users who may not have learnt programming languages through the use of ready-made video, audio, graphics and other clip art materials under the supervision of multimedia experts. File size, computer operating system, speed, hard disk capacity, font size and type, image quality and resolution, audio quality, use of transitions and other effects and colours have to be considered for smooth and successful creation.

Evaluation is the final stage that has to do with evaluating the lesson quality and learning efficiency of the package from the learners. This includes quality evaluation of the lesson objectives, organising small group rehearsal testing to find out the efficiency and effectiveness of the evaluation through pre-test and post-test results comparison. The pretest and post-test mean score indicates its effectiveness. (Saidu, Dahiru & Muhammad (2019). Hence, IMMCAI theory is in conformity with the purpose of this study which has to do with developing and testing the effect of CAI on students‟ performance in Integrated Science.

One of the key approaches in learning using CAI is the Cognitive Learning Theory developed by Robert Gagne. (Saidu, Dahiru & Muhammad (2019). Cognitive theory are based on information-processing models which are concerned with how individuals gain knowledge and how they use it to guide decisions and perform effective actions. This theory tries to understand the mind and how it works and to

achieve this, it view the computer as a model of the brain and employ much of the terminology and concepts of information processing. (Sedega, 2017). This theory postulates that learning comprises of the simple connection of responses to stimuli where experience is always arranged and the learner reacts to a complex pattern of stimuli which enables the learner perceives stimuli in organised units and not in a separated part. (Lowe, 2004). Cognitive leaning processes are rational activities that help information to move from one memory to another through the process of attention, perception, repetition, coding and retrieving information (Erisen, Şahin, & Çeliköz, 2016). Cognitive learning theory is most applicable in CAI package design and this approach has been pioneered most actively by Robert M. Gagne (Sedega, 2017).

According to Sedega (2017), Gagne has emphasised the importance of identifying the goals of the learning task followed by the development of specific instructional objectives to meet these goals. With regard to the role of teacher or adviser in CAI, Gagne suggested that students be provided with a little help at a time, thus permitting the student to use as much as he needs. Another point raised by Gagne is in defense of drill and practice. He indicated his belief that drill and practice, if viewed as part of cognitive learning theory, simply speeds up the learning process and make learning more efficient (Sedega, 2017). Based on Gagne‟s suggestion as cited by Sedega (2017), it can be inferred that the Cognitive Learning Theory is a theory that focuses on how students learn through a designed sequence of instructional strategy by interacting and responding to drafted problems or issues and logically finding solution through the application of computer and its related package. The cognitive learning theory was useful as it provides the highlight on the required process that students can learn using computer with specified guidelines to be followed and responded to the

designed and integrated stimuli by paying attention and following the stages incorporated in the CAI as well as comprehending and studying the enclosed information, practicing, coding where necessary, repeating exercises as well as saving and retrieving information without instructor‟s intervention. The process of learning using computer as contained in the cognitive learning theory is significant to be used along with the IMMCAI theory (Saidu, Dahiru & Muhammad, 2019). Figure 2.3 shows the connection between the two theories for CAI implementation in teaching and learning,

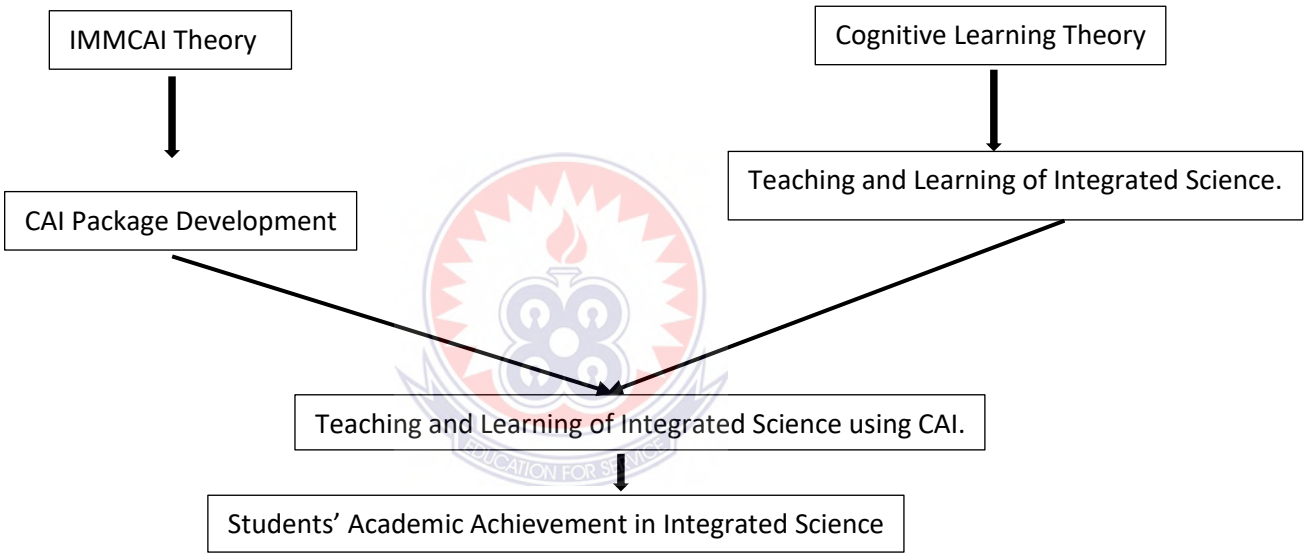


Figure 2.3: Connection Between the IMMCAI and cognitive Learning Theory. Adopted from Trirathanakul et al., (2008).

inst2.7 Review of Related Literature

In a review of empirical studies on CAI, Cotton (1997) concluded that the use of CAI as a supplement to conventional instruction produces higher performance than the use of conventional instruction alone, research is inconclusive regarding the comparative effectiveness of conventional instruction alone and CAI alone, and that computer-

based education (CAI and other computer applications) produces higher performance than conventional instruction alone.

In addition, students learn instructional contents relatively faster with CAI than with conventional instruction alone; their retention ability with CAI is better than with conventional instruction alone. (Ezenwafor, Eze & Owunsa 2020).

Furthermore, computer assisted instruction has been found to boost students‟ performance than the conventional instructional method in counsellor education (Karper, Robinson, & Casado-Kehoe, 2005). However, Mill (2001) findings revealed that CAI was found to be as effective as classroom for fact based learning, but not as effective for topics requiring critical thinking or mathematical problem solving. In addition, students engaged by using traditional instruction combined with the use of computer performed significantly better than students taught using traditional instruction in a college setting (Akour, 2006).

Owusu (2009) worked on effects of computer-assisted instruction on senior high school students‟ performance in Biology in Ghana. The study used 75 senior high school (SHS) students and adopted pretest, posttest quasi-experimental design. The findings revealed that the students that were instructed by the conventional approach performed better on the posttest than those instructed with the use of CAI. Also, the performance of low achievers within the experimental group improved after they were instructed by the CAI and CAI group showed positive attitudes towards CAI when they were interviewed.

Tekbiyik, Konur and Pirasa (2008) also conducted their study on effects of computer assisted instruction on students‟ attitudes towards science courses in Turkey using 125 students for the study. They explained that an average student‟s attitude towards science course moved from the 50th percentile to the 75th percentile when computer assisted instruction was used. In other words, a student‟s attitude towards science improved after the student was exposed to CAI. The study used CAI which is similar to the present study.

Salahudeen (2012) investigated the effects of Computer-Assisted Instructional package on Learning of Longitude and Latitude among Secondary School Students in Minnna Metropolis. The study used 120 Senior Secondary School (SSS) Students and adopted the pretest and posttest quasi experimental control group design. The result revealed that the experimental group performed better than the control group. Gender and age differences were found to have no significant effect on the mean performance of the experimental group. This study is relevant to the present study in terms of the instrument (CAI).

In the recent study of Alhassan (2012) on effects of computer assisted instructional package on performance and retention in geometry among Junior Secondary School Students in Minna Metropolis, the study used 80 Junior Secondary School (JSS) Students and adopted the pretest - posttest quasi experimental–control group design. The finding revealed that the experimental group performed better than the control group and male students performed better than female students when taught geometry using computer. This study is relevant to the present study since it also tried to see the effect of computer assisted instruction on academic performance of students.

Suleman, Hussain, Naseer and Iqbal (2017) also conducted a similar study on the Effects of Computer-Assisted Instruction (CAI) on Students‟ Academic Performance in Physics at Secondary Level in Karak District, Pakistan. A sample of 46 students of Grade-09 was selected through simple random sampling technique from Government Boys High School Khurram Karak. The participants were separated into control and experimental groups based on pretest outcomes which was developed in their previous knowledge about physics. Pretest-Posttest Equivalent Groups Design was used to achieve the required outcomes. Physics Performance Test was used as research instrument comprising of six levels of cognitive domain (knowledge, comprehension, application, analysis, synthesis and evaluation). The test was developed in four units of Physics taught during the experiment. The units were; Physical Quantities & Measurement; Kinematics; Dynamics; and Gravitation. There were total of 60 multiple choice questions (MCQs.) in the said performance test carrying 120 marks in total. Each level of domain comprised of 10 MCQs. The same Physics Performance Test was used as retention test. The findings revealed that computer-assisted instruction has a remarkable positive effect on students‟ academic performance in Physics. CAI was found more effective and successful than traditional teaching method in subject of Physics. CAI was found more useful in different level of cognitive domain. Furthermore, computer assisted instruction was found more effective in the retention of students as compared to traditional method. CAI was found more useful in clarifying students‟ concept of difficult topics in Physics.

Abdulai, Yusuf and Mohammed (2019) did a similar study and found that CAI is also effective in boosting students‟ academic performance in different levels of cognitive domain in chemistry. Yusuf and Afolabi (2010) also worked effects of computer assisted instruction (CAI) on secondary school students‟ performance in biology. The

research was a quasi- experimental involving a 3 x 2 factorial design. The sample for the study comprised 120 first year senior secondary school students (SSS I) sampled from three private secondary schools, in Oyo State, Nigeria. The students‟ pre-test and post test scores were subjected to Analysis of Covariance (ANCOVA). The findings of the study showed that the performance of students exposed to CAI either individually or cooperatively were better than their counterparts exposed to the conventional classroom instruction. However, no significant difference existed in the performance of male and female students exposed to CAI in either individual or cooperative settings. Based on the research findings recommendations were made on the need to develop relevant CAI packages for teaching biology in Nigerian secondary schools.

Nwafor and Okoi (2016) also researched into the effects of computer assisted instruction on junior secondary school students‟ performance in basic science. Quasi-experimental design was used for the study. Two co-educational schools were drawn for the study through simple random sampling technique. One school was assigned to the treatment group while the other was assigned to the control group through a simple toss of the coin. Basic Science Achievement Test (BSAT) with a reliability score of 0.75 was the instrument used to collect data. Three research questions and three null hypotheses guided the study. The data for the research questions were answered using mean and standard deviation, while the hypotheses were tested using the analysis of Covariance (ANCOVA) at an alpha level of 0.05 and the findings of the study revealed that computer assisted instruction as a method of teaching enhanced higher students‟ performance in Basic Science than the conventional method. In the area of motivation, CAI has been found to be a better tool in motivating students to learn at their own pace (Nwanne, 2017).

Although, CAI has emerged in different forms of educational materials inside senior high schools, there is not much research on the evidence that CAI can improve students‟ academic performance in Integrated science at the Senior High School level. Moreover, students‟ acceptance and satisfaction with CAI for teaching and learning of Integrated Science have not received much attention in the literatures especially in the Ghanaian SHSs. Thus, much remain for empirical study on the use of CAI to improve students‟ academic performance in Integrated Science education in Ghanaian SHSs. Hence, the reason for carrying out this study.

2.8 Conceptual framework.

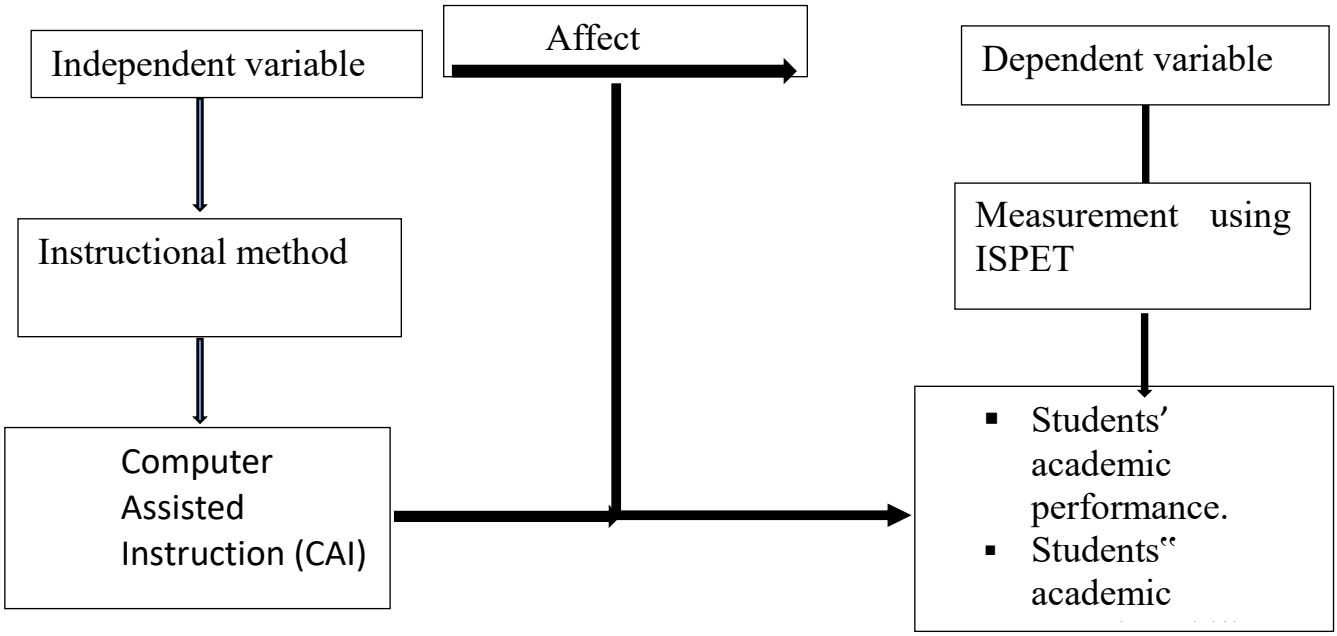


Figure 2.4: Conceptual Framework for the use of Computer Assisted Instruction. Source: This study

From figure 2.4, the independent variable which is the instructional method, thus, CAI is hoped to affect students" academic performance and retention ability which will be measured using the research instrument (ISPET).

CHAPTER THREE

METHODOLOGY

3.0 Overview

This study sought to ameliorate students‟ academic performance in integrated science using Computer Assisted Instruction in Juaboso Senior High School. The chapter incorporated a description of the Study Area, Research Design, Population, Sample and Sampling Techniques, Instrumentation, Validity and Reliability of the Research Instrument, Pre-Intervention, Intervention, Post Intervention, Data Collection Procedure, Data Analysis and Ethical consideration.

3.1 Study Area

Juaboso District was created out of Sefwi Wiawso District in 1998. It is located in Western North Region of Ghana. The district shares boundaries with Bia, Asunafo North District in the north. Asunafo South and Wiawso Districts to the east, Aowin Suaman District to the south and La Cote d‟Ivoire to the west. The district capital is Juaboso and is located about 360km to the North West of Sekondi, and a distance of 225km from Kumasi. The district has a surface area of 1924 square kilometers. The vegetation of the district is equatorial rain forest type with the semi-deciduous forest yielding various tree species including odum, wawa, mahogany,ofram, etc. About 27% of the total land surface has been marked for forest reserves. The Krokosue forest, which is earmarked as forest reserve enhances the district‟s ecosystem. Agriculture is the main occupation of the economy employing about 80% of the population. The major crops grown are cocoa, plantain, cocoyam, oil palm, rice, cassava and maize. Education –wise, Juaboso District has ten educational circuits managing 162 preschools, 121 primary schools, 63 junior high schools and 3 senior high schools with one situated at Juaboso and other at Sefwi Boinzan and Sefwi

Bonsu-Nkwanta. The programmes run by the schools are General Science, General Agriculture, General Arts, Home Economics, Business and Visual Arts

3.2 Research Design

Action research design was the design used for this study. Action research in education is any systematic inquiry conducted by teachers, principals, school counsellors, or other stakeholders in the teaching and learning environment to gather information about the ways in which their particular schools operate, the teachers teach, and the students learn and its purpose is to provide teacher-researchers with a method for solving everyday problems in their own classroom (Gay, Mills & Airasian, 2012). Action research allows teachers to study their own classrooms and study how their students learn and improve the quality of learning in the classroom. It also identifies an area of focus, collects data, analyses the data gathered and develops a plan of action (Mertler, 2017). It can also effect positive change in a school setting and improve the lives of students (Gay, Mills & Airasian, 2012). According to Cohen, Manion and Morrison (2018), the purpose of action research is to plan, implement, review and evaluate an intervention designed to improve practice or solve local problem to empower participants through research involvement and ideology critique and this was the main purpose of this study hence the implementation of this design. The action research methodology used in this study was Mertler's (2017) four stages of action research cycle. namely; plan, act, observe, and then reflect. The planning phase resulted in the problem of practice, a review of literature, a targeted research question, and a research plan. The acting phase included collecting and analysing data. The developing phase involved the creation of an action plan based on the analysis of data. Finally, the reflecting phase involved the results and reflection of the study.

3.3 Population

The target population of the study consisted of all students in Juaboso SHS. All form three students constituted the accessible population since the selected topics were all in the form three Integrated Science syllabus. The total final year students‟ population in the school at the time of the study was four hundred and fifty students, consisting of two hundred and fifty-four male and one hundred and ninety-six female students while the entire population of the school was one thousand, one hundred and twenty-six consisting of six hundred and seventeen males and five hundred and nine females.

3.4 Sample and Sampling Techniques

There were twelve final year classes at Juaboso Senior High School at the time of the study. Out of these 12 classes, one class was selected using simple random sampling technique for the study. Each individual class name was written on a separate slip of paper, placed in a container bowl which was well shaken. A slip of paper was then taken from the bowl and the class name on it was selected for the study, which was form 3 Art 3A. In the selection of the subjects an entire selected class was used for the study. (Creswell, 2012). There were thirty-seven students in the selected class which consisted of twenty-one males and sixteen females.

3.5 Instrumentation

Integrated Science Performance Test (ISPET) was used as the research instrument which was developed by the researcher together with an I.C.T expert at the department of I.C.T, university of Education, Winneba under the supervision of the supervisor of this study. ISPET was developed from three units of Integrated Science. That is, nervous system, electronics and variation and inheritance. These topics were selected because, from the researcher‟s observation, students find it difficult in

learning and answering questions on them. There were thirty multiple choice questions carrying 30 marks in total. Out of these questions, eight were on electronics, seven were on nervous system and fifteen were on variation and inheritance. The questions were constructed using a table of specification base on the six levels of cognitive domains (knowledge, comprehension, application, analysis, synthesis and evaluation). Each level of cognitive domain comprised five multiple choice questions. The same ISPET was used as the retention test after a slight modification in the order of the items. (See appendix A for the table of specification)

3.6 Validity of research instrument

To ensure validity, table of specification was used to develop ISPET. It was then given to experience Integrated Science teachers and the supervisor for review with respect to content, construct and criterion validity. Their comments further improved the quality of the instrument. The same test was used for pre-intervention test, pos-intervention ttest and retention test. In order to reduce errors of memorization of previous test items the researcher reshuffled the items of the post-intervention test and retention test.

3.7 Reliability of Research Instrument

After ISPET was modified based on expert advice, it was field tested. The test was administered to students in Boinzan Senior High to determine its reliability. Forty-one form three students took part in the test and it took them approximately 30 minutes to complete. Both the question papers and the answer sheets were collected from the students just after the test. The marking scheme developed by the researcher base on the test items were used to mark the collected scripts (see appendix E). Students‟ total scores for the items ranged from 0 to 30. The reliability of the test was calculated

using the Kuder-Richardson formula 21 (K-R_{21}) and found to be 0.78 (see appendix C) According to Frankel and Wallen (2003), reliability co-efficient of a test for data collection in research studies should be 0.70 and may be higher. Thus, the test had good reliability and was considered good for use based on literature.

3.8 Pre-intervention

Before conduction of intervention, formal approval was sought from the headmaster through the head of department of science of Juaboso Senior High School. After getting permission, pre-intervention test was administered to the students. (see appendix D) This took place on Monday, 12th May, 2021 which lasted for thirty minutes.

3.9 Intervention

A period of six weeks was used for the intervention. Out of which four weeks were used for active learning using the CAI package which started on the 17th of May 2021 and ended on the 7th of June 2021. Two weeks later, a retention test was issued to find out how much knowledge the students had retained in their cognitive domain and this took place on the 23rd of June, 2021. During the four weeks of active teaching and learning, three topics in Integrated Science were covered in seven different lessons. All the seven lessons took place at the school‟s Biology laboratory. The nervous system was the first topic treated which lasted for a week followed by electronics which also lasted for one week. Variation and inheritance was the last topic treated and it lasted for two weeks. Nervous system and electronics were taught in two different lessons each while variation and inheritance was taught in three different lessons. In all, seven different lessons took place to cover all the three topics. These lessons were all facilitated by the teacher-researcher using the CAI package. There

were three different CAI packages, that is, a topic to a package. After each treated topic, day students who were having personal computers and smart phone were given the CAI package on that topic, the package was also put on the computers at the school‟s ICT laboratory for students to access it at their leisure time to revise on the contents being taught. Details of the various lessons on how the CAI package was used in the teaching and learning process in the seven lessons are discussed below.

3.9.1 Lesson 1

Topic : The Nervous system.

Sub-topic: 1. structure and functions of the nervous system.

2. Causes and effects of damages to brain and the spinal cord.

Day/Duration: Monday, 17/05/2021, 2 hours.

Time: 10:00AM to 12:00P M

Lesson objectives: after this lesson, student will be able to;

1. Describe the structure of the nervous system.
2. State the causes and effects of damage to the brain and the spinal cord.

Teaching-learning-materials: marker, whiteboard, laptop with CAI package, projector, light source, mini speaker.

Teacher Learner Activities:

The lesson started immediately after the students returned from their first break. During the break time, teacher researcher set-up the computer and its related devices for teaching and learning to commence. After the arrival of students, the researcher roamed throughout the class to make sure the class is in a full condition for teaching and learning, in doing so, students who were not able to have a full view of the

projected document and the whiteboard were made to sit at a place that provided them a much clearer view.

The teacher then introduced the lesson by reviewing students‟ relevant previous knowledge (RPK) on the topic from Junior High School which led to its introduction.

Lesson objectives were then communicated to the students, they were also made aware that CAI Package was going to be used for the teaching and learning and so they should take note of major points, raise their hands if they wanted to ask a question.

Students were asked to raise one leg and one hand while standing. In that position, student was told to rotate and nod the head. Students were then asked how the tasks were managed. A student said “I was able to do the tasks because of the help of my brain and spinal cord” while other student also added to the above point the contribution of nerve cells also helped in performing the tasks. Teacher then made student aware that the brain, spinal cord and the nerves form the nervous system.

The structure and functions of the nervous system was then discussed with students using audio-visual of the structure of the nervous system of human embedded in the CAI package and this was used to attain the first objective.

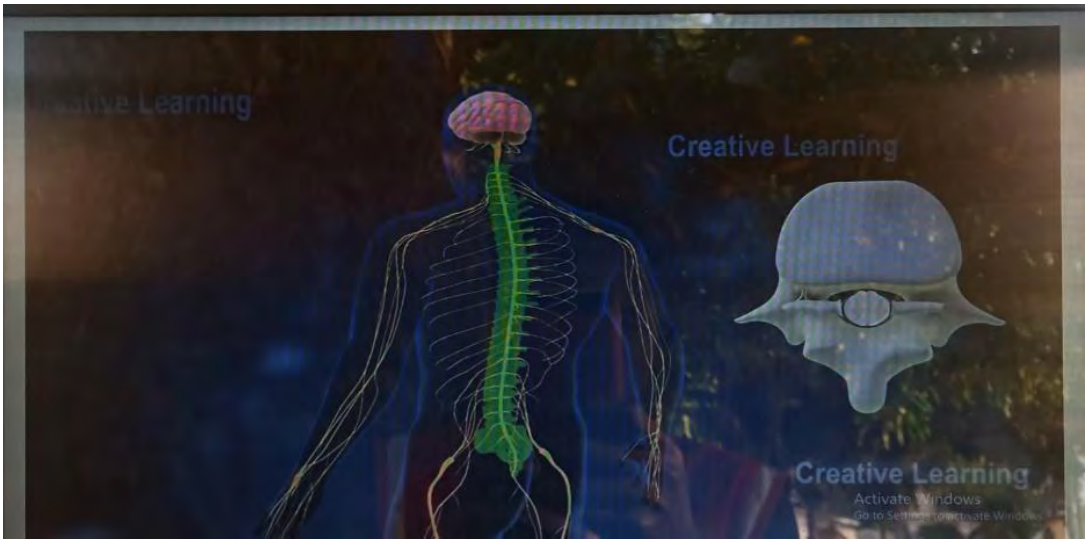


Figure 3.1: Screenshot of video showing the structure of the nervous system.

Students were informed that the brain and the spinal cord together form the central nervous system and it controls and coordinates body activities. The nerve cells form the peripheral nervous system and they link the CNS to the sense organs. Treatment of the parts of the brain and the spinal cord and their functions were also covered. Discussion of the three types of neurones and their functions were made in addition, students were given some minutes to draw the general structure of the nerve cell in their note book using pencil.

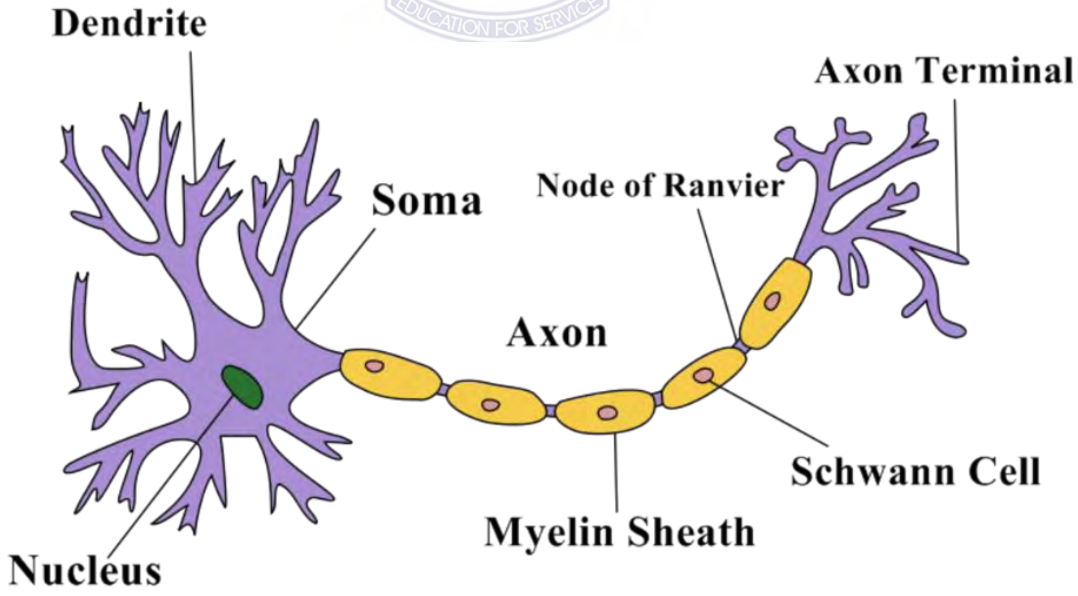


Figure 3.2: Structure of the nerve.

Teacher then brainstormed students to state three causes of damage to the CNS. Students then made mention of accidents, diseases, drug abuse. After discussing the above points with students, teacher then added to it depression. The future"s wheel embedded in CAI as shown in figure 3.3 below was mainly used to explain the consequences of drug abuse on the individual, the family and the society.

Figure 3.3: the future wheel explaining consequences of drug abuse.

Teacher closed the lesson by allowing student to response to the drill and practice questions in the CAI package. Students were then informed to read on voluntary and involuntary actions as well as the endocrine system. The lesson was closed at exactly 12:21PM.

3.9.2 Lesson 2

Topic : The Nervous system

Sub-topic: 1. Voluntary and involuntary actions

2. The endocrine system

Day/Duration: Wednesday, 19/05/2021, 2 hours.

Time: 1:30PM to 3:30PM

Lesson objectives: after this lesson, the student will be able to;

1. Differentiate between voluntary and involuntary actions.
2. Describe the endocrine system.

Teaching-learning-materials: marker, whiteboard, laptop with CAI package, projector, light source, mini speaker.

Teacher Learner Activities:

Teacher revised students‟ knowledge on the previous lesson taught.

Teacher asked students to give three examples of activities that are carried out by themselves that they have control over them.

Student's response: learning, waving of the hand and bathing.

Student was questioned again to give three examples of activities carried out by themselves that they cannot control.

Student's response: jerking of the knee, sneezing and blinking of the eye.

Teacher then explained to students that the activities that can be controlled are called voluntary actions and those that cannot be controlled are called involuntary actions.

Teacher then projects to student examples of both voluntary and involuntary actions and guided them to group them into either voluntary or involuntary actions. Students were then taking through the reflex arc using videos and images embedded in the CAI package. They were made aware that the path through which a nerve impulse travel is called the reflex arc. The importance of reflex action was also discussed with students.

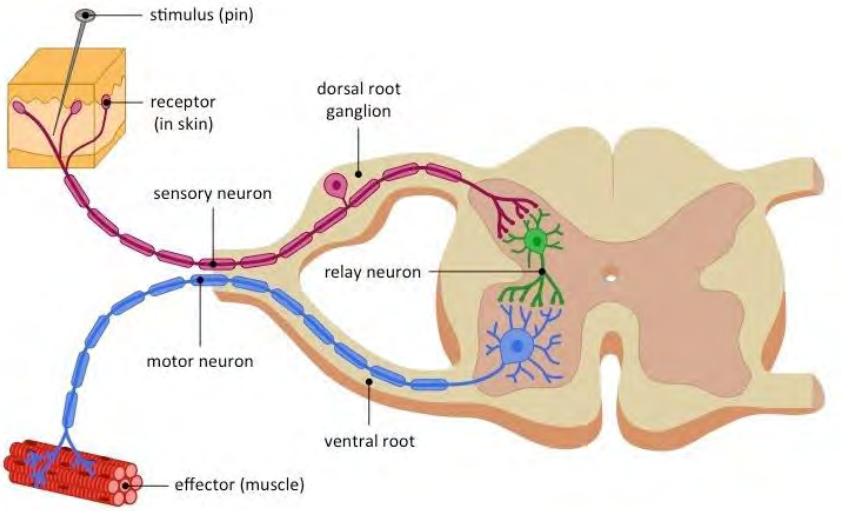


Figure 3.4: Diagram of the reflex arc.

The endocrine system was treated using a chart, images and videos in CAI package. Students learnt that the endocrine system produces chemical substances called hormones which control growth, behaviour, reproduction and other activities. The endocrine glands and the hormones they produce were also discussed as well as the effects of over secretion and under secretion of these hormones.

Using questioning and answering method, the differences between endocrine system and the nervous system were also discussed.

Lesson was closed by allowing students to answer the drill and practice questions in the CAI package. The lesson ended at exactly 3:16pm.

3.9.3 Lesson 3

Topic : Electronics

Day/Duration: Monday, 24/05/2021, 2 hours.

Time: 10:00AM to 12:00P M

Lesson objectives: after this lesson, the student will be able to:

1. Describe the behaviour of LED, resistor, capacitor and inductor in electronic circuit.

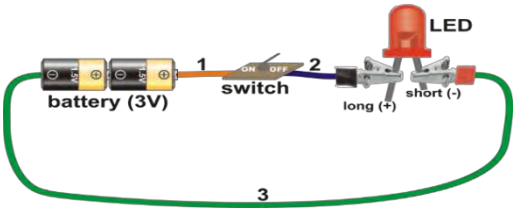
2. Classify solid materials into conductors, semiconductors and insulators.
3. Explain P-type and N-type semiconductors and the formation of P-N junction diode

Teaching-learning-materials: marker, whiteboard, laptop with CAI package, projector, light source, mini speaker.

Teaching learning-activities.

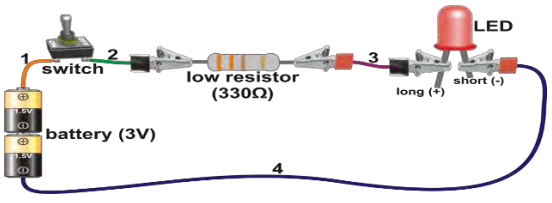
Students were asked to list some electronic components and their uses based on their previous knowledge of electronics from primary and JHS. Students were shown images of these electronic components; LED, resistor, capacitor and inductor. They were made to draw them in their note books too. Using images and videos in CAI package, students were guided to appreciate the behaviour of these components in both direct and alternating currents. From the tutorials, it was deduced that;

1. For a circuit with d.c source and LED, when the key is closed, the LED lights brightly but if resistor is added to the LED and the key is closed, the brightness of the LED decreases because the resistor causes opposition to the flow of the current. Figure 3.5a and 3.5b shows the images used for the above activities.



LED lights brightly

Figure 3.5a:d.c circuit with LED



Brightness of LED dicreases

Figure 3.5b:d.c circuit with LED and resistor.

2. For the circuit with d.c source, capacitor and LED, When the key is closed, the LED lits for some time and then dims slowly. The LED lits when the capacitor

is discharging charges and dims slowly to off when all the charges are discharged. The LED will not have lit when the capacitor is charging. In an a.c. circuit, the *LED* remains lit uniformly when the switch is closed. This is because the capacitor is charged and discharged continuously at the frequency of the a.c. source. Figure 3.6a and 3.6b shows the circuit diagram and a screenshot of the behaviour of capacitor in both d.c and a.c soureces.

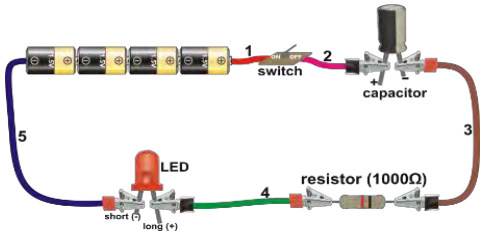


Figure 3.6a: circuit diagram of capacitor

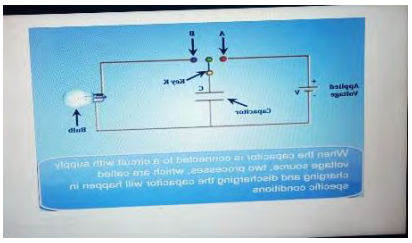


Figure 3.6b: screenshot of video of capacitor.

3. For the circuit with d.c source, inductor and LED, when the key is closed, When the key is closed, LED does not light up, it just gives off a flash of light. The inductor stores the electrical charges from the d.c source. When the key is opened, the stored charges are released to light up the LED. For the circuit with a.c source, inductor and LED, the LED gives off a steady light because the stored electrical energy released reverses rapidly. Figure 7a and 7b shows the circuit diagram and a screenshot of the behaviour of inductor in both d.c and a.c soureces.

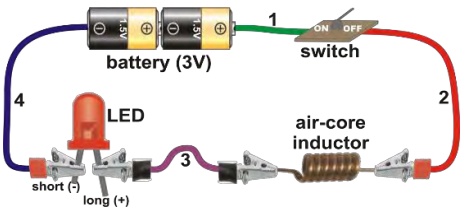


Figure 3.7a: circuit diagram of inductor

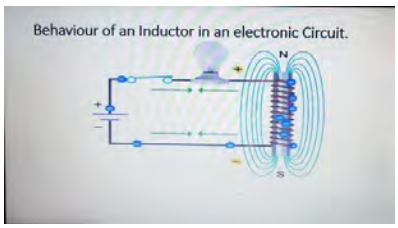


Figure 3.7b: screenshot of video of inductor

Students were then engaged in a discussion on conductors, semiconductors and insulators to attain the second objective of the lesson. It was discussed that conductor is a substance that allows electricity to flow through it easily. it has very low resistivity to current. It conducts electricity because their outer electrons are loosely bound their atoms making them have free movement. They are basically metals. Example: copper, aluminium, silver, mercury. Insulators are materials that do not conduct electricity. They have high resistivity. They have their outermost electrons held strongly by their atoms. Examples: wood, pen. semiconductors are materials having their conductivity lying between conductors and insulators. Semiconductors are used in making diodes, transistors, integrated circuits (ICs), resistors. Example; silicon, germanium. There are two types of semiconductors; N-type and P-type semiconductors. The N-type semiconductor is formed when a pure tetravalent semi-conductor like Germanium is doped with a pentavalent impurity atom like phosphorus. Since the charge carriers which are electrons carry negative charges, the resulting semi-conductor is called N-type (N for negative). P-type semi-conductor is formed when a pure tetravalent semi-conductor like Germanium is doped with a trivalent impurity atom like aluminium. Since the charge carriers which are “holes” have positive charges, the resulting semi-conductor is called P-type (P for positive).

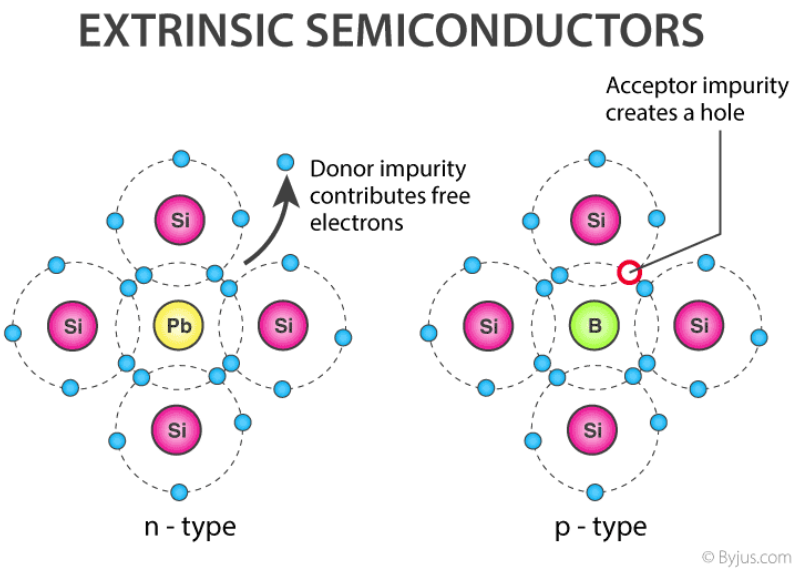
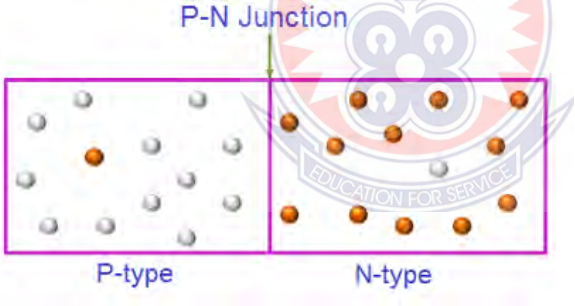


Figure 3.8: diagram showing formation of n-type and p-type semiconductors.

Students also learnt that, when a P-type semi-conductor is joined to an N- type semi-conductor, a diode is formed and it is called the P-N junction diode and the boundary formed is called the P-N junction.



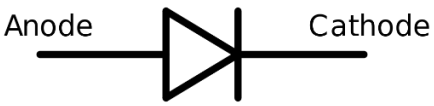


Figure 3.9a: diagram showing formation of P-N Diode. Figure 3.9b: symbol of diode.

Student was then called to give a summary of the lesson treated atfeter that teacher guided student to answer the questions at the drill and practice section of the lesson and the lesso n came to and end.

3.9.4 Lesson 4

Topic : Electronics

Day/Duration: Wednesday, 26/05/2021, 2 hours.

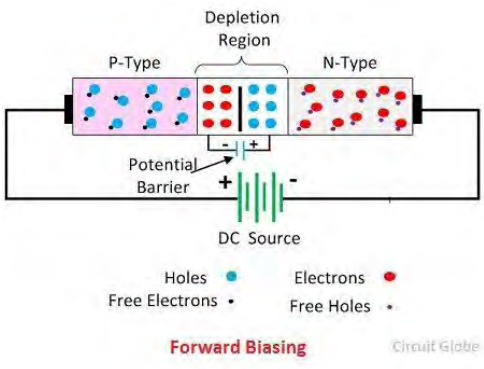
Time: 1:30pm to 3:30pm

Lesson objectives: after this lesson, the student will be able to:

1. Describe the behaviour of P-N junction diode in a d.c and a.c electronic circuits.
2. Describe the structure of a transistor and state its uses.

Teaching and learning activities.

Students previous knowledge on P-N junction diode was revised. By the help of the CAI package, teacher discussed with student the behaviour of P-N junction diode. Student learnt that, the application of external voltage to a P-N junction diode is called biasing, and there are two types of biasing; Forward bias and Reversed bias. When the p-type region of the p-n junction is connected to the positive terminal of the battery, current will flow and the diode is said to be on forward bias but if the voltage is connected across a P-N junction diode with the negative terminal to the P region and positive terminal to the N region, no current flows and the diode is said to be in a reversed bias. The P-N junction diode is used as a rectifier. (changing alternating current to direct current) since it allows current to flow in only one direction



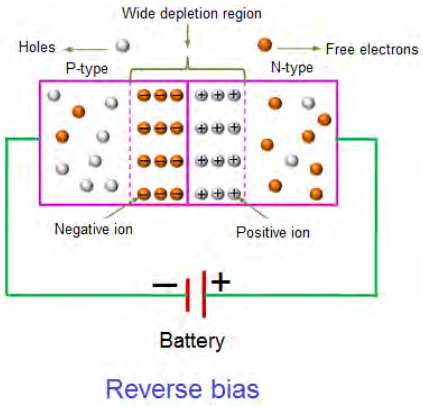


Figure 3.10a: diagram of forward bias.

Figure 3.10b: diagram of reverse bias.

A transistor is the material formed when N-type semiconductor is sandwiched by two P-type semiconductors or P-type semiconductor sandwiched by two N-type semiconductors. The middle region of a transistor is called the base (b). The outer regions are called emitter (e) and the collector(c).

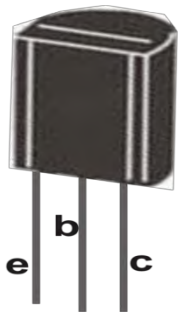


Figure 3.11: diagram of transistor

N-P-N transistor is a type of transistor in which P-type semiconductor is sandwiched by two N-type semiconductors.

Figure 3.12a: block diagram of n-p-n transistor. Figure 3.12b: schematic diagram of n-p-n transistor.

P-N-P transistor is a type of transistor in which N-type semiconductor is sandwiched by two P-type semiconductors.

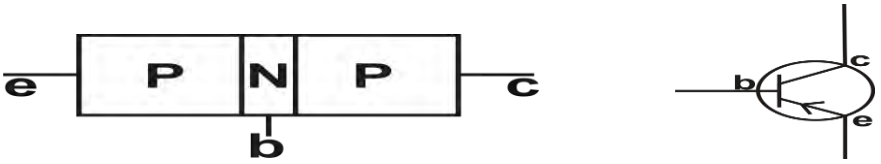


Figure 3.13a: block diagram of p-n-p transistor. Figure 3.13b: schematic diagram of p-n-p transistor.

After these activities, the lesson then came to an end. Student was advised to visit the school"s ICT lab at their leisure period to revise continuously about the lessons being taught. Students were also told to read on variation and inheritance which was the next topic treated.

3.9.5 Lesson 5

Topic : Variation and inheritance.

Sub-topic: 1. Nucleus, chromosomes and genes as sequence of inheritance.

2. Causes and consequences of variation.

Day/Duration: Monday, 31/05/2021, 2 hours.

Time: 10:00AM to 12:00PM

Lesson objectives: after this lesson, student will be able to;

1. Relate the nucleus, chromosomes and genes as a sequence of inheritance.
2. Explain the causes and consequences of variation.

Teaching and learning activities.

Introduction: Living organisms transmit traits from their parents making them similar to the. Every organism has got its own distinctive characteristics which makes it different from other organisms of the same kind. This is called **variation.** The study of the hereditary and variations is called **genetics.** Student was then brainstormed to find out some organelles of cells including the nucleus. The importance of the nucleus as the structure for storage of genetic materials was discussed. It was learnt that the name of the genetic materials are the chromosome and genes. Chromosomes and genes were described in details using pictures and video in the CAI package.

Chromosome is a threadlike structure found in the nucleus of a cell which contains a genetic material called DNA. Gene is a single unit of heredity material located at a specific locus on a chromosome.

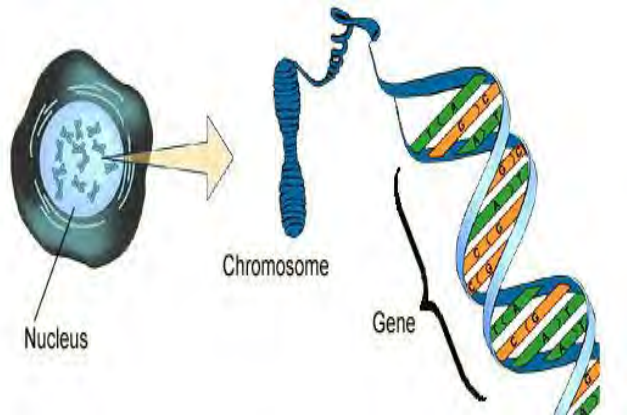


Figure 3.14: diagram of nucleus, chromosome and gene

Some terminologies associated with chromosomes and genes are;

Locus: a fixed point on a chromosome occupied by a gene.

Alleles: an alternative form of a gene that occupy the same locus on a homologous chromosome which produce contrasting characteristics. Example: Tt where T = tallness and t = shortness

Dominant gene: a gene that suppressed the effect of another gene on the same locus. It is represented by a capital letter.

Recessive gene: a gene whose effect is suppressed by a dominant gene. It is represented by a small letter. Example, Tt means T is dominant over t.

Genotype: This is the genetic makeup of an organism.

Phenotype: This is the physical characteristics of an organism.

Homozygous: an organism that has same alleles for a particular trait. Example TT = homozygous tall, tt = homozygous short

Heterozygous: an organism that hat different alleles for a particular trait. Example: Tt = heterozygous tall, Rr = heterozygous red.

F1 generation (First filial generation): this is the offspring produced by crossing parental generation

F2 generation (second filial generation): the offspring produced by crossing the offspring of F1 generation.

The inheritance of a single pair of contrasting characters that was investigated into by Gregor Mendel was explained, tutorials in CAI about the experiments on garden pea plant by Mendel was shown to students and this led to the discussion of the Mendel‟s laws of inheritance. These laws are;

The law of segregation: it states that organism‟s characteristics are determined by internal factors (genes) that occurs in pairs.

The law of independent assortment: it states that, anyone of a pair of characters may combine with either one of another pair.

Law of dominance: it states that; one form of hereditary traits prevents the expression of the other form.

In attempt to attain the second objective of the lesson, teacher projected to students three different images and they were asked to state the differences among the organisms in each image.

Students then made mention of baldness, skin colour, hair colour, colour of the eye. Students were then told that these differences that exist in organisms of the same species is called variation. Other characteristics that such as body movement, body weight. tongue rolling, Sex, Rhesus factor, sickle cell anaemia, albinism, hairiness of body, blood group and height which show variation were also treated. These characters were then grouped into continuous and discontinuous variation. Students learn that is a type of variation where there are intermediate forms between the organisms under consideration. Examples of continuous variation are weight, height, intelligence. Discontinuous variation is the variation where there is a clear-cut difference between organisms. Examples of discontinuous variation are eye colour, blood group, sex, Rhesus factor, tongue rolling.

The image below was used to discuss the environmental causes of variation

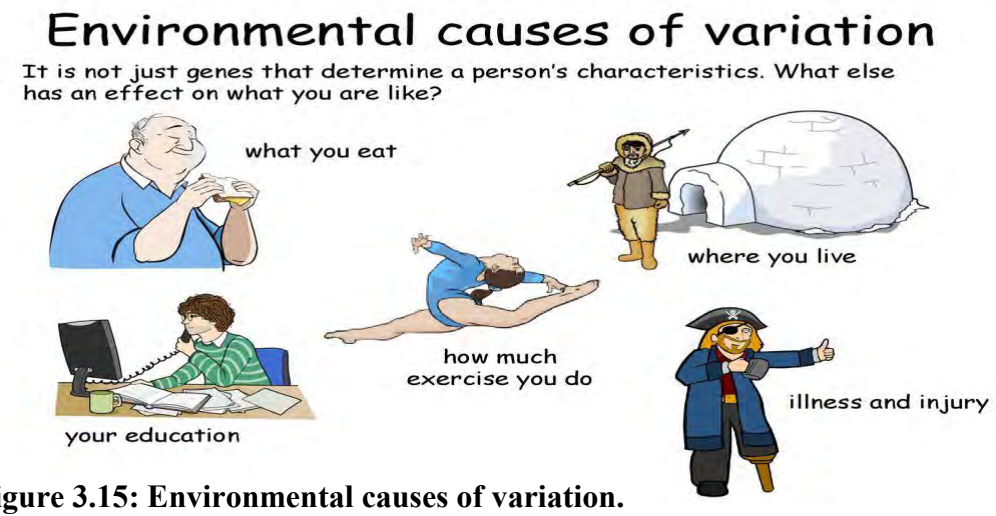


Figure 3.15: Environmental causes of variation.

Mutation was also explained as the genetic cause of variation using the image below

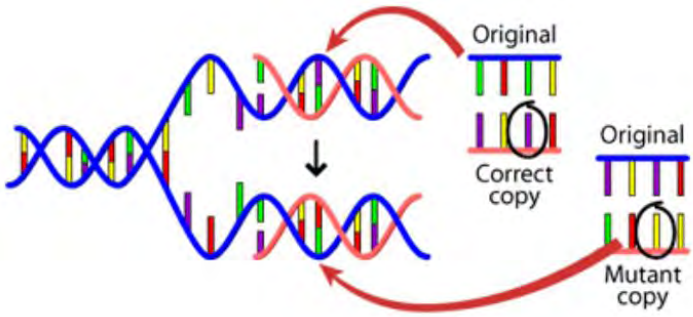


Figure 3.16: diagram showing mutation in a gene.

Mutation is the spontaneous change in a gene or chromosome which may produce a change in the characteristic under its control. If the change occurs in the gene, it is called gene mutation. If it occurs in the chromosome, it is called chromosome mutation.

Teacher summarizes the day's lesson and used the drill and practice questions in CAI to evaluate the lesson.

3.9.6 Lesson 6

Topic : Variation and inheritance.

Sub-topic: 1. Sex determination in humans.

2. Sex linked characters

Day/Duration: Wednesday 2/06/2021, 2 hours.

Time: 1:30pm to 3:30pm

Lesson objectives: after this lesson, the student will be able to;

1. Explain how sex is determined in humans.
2. Explain sex linked characters and give some common examples.

Teaching and lesson activities.

Using questioning and answer, students RPK on chromosomes was revised. Teacher then used pictorial representation of test cross on sex determination in CAI package to explain to students how sex is determined in humans. Students learnt that Sex is determined at fertilization and it is the chromosome of the man that determines the sex of the child. There are 23 pairs of chromosomes in humans. The first 22 pairs are called body chromosomes (autosomes). The 23rd paired chromosome is called sex chromosome. Females have their sex chromosomes to be XX while males have XY. During fertilization, if the X chromosome of the male fuses with one of the X chromosomes of the female, the results is XX and the child will be a female. If the Y chromosome of the male fuses with any of the X chromosomes of the female the result is XY and the child will be a male. A chart in the CAI package was projected to students to draw into their note books. They also learnt that sex-linked characters are characters which are easily passed-on from parents to offspring. Examples of heritable characters are Blood group, Rhesus factor, Hairy ear lobe, Baldness, tongue rolling, eye colour and Colour blindness.

3.9.7 Lesson 7

Topic : Variation and inheritance.

Sub-topic: 1. Blood group and Rhesus-factor

2. Sickle cell gene and sickle cell disease.

Day/Duration: Monday 7/06/2021, 2 hours.

Time: 10:00Am to12:00pm

Lesson objectives: after this lesson, student will be able to;

1. State the types of blood groups and Rh-factor in humans.
2. Distinquish between sickle cell gene and sickle cell disease.

Teaching and learning activities

Teacher used discussion method with the help image on blood group in CAI to state the types of blood groups and Rh-factor in humans. Students studied that There are 4 blood groups and each person belongs to one. These are blood group A, B, AB and O. some terminologies such as antigen, antibody were also taught using images embedded in the CAI package as shown in figure 16 below.

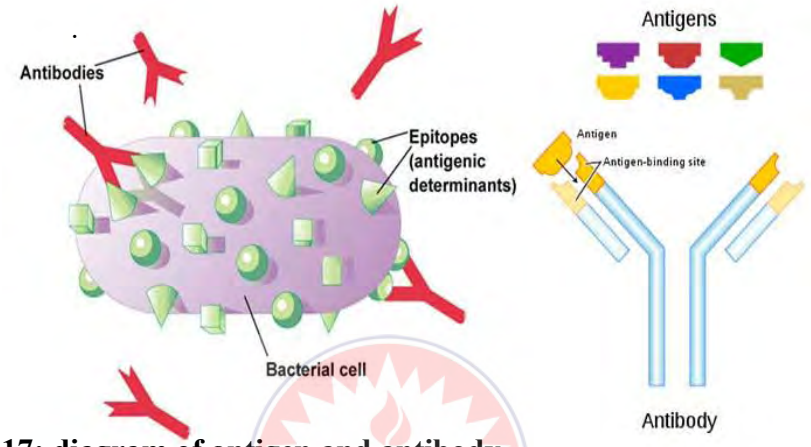


Figure 3.17: diagram of antigen and antibody

The various blood groups and their antigens and antibodies were also treated using figure 3.18 below which was also included in the package. Blood compatibility was treated and the summary of it is shown below in figure 3.19. It was deduced that, for blood transfusion to be successful, there must be compatibility of the antigen to antibody to prevent agglutination of blood which could lead to death of patient.

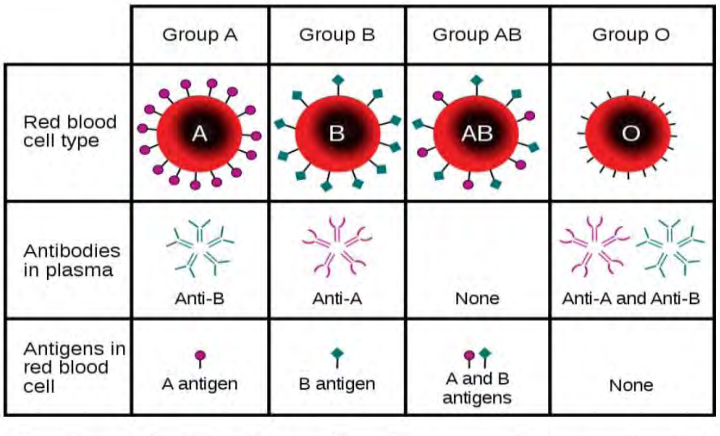


Figure 3.18: diagram of blood groups, antigens and antibodies

Recipient	Blood donor			
	O	A	B	AB
O	✓	x	x	x
A	✓	✓	x	x
B	✓	x	✓	x
AB	✓	✓	✓	✓

Figure 3.19: summary of blood compatibility.

Rhesus-factor is an antigen produced in the red blood cells of rhesus monkey which is also found in human beings. A person may have blood group A+, A-, B+, B-, AB+, AB-, O+ or O-. The positive and negative signs represent the presence or absent of Rh factors as shown in figure 3.20 below.

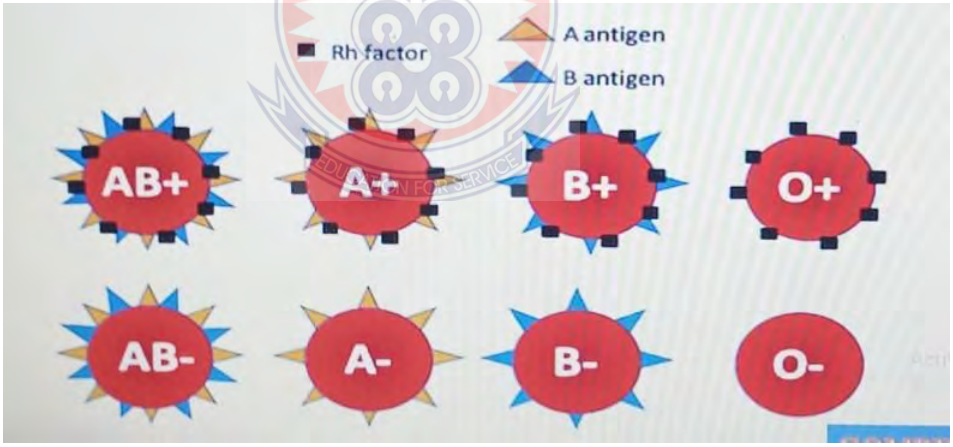


Figure 3.20: showing present or absent of Rh factor in blood groups

Teacher shown to students an audio visual showing the effect of a Rhesus man marrying a woman without Rhesus factor. After students watched the video, it was summarised that, If Rh+ blood is introduced into Rh- person, production of antibodies against the factor is induced. During first pregnancy of Rh+ foetus, only small quantities of antibodies are produced hence this may not cause a problem. During subsequent pregnancies involving positive rhesus foetus, enough antibodies would have been produced in the woman. This may

lead to blood clotting in the foetus if there is a leakage of blood across the placenta of the woman leading to death of the foetus. This is why it is not advisable for Rh negative woman to marry a Rh+ man.

An image of normal red blood cell and sickle-shaped red blood cell was shown to students. Using these images teacher explained to students that Sickle cell gene is a recessive gene which alters the structure of haemoglobin in red blood cells and this makes the RBC to become sickle-shaped instead of the normal biconcave disc shape. Normally, S is denoted as the allele for normal RBC while s is denoted for sickle cells and that,

1. A normal person will have the allele **SS.**
2. A person with sickle-cell anaemia will have the allele **ss.**
3. A carrier sickle-cell person will have the allele **Ss.**

An image of a test cross between two carriers of the sickle-cell gene was projected and explained to students. They were then given some time to copy it into their note book for future reference. This image is also shown in figure 3.21 below. students were then advised to seek for counselling and medical examination when getting married to avoid increasing the rate of sickle cell anaemia.

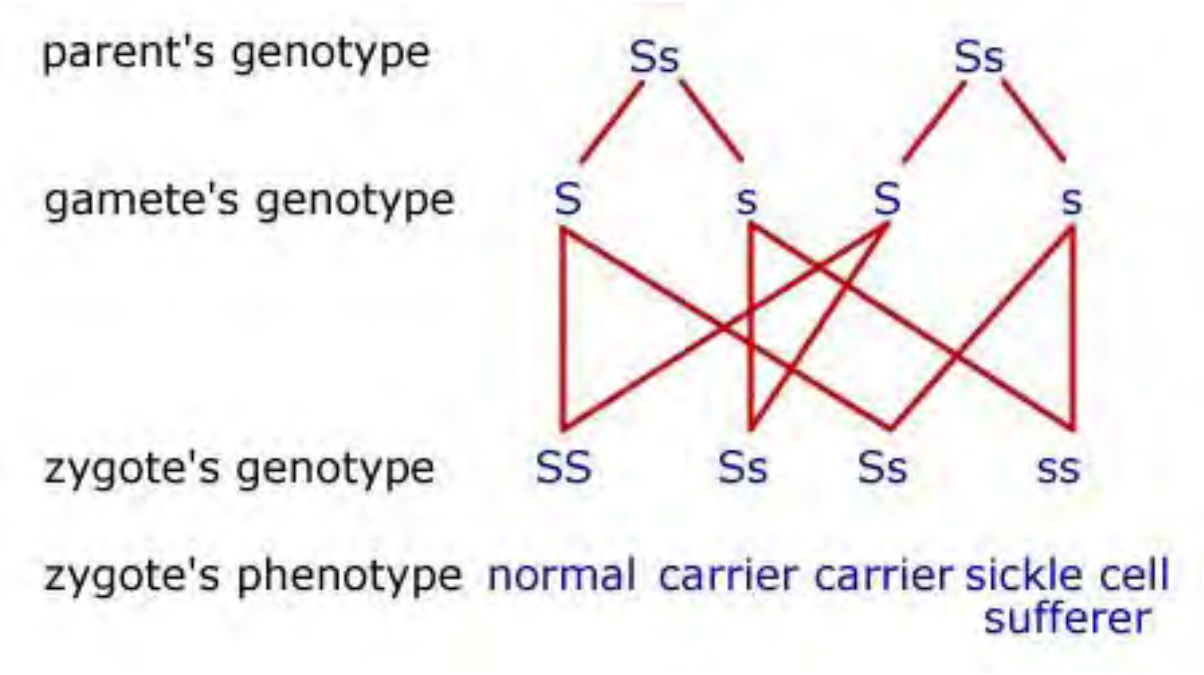


Figure 5.21: Test cross between two carriers of the sickle-cell gene

Teacher called student to summarise the lesson taught. Afterwards, students were made to answer the questions under the drill and practice in the CAI package.

He also made students aware that, the lessons had ended and that a test would be conducted in their next lesson instead of the normal teaching and learning. The lesson finally ended at exactly 3:28pm.

3.10 post-intervention

A post-intervention test was given to the students in their next lesson after the intervention to examine their academic performance (see appendix F). Then after two weeks, the said post-intervention test with slight sequential change with respect to items was issued again to the students as retention test (see appendix H).

3.11 Data Collection Procedure

Data was collected through pre-intervention test, post-intervention test and retention test. The responses of the subjects to ISPET were scored using the marking scheme. Each correct response was scored one point with a maximum score of 30 marks.

3.12 Data Analysis Procedure

Participants‟ scores from pre-intervention test, post-intervention test and retention test were organised and analysed using descriptive statistics (mean, standard deviation) and Inferential statistics (dependent sample t-test through SPSS).

3.13 Ethical Considerations

Ethical considerations are values and principles that distinguish between rights and wrong in research studies (Burgess, 1989). In considering the ethics to this study, disciplinary practice was followed to safeguard the responses of students and teacher researcher. Also, maintaining privacy and confidentiality as well as planning of the research to avoid misleading results were ensured. Plagiarism was totally avoided as far as this study is concern.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

In this chapter, the analysis of data using descriptive statistics (mean, standard deviation) and Inferential statistics (dependent sample t-test through SPSS) and results of such analysis are presented. The data generated by Integrated Science Performance Test (ISPET) are used to answer the relevant research questions or research hypotheses.

Research question 1: What is the effect of CAI on students‟ academic performance in teaching and learning of Integrated Science at JSHS?

The descriptive statistics such as mean and standard deviation were used to test this research question. As shown in Table 4.1 (distribution of students‟ pre-intervention test), 10 (27%) students had a score of 6, 6(16.2%) students had a score of 7 and 5(13.5%) students had a score of 8, 4(10.8%) students had a score of 5 and 9 respectively, 3(8.1%) students had a score of 10, However, 2(5.4%) students had a score of 1 and 2 respectively while 1(2.7%) student had a score of 4. This gave a mean score of 6.43.

Table 4.1: Frequency Distribution Table of students' pre-intervention test score.

Score (30 marks)	Frequency	Percentage (%)
1	2	5.4
2	2	5.4
4	1	2.7
5	4	10.8
6	10	27.0
7	6	16.2
8	5	13.5
9	4	10.8
10	3	8.1
Total	**37**	**100**

Mean = 6.43

Also, as shown in Table 4.2 below ((distribution of students‟ post-intervention test), 5 (14.3%) students had a score of 9, 3(8.6%) students had a score of 21 and 26 respectively, 2(5.7%) students had a score of 7, 8, 10, 12, 14, and 24 respectively while 1(2.9%) student had a score of 6, 11, 13, 15, 16, 17, 18, 19, 20, 28 and 29 respectively and this gave a mean of 16.

Table 4.2: Frequency Distribution Table of students' post-intervention test score.

Score (30 marks)	Frequency	Percentage(%)
6	1	2.9
7	2	5.7
8	2	5.7
9	5	14.3
10	2	5.7
11	1	2.9
12	2	5.7
13	1	2.9
14	2	5.7
15	1	2.9
16	1	2.9
17	1	2.9
18	1	2.9
19	1	2.9
20	1	2.9
21	3	8.6
24	2	5.7
26	3	8.6
27	1	2.9
28	1	2.9
29	1	2.9
Total	**35**	**100**

Mean = 16

Table 4.3 shows the summary of the descriptive statistics of students" academic performance on both pre-intervention and post-intervention tests. Based on Table 4 the answer to question one which states: "What is the effect of CAI on students" academic performance in teaching and learning of Integrated Science? is that the mean score for the pre-intervention test score was 6.43 and that of the post-intervention test score was 16. This indicates that there is a significant difference between the mean scores of the pre-intervention test and post-

intervention test. The mean difference is 9.8 in favour of post-intervention test. Therefore, the answer to the research question one is that there exist significant differences in favour of post-intervention test.

Table 4.3: Summary of distribution statistics of pre-intervention and post-intervention tests.

Test	N	Mean	SD	MD
Pre-intervention	37	6.43	2.32	9.8
Post-intervention	35	16	7.24	

Key: SD=standard deviation, MD=mean difference.

To test whether there was a statistically significant difference or not in the mean score of the pre-intervention test and post-intervention test. Ho 1 which states that "There is no statistically significant difference between students" academic performance on pre-intervention test and post-intervention test in teaching and learning of Integrated Science using CAI" was used. This hypothesis was tested by selecting the scores of the pre-intervention test and post-intervention test to a two sampled t-test and the summary of the results is shown in Table 4.4 below.

The outcome of Table 4.4 portrays that, there is a statistically significant ($p \leq 0.05$) difference between the academic performance of students" pre-intervention and post-intervention tests as the t-statistical value is larger than the t-critical value at 0.05. Since the alpha value at 0.05 is greater than the p-value at 0.000, the null hypothesis 1 was rejected and alternative hypothesis was stated that there is a statistically significant difference between students" academic performance on pre-intervention test and post-intervention test in teaching and learning of Integrated Science using CAI.

Again, the mean values undoubtedly reveal that students" academic performance on post-intervention test was excellent as compared to the pre-intervention test with a mean of 6.23.

Table 4.4: Sample t-test on Performance Score on pre-intervention and post-intervention tests.

Test	N	Mean	SD	DF	t-value		p-value
					statistical	critical	
Pre-intervention	37	6.43	2.32				
				41	7.46	2	0.000*
Post-intervention	35	16	7.24				

Key:N=number of scores, SD=standard deviation, DF=degrees of freedom, *= significant at p≤ 0.05

Table 4.4 depicts that students‟ academic performance really increased after the intervention from a mean of 6.43 to a mean of 16.

The implication of this finding therefore is that, CAI is more effective in improving students‟ academic performance in Integrated Science. This finding is in support to the finding of Suleman (2017) who found that CAI has a significant positive effect on students‟ academic performance. This positive effect is similar to the study carried out by Tareef (2014). Khadiravan (2009) in his study found that the adoption of any treatment as an instructional framework greatly improves students‟ interest in learning and this may be to the fact that CAI enhanced the interest of the students and encouraged them to learn as seen in the study conducted by Nwanne (2017) who found that CAI motivates students to learn. It could be explained also that the use of CAI as emphasised in the theoretical framework engages learners, makes them active participants rather than remaining passive recipients of scientific facts and alert as well as motivates or enhances their interest through constant feedback mechanism.

This finding also is in agreement with Nwafor (2016), Orjika (2012), Sulahudeen (2012) and Alhassan (2012) who in their studies found out that CAI improves students‟ academic performance. This confirms the recommendation made by Afolabi and Yusuf (2010) that relevant CAI packages should be used for teaching and learning after he found out that

students exposed to CAI either individually or cooperatively performs better than their counterparts exposed to only conventional teaching.

Research question 2: What is the effect of Computer Assisted Instruction (CAI) on students‟ academic performance in different level of cognitive domain, that is, knowledge, comprehension, application, analysis, synthesis and evaluation in Integrated Science at JSHS?

In an attempt to answer research question two, the pre-intervention test was compared to the post-intervention test using descriptive statistics and t-test.

Table 4.5 shows the summary of results of the data collected from both tests.

Table 4.5: Inferential Analysis of students' academic performance on pre-intervention and post-intervention tests in different levels of cognitive domain.

Levels of cognitive domain	Pre-intervention test		Post-intervention test		P-value
	Mean	SD	Mean	SD	
Knowledge	0.95	0.85	2.03	1.49	0.000*
Comprehension	1.51	1.22	2.45	1.19	0.001*
Application	1.38	0.95	1.74	1.22	0.164
Analysis	1	0.88	1.71	1.15	0.004*
Synthesis	1.67	1.11	2.20	1.39	0.080
Evaluation	0.97	0.79	1.74	1.07	0.001*

*=significant at P≤0.05

Table 4.5 shows that, the P-value for knowledge, comprehension, analysis and evaluation is 0.000, 0.001, 0.004 and 0.001 respectively. This means that, there is as statistically significant difference in students‟ academic performance between pre-intervention and post-intervention tests. The means for these four cognitive domains clearly shows that students‟ performed

better in knowledge, comprehension, analysis and evaluation after the intervention, hence, the null hypothesis two which states that; "There is no statistically significant difference between students" academic performance in different levels of cognitive domain on pre-intervention test and post-intervention test" is rejected in favour of post-intervention test in the case of knowledge, comprehension, analysis, and evaluation.

Conversely, no statistically significant difference was found between the academic performance of pre-intervention and post-intervention tests in the case of application and synthesis, hence, the researcher failed to reject the null hypothesis since the P-values were found to be 0.164 and 0.080 respectively, hence, the null hypothesis for application and synthesis was retained.

In answering research question two, it can be concluded that, the effect CAI has on students is the improving of students" academic performance in knowledge, comprehension, application analysis, synthesis and evaluation and this is consistent with previous research finding conducted by Suleman, Hussain, Naseer and Iqbal (2017) who in their study discovered that students showed better performance in the said levels of cognitive domain when taught using CAI.

Even though there was no significant difference in the case of application and synthesis but their means showed that there was an improvement in students" academic performance. This finding is also in line with the study conducted by Abdulahi, Yusuf and Mohammed (2019) who revealed in their study that CAI is effective in improving students" academic performance in different levels of cognitive domain in Chemistry. This finding could be to the ability CAI has in helping students to be learner-cantred and activity oriented (Gana, 2013). Furthermore, students were found to be more interested, excited, satisfied and participated in the teaching and learning process and this made them more efficacious and propelled them to learn. This result showed that, CAI really helped the students to focus on the physical

meaning of the abstract concepts and subsequently got a detailed understanding of the theory. (Azar & Sangulec, 2011).

Research question 3: What is the impact of Computer Assisted Instruction (CAI) on the retention of students‟ academic performance in Integrated Science at JSHS?

To answer this question, students‟ test scores from post-intervention and retention tests were analysed using descriptive and inferential statistics (sample t-test). Results from the analysis is presented in Table 4.6.

Table 4.6: Inferential Analysis of students' academic performance on post-intervention test retention test.

Test	**N**	**Mean**	**SD**	**DF**	**t-value** statistical	**p-value** critical	
Post-intervention	35	16	7.2	44	2.6	2.0	0.01
Retention	36	19.36	2.9				

Key: N=number of scores, SD=standard deviation, DF=degrees of freedom.

Based on the inferential analysis, the outcome of Table 4.6 shows that, there is a statistically significant ($p \leq 0.05$) difference between students‟ academic performance on pre-intervention test and retention test in favour of the retention test since the P-value (0.01) is less than the alpha value of 0.05. Furthermore, the mean values clearly show that students showed better performance on retention test (mean=19.36, SD=2.9) than post-intervention test (mean=16, SD=7.2). So, the null hypothesis was rejected and an alternate hypothesis was formulated that there is "statistically significant difference between students‟ academic performance on post intervention test and retention test".

This finding agrees with that of Ezenwafor et al., (2020) who reported that students taught with CAI had higher mean retention than those taught using conventional lecture method. This finding is also in support of that of the study conducted by Abdulahi, Yusuf and Mohammed (2019) who also discovered that CAI has the ability to help students retain knowledge. Again, this finding of the current study also supports the findings of Okoye (2018) and Suleman, Hussain, Naseer and Iqbal (2017) who found that CAI was significantly more viable in learners‟ retention performance. The findings from the study conducted by Achor and Ukwuru (2014), Alhassan (2012) and Anyamene, Nwokolo, Anyachebelu, and Anemelu, (2012) are also in support of this result. It could also be seen from Figure 4.4 that students‟ performance gradually increased from pre-intervention test to retention test after the treatment and this shows that CAI is a successful and a beneficial approach for building up students‟ retention capacity and boosting students‟ academic performance (Afolabi, 2010).

The summary of finding and conclusion emanating from the study together with recommendations for further studies are also presented in Chapter five.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

The study was conducted to improve students‟ academic performance in Integrated Science using computer assisted instruction in Juaboso Senior High School. The data collected were analysed using mean and t-test statistical tools. This chapter is presented under the following sub-headings:

1. Summary of the Study
2. Summary of Major Findings
3. Conclusion
4. Recommendations
5. Suggestions for Further Study

5.1 Summary of the Study

The purpose of this study was to use computer-assisted instruction to improve students‟ academic performance in Integrated Science in Juaboso Senior High School. Thirty-seven students were used for the study. The concepts selected for the study were nervous system, electronics, variation and inheritance. Three null hypotheses were stated and tested at $p \leq 0.05$ levels of significant. Integrated Science Performance Test (ISPET) made up of 30 multiple choice questions was used to measure the academic performance of the students before and after treatment. The data collected from the performance test were analysed using descriptive statistics (mean, standard deviation) and Inferential statistics (dependent sample t-test through SPSS). The results and discussion are reported in Chapter Four.

5.2 Summary of Major Findings

The finding revealed the following:

1. There was aststistically significant difference between students‟ performance score on pre-intervention test and post-intervention test in favour of post intervention test. This means the students‟ academic performance really improved after the treatment confirming that CAI has a remarkable positive effect on students‟ academic performance.
2. There was a statistically significant difference between students‟ academic performance score on pre-intervention test and post-intervention test in favour of post intervention test in knowledge, comprehension, analysis and evaluation. Conversely, no significant difference was found in the case of application and synthesis on students‟ pre-intervention and post-intervention tests. Nevertheless, the means of these two cognitive domains on post-intervention test were higher than that of the pre-intervention test indicating an improvement in students‟ academic performance.
3. There was statistically significant difference between students‟ academic performance on post intervention test and retention test in favour of retention test and this points out that CAI has the ability to help students retain some amount of knowledge.

5.3 Conclusion

The findings of this study have shown that academic performance of students in Juaboso Senior High School has improved through the use of CAI in teaching nervous system, electronics and variation and inheritance. It has been seen from the results that; CAI has that ability to improve the academic performance of learners in the various levels of cognitive domain in Integrated Science. It was found more

compelling, effective, rewarding and valuable in teaching of Integrated Science at Juaboso Senior High School. Moreover, it can be concluded that CAI has a positive effect on students‟ retention ability in integrated science.

5.4 Recommendations

From the findings of this study, the following recommendations are made:

1. Integrated Science teachers should be encouraged to use CAI in teaching and learning of Integrated Science since it improves students‟ academic performance.
2. Integrated Science teachers in Juaboso Senior High School should be given special training in the effective utilisation of CAI packages in teaching and learning od Integrated Science.
3. Teaching and learning materials such as computers should be provided to Juaboso SHS on by government agencies such as Ministry of Education and Ghana Education Service for effective utilisation of Computer Assisted Instruction (CAI) in teaching and learning of integrated science.

5.5 Suggestions for further study

The results obtained in this research are for Integrated Science. This method can therefore be tried out in other subjects such as Chemistry, Biology, Physics and Mathematics at the SHS level. Moreover, this type of study could be extended to other Senior High Schools in Ghana for widening and generalising the scope of the findings of such studies.

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APPENDICES

Appendix A

Table of specification for construction of ISPET

	Cognitive levels						
content	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	**Total**
electronics	-	1	2	2	2	1	**8**
Nervous system	4	1	1	-	-	1	**7**
Variation and inheritance	1	3	2	3	3	3	**15**
total	**5**	**5**	**5**	**5**	**5**	**5**	30

APPENDIX B

DESCRIPTIVE STATISTICS 0F PILOT TEST

Students score from pilot test

8	9	11	21
9	11	21	10
11	9	8	7
9	15	9	9
6	19	21	18
9	16	13	20
12	28	16	10
10	29	22	12
9	10	17	14
10	11	9	15
12			

DESCRIPTIVE STATISTICS 0F PILOT TEST

Mean	13.34146341
Standard Error	0.875555403
Median	11
Mode	9
Standard Deviation	5.606290021
Sample Variance	31.4304878
Kurtosis	0.796216124
Skewness	1.131548403
Range	23
Minimum	6
Maximum	29
Sum	547
Count	41

APPENDIX C

CALCULATION OF RELIABILITY OF ISPET

$$rtt = \frac{n}{n-1}\left[1 - \frac{x(n-x)}{ns^2}\right]$$

n = number of test items (30)

x = mean

s^2 = variance

x = 13.34

s^2 = 31.43

rtt = reliability co-efficient

rtt = $\frac{30}{30-1}\left[1 - \frac{13.34(32-13,34)}{30(31.43)}\right]$

rtt = 1.03 $[1-\frac{222.2}{942.9}]$

rtt = 1.03 [1.0.24]

rtt = 1.03[0.76]

rtt = 0.78

APPENDIX D

INTEGRATED SCIENCE PERFORMANCE TEST

(PRE-INTERVENTION TEST).

INSTRUCTION: Choose from the options (**a-d**) the one that best answers each question below

TIME **:** 30 MINUTES.

CLASS **:** FORM THREE (3 ARTS 3A).

1. In a certain breed of dog, brown fur is dominant over white fur. **Produce** the possible genotype of a dog with brown fur which produces a white puppy.

a. BB B. BW C. Bw d. Bb

2. All of the following are continuous variations in human beings which can be measured. **Depict** the odd one.

a. Ability of pupils to roll their tongue
b. Height of pupils in a class
c. Number of red blood cells per cubic millimeters of blood
d. Weight of pupils in a class

3. **Depict** the phenotypic ratio of selfing the offspring of a cross between homozygous tall and homozygous short orange plant.

a. 1:1 b. 3:1 c.1:2:1 d. 1:1:2

4. A homozygous black rabbit is mated to a white rabbit. If the black colour is dominant to white colour, **determine** the colour of the young rabbit.

a. All will be white
b. All will be black
c. Some will be black and some will be white
d. They will be partly white and partly black.

5. In a certain breed of cattle, black fur was dominant over white fur. **Determine** the possible genotype of a cattle with black fur which produces a white calf.

a. BB b. BW c. Bw d. Bb

6. A man heterozygous for the albino gene marries an albino woman. **Determine** the percentage of albino offspring they are likely to produce.

a. 10% b. 25% c. 50% d. 75%

7. **Calculate** the percentage of children that would be universal donors if there is a marriage between a heterozygous man and heterozygous woman with blood groups A and B respectively.

a. 25% b. 50% c. 75% d. 100%

8. A newly developed variety of maize has a chromosome number of 16 in the zygote. **Predict** the chromosome number of its endosperm.

a. 8 b. 16 c. 32 d. 36

9. **Identify** the correct statements about continuous variation.

i. the characteristics are not easily distinguishable

ii. it is caused by combine effects of few genes.

iii. It exhibits many intermediate characteristics

iv. The environment has little or no effect on the way the genes express themselves,

a. I and II only b. II and III only c. I, II and III only d. II, III and IV only

10. **Select** from the following characteristics that can be influence by the environment.

i. ABO blood systems of humans

ii. Rhesus factor

iii. Scar

a. I only b. II only c. III only d. II and III only.

11. **Examine** from the following statements the one which is correct about a dominant gene. It

a. Consists of a pair of alleles

b. Expresses itself in the homozygous state only

c. Expresses itself in the heterozygous state only

d. Expresses itself in both homozygous and heterozygous states

12. An **example** of continuous variation in human population is

a. Colour blindness b. Blood group c. hair colour d. intelligence

13. A red flowered plant with genotype RR is crossed with a white flowered plant with genotype rr. **Give** the percentage the genotype of their offspring.

a. 50%RR b. 50% rr c. 100%Rr d. 100%RR

14. Which of the following blood groups is known as universal receipients?

a. A b. B c. AB d. O

15. Which of the following groups of characteristics in humans is **classified** as phenotype?

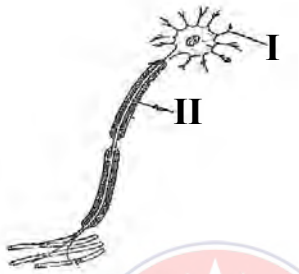
a. Blood group and height

b. Eye colour and height

c. Eye colour and blood group

d. Height and rhesus factor

Use the diagram below to answer question **16 to 18**.



16. **Identify** the cell shown above

a. epidermal cell b. nerve cell c. root tip cell d. Sperm cell

17. **Determine** the location of the cell above in the human body. All parts of the

a. brain

b. spinal cord

c. body

d. testis

18. **Name** the part labeled **I**

a. axon b. dendrite c. nucleus d. soma

19. **Assign** the reason why the withdrawal of the hand when it touches a hot object is a reflex action. It is

a. a delayed response.

b. An automatic response

c. Initiated from the cerebrum

d. Under the control of the cerebrum

20. **Give** the part of the brain that is responsible for balancing and co-ordination.

a. Cerebellum b. cerebrum c. hypothalamus d. medulla oblongata.

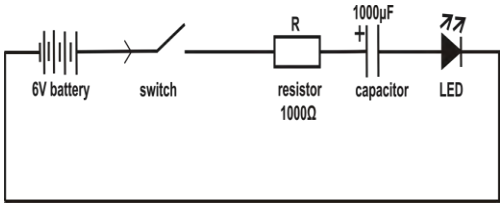
21. **Identify** the following parts of the brain that is responsible for memory

a. Cerebrum b. Cerebellum c. hindbrain d. medulla oblongata

22. **Select** from the following hormones, the one that affects the rate of heartbeat.

a. Adrenaline b. progesterone c. insulin d. thyrosine.

Use the diagram below to answer question **23 to 26.**



23. **Give** the function of the resistor in the circuit above. it

a. Opposes the capacitance in the circuit

b. Opposes the resistance in the circuit.

c. Opposes the the current in the circuit

d. Opposes the volatage in the circuit

24. **Calculate** the total voltage in the circuit if 1.5v battery is added.

a. 6v b. 7.5v c. 9v d. 10.5v

25. What is the **use** of the capacitor in the circuit? it

a. stores electrical charges

b. stores electrical energy

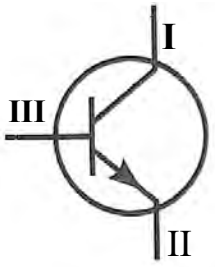
c. opposes the flow of electricity

d. Opposes the capacitance

26. **Analyse** the behavior of the LED if the key is closed. The LED

a. Lits b. will not lits c. lits and dims slowly d. lits and bright slowly.

Use the diagram below to answer question **27 and 28**



27. **Identify** the instrument above

a. Capacitor b. resistor c. n-p-n transistor d. p-n-p transistor

28. **Write** the name of the part labeled **II** ……

a. Base b. collector c. emitter d. transistor

29. **Predict** from the following statements the one that is/are correct about a forward biased p-n junction diode.

i. P-type semiconductor is connected to the positive terminal of a cell

ii. P-type semiconductor is connected to the negative terminal of a cell

iii. N-type semiconductor is connected to the negative terminal of a cell

a. I only b. II only c. I and II only d. I and III only

30. **Depict** the behavior of LED if connected in series with a capacitor and a d.c source when the key is closed.

a. Does not lights

b. Blows off

c. Lights and goes off

d. Lights and stays on.

APPENDIX E

MARKING SCHEME FOR PRE-INTERVENTION TEST.

1.	D	16.	B
2.	A	17.	C
3.	C	18.	B
4.	B	19.	B
5.	D	20.	A
6.	C	21.	A
7.	A	22.	A
8.	A	23.	C
9.	B	24.	B
10.	C	25.	A
11.	D	26.	C
12.	D	27.	C
13.	C	28.	C
14.	C	29.	D
15.	B	30.	C

APPENDIX F

INTEGRATED SCIENCE PERFORMANCE TEST

(POST-INTERVENTION TEST).

INSTRUCTION: Choose from the options (**a-d**) by circling the one that best answers each question below

TIME **:** 30 MINUTES.

CLASS **:** FORM THREE (3).

31. **Give** the part of the brain that is responsible for balancing and co-ordination.

b. Cerebellum b. cerebrum c. hypothalamus d. medulla oblongata.

32. All of the following are continuous variations in human beings which can be measured. **Depict** the odd one.

e. Ability of pupils to roll their tongue

f. Height of pupils in a class

g. Number of red blood cells per cubic millimeters of blood

h. Weight of pupils in a class

33. **Depict** the phenotypic ratio of selfing the offspring of a cross between homozygous tall and homozygous short orange plant.

b. 1:1 b. 3:1 c.1:2:1 d. 1:1:2

34. In a certain breed of cattle, black fur was dominant over white fur. **Determine** the possible genotype of a cattle with black fur which produces a white calf.

b. BB b. BW c. Bw d. Bb

35. **Select** from the following hormones, the one that affects the rate of heartbeat.

b. Adrenaline b. progesterone c. insulin d. thyrosine.

36. **Assign** the reason why the withdrawal of the hand when it touches a hot object is a reflex action. It is

e. a delayed response.

f. An automatic response

g. Initiated from the cerebrum

h. Under the control of the cerebrum

37. A homozygous black rabbit is mated to a white rabbit. If the black colour is dominant to white colour, **determine** the colour of the young rabbit.

e. All will be white

f. All will be black

g. Some will be black and some will be white

h. They will be partly white and partly black.

38. **Identify** the correct statements about continuous variation.

v. the characteristics are not easily distinguishable

vi. it is caused by combine effects of few genes.

vii. It exhibits many intermediate characteristics

viii. The environment has little or no effect on the way the genes express themselves,

b. I and II only b. II and III only c. I, II and III only d. II, III and IV only

39. **Select** from the following characteristics that can be influence by the environment.

iv. ABO blood systems of humans

v. Rhesus factor

vi. Scar

b. I only b. II only c. III only d. II and III only.

40. **Examine** from the following statements the one which is correct about a dominant gene. It

e. Consists of a pair of alleles

f. Expresses itself in the homozygous state only

g. Expresses itself in the heterozygous state only

h. Expresses itself in both homozygous and heterozygous states

41. An **example** of continuous variation in human population is

b. Colour blindness b. height c. hair colour d. ABO blood group

42. A newly developed variety of maize has a chromosome number of 16 in the zygote. **Predict** the chromosome number of its endosperm.

b. 8 b. 16 c. 32 d. 36

43. **Predict** from the following statements the one that is/are correct about a forward biased p-n junction diode.

iv. P-type semiconductor is connected to the positive terminal of a cell

v. P-type semiconductor is connected to the negative terminal of a cell

vi. N-type semiconductor is connected to the negative terminal of a cell

b. I only b. II only c. I and II only d. I and III only

44. Which of the following blood groups is known as universal recipient?

b. A b. B c. AB d. O

45. Which of the following groups of characteristics in humans is **classified** as phenotype?

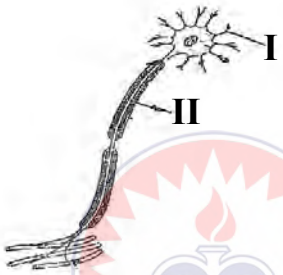
e. Blood group and height

f. Eye colour and height

g. Eye colour and blood group

h. Height and rhesus factor

Use the diagram below to answer question **16 to 18**.



46. **Identify** the cell shown above

b. epidermal cell b. nerve cell c. root tip cell d. Sperm cell

47. **Determine** the location of the cell above in the human body. All parts of the

e. brain

f. spinal cord

g. body

h. testis

48. **Name** the part labeled **I**

b. axon b. dendrite c. nucleus d. soma

49. In a certain breed of dog, brown fur is dominant over white fur. **Produce** the possible genotype of a dog with brown fur which produces a white puppy.

b. BB B. BW C. Bw d. Bb

50. **Depict** the behavior of LED if connected in series with a capacitor and a d.c source when the key is closed.

e. Does not lights

f. Blows off

g. Lights and goes off

h. Lights and stays on.

51. A man heterozygous for the albino gene marries an albino woman. **Determine** the percentage of albino offspring they are likely to produce.

b. 10% b. 25% c. 50% d. 75%

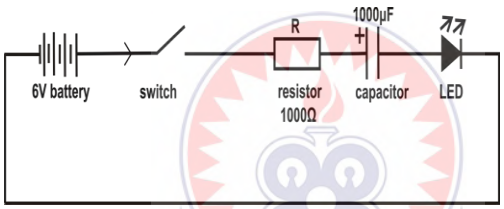
52. **Identify** the following parts of the brain that is responsible for memory

b. Cerebrum b. Cerebellum c. hindbrain d. medulla oblongata

53. **Calculate** the percentage of children that would be universal donors if there is a marriage between a heterozygous man and heterozygous woman with blood groups A and B respectively.

b. 25% b. 50% c. 75% d. 100%

Use the diagram below to answer question **24 to 27.**



54. What is the **use** of the capacitor in the circuit? it

e. stores electrical charges

f. stores electrical energy

g. opposes the flow of electricity

h. Opposes the capacitance

55. **Give** the function of the resistor in the circuit above. it

e. Opposes the capacitance in the circuit

f. Opposes the resistance in the circuit.

g. Opposes the the current in the circuit

h. Opposes the volatage in the circuit

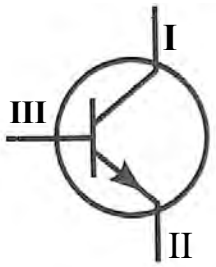
56. **Calculate** the total voltage in the circuit if 1.5v battery is added.

b. 6v b. 7.5v c. 9v d. 10.5v

57. **Analyse** the behavior of the LED if the key is closed. The LED

b. Lits b. will not lits c. lits and dims slowly d. lits and bright slowly.

Use the diagram below to answer question **28 and 29**



58. **Identify** the instrument above

b. Capacitor b. resistor c. n-p-n transistor d. p-n-p transistor

59. **Write** the name of the part labeled **II** ……

b. Base b. collector c. emitter d. transistor

60. A red flowered plant with genotype RR is crossed with a white flowered plant with genotype rr. **Give** the percentage the genotype of their offspring.

b. 50%RR b. 50% rr c. 100%Rr d. 100%RR

APPENDIX G

MARKING SCHEME FOR POST-INTERVENTIO TEST.

1.	**A**	**16.**	**B**
2.	**A**	**17.**	**C**
3.	**C**	**18.**	**B**
4.	**D**	**19.**	**D**
5.	**A**	**20.**	**C**
6.	**B**	**21.**	**C**
7.	**B**	**22.**	**A**
8.	**B**	**23.**	**A**
9.	**C**	**24.**	**B**
10.	**D**	**25.**	**C**
11.	**B**	**26.**	**B**
12.	**A**	**27.**	**C**
13.	**D**	**28.**	**C**
14.	**C**	**29.**	**C**
15.	**B**	**30.**	**C**

APPENDIX H

INTEGRATED SCIENCE PERFORMANCE TEST

(RETENTION TEST).

INSTRUCTION: Choose from the options (**a-d**) the one that best answers each question below

TIME **:** 30 MINUTES.

CLASS **:** FORM THREE (3).

61. **Give** the part of the brain that is responsible for balancing and co-ordination.

c. Hind brain b. cerebrum c. hypothalamus d. Cerebellum.

62. All of the following are continuous variations in human beings which can be measured. **Depict** the odd one.

i. Ability of pupils to roll their tongue

j. Height of pupils in a class

k. Number of red blood cells per cubic millimeters of blood

l. Weight of pupils in a class

63. **Depict** the phenotypic ratio of selfing the offspring of a cross between homozygous white and homozygous black cat.

c. 1:1 b. 3:1 c.1:2:1 d. 1:1:2

64. In a certain breed of cattle, black fur was dominant over white fur. **Determine** the possible genotype of a cattle with black fur which produces a white calf.

c. BB b. BW c. Bw d. Bb

65. **Select** from the following hormones, the one that affects the rate of heartbeat.

c. Insulin b. gulucagon c. adrenaline d. thyrosine.

66. **Assign** the reason why the withdrawal of the hand when it touches a hot object is a reflex action. It is

i. a delayed response.

j. An automatic response

k. Initiated from the cerebrum

l. Under the control of the cerebrum

67. A homozygous black rabbit is mated to a white rabbit. If the black colour is dominant to white colour, **determine** the colour of the young rabbit.

i. All will be white

j. All will be black

k. Some will be black and some will be white

l. They will be partly white and partly black.

68. **Identify** the correct statements about continuous variation.

ix. the characteristics are not easily distinguishable

x. it is caused by combine effects of few genes.

xi. It exhibits many intermediate characteristics

xii. The environment has little or no effect on the way the genes express themselves,

c. I and II only b. II and III only c. I, II and III only d. II, III and IV only

69. **Select** from the following characteristics that can be influence by the environment.

vii. Blood group

viii. Weight

ix. Rhesus factor

c. I only b. II only c. III only d. II and III only.

70. **Examine** from the following statements the one which is correct about a dominant gene. It

i. Consists of a pair of alleles

j. Expresses itself in the homozygous state only

k. Expresses itself in the heterozygous state only

l. Expresses itself in both homozygous and heterozygous states

71. An **example** of continuous variation in human population is

c. Colour blindness b. blood group c. hair colour d. intelligence

72. A newly developed variety of maize has a chromosome number of 16 in the zygote. **Predict** the chromosome number of its endosperm.

c. 8 b. 16 c. 32 d. 36

73. **Predict** from the following statements the one that is/are correct about a forward biased p-n junction diode.

vii. P-type semiconductor is connected to the positive terminal of a cell

viii. P-type semiconductor is connected to the negative terminal of a cell

ix. N-type semiconductor is connected to the negative terminal of a cell

c. I only b. II only c. I and II only d. I and III only

74. Which of the following blood groups is known as universal recipient?

c. A b. B c. AB d. O

75. Which of the following groups of characteristics in humans is **classified** as phenotype?

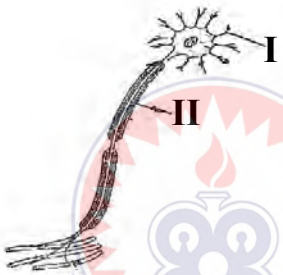
i. Blood group and height

j. Eye colour and weight

k. Eye colour and blood group

l. Height and rhesus factor

Use the diagram below to answer question **16 to 18**.



76. **Identify** the cell shown above

c. epidermal cell b. nerve cell c. root tip cell d. Sperm cell

77. **Determine** the location of the cell above in the human body. All parts of the

i. brain

j. spinal cord

k. body

l. testis

78. **Name** the part labeled **I**

c. axon b. dendrite c. nucleus d. soma

79. In a certain breed of dog, brown fur is dominant over white fur. **Produce** the possible genotype of a dog with brown fur which produces a white puppy.

c. BB B. BW C. Bw d. Bb

80. **Depict** the behavior of LED if connected in series with a capacitor and a d.c source when the key is closed.

i. Does not lights

j. Blows off

k. Lights and goes off

l. Lights and stays on.

81. A man heterozygous for the albino gene marries an albino woman. **Determine** the percentage of albino offspring they are likely to produce.

c. 10% b. 25% c. 50% d. 75%

82. **Identify** the following parts of the brain that is responsible for memory

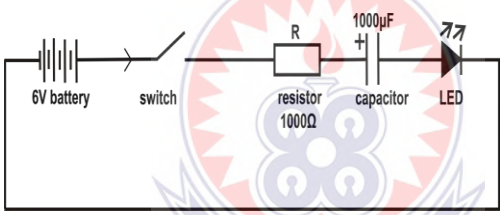
c. Fore brain b. middle brain c. hind

d. brain d. hypothalamus

83. **Calculate** the percentage of children that would be **universal recipient** if there is a marriage between a heterozygous man and heterozygous woman with blood groups A and B respectively.

c. 25% b. 50% c. 75% d. 100%

Use the diagram below to answer question **24 to 27.**



84. What is the **use** of the capacitor in the circuit? it

i. stores electrical charges

j. stores electrical energy

k. opposes the flow of electricity

l. Opposes the capacitance

85. **Give** the function of the resistor in the circuit above. it

i. Opposes the capacitance in the circuit

j. Opposes the resistance in the circuit.

k. Opposes the the current in the circuit

l. Opposes the volatage in the circuit

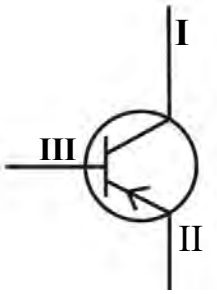
86. **Calculate** the total voltage in the circuit if 2.5v battery is added.

c. 6.5v b. 7.5v c. 8.5v d. 9.5v

87. **Analyse** the behavior of the LED if the key is closed. The LED

c. Lits b. will not lits c. lits and dims slowly d. lits and bright slowly.

Use the diagram below to answer question **28 and 29**



88. **Identify** the instrument above

c. Capacitor b. resistor c. n-p-n transistor d. p-n-p transistor

89. **Write** the name of the part labeled **II** ……

c. Base b. collector c. emitter d. transistor

90. A red flowered plant with genotype RR is crossed with a white flowered plant with genotype rr. **Give** the percentage of the genotype of their offspring.

c. 50%RR b. 50% rr c. 100%Rr d. 100%RR

APPENDIX I

MARKING SCHEME FOR RETENTION TEST.

1.	**D**	**16.**	**B**
2.	**A**	**17.**	**C**
3.	**C**	**18.**	**B**
4.	**D**	**19.**	**D**
5.	**C**	**20.**	**C**
6.	**B**	**21.**	**C**
7.	**B**	**22.**	**A**
8.	**B**	**23.**	**A**
9.	**B**	**24.**	**A**
10.	**D**	**25.**	**C**
11.	**D**	**26.**	**C**
12.	**A**	**27.**	**C**
13.	**D**	**28.**	**D**
14.	**C**	**29.**	**C**
15.	**B**	**30.**	**C**

APPENDIX J

STUDENTS' MARKED SCRIPTS FROM PRE-INTERVENTION, POST-INTERVENTION AND RETENTION TEST

17/30

INTEGRATED SCIENCE ACHIEVEMENT TEST
(POST-INTERVENTION TEST).

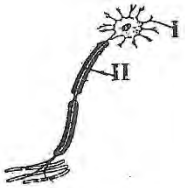
INSTRUCTION: Choose from the options (**a-d**) by circling the one that best answers each question below

TIME : 30 MINUTES.
CLASS : FORM THREE (3).

1. **Give** the part of the brain that is responsible for balancing and co-ordination.
a. Cerebellum b. cerebrum c. hypothalamus d. medulla oblongata.
2. All of the following are continuous variations in human beings which can be measured. **Depict** the odd one.
a. Ability of pupils to roll their tongue
b. Height of pupils in a class
c. Number of red blood cells per cubic millimeters of blood
d. Weight of pupils in a class
3. **Depict** the phenotypic ratio of selfing the offspring of a cross between homozygous tall and homozygous short orange plant.
a. 1:1 b. 3:1 c. 1:2:1 d. 1:1:2
4. In a certain breed of cattle, black fur was dominant over white fur. **Determine** the possible genotype of a cattle with black fur which produces a white calf.
a. BB b. BW c. Bw d. Bb
5. **Select** from the following hormones, the one that affects the rate of heartbeat.
a. Adrenaline b. progesterone c. insulin d. thyrosine.
6. **Assign** the reason why the withdrawal of the hand when it touches a hot object is a reflex action. It is
a. a delayed response.
b. An automatic response
c. Initiated from the cerebrum
d. Under the control of the cerebrum
7. A homozygous black rabbit is mated to a white rabbit. If the black colour is dominant to white colour, **determine** the colour of the young rabbit.
a. All will be white
b. All will be black
c. Some will be black and some will be white
d. They will be partly white and partly black.

8. **Identify** the correct statements about continuous variation.
   i. the characteristics are not easily distinguishable
   ii. it is caused by combine effects of few genes.
   iii. It exhibits many intermediate characteristics
   iv. The environment has little or no effect on the way the genes express themselves,
   a. I and II only (b.) II and III only . c. I, II and III only d. II, III and IV only
9. **Select** from the following characteristics that can be influence by the environment.
   i. Blood group
   ii. Weight
   iii. Rhesus factor
   a. I only b. II only (c.) III only d. II and III only.
10. **Examine** from the following statements the one which is correct about a dominant gene. It
   a. Consists of a pair of alleles
   b. Expresses itself in the homozygous state only
   c. Expresses itself in the heterozygous state only
   d. Expresses itself in both homozygous and heterozygous states
11. An **example** of continuous variation in human population is
   a. Colour blindness b. blood group c. hair colour (d.) intelligence
12. A newly developed variety of maize has a chromosome number of 16 in the zygote. **Predict** the chromosome number of its endosperm.
   a. 8 b. 16 (c.) 32 d. 36
13. **Predict** from the following statements the one that is/are correct about a forward biased p-n junction diode.
   i. P-type semiconductor is connected to the positive terminal of a cell
   ii. P-type semiconductor is connected to the negative terminal of a cell
   iii. N-type semiconductor is connected to the negative terminal of a cell
   a. I only (b.) II only c. I and II only d. I and III only
14. Which of the following blood groups is known as universal recipient?
   a. A b. B (c.) AB d. O
15. Which of the following groups of characteristics in humans is **classified** as phenotype?
   a. Blood group and height
   b. Eye colour and weight
   (c.) Eye colour and blood group
   d. Height and rhesus factor

Use the diagram below to answer question 16 to 18.



16. **Identify** the cell shown above

a. epidermal cell (b) nerve cell c. root tip cell d. Sperm cell

17. **Determine** the location of the cell above in the human body. All parts of the

a. brain

b. spinal cord

(c) body

d. testis

18. **Name** the part labeled I

(a) axon b. dendrite c. nucleus d. soma

19. In a certain breed of dog, brown fur is dominant over white fur. **Produce** the possible genotype of a dog with brown fur which produces a white puppy.

a. BB B. BW C. Bw (d) Bb

20. **Depict** the behavior of LED if connected in series with a capacitor and a d.c source when the key is closed.

a. Does not lights

b. Blows off

(c) Lights and goes off

d. Lights and stays on.

21. A man heterozygous for the albino gene marries an albino woman. **Determine** the percentage of albino offspring they are likely to produce.

a. 10% (b) 25% c. 50% d. 75%

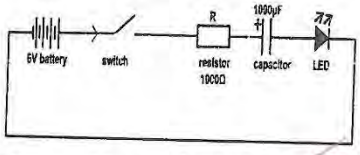
22. **Identify** the following parts of the brain that is responsible for memory

a. Fore brain b. middle brain c. hind brain d. hypothalamus

23. **Calculate** the percentage of children that would be **universal recipient** if there is a marriage between a heterozygous man and heterozygous woman with blood groups A and B respectively.

a. 25% b. 50% (c) 75% d. 100%

Use the diagram below to answer question 24 to 27.



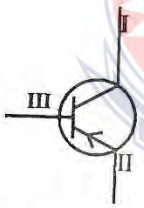
24. What is the **use** of the capacitor in the circuit? it
   a. stores electrical charges
   b. stores electrical energy
   c. opposes the flow of electricity
   d. Opposes the capacitance

25. **Give** the function of the resistor in the circuit above. it
   a. Opposes the capacitance in the circuit
   b. Opposes the resistance in the circuit.
   c. Opposes the current in the circuit
   d. Opposes the voltage in the circuit

26. **Calculate** the total voltage in the circuit if 2.5v battery is added.
   a. 6.5v b. 7.5v c. 8.5v d. 9.5v

27. **Analyse** the behavior of the LED if the key is closed. The LED
   a. Lits b. will not lits c. lits and dims slowly d. lits and bright slowly.

Use the diagram below to answer question **28 and 29**



28. **Identify** the instrument above
   a. Capacitor b. resistor c. n-p-n transistor d. p-n-p transistor

29. **Write** the name of the part labeled II .....
   a. Base b. collector c. emitter d. transistor

30. A red flowered plant with genotype RR is crossed with a white flowered plant with genotype rr. **Give** the percentage of the genotype of their offspring.
   a. 50% RR b. 50% rr c. 100% Rr d. 100% RR

INTEGRATED SCIENCE ACHIEVEMENT TEST

(PRE-INTERVENTION TEST).

INSTRUCTION: Choose from the options (**a-d**) the one that best answers each question below

TIME : 30 MINUTES.

CLASS : FORM THREE (3 ARTS 3A).

1. In a certain breed of dog, brown fur is dominant over white fur. **Produce** the possible genotype of a dog with brown fur which produces a white puppy.

a. BB B. BW C. Bw d. Bb

2. All of the following are continuous variations in human beings which can be measured. **Depict** the odd one.

a. Ability of pupils to roll their tongue

b. Height of pupils in a class

c. Number of red blood cells per cubic millimeters of blood

d. Weight of pupils in a class

3. **Depict** the phenotypic ratio of selfing the offspring of a cross between homozygous tall and homozygous short orange plant.

a. 1:1 b. 3:1 c.1:2:1 d. 1:1:2

4. A homozygous black rabbit is mated to a white rabbit. If the black colour is dominant to white colour, **determine** the colour of the young rabbit.

a. All will be white

b. All will be black

c. Some will be black and some will be white

d. They will be partly white and partly black.

5. In a certain breed of cattle, black fur was dominant over white fur. **Determine** the possible genotype of a cattle with black fur which produces a white calf.

a. BB b. BW c. Bw d. Bb

6. A man heterozygous for the albino gene marries an albino woman. **Determine** the percentage of albino offspring they are likely to produce.

a. 10% b. 25% c. 50% d. 75%

7. **Calculate** the percentage of children that would be universal donors if there is a marriage between a heterozygous man and heterozygous woman with blood groups A and B respectively.

a. 25% b. 50% c. 75% d. 100%

8. A newly developed variety of maize has a chromosome number of 16 in the zygote. **Predict** the chromosome number of its endosperm.

a. 8 b. 16 c. 32 d. 36

9. **Identify** the correct statements about continuous variation.

i. the characteristics are not easily distinguishable
ii. it is caused by combine effects of few genes.
iii. It exhibits many intermediate characteristics
iv. The environment has little or no effect on the way the genes express themselves,

a. I and II only b. II and III only c. I, II and III only d. II, III and IV only

10. **Select** from the following characteristics that can be influence by the environment.

i. ABO blood systems of humans
ii. Rhesus factor
iii. Scar

a. I only b. II only c. III only d. II and III only.

11. **Examine** from the following statements the one which is correct about a dominant gene. It

a. Consists of a pair of alleles
b. Expresses itself in the homozygous state only
c. Expresses itself in the heterozygous state only
d. Expresses itself in both homozygous and heterozygous states

12. An **example** of continuous variation in human population is

a. Colour blindness b. height c. hair colour d. intelligence

13. A red flowered plant with genotype RR is crossed with a white flowered plant with genotype rr. **Give** the percentage the genotype of their offspring.

a. 50%RR b. 50% rr c. 100%Rr d. 100%RR

14. Which of the following blood groups is known as universal receipients?

a. A b. B c. AB d. O

2 |

15. Which of the following groups of characteristics in humans is **classified** as phenotype?

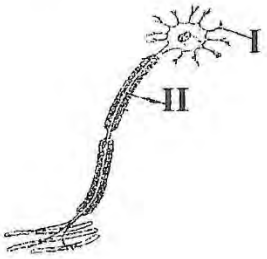
a. Blood group and height

b. Eye colour and height

c. Eye colour and blood group

d. Height

Use the diagram below to answer question **16 to 18.**



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a. epidermal cell b. nerve cell c. root tip cell d. Sperm cell

17. **Determine** the location of the cell above in the human body. All parts of the

a. brain

b. spinal cord

c. body

d. testis

18. **Name** the part labeled**I**

a. axon b. dendrite c. nucleus d. soma

19. **Assign** the reason why the withdrawal of the hand when it touches a hot object is a reflex action. It is

a. a delayed response.

b. An automatic response

c. Initiated from the cerebrum

d. Under the control of the cerebrum

20. **Give** the part of the brain that is responsible for balancing and co-ordination.

a. Cerebellum b. cerebrum c. hypothalamus d. medulla oblongata.

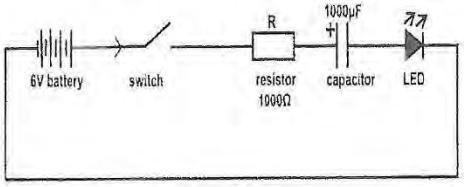
21. **Identify** the following parts of the brain that is responsible for memory

a. Cerebrum b. Cerebellum c. hindbrain d. medulla oblongata

22. **Select** from the following hormones, the one that affects the rate of heartbeat.

a. Adrenaline b. progesterone c. insulin d. thyrosine.

Use the diagram below to answer question **23 to 26.**



23. **Give** the function of the resistor in the circuit above. it

a. Opposes the capacitance in the circuit

b. Opposes the resistance in the circuit.

c. Opposesthe the current in the circuit

d. Opposes the volatage in the circuit

24. **Calculate** the total voltage in the circuit if 1.5v battery is added.

a. 6v b. 7.5v c. 9v d. 10.5v

25. What is the **use** of the capacitor in the circuit? it

a. stores electrical charges

b. stores electrical energy

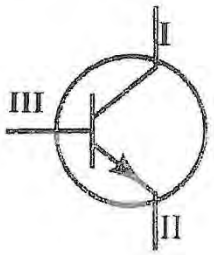
c. opposes the flow of electricity

d. Opposes the capacitance

26. **Analyse** the behavior of the LED if the key is closed. The LED

a. Lits b. will not lits c. lits and dims slowly d. lits and bright slowly.

Use the diagram below to answer question **27 and 28**



27. **Identify** the instrument above

a. Capacitor b. resistor c. n-p-n transistor d. p-n-p transistor

28. **Write** the name of the part labeled**II**.....

a. Base b. collector c. emitter d. transistor

29. **Predict** from the following statements the one that is/are correct about a forward biased p-n junction diode.

i. P-type semiconductor is connected to the positive terminal of a cell

ii. P-type semiconductor is connected to the negative terminal of a cell

iii. N-type semiconductor is connected to the negative terminal of a cell

a. I only b. II only c. I and II only d. I and III only

30. **Depict** the behavior of LED if connected in series with a capacitor and a d.c source when the key is closed.

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