EFFECTS OF COMPUTER-BASED INSTRUCTIONAL STRATEGIES ON THE PERFORMANCE OF PHYSICS STUDENTS IN SECONDARY SCHOOLS IN KADUNA STATE

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AUGUST, 2017

DECLARATION

I hereby declare that this research on"Effects of computer-based instructional strategies on the performance of physics students in secondary schools in Kaduna State", was carried out by me in the Department of Educational Foundation and Curriculum, Faculty of Education, Ahmadu Bello University, Zaria. All citations have been duly acknowledged and no part of this work was previously presented for another degree at this or any other university.

_____ _____

Jovial Ngbede AGBO Date

CERTIFICATION

This research work on: EFFECTS OF COMPUTER-BASED CONCEPT MAPPING STRATEGIES ON PERFORMANCE OF PHYSICS STUDENTS IN SECONDARY SCHOOLS IN KADUNA STATE by Agbo, Jovial Ngbede (P14EDFC8088), meets part of the regulation governing the award of the degree of Masters in Instruction Technology in Ahmadu Bello University, Zaria, and it's approved for its contribution of knowledge and literary presentation.

Dr. S. A. Zubairu Chairman, Supervisory Committee	Date
Dr. A. I. Gambari Member, Supervisory Committee	Date
Prof. B. Maina Head of Department	Date
Prof.S. Z. Abubakar Dean, School of Post-Graduate Studies Ahmadu Bello University, Zaria	Date

DEDICATION

This work is dedicated to my late father, Mr. Godwin AgboAmeh, for setting me on the best foundation and leaving visible footprints in all aspects of my life.

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I want to first and foremost, acknowledge God Almighty, the Alpha and Omega, for seeing me through the period of my studies in Ahmadu Bello University, Zaria, and for being my source of inspiration.I am highly indebted to my supervisors; Dr. S. A. Zubairu and Dr. A. I. Gambari, for their thoroughsupervision, advice, counsel and criticisms which made me a better person. To all the other lecturers in the Department of Educational Foundations and Curriculum; for moulding me into a more useful instrument for the society, I am very grateful.Special thanks to the one and only love of my life, Mrs. Felicia EneJovial, who stood by me throughout this programme; your encouragement and unflinching support will never be forgotten. To my beloved children (Shabach and Tehillah) in whom I am well pleased; thank you for enduring with me. I want to sincerely appreciate my wonderful mummy; Mrs. Agnes Ameh, my siblings; Johnson, Victoria, Esther, Peter and Emmanuel, and in-laws for their supports in prayers, morally and in diverse ways which has brought me thus far. Victory songs will never cease from your mouth. God will surely reward you for your show of love towards me.The Staff of Ministry of Education and Educational Resource Centre (ERC), Kaduna who gave me free access to vital information which aided this research work, the West African Examinations Council (WAEC) and National Examinations Council (NECO), I am highly appreciative of your efforts and permission to access your materials. Also, I sincerely appreciate all the staff and students of G. S. S. Yarbung, Blessed Comprehensive Schools, Victory Academy, Oxford International School and Al-Aleem Academy in Kaduna for their cooperation and support which made this work feasible. To Prof. E. E. Achor of Benue State University, Makurdi, Mr. Charles Onyeke of Federal University of Agriculture, Makurdi, Mr. JideOloyede, Mr. HarunaGarba and Mr. Charles Gabriel who validated my

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ABSTRACT

This study examined the effects of computer-based instructional strategies on the performance of physics students in secondary schools in Kaduna state.The study was guided by six research questions and six null hypotheses which were tested at 0.05 alpha levels. The comparative effects of the spider and hierarchical modes of computer-based concept mapping strategies was explored. The study also examined the influence on gender on students' performance in physics when taught using the two modes of computer based concept mapping strategies. All literatures reviewed in the study were duly acknowledged. The instrument used in the study were: researcher adapted Physics Performance Test (PPT), Computer-Based Concept Mapping Instruction Packages (CBCMIP) and Computer Based Instruction Package (CBIP), which were validated by experts. The instruments were pilot tested using students who are part of the population but not in the study sample and a reliability coefficient of 0.9 was obtained using Kuder-Richardson formula (K-R 20). The study employed pre-test-post-test control group quasi experimental research design. The sample population comprises of 110 SS2 Physics students drawn from three private secondary schools in Kaduna South Local Government Area of Kaduna State. Three intact classes were selected through simple random sampling technique from each of the selected schools and were later sub-divided into two experimental and one control groups respectively. From the data collected, mean and standard deviation were used to answer the three research questions whileANCOVAwas used to test the three null hypotheses. Findings of the study revealed that students taught with computer-based concept mapping strategies have almost the same level of performance with those taught using just computer based instruction. The findings also revealed that gender has no significant effect on the academic

performance of students when taught using computer-based concept mapping instructional strategies. Finally, it was recommended that physics teachers should be exposed to seminars, workshops, and trainings; they should be encourage to use ICT tools in teaching while students should be given access to computer usage with necessary facilities and other researchers can replicate the study in a wider geographical scope or other subjects and/or units in physics.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The growth and development of most nations are dependent on science, technology and mathematics education. Science is an organized body of knowledge, which enhances the ability to acquire skills. It is a search for meaning or exploration of events in nature (Ifeakor, 2006). Science and technology related subjects that would enable students have a substantial understanding of science and be able to apply scientific knowledge in solving problems in their ever changing society are mathematics, chemistry, biology, healthscience, introductory technology and physics.

Physics is one of the compulsory subjects for one to study science and technology related courses in tertiary institutions. It is a science that uses quantitative measurement and experimental observations in order to understand natural events. It can explain natural events mathematically and can relate these events to daily life events (Eren&Gurdal, 2010; Tekbiyik&Akdeniz, 2010). Of all the sciences, Physics is the one that students experience the most difficulties with because most of the physical notions are abstract. Also, when compared to other lessons, although there are many relationships between main subjects and number of the subjects to be learned, simply knowing definitions is not enough to learn the subject (Karaca, 2013). Theories and numerical expressions also make it difficult to understand Physics and to make a connection between the subjects (Arvind& Heard, 2010; Ergul&Cigrik, 2013; Jian-Hua & Hong, 2012; Bakac, Tasoglu&Akbay, 2011).

The technological development of any nation lies in the study of science especially physics. The role of physics in national development is acknowledged in the whole world. The significance of physics in all fields of science and technology has made physics

imperative to be included in the curriculum of senior secondary school to be offered by science oriented students. With the importance of physics and provisions made by the Federal Government of Nigeria for effective teaching and learning of physics, the objectives of its teaching and learning as stated in the Nigerian secondary school Physics curriculum is yet to be achieved.

The Federal Government of Nigeria made special provisions and incentives through the provision of laboratory facilities, instructional materials, training and retraining of teachers, provision of research grants and adoption of Information and Communication Technology (ICT) to improve the teaching and learning of science (physics inclusive) in the secondary schools (FRN, 2015). Part of the requirements for any school to be enrolled for WAEC and NECO is that the school must have science laboratories. Also, schools are expected to be provided with computer systems. Furthermore, the Federal Government stated that "In recognition of the prominent role of information and communication technology in advancing knowledge and skills necessary for effective functioning in the modern world, there is an urgent need to integrate information and communication technology into education in Nigeria (FRN, 2015). Despite all the efforts made by the Federal government, physics students perform very poorly (WAEC, 2016).

All around the world, teachers are becoming more aware of new teaching strategies and tools that can be used in the classroom with initiatives in teaching-learning that integrates the inquiry based learning with informationcommunication technology, audio-visual interactivity packages, visual models and concept-mapping instructional strategies in an effort to aid and effect student-centred learning (Dean, 2008). Several research in education show the efficacy of these new teaching strategies (Cañas, Novak & Gonzalez, 2004; Hay, Kinchin&Lygo-Baker, 2008; Kathy et al, 2006). Despite these advances, physics teaching and learning in Nigeria still retain the old and conservative approach to teaching and learning.

A concept map is a description of how propositions are organized(Novak, 1998). Concept maps reflect how ideas, opinions, and propositions are organized in the knowledge structure of students who construct the concept maps, and give observations on students' states. From the observations, teacher can assess the knowledge structure of students.They are forms of graphical organizers which allow learners to perceive the relationships between concepts through diagramming of keywords representing those concepts. These concepts are usually enclosed in circles or boxes of some type and relationships between concepts indicated by connecting lines linking two or more concepts. The process of using these graphical tools for organizing and presenting knowledge is referred to as concept mapping (Novak, 1998).

Computer-based instructional strategy refers to instruction or remediation presented on a computer. These modes of instructions are interactive and can illustrate a concept through attractive animation, sound and demonstration. It allows students to progress at their own pace and work individually. Computers provide immediate feedback, letting students know whether their answer is correct or not. If the answer is not correct, it shows how the students can get the correct answer. Many researchers have used computer-based instruction indifferent subject areas to improve effective teaching and learning. For instance Yusuf andAfolabi (2010), investigated the effects of computer assisted instruction on secondary school students' performance in biology. The findings of the study showed that the performance of students exposed to Computer Assisted Instruction either individually or cooperatively were better than their counterparts exposed to conventional classroom instruction. Also, Tapscott (2008) investigated the effect of computer-based instruction on academic achievement in sciences; the result was also positive in favour of the students engaged in the computer assisted instruction.

Computer-based concept mapping instructional strategy incorporates the use of computer instruction and other ICT tools with concept mapping. With computer-based concept mapping, concept representations and their respective links are not static; both can be expanded as knowledge or elaboration of an idea increases. Errors in describing ideas can be easily corrected and adapted. Most computer-based concept mapping tools allow the user to point and drag a concept or group of concepts to another place on the map and automatically update all the appropriate links (Anderson-Inman &Zeitz, 2013)

Gender in relation to performance has been an issue of interest and concern to researchers in education. There are varying opinions on which gender (either males or females) achieves better than the other. On this, there are those that claim that males performed better than females, yet others claim that females achieved higher or better than their male counterparts (Ofoegbu, 2008). On the debate, the widely held view that females were superior in language use (acquisition and performance) was based mainly on studies in foreign countries especially English speaking ones and that this position is not tenable in Nigeria. She concluded that her survey on research studies on gender influence on achievement in language in Nigeria indicate that many studies did not establish enough evidence to support the claim that females are better than males in language (Azikiwe, 2009).Furthermore, Njoku (2009), in his study on enhancing the relevance of chemistry curriculum delivery using science, technology and society (STS), stated that female students underachieve in science, technology and mathematics education relative to their male classmates. The issue of gender becomes crucial in this present day because the schools in the research are co-educational. Also, the contradictory evidences in academic performance due to gender has necessitated the need to verify how computer-based concept mapping instructional strategies can influence students'performance in physics. This study therefore,

will examine the effects of computer-based concept mapping instructional strategy on students'performance in physics.

1.2 Statement of the Problem

The performance of students in science generally has been quite unsatisfactory over the years (Olorukoba, 2007). The external examining bodies such as West African Examination Council (WAEC) and National Examination Council (NECO) have repeatedly reported poor performance in physics. The report of the Chief Examiner, West African Examination Council, WAEC(2015) revealed that candidates' performance were poor. Furthermore, a critical look at the statistics of candidates' enrolment and performance in physics in Kaduna state for the years 2011 to 2016 shows that the performance of the candidates were poor. The percentage failure of physics students in the West Africa Senior Schools Certificate Examination (WASSCE) for the years 2011, 2012, 2013, 2014, 2015 and 2016 are 50.78, 53.61, 38.33, 51.65, 40.05 and 33.58 respectively (Appendix A).

The persistent poor performance, according to the Chief Examiner for the year 2015-2016 was as a result of: Poor understanding of general principles and concepts, heat, energy changes, matter and motion (WAEC, 2016).This poor performance as indicated by the results can be attributed to many factors which include; ineffective teaching methods, unqualified and inexperienced teachers teaching the subject, lack of appropriate and effective use of media among others(WAEC, 2016). This persistent poor performance also implies that a larger percentage of science students will not be admitted to study science and technology related courses in higher institutions since physics is one of the subjects that must be passed at least at credit level in SSCE in order to study science and technology related courses in higher institutions. Despite all that has been done to improve students'achievement especially in physics, students still perform poorly. The researcher is of the view that an alternative teaching method like the computer-based concept mapping strategies if employed might

improve the performance of physics students. Therefore, this study seeks to determine the effects of computer-based concept mapping instructional strategies on students' performance in physics.

1.3 Objectives of the Study

The purpose of this study is to investigate the effect of two modes of computer-based concept mapping instructional strategy on the performance of physics students in secondary schools in Kaduna State. Specifically, the study found out the:

(i) Differencebetween the performance of students taught physics usingcomputer-based concept mapping strategies and those taught using computer assisted instruction.

(ii) Differencebetween the performance of male and female students taught physics using hierarchical mode of computer-based concept mapping instructional strategy.

(iii) Difference between the performance of male and female students taught physics using spider mode of computer-based concept mapping strategy.

1.4 Research Questions

The study was guided by the following questions:

(i) What is the difference between the performance of students taught physics using computer-based concept mapping strategies and those taught using computer assisted instruction?

(ii) What is the difference between the performance of male and female students taught physics using hierarchical mode of computer-based concept mapping instructional strategy?

(iii) What is the difference between the performance of male and female students taught physics using spider mode of computer-based concept mapping instructional strategy?

1.5 Research Hypotheses

The following hypotheses were formulated and tested at 0.05 alpha level:

HO_1: There is no significant difference between the mean performance of students taught physics using computer-based concept mappingstrategies and those taught with computer assisted instruction.

HO_2: There is no significant difference between the mean performance of male and female students taught physics using hierarchical mode of computer-based concept mapping instructional strategy.

HO_3: There is no significant difference between the mean performance of male and female students taught physics using spider mode of computer-based concept mapping instructional strategy.

1.6 Significance of the Study

It is expected that the teaching and learning process, students, teachers, teacher trainees, curriculum developers, policy makers, parents, government and the nation at large would benefit from the findings of this study in the following ways:

The result of this is expected to have positive impacts on teaching and learning of physics in secondary schools, as it should re-emphasize the need for teachers to always enrich the teaching and learning process with instructional media. This should encourage head, hand, eyes and heart co-ordination and promote harmonious interaction between learners and materials to be learnt. This in turn would relieve passivity, monotony, excessive verbalism, thereby preventing physics from being taught in a manner that produces in the mind of learners a feeling of boredom and distaste for physics.

The results of this study is expected to be useful to the learners as it should provide opportunities for students to practice basic skills, learn some basic computer concepts on their own and at their own pace. Also it can lead to arousing students interest in science especially physics, make them to be creative and help in the generation of ideas to solve world problems. Since students learn differently and at different pace, abstract concepts are simplified and individualized learning will be encouraged.

The result is expected to encourage teachers to use multiple media (especially ICT media) in presenting instructions to students.It will also help teachers to save time and energy in delivering instruction, vary their instructional approaches, develop creative skills and help in making their lesson interesting as well as making their instructional objectives to be effectively achieved. Theoretically, the findings of this study should help teachers to give students task in hierarchical order. It will help teachers to move from simple to complex task. It will also enhance and broaden the ICT skills of the teachers as they use the package for teaching.

The findings could hopefully assist curriculum planners to include in the curriculum for secondary level the instructional materials/strategies such as the computer-based concept mapping that would help in bringing about meaningful learning. It may also provide locally produced computer-based instructional package, the use of which would consequently build up teacher's and learners confidence in the subject matter and to be information and communication technology (ICT) compliant. This is to give direction and confidence to the teacher whose job it is to put the curriculum into use and to ensure the attainment of specific objectives of learning science.

The findings of this study would be of immense benefit to the nation as it could lead to the turnout of learners with solid foundation in science (physics) and ICT to meet the demands of science and technology of the new millennium. This study may be a spring board

for future researchers who might wish to embark on a similar study in physics or other discipline such as chemistry, biology or mathematics.

1.7 Scope of the Study

This research examined the effects of two modes of computer-based concept mapping instructional strategies on the performance of students in physics. The two modes were the "hierarchical" and "spider" modes respectively. The reason for choosing these two modes is that although both modes are easy to read, the spider mode has all data radiating outward and organized around a unified theme while the hierarchical mode follows a definite pattern with the data arranged vertically and central theme on the top.Kaduna South Local Government Area of Kaduna State was used and threeco-educational schools were covered. Kaduna South Local Government Area was chosen because it is an area where students' difficulties and poor performance in physics have been identified and most of the schools in the Local Government are in the urban area where there is access to computer education and other ICT facilities. One of the schools served as the control group while the other two served as the experimental group. The study was limited to Senior Secondary School II (SSS II) students of the Secondary Schools selected in Kaduna. The choice of SS II was based on the fact that the National curriculum for secondary school (Federal Ministry of Education FME, 2009) provides that the aspect of senior secondary school physics upon which the treatment was based be taught at the second year of senior secondary. The choice of SSII students is also based on the following premises: That the proposed students must have been selected and enrolled for physics subject; That they have been exposed to the teaching of the SSCE physics syllabus and are not pre-occupied with any major examination; That they are expected to have been exposed to some pre-requisite of physics concepts at SSI level. This is important because certain prerequisite skills need to be acquired before the complex ones. The topics or subject matterscovered are "Newton's laws of motion" and "Centre of

gravity"which aretopics in Senior Secondary II Physics syllabus. The reason for choosing these topics is because they are two critical aspects of "motion" which has been identified as one of the areas of students' weaknesses as reflected in their results performances by the examination body (WAEC).

1.8 Operational Definition of Terms

The following concepts are operationally defined in relation to the study for clarification purposes:

1. **Concept Mapping:**This refers to information in form of graphics and animation used to teach concepts in physics by creating a visual representation of the text structure and associated personal knowledge within that display.
2. **Instructional Strategy:** It is a medium adopted by a teacher to teach a lesson, this includes the use of games, computers, text books, ICT tools that stimulates learning.
3. **Hierarchical Concept Map:** This is a concept mapping mode that presents information in a descending order of importance, with the most important information placed on the top.
4. **Spider Concept map**: This is a map organized by placing the central theme or unifying factor in the centre of the map, with outwardly radiating sub-themes surrounding the centre of the map.
5. **Computer-based concept mapping**: This is an instructional strategy which incorporates the use of computer instruction and other ICT tools with concept mapping.
6. **Computer Assisted Instruction:** It is a form of instruction that employs the use of computer and other ICT tools in teaching and learning.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter reviews the relevant literature. It is carried out under three broad sections namelyconceptual framework, theoretical frameworkand empirical studies.

2.2 Conceptual Framework

Science and technology education are critical to national development and the sustenance of such development. The world of today is dominated by science and technology, so much so that almost everything is now scientific and technological in nature. Technological artifacts and processes have so dominated the home, workplace, and indeed the totality of the environment that everybody needs at least, basic knowledge of science and technology to contribute to development efforts and to at least, survive if not succeed in the society of today. This implies that science and technology education should be accessible to all citizens for conducive living in the modern society of today (Njoku, 2007).The knowledge and application of science, technology and mathematics are indispensable for the transformation of Nigerian economy into an industrial and self-reliant one (FRN, 2015).

For any nation to achieve the above and attain the status of self-reliance, science and technology must be an important component of the knowledge to be given to all citizens of that nation irrespective of tribe/ethnicity, creed, or sex (Nsofor, 2006). She added that no nation can develop technologically and otherwise as rapidly as she wants if her citizenry do not have solid foundation in science. For any nation including Nigeria to attain sustainable development, there is the need to recognize science education as a priority area of education for her citizens (Olorundare, 2011). According to him, a scientifically literate person has an adequate understanding of the nature of science including concept, principles, theories and

processes of science, technology and mathematic; and an awareness of the complex relationships between science, technology and the society with the ultimate purpose to describe and explain natural happenings from their everyday life experiences. Nigerian government realized this facts and stated the goal of science education thus: Cultivate inquiring, knowing and rational mind for the conduct of a good life and democracy;

produce scientists for national development; service studies in technology and the cause of technological development; andprovide knowledge and understanding of the complexity of the physical world, the forms and conduct of life (FRN, 2015).

The late South African President Nelson Mandela echoed similar sentiments at the inauguration of the Science Academy of South Africa. He remarked that the impact of science and technology was so glaring that no one needed to be persuaded to behold its awesome utility to national growth and prosperity (Mandela, 1994). Abilu (2005) expressed the opinion that Nigerian citizens should pursue science, technology and mathematics education to prevent Nigeria from being a perpetual slave to the developed world. Therefore, Nigerian curriculum should be geared towards this mission.In the National Policy on Education (FRN, 2015), the policy statement expresses an acknowledgement that we are living in a modern age of science and technology where basic knowledge and the application of science, mathematics and technology are very important for any meaningful development.Also, every successive Federal and State Governments in Nigeria had made frantic efforts to improve the status of science teaching in Nigeria. Science and technology education was one of the seven point agenda of Yar'adua's Administration. Salami (2003), summarized government efforts to integrate and intensify science and technology values in Nigeria education system to include:establishment of several unity and special science schools, vocational and technical schools in some states;establishment of technical workshops in secondary and technical schools; establishment of federal universities of

technology and agriculture; establishment of the National Agency for science and engineering infrastructure, to collate and distribute relevant research findings in science and technology; establishment of technical teacher's training colleges and colleges of education for NCE (Technical); distribution of science equipment worth millions of naira to various secondary schools; Enforcing an admission policy into universities of 60:40 ratios in favour of science and science related disciplines; popularization of science and technology through the formulation of the junior engineers, technicians and scientists (JETS) clubs in post-primary institutions all over the country; Annual investment into teacher-in-service training, workshops, seminars and so on; Payment of science allowances to science teachers andcreation of ministry of science and technology are all aimed at promoting science and technical education and Nigeria's technological progress.

2.2.1 Overview of Physics Curriculum in Nigeria

Physics is a physical science which deals with the fundamental concept of matter, energy, space, motion and the relationship between them. Physics is one of the science subjects taught at the senior secondary school level of Nigeria's educational system. After the Junior Secondary School three (JSSIII) examinations, all students found suitable to study science in the SSS class are enrolled to study physics at least during the first and second year of the three years duration. The national policy on education stated that physics can be taken as one of the "cores" among science subjects (i.e. biology, chemistry, physics or health science) with other one vocational elective and two non-vocational elective subjects(FRN, 2015).

Physics is a crucial subject for technological development and as such, its teaching and learning must be a matter of national concern. Apart from the age long reason of preparing students to write or pass their examinations, Bajah (2000), gives the following as perhaps more long term objectives of teaching science: To sharpen the powers of observation

of the students; To direct the attention of students to matters which are significant to them and the society; To continue the process of science vocabulary, not only by definition but by experience; To prepare the students to take off into the existing world of science later in life.

The Federal Ministry of Education (2015), gives the following objectives for teaching secondary school physics:To provide basic literacy in physics for functional living in the society; To acquire essential scientific skills and attitudes as a preparation for the technological application of physics; To acquire basic concepts and principles of physics as a preparation for further studies; and To stimulate and enhance creativity.With these objectives, Physics was designed and introduced into the national curriculum for secondary institutions to provide functional scientific and technological education to Nigerians. To promote scientific understanding of physics (meaningful physics learning), requires an increased focus on secondary school level students higher-order thinking skills (Anderson &Krathwohl, 2001) that is, applying, analyzing, evaluating and creating or synthesizing. Inculcating meaningful learning in physics can help students understand basic principles of physics that they also encounter in everyday life. Meaningful learning can occur when students not only remember, but also make sense of and are able to apply what they have learnt (Anderson &Krathwohl, 2001). According to Minzes, Wanderseeand Novak (2000), meaningful learning occurs when students seek to relate new concepts and propositions to relevant existing concepts and propositions in their cognitive structure. Thus, meaningful learning is knowledge construction, in which students seek to "make sense" of their experiences. Meaningful learning is an active, constructive and cumulative, goal-directed, authentic, and takes place in a technology-rich environment (Jonassen, Beissner and Yacci, 2009). To improve and encourage meaningful learning which can lead to not only students remembering the concepts and principles taught in physics, but that will lead to greater

achievement in physics, appropriate instructional material/strategies has to be employed in teaching and learning of physics especially at secondary school level.

2.2.2 Importance of Instructional Media in Teaching and Learning

In view of the importance of science to mankind, efforts have been made to improve the quality of its teaching and learning in secondary schools both by government and professional associations (Lagoke, 1999). Media are channels through which messages, information, ideas and knowledge are disseminated. They are collection of materials equipment and approaches or strategies that can be used effectively for communication. Whenever such materials, equipment and strategies are used for teaching and learning, they are referred to as instructional media (Ajelabi, 2000). There is the need to adopt a proactive and informed attitude towards our teaching to make most effective use of emerging technologies. The effective use of these emerging technologies will lead to an improved teaching and learning in our schools. Such technologies as computer when used effectively, will lead to the improvement of teaching and learning process (Hollingworth, 2002).

Effective teaching and learning in any subject at any institution are dependent on the instructional strategies used. The instructional method, strategies and or material used is a major factor responsible for the level of achievement as well as retention in any subject by students (Mahajan, 2003). The quality of science especially physics teaching and learning can be improved through the use of appropriate instructional media. In science, most of the concepts are acquired during instruction. The instructional strategy employed by the teacher plays an important role in concept acquisition and meaningful learningAlso, (Ezenwa, 2009).

Ofoegbu (2008) opined that teaching is changing and in many ways becoming a more difficult job because of increasingly numerous contradictory expectations which according to her as stated in Fox (2005); We are living in an age of information overload with the expectations that students will learn higher level skills such as how to access, evaluate,

analyze and synthesize vast quantities of information. Teachers are expected to teach students to solve complex problems that require knowledge necessary across many subject areas even as they are held accountable for the teaching and learning of isolated skills and information.

Teachers are expected to meet the needs of all students and more than toward fulfillment of their individual potential. Technology can assist with some of these expectations and make teachers and their students more successful. Technological progress impacts on our everyday life with an ever increasing frequency and effect. How advances in technology might influence teaching and learning must be of special importance to all physics educators. (Ofoegbu, 2008).

2.2.3 Relevance of Information and Communication Technology in Education

ICT, an acronym for Information and Communication Technology, is often used as an extended synonym for information technology (IT), It is a more extensive term (i.e. more broad in scope) that stresses the role of unified communications and the integration of telecommunications (telephone lines and wireless signals), computers as well as necessary enterprise software, middleware, storage, and audio-visual systems, which enable users to access, store, transmit, and manipulate information. There is no generally acceptable definition of the term ICT. We will therefore present below the following definitions.

Information Technology comprise of various kinds and sizes of computers. The computers are connected via telephones to facilitate the storing of the data they house. The data comes in many forms: texts, sounds and pictures.The definition places much emphasis on computers as information technology (Wali, 2000).Information Communication Technology and systems include all the different means, methods and tools that humans have used throughout history to help manage information, conduct business, communicate with others and better understand the world (Laudon, 2004). This definition is very elastic. It incorporate virtually every kind of device used in gathering and disseminating information.

ICT is a generic term referring to technologies that are used for collecting, storing, editing and passing on information in various forms (Liverpool, 2002).This definition is precise.Butcher (2003), citing Gunton (1993) defines ICT as: electronic technologies for collecting, processing and communicating information. They can be separated into two categories; those who process information, such as computer systems, and those which disseminate information, such as telecommunication systems.

From the definitions above, we can make the following deductions:information and communication technology carries out the following functions:collecting information; storing information; processing information; communicating information; and they are technologies, equipment and methods used to handle information. These include computers, telecommunications and electronics.Essentially, a modern information system follows the same pattern as the communication cycle or process. It is an input-process-output cycle. It involves taking in data such as raw scores, names, pictures and sounds, information (input), analyzing the information using computer to process (store, manipulate, rearrange and analyse) the data and finally displaying this processed information to users usually on computer screens, television screens, printers, or even through loud speakers (output). The information supplied as output can then be used as a basis for acting on the data that was input (feedback) (NTI, 2012).

Although a large assortment of information and communication technologies exist, Laudon (2004) categorized the different kinds into five basic types:sensing technologies (sensors, scanners, keyboards, mouse, electronic pens, touch screens etc.); communication technologies (fax, cellular telephones, landline, television, radio, video, computer); analysing Technologies (microcomputers, personal computers (PC), desktops, laptop, notebook, handheld, palmtop); display technologies (display screens, printers, loudspeakers etc.); storage technologies (magnetic tape, floppy diskettes and hard discs, magnetic discs, optical

discs (CD Rom, VCD, DVD).Information communication technology as an instructional medium is currently penetrating education more and more. This is because it has the potential to transform the nature of education, where and how learning takes place and the roles of students and teachers in the learning process. The use of ICT both by teachers and students is bringing changes in our concepts of educational process and in a way that process is institutionalized. ICT enters into the classroom in the manner of an educational facility similar to the overhead projector, the film projector, or the tape recorder and it can be used in both arts and science subjects. With ICT, students can perform calculations, analyse sets of data, and stimulate laboratory experiments and real life processes. Students can also visualize abstract concepts and numerical results, text and information retrieval (NTI, 2012).

ICT can help students to:ask questions, predict and hypothesize; observe, measure, record and manipulate variables; interpret their results and evaluate scientific evidence andpresent and communicate their findings in a variety of ways (Yusuf, 2005).The use of ICT can extend and enhance students understanding of science through simulations and modeling. It will help students to understand phenomena which may be too slow, too fast, too dangerous or too expensive to carryout in the school laboratories (Owen, 2003). The Nigerian national policy on education (FRN, 2015), and with particular reference to science and technology, considered ICT as an important tool for laying a solid foundation of science, technology and mathematics education at all levels of the Nigerian education system. ICT includes radio, television, videos, computers sensors, satellite connections, internet and all the software which are used by teachers for teaching and learning in order to achieve a meaningful learning by the students (Ajagun, 2003).

Literatures dealing with technology and pedagogy attests to the powerful impact ICT can have on the teaching and learning process (Akudolu, 2003). ICT has three positions in the curriculum and these are:learning about ICT; learning with ICT andlearning through

ICT.Learning about ICT refers to ICT concept as a subject of learning in the school curriculum while learning with ICT is concerned with the use of ICT as a medium to facilitate instruction. While sharing this view, Pelgrum and Law (2003) maintain that learning through ICT refers to the integration of ICT as an essential tool into a course curriculum, such that the teaching and learning of that course/curriculum is no longer possible without it.

In recent years, ICT and the Internet have emerged as dependable media of interaction. Unlike the broadcast media, the Internet can facilitate the participation of the periphery in an eminently democratic discourse, which can be empowering. And if properly deployed, quality concerns hitherto forced by economic and power considerations to be confined to the haves can now be within the reach of everyone. The need of the hour is, therefore, to recognise this potential, promote universal access, facilitate participatory forums, and develop communities and interest groups. Left to market forces alone, the reach is bound to remain limited. The Internet can be a sound investment for continuous on-demand teacher training and support, research and content repositories, value-added distance education, and online campuses aimed at increasing the access, equity, and quality of education.The model of education prevalent today presumes the existence of groups endowed with abilities, knowledge, and skills, which at times even subsume the right values, and which therefore acquire the mandate to educate. This separation of the centre and the periphery has led to the alienation and disempowerment of large communities of people. The fact that we continue to invest in adult education, that we continue to grapple with the problem of dropouts and continue to deal with issues relating to the provision of even minimum facilities can be traced largely to this chasm. Both for logical reasons and as a moral compulsion, it has become necessary to strengthen multiple, albeit shifting, centres. The challenge of population alluded to earlier can only be met if we overcome this centre-dominant thinking (Hawkridge, 2003).

The implication of this idea is that knowledge is not centred at any powerful location, but is available everywhere. What constitutes education is an opportunity for every individual to develop his or her latent abilities and skills, to choose his or her teachers, and to benefit from select experiences. The problems of certification and standardisation, recognition of what constitutes legitimate knowledge, deciding who is a legitimate teacher, and determining what abilities, knowledge, and skills constitute legitimate education may all have to be looked at from drastically different perspectives (NTI, 2012).

In systemic reforms: ICT is used in an equitable and democratic manner to enhance the selfworth and self-image of the poor and the disadvantaged; ICT counter the tendency to centralise; promote plurality and diversity; Shift focus from fixed to flexible curricula with competencies and skills identified rather than specific factual content; Deploy Educational Technology to enhance open education, which implies openness in curriculum transactions; Work towards transforming all schools into ICT-rich environments; Create opportunities for administrators and educational leaders in the school system to become Educational Technology savvy and to be able to use ICT tools competently (NTI, 2012).

In refreshing the skills of in-service teachers; it create a system of lifelong professional development and support, especially of educational leaders and managers such as headmasters and principals; Encourage ICT literacy for official and personal use to increase comfort and later enhance creativity in educational work; Support the development of and nurture teachers' self-help groups/professional development groups on the ground as well as online (NTI. 2012).

In pre-service teacher education: To introduce teachers to flexible models of reaching curriculum goals; Introduce use of media and technology-enabled methods of learning, making it inherent and embedded in the teaching-learning process of teachers; Train teachers

to evaluate and integrate available materials into the learning process; Enable trainee teachers to access sources of knowledge and to create knowledge (NTI. 2012).

In school education; ICT move schools from predetermined set of outcomes and skill sets to one that enables students to develop explanatory reasoning and other higher-order skills; Enable students to access sources of knowledge, interpret them, and create knowledge rather than be passive users; Promote flexible models of curriculum transaction; Promote individual learning styles; Encourage use of flexible curriculum content, at least in primary education, and flexible models of evaluation; Insights gained from various experiments aimed at reforming the school environment point towards the need for reform both in the system and within the classroom. ICT will have a significant role to play here (NTI, 2012).

In research: It create a framework to identify the generic skills (problem identification and troubleshooting, for instance) needed for the new initiatives to be undertaken; It enable researchers to acquire knowledge about how learning takes place in ICT-rich learning environments, optimising learning paths for learners with different learning styles coming from a variety of social backgrounds, including gender differences; Examine possibilities of adopting mobile technologies for learning purposes (NTI, 2012).

The use of information and communication technology is becoming an integral part of education in many parts of the globe. Nigeria is not left behind as ICT is gradually finding its way into the educational system (Olaofe, 2005). Despite the limitations brought about by economic disadvantages, it is observed that the influence of ICT on education is to enhance the ability of each learner to generate access, adopt and apply knowledge and information to solve complex problems (Ajayi, 2001).

Liverpool (2002) discussed the uses of ICT in teacher education and divides them into four forms: ICT as object, ICT as assisting tools, ICT as a medium for teaching and learning and ICT as a tool for organization and management in schools.ICT as object refers to learning

about ICT, mostly organized in specific courses such as “computer education”. Learners familiarize themselves with hardware and software. Here, what is being learnt depends on the types of education and the level of the students. The aimis computer literacy.ICT as an assisting tool involves carrying out assignments, collecting data and documentation, communicating and conducting research, typically, ICT is used independently from the subject matter. As a medium for teaching, ICT serves as a medium through which teachers can teach and learners can learn. It may be in form of drills, simulation, practice tutorials, exercises and educational networks and as a tool for organization and management,entails the use of ICT in handling school records, like timetabling, attendance, fees collection, examination result and general communication (NTI, 2012).

The new ICT facilities could allow teachers and learners to move into the role of guidance and facilitator in assisting students to gain the required skills and utilizes the knowledge available in various forms (Barton and Haydn, 2004). Shehu (2006), highlighted the following benefits of ICT in the classroom environment:providing students with chance of studying, investigating and practicing complex skills, procedures and concepts in a realistic but non-risky situation. Complex skills at a realistic level can be tried by the students without actual risk to people, capital or other sources; increasing student’s access to information. Access to instruction is so flexible and ensures broad viability and availability of educational opportunities. It is a cost-effective system of instruction and learning materials can be accessed irrespective of time and space; adapting instruction to the abilities and preferences of the individual students and increasing the amount of personalized (individualized) instruction a student receives(UNESCO, 2012. Many students benefit from the immediate responsiveness of computer interactions and appreciate the self-paced and private learning environment; ICT helps teachers to supplement their lessons using drill and practice software and provides primary instruction in learning centers through tutorial or

simulation software; It also helps teachers to improve upon their performance and enable them to enhance the achievement of their students. This will result in improvement of teachers overall efficiency and saves valuable time; ICT to some extent helps to minimize the problem of teacher's scarcity in certain areas of socialization. Many teachers can make use of computer-based software as an aid to interact with a group or the whole class of students; ICTs are one of the major contemporary factors in shaping the now global economy and producing rapid changes in the society. They have fundamentally changed the way people learn, communicate and do business (UNESCO, 2012).

Considering the important role played by ICT, Nigeria should do something to overhaul its educational sector or it would continue to produce "analogue graduates" who cannot fit into the practice of modern technology (Ajagun, 2003). However, in recognition of the prominent role of information and communication technology in advancing knowledge and necessary skills, it is stated in the national policy on education that for effective functioning, in modern world, there is an urgent need to integrate information and communication technology into Nigerian education system (FRN, 2015). Information and Communication Technologies (ICT) have become key tools that have had a revolutionary impact on how we see the world and how we live. ICT is having a revolutionary impact on educational methodology globally. However, this revolution is not widespread and needs to be strengthened to reach a large percentage of the population. Therefore, there is need for Nigeria to borrow a leaf from developed countries like the United States of America and Australia on the type of modern methods of delivery they adopt and use in teaching and learning processes (Mac-Ikemenjima, 2005).

The Federal Government of Nigeria realized the need for ICT and approved the National information technology policy. This policy focuses on the use of IT for education, creation of wealth, poverty eradication, job creation and global competitiveness. Thus, it is

important to note that the rapid growth of ICT in Nigeria presents a number of prospects for the advancement of the industrial sector in Nigeria by providing more effective ways of developing human resources that lubricate the machinery for industrial growth and development (NITDA, 2011).

2.2.4 Overview of Computer Based Instruction

A computer is a combination of hardware devices and programs assembled to accomplish some specific tasks. Computer is a technological information processing device which can be used to present instructional events that are designed, developed and produced for an individualized learning situation. The computer has been adopted and adapted for this purpose because it can perform numerous mathematical and logical operations without the intervention of a human operator during the run (Brightman and Dunsdate, 1986).

The computer is an electronic automatic machine which is capable of receiving, storing, recalling or retrieving information put into it. It is the fastest processing machine ever invented by man. It is useful in almost all spheres of life such as in hospitals for keeping records of patients, drugs, staff and accounts, instruments for diagnosis and treatment. It facilitates the banking system and help in rendering quick banking services to clients. It is very useful in professional services such as engineering, chartered firms and business. Thus computer is regarded as an all-purpose machine (Ezeliora, 1997).

Computer has been found to be the most suitable, reliable and versatile medium for individualizing instruction. It is able to deal simultaneously with large number of students on individual basis and this tends to lower the cost, in the long run (Becta, 2003). From the foregoing, the application of computer technology to classroom environment has a significant role in the present dispensation. However, adequate consideration should be given to ComputerAssisted Instruction (CAI) software for the upliftment of frontier of knowledge of science. Since this is the era of instructional technology, where computer is playing an

important role in industry and commerce, attention should be focused on the use of computer in school settings (Abimbade, 2008).

With the advent of computer-based learning, instructors are shifting from traditional methods of instruction to computerized methods of instruction in developed nations. As new ideas and methods of doing things are changing, majority of educators are increasingly being faced with the challenges of using modern technology (computer) for teaching in their institutions (Hennessy, Deaney& Ruthven, 2005). Through the use of computer, the roles of many teachers are changing from the traditional lock-step giver of information to that of presenter, manager and facilitator of learning. For instance, in the United States, computers have been described as "the new basic" of education and the internet as "the blackboard of the future" (Becta, 2003). Today, teachers are expected to make use of modern instructional methods which are appropriate for the students and which contribute to the development and employment conditions, and can assist them to carry out swiftly, efficiently and effectivelywhat has to be done in the teaching-learning environment (Mohammed &Ekpunobi, 2003).

The full potential of computers is yet to be exploited within the Nigerian school system. Successful implementation of computer education can only be assured through teachers who have acquired necessary knowledge and skills. If computer education is to succeed in Nigerian schools, teachers must be competent in the use of computers (Maruf, 2007 and Yusuf, 2005).Computer has wide application in education. Computer-Based Education (CBE) and Computer-Based Instruction (CBI) are the broadest terms and can refer to virtually any kind of computer used in educational setting, including drill and practice, tutorials, simulations, instructional management, supplementary exercise, programming, database development, writing; using word processors, and other applications. These terms may refer either to stand alone computer learning activities or to computer activities which

reinforce the materials introduced and taught by teachers (Bangert-Drowns, Kulik, &Kulik, 1985).

2.2.5 Overview of Concept Mapping

Concept mapping is a type of knowledge representation. It is a technique for representing the structure of information visually (Schie, 2002). Concept mapping is a technique for visually representing the structure of information.A concept map is a graphical representation where nodes (points or vertices) represent concept, and links (arcs or lines) represent the relationships between concepts. The concepts, and sometimes the links are labeled on the concept map. The link between the concepts can be one way, two-way or non-directional. The concepts and the links may be categorized, and the concept may show temporal or causal relationship between concepts (Novak, 1998).

In another word, a concept map consists of hierarchically arranged nodes or cells that contain a concept, item or question and labeled links. The relationship between nodes/ concepts is indicated by "linking" words and an arrow to describe the direction of the maps. Concept mapping supports the visualization of such conceptual framework and stimulates prior knowledge by making it explicit and requiring the learner to pay attention to the relationship between concepts (Jonassen, 2006). Concept maps are particularly useful for representing networks of concepts, where links do not only connect adjacent concepts but are often linked to concepts in different sections of the concept map. The resulting web of concepts increases the number of relationships that connect new information to existing concepts increasing the stability of the new information.This type of structural flexibility makes concept mapping highly suitable for hypermedia environments, since the type of linking employed in concept maps is an excellent representation of hypermedia's non-linear paradigm. Concept maps can be useful as a tool for conceptual development of hypermedia,

navigational structures within hypermedia applications, and interfaces for the indexing and retrieval of hypermedia objects (Plotnick, 2007).

Concept mapping is a pedagogical strategy/meta-cognitive tool based on Ausubel-Novak-Gowin theory of meaningful learning. It is based on the idea that meaningful learning occurs when new knowledge is consciously, explicitly and deliberately linked with relevant concepts which the learner already knows. That is, teaching from known to unknown concepts and from concrete to abstract concepts. It encourages students to learn difficult concepts. Concept map is a schematic representation of a set of concept meanings embedded in a framework of propositions. Concept mapping is a tool that promotes meaningful learning as opposed to rote learning. The hierarchical order of concept mapping integration therein as well as its explicitness makes it an approach that concretizes abstract knowledge. Its application therefore in linking the principles and concepts in science is a welcome departure from algorithmic methods and conventional methods in solving problems in science (Okafor and Okeke, 2006).

Concept mapping has become increasingly useful as an instructional and meta-learning tool to facilitate meaningful learning that results when students consciously and explicitly tie new concept to relevant knowledge they already possess (Chen, 2008). Wang, (2007) opined that concept mapping can be used to organize classroom teaching in order to achieve a three-dimensional objectives of teaching and help teachers to understand students' knowledge structure, evaluate students' development and also promote students self-reflection, knowledge construction and make them grasp the knowledge structure entirely and form the strategy of cognition and meta cognition. Concept maps have been used successfully over a range of ages and educational levels from children as inexperienced as kindergarten to sophisticated adult graduate students (Sticeand Alvarez, 1987). They proposed that if students begin the use of concept maps at a younger age before their learning pattern are firmly

established, mapping will be easier and more influential in their achievement and attitude. Concept mapping puts concepts into perspective, analyzes relationships and prioritizes information (Landsberger, 2001). Gabel (2003), sees concept mapping as a successful technique that improves the understanding of science. That concept maps are schematic diagrams that use words to show the relationship of one concept to another. Concept mapping helps students focus on the relationship among concepts so that students' long-term memories will accord with the scientific view.

Concept mapping can be very boring, but it can be effective when used with other teaching techniques. Schie (2002), highlighted several purposes that concept mapping can be used:creativity tool: drawing a concept map can be compared to participating in a brainstorming session. As one put ideas down on paper without criticism, the ideas become clearer and the mind becomes free to receive new ideas. These new ideas may be linked to ideas already on the paper, and they may also trigger new associations leading to new ideas; Communication tool: A concept map produced by one person represents one possible way to structure information or ideas. This is something that can be shared with others. A concept map produced by a group of people represents the ideas of the group. In either case, concept mapping can be used as a communication tool for people to use to discuss concepts and the relationships between the concepts. They may try to agree on a common structure to use as a basis for further action; learning tool: Constructivist learning theory, argues that new knowledge should be integrated into existing structures in order to be remembered and receive meaning. Concept mapping stimulates this process by making it explicit and requiring learner to pay attention to the relationship between concepts; Problem solving: Concept mapping is also gaining inroads as a tool for problem solving in education. Concept mapping may be used to enhance problem-solving phases of generating alternative solutions and

options. Since problems-solving in education is usually done in small groups, learning should also benefit from the communication enhancing properties of concept mapping.

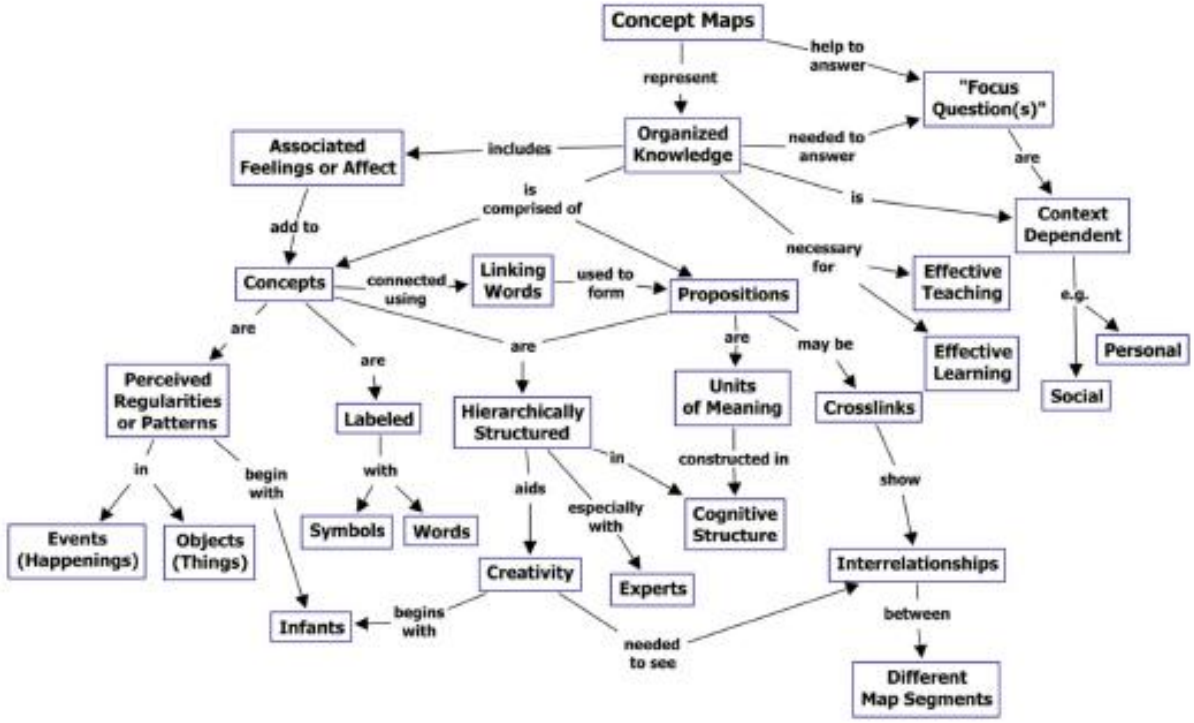


Figure 1: A concept map showing the key features of concept maps
(Canas; Novak, 1998)

There are four major categories of concept maps. These are distinguished by their different formats for representing information. Examples of the various types of concept maps are presented below:

Spider Concept Map

The spider concept map is organized by placing the central theme or unifying factor in the center of the map. Outwardly radiating sub-themes surround the center of the map. The spider concept map is; easy to configure, all data is organized around a unified theme (diagnosis) and easy to read but it is difficult to show relationships without making the map very messy and hard to read and it doesn't allow for integration of all data and the relationships among data(Novak, 1998)

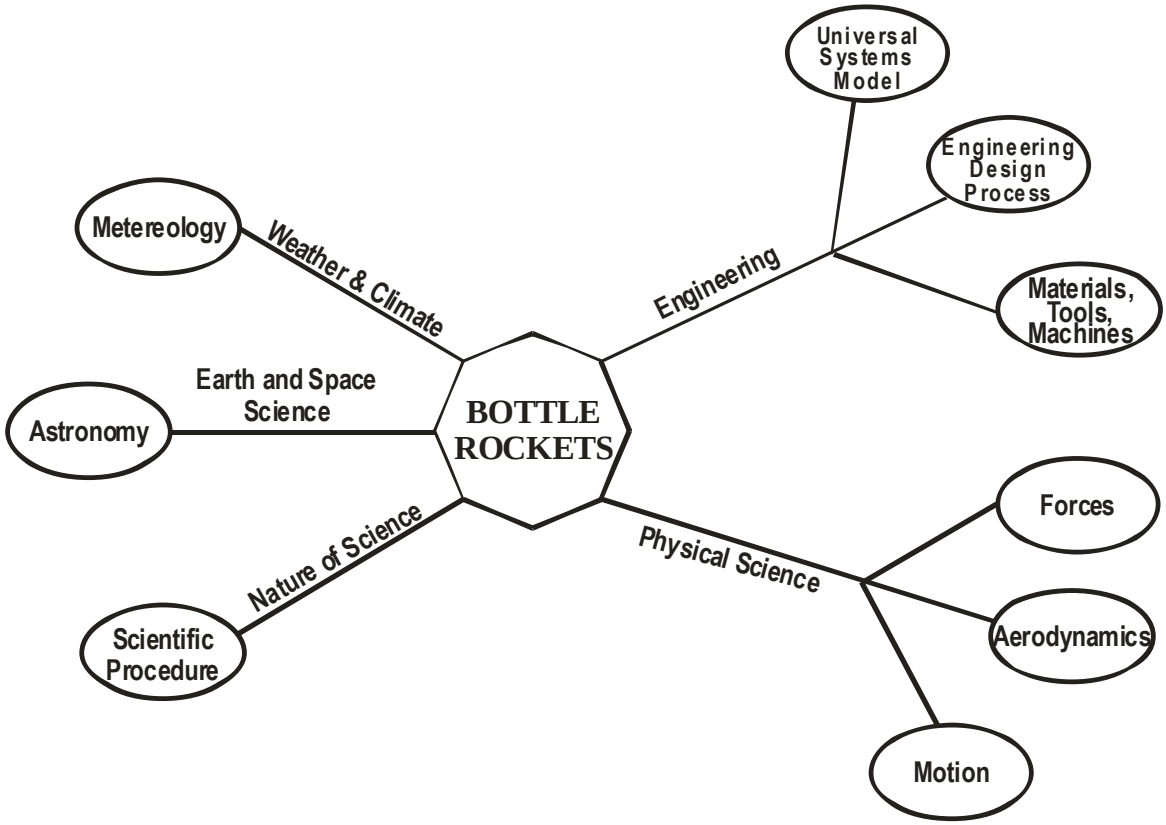


Figure 2: A Spider Concept Map (Novak, 1998)

Hierarchical Concept Map

The hierarchical concept map presents information in a descending order of importance. Themost important information is placed on the top. Distinguishing factors determine the placement of the information. It follows a definite pattern, most general data is located at the top and moves to the most specific and it is easy to read but it shows no interrelationship between data and does not allow for critical thinking and thus limited problem solving. (Novak, 1998)

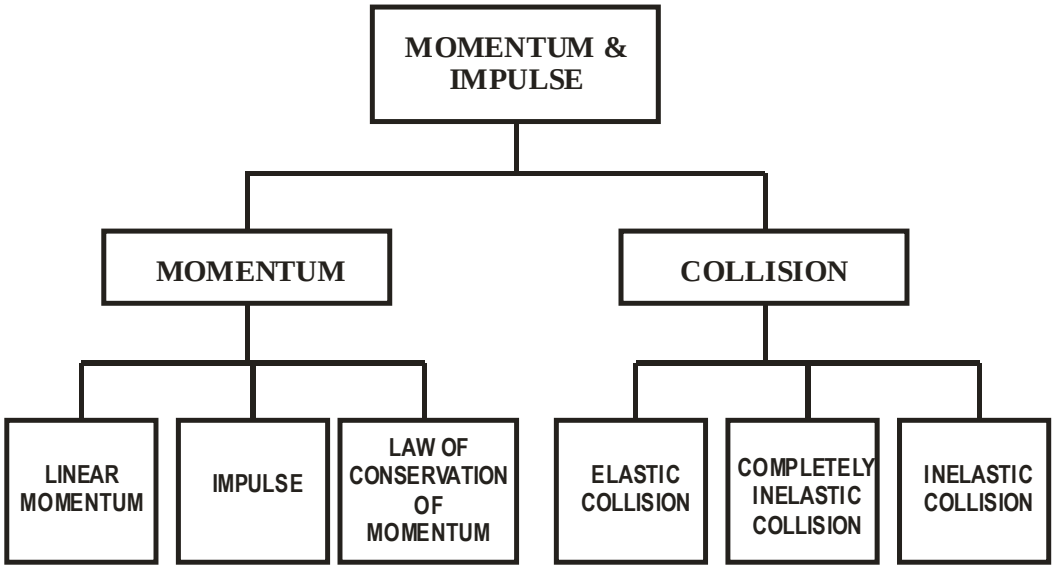


Figure 3: A Hierarchical Concept Map (Novak, 1998)

Flowchart Concept Map

The flowchart concept map organizes information in a linear format. It is easy to read, Information is organized in a logical, ordered fashion but very minimal data is noted on concept map, lack of critical thinking and clinical reasoning skills used and is usually very incomplete.

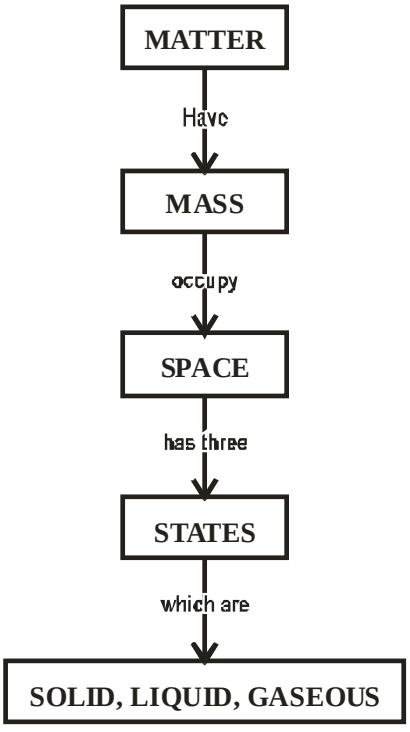


Figure 4: A Flowchart Concept Map (Novak, 1998)

Systems Concept Map

The systems concept map organizes information in a format which is similar to a flowchart with the addition of INPUTS and OUTPUTS. The systems concept map is very complete, it includes all data on the map and shows many relationships between the data, uses critical thinking skills along with problem solving skills and links theory and practice very well. On the other hand, with critical clients, map can get very involved and sometimes difficult to read due to the number of relationships noted and it takes more time to complete. (Novak, 1998)

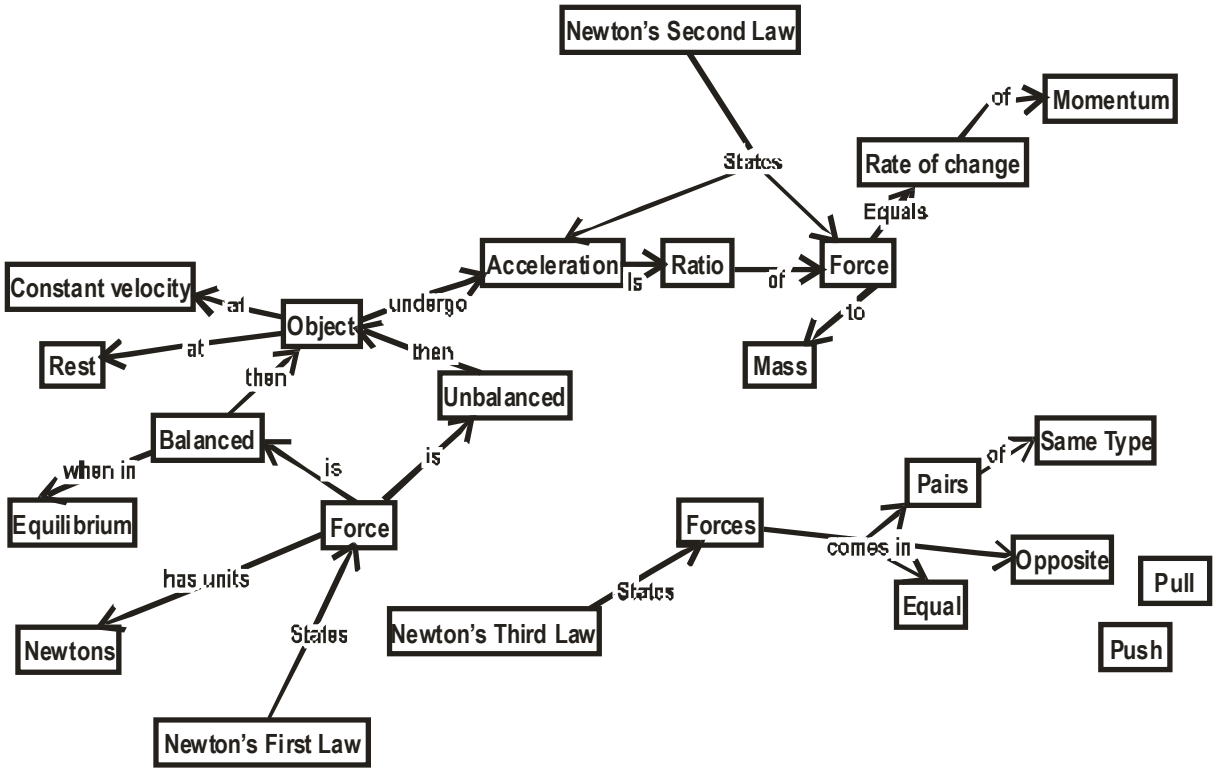


Figure 5: A Systems Concept Map (Novak, 1998)

Concept mapping instructional strategy (CMIS) falls into the broad family of graphic organizing tools that include mind mapping and spider diagrams, and was firstly developed by Novak and his research group in Cornell University in the early 1970's as an approach to identifying knowledge structures of an individual learner. The outcome of the procedure of concept-mapping a particular concept is called a Concept Map, which is a visual

representation of knowledge structure of the concept in a two-dimensional, hierarchical, node-linked diagram that depicts declarative knowledge in succinct graphic form. (Canas, Novak, and Gonzalez, 2006; Uniserve, 2009; Valadares, Fonseca and Soares, 2004).

Concept mapping enable learners to actively construct a conceptual framework to which new ideas and knowledge are added, related, and refined thereby improving on their learning capability and strategy (Fonseca and Soares, 2004). They further affirmed that unless there is understanding of the contents of materials to be learnt in terms of the basic concepts, students are bound to commit unassimilated data into short-term memory and so no meaningful learning occurs, according to the authors, meaningful learning occur when information is presented in a potentially meaningful way, and the learner is encouraged to anchor new ideas with the establishment of links between old and new materials.In particular, concept mapping offers a technique for revealing students' cognitive structure, and involves the following systemic steps:Identifying the major components of the concept; arranging the concept's components in hierarchical order; linking the components with linking phrases; making cross links with directed lines.

2.3 Theoretical Framework

Theoretical framework that influences this study will examine two areas of theories that contribute to the growth of computer based concept mapping instructional strategies. Learning is a construct which is not directly observable but only inferred from the behaviour or activities of the learner. Learning can be defined as a relatively permanent change in behavior that results from experience in the environment and is manifested in performance (Mallum& Haggai, 2000). Therefore, many psychologists have formulated theories meant to explain the processes of learning. Learning theory is a tested model that explains the process of learning in animals and human beings. These theories may be broadly divided into three

among others, namely: Behaviorism/S-R theories of learning: Skinner's Operant Conditioning,Cognitive theories of learning: Gagne's theory and David Ausubel's theory.

2.3.1 Skinner's Operant Conditioning

Skinner's view grew out of observations of the performance of animals in a device that he invented. It consisted of a small box with a lever at one side. Whenever the animal depressed the lever, a pellet of food (positive reinforcement) was delivered. This came to be known as Skinner box, and has been widely used in learning studies for more than 50 years.

Skinner concerned himself in the early years predominantly with the study of low-level behaviours of animals, and as a result contributed significantly to our knowledge of how simple behaviours are both learned and weakened (extinguished). Skinner then applied these concepts to complex behaviour and its modifications. His assumption was that high-level behaviour, when properly analyzed, could be interpreted in terms of the complex interplay of elementary concepts and principles. He entirely rejected cognitive explanations of behaviour as well as any explanations attributing behaviour to internal factors within humans or animals. Skinner's later years were concerned with testing his theories concerning complex behaviour through the study of learning in human subjects. He developed teaching machines and programmed learning based on his response/reinforcement model (Skinner, 1968).

There was emphasis on positive reinforcement throughout his writings. Early studies indicated that punishment only temporarily suppressed behaviour. Later studies did indicate that punishment can be effective. In general, a combination of strong positive reinforcement for a correct response and mild punishment for an incorrect response has been found to provide optimal support for learning (Skinner, 1968).

Skinner's views are directly applicable to the drill and practice and tutorial forms of CAI, and has been used successfully in these areas for many years. Once mastery is reached, skinner emphasize that students must be weaned from this approach in order to avoid rapid

extinction (weakening) of the response. To do this, he recommended shifting from continuous reinforcement to a pattern of intermittent reinforcement. The most effective pattern yielding the greatest retention of learning appears to be a shift first to a fixed-ratio schedule (in which every fifth or tenth, etc, response is reinforced), and finally to variable-ratio schedule (in which every nth response is reinforced with delivery on a random basis). Skinner emphasized that through these methods, behaviour could be maintained indefinitely on a very small number of reinforcements. He concluded that through a proper understanding of contingencies of reinforcements, we should be able to make students eager and diligent and be reasonably sure that they will continue to enjoy the things we teach them for the rest of their lives (Skinner, 1968).

Skinner's illustration of how to develop a programmed learning sequence is directly applicable to the design of CBI tutorial modules, as follows: Obtain a clear, detailed objective specification of what it means to know about the given subject matter; Write a series of information, question and answer frame that expose students to the material in graded steps of increasing difficulty and that frequently retest the same facts from many different angles; Require the learner to be active i.e., require a response for each frame; Provide immediate feedback for each answer (response); Try to arrange the material and questions in such a manner that the correct response is likely to occur and be reinforced (i.e., avoid errors, so that learning is not accompanied by punishing failures); Permit students to proceed at their own pace; and provide ample backup reinforcement (praise, merits) for diligent and effective work (Skinner, 1968).

2.3.2 Cognitive Theories

Cognitive theories are based on information-processing models. These are concerned with how individuals gain knowledge and how they use it to guide decisions and perform effective actions. These theories try to understand the mind and how it works. To achieve

this, they view the computer as a model of the brain and employ much of the terminology and concepts of information processing. A cognitive learning theory is concerned with several key items such as: Effect of stimuli on the organism's receptors; Storage of information in short-term memory (working memory); Storage of information in long-term memory; Processes involved in encoding and decoding information and Retrieval of the stored information, its possible combination with other data, and its ultimate effect on behaviour of the organism(Gagne and Briggs, 1979).

Cognitive theory recognizes the importance of reinforcement, but does not give it the central importance accorded by Skinner. It indicates that learner behaviour sets in motion a process that depends on external feedback, which involves confirmation of correct performance. An important concept contained in some cognitive theories is the executive control process. This process controls cognitive strategies relevant to learning and remembering in relation to such important activities as controlling attention, encoding of incoming information, and retrieval of stored data. These types of activities were not considered in traditional behaviourism, nor were they given importance by Skinner. Their applications to computer-based instruction, however, are critical. It is perhaps, in this area that cognitive theory has contributed the most to CBI.

Considering cognitive learning theory overall, the following kinds of processing during any single learning act could include: attention–selection among incoming stimuli; selective perception – encoding selected items for storage in short-term memory; rehearsal – maintaining data in short-term memory; semantic encoding – preparing information for storage in long-term memory; retrieval – searching and restoring information in working memory; response organization – selecting and organizing performance; Feedback – the external event that sets in motion the process of reinforcement and executive control process

– selecting and activating cognitive strategies. (Gagne and Briggs, 1979; Bower and Hilgard, 1981).

A graphical illustration of the above model is provided in figure 6:

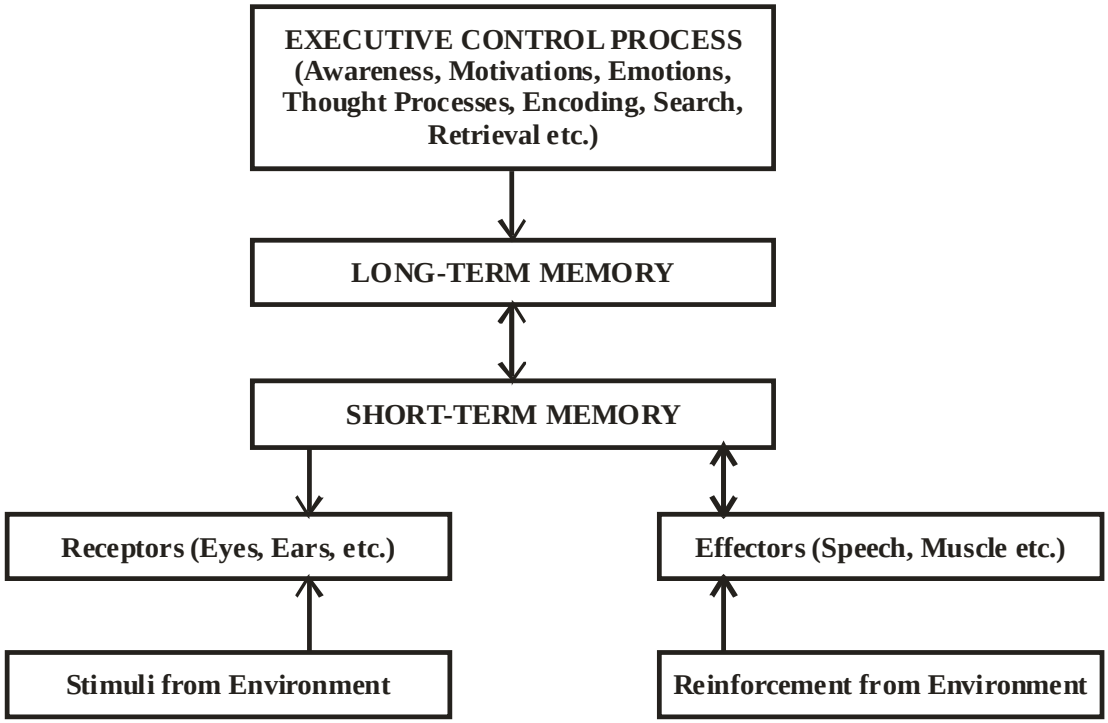


Figure 6: Cognitive learning theory model

Cognitive learning theories are most applicable to the design and development of tutorials. This approach has been pioneered most actively by Robert M. Gagne, a former follower of Skinner and the behaviourist model. Gagne has emphasized the importance of identifying the goals of the learning task followed by the development of specific instructional objectives to meet these goals. He emphasizes that such objectives must be stipulated in concrete behavioural terms. To develop instructional objectives, it is necessary to analyze the criterion task into elementary behavioural components and to determine their organization. The skill level of the students must then be assessed and programmes designed to teach the skills(Gagne and Briggs, 1979).

In development and presentation of materials, Gagne has followed Skinner in emphasizing that learning must occur in small steps, sequenced so that lower-level learning

required for performance on more complex task is learnt first. In regard to the role of teacher or adviser in CBI, he has again followed Skinner's lead by emphasizing that hints and help needs to be adapted to the individual learner. He has suggested that students be provided on a little help at a time, thus permitting the students to use as much as he needs. The student is thus placed in control of the learning situation. So far as the mastery is concerned, Gagne has expanded Skinner's basic views on the topic to include more details related to human learning. He has defined mastery as materials that have been learned to the level of which they are readily accessible to recall at the time of learning(Gagne and Briggs, 1979).

Gagne's most significant contribution, however, relates to his application of cognitive learning theory to the task of designing CBI modules. Thus, he has brought to the topic some additional insights and emphases, such as his concern with gaining the student's attention and developing expectancies. This can be achieved in a CBI module by providing advance organizers in the instruction. These organizers might take the forms of charts or graphs that reflect the structure and organization of the lesson content. Five categories of learning outcomes that represent all types of learning include: intellectual skills (how to do something of an intellectual sort); cognitive strategies (capabilities that govern the individual's own learning, remembering, and thinking behaviour; verbal information; motor skills and attitudes(Gagne and Briggs, 1979).

Within these various types of learning, Gagne and Briggs (1979) expressed the belief that there must be nine events of instruction. The internal learning processes (expressed in terms of cognitive theory) and external instructional events that he has postulated are listed below: The internal learning processes are: alertness; expectancy; retrieval to working memory; selective perception; semantic encoding; retrieval and responding; reinforcement; cueing retrieval; generalizing. While the external instructional events are: gaining attention; informing learner of lesson objective; simulating recall of prior learning; presenting stimuli

with distinctive features; guiding learning; eliciting performance; providing informative feedback; assessing performance; enhancing retention and learning transfer.

The implication of these theories and innovations on instructional development are two folds. They stress the importance of entry behaviour that will provide necessary clues in the instructional process and an instructional programme that is activity oriented, both of which are preconditions for effective performance. Attendant to this is the function of motivating the willingness of the learner to play the leading role of reconstruction. An attractive and interesting instructional device that will present challenging learning tasks to the students in an innovative manner will promote effective learning performance. This device is the computer.

The theoretical framework for concept mapping will be advanced using the cognitive learning theory of David Ausubel. Ausubel (2000) proposed the idea of meaningful learning. Teachers can encourage meaningful learning by using tasks that actively engage the learner in searching for relationship between her/his existing knowledge and the new knowledge. Cognitive theorists focus on how to engage learners' cognitive processes during learning. The theory emphasizes the importance of individual knowledge construction. The consequence of this is the use of meta-cognitive strategies. One of such strategies is concept mapping.

Constructivists viewed that knowledge is a construction of reality, that learners are active and proactive in the process of learning. Learning should involve many interconnected pieces of information. New pieces of information are added to this connected set of ideas and become interrelated to the information that is already there. This forms a massive web of ideas and leads the learner to related information that becomes integrated as personal knowledge. (Novak and Gowin, 1984). The learner has to make the assimilation of new concepts into existing cognitive structures in order for learning to be meaningful. Therefore, to acquire meaningful learning, the learner requires a deliberate effort to relate new

knowledge to relevant concepts he already possesses, concept mapping is one of the instructional strategies that can foster meaningful learning.

Learning Theories and Technology Integration

The world we live in has become a technical world. Nearly all aspects of society have been influenced by technology (Fouts, 2000). The fact that virtually all segments of society have changed dramatically by information technologies and will continue to change in the future cannot be ignored. Schools must be a part of these changes and research should proceed with the assumption that technology is and will continue to be a growing element within schools (Fouts, 2000).This is the main reason the student population is so interested in the use of technology. It is impossible to grow up in a world that has become technological in nature and not be influenced by it. The world we live in has been changed dramatically by information technologies. The world is increasingly sophisticated, multifaceted and nuanced. People need high-level learning skills to respond, learn and adjust to ever-changing circumstances. As the world grows increasingly complex, success and prosperity will be linked to people's ability to think, act, adapt and communicate creatively (Stratham &Torell, 1996).

In order to prepare students for the demands of this new century change in the way teaching and learning occurs must take place. Learning environments must become more authentic, by giving students the opportunities to use higher order thinking and problem solving skills connected to real world applications (Fouts, 2000). It is this need along with the change in the current student population that has led to the rethinking of learning theories and the revamping of learning environments. These new theories whose foundations are based on older educational theories are vastly different in their methods of teaching and learning.Technology integration, if done properly, can do many things to help in the process

of creating more authentic learning environments and more. If the learning environment is technologically rich, it can increase self-esteem and enthusiasm for learning (Fouts, 2000). This can lead to more positive attitudes for learning, as well as lower absentee and dropout rates. In fact, having a more technologically rich learning environment eventually lead to a higher rate in college attendance and scholarships (Stratham &Torell, 1996). Technologically rich learning environments provide for better development of life skills. These skills include organizational, problem solving, inquiry, and collaboration skills. The learning environment is improved by providing more cooperative learning and reduced competition (Stratham andTorell, 1996). Research also has shown that technology integration increases the chance of interaction within the learning environment (Keengwe, 2008). Because many new technologies are interactive, it is now easier to create environments in which students can learn by doing, receive feedback, and continually refine their understanding and build new knowledge (Fouts, 2000). It is these new environments, which have so much interaction between the participants in the learning community, that emerging theories on learning support and try to create.

Emerging theories that support the use of technology and help to create more authentic learning environments

Situated cognition

Situated Cognition is a learning theory which supports the idea that learning occurs only when situated within a specific context. It believes that learning takes place in a learning community or community of practice, where the learners take an active role in the learning community. It involves a process of interaction between the learners within the community, the tools available within the specific situation and the physical world. It is within this active participation, this interaction (whether with tools, artifacts or other people), where knowledge is located. Therefore knowing evolves as the learners participate and interact within the new

situation. Cognition is linked to the action the learners in the community take, whether it is physical in nature or a reflective process within the learners themselves (Myers & Wilson, 2010). The development of knowledge and competence, like the development of language, involves continued knowledge-using activity in authentic situations (Myers & Wilson, 2010). Situated Cognition also takes into account the culture of the community at large and "treats culture as a powerful mediator of learning and practices, both for students and teachers (Myers and Wilson, 2010).Basically, a program based on this theory will not be successful if the larger communities, outside the learning environment, culture is not considered, as it can define what may be possible within the learning environment (Myers & Wilson, 2010). The main points to remember about situated cognition are that knowing, learning and cognition are social constructions, expressed in actions of people interacting within communities (Myers and Wilson, 2010). Therefore without action there is no learning.

So what is the role of technology within this emerging theory of learning? As stated above action needs to take place in order for cognition to occur. This action must take place within a community of practice or learning community. This action often involves interaction between tools and or artifacts that are situated in the community (Myers & Wilson, 2010). These tools and or artifacts are invaluable parts to the learning system. Without these parts the interactions that they produce, assist or motivate, may not occur. Therefore technology in this learning theory is a piece of the learning environment that helps to bring about cognition. These tools and constructed environments constitute the mediums, forms, or worlds through which cognition takes place. Problem solving involves reasoning about purposes in relationship to the resources and tools which a situation affords (Myers & Wilson, 2010).

DistributedCognition

In distributed cognition, the student is afforded more power. In other words it is a student centered approach to learning where the learners participate in a systematically designed learning environment that supports interaction amongst its participants. Distributed cognition describes a construction of knowledge that takes place in a natural environment which is synergistically connected to the cognitive actions taken by the participants in the learning environment (Bell & Winn, 2010). This theory promotes learning in a community of learners or a system where interaction takes place. It is through this interaction where cognition occurs. Distributed Cognition requires sharing of cognitive activity among the parts and participants of this system, which can be other people or artifacts such as devices, technologies or media. These participants distribute their cognition among other learners and physical or digital artifacts by externally representing their knowledge. Artifacts can help to scaffold new capabilities as well as off-load a certain amount of cognitive work thus reducing the cognitive load of the learners and helping to augment their capabilities. At times, by using these artifacts, a little bit of the information might stick with the user, this is known as cognitive residue. It is through interaction with other members and artifacts that progresses learning (Bell & Winn, 2010).

The role of technology within this theory is an invaluable part of the system in which the learners are interacting. This interaction can either help to distribute their knowledge, off-load certain amounts of cognitive work making the cognitive load less and or help to scaffold new capabilities (Bell and Winn, 2010). In this theory, technology (artifacts and or tools) can be used to help extend human capabilities. An example of this might be the use of manipulatives in the early development of basic addition skills (Bell & Winn, 2000). The problem might be too complex for the child to solve, but with the use of the manipulative, they can visually represent their thinking and use the tool to help them solve the problem. Another example of this is taken from a case study that was conducted using robotics to produce solving problem

skills. In this case study, students were placed into small collaborative groups and were asked to construct a robot, using Lego Mindstorm for schools kits, which would perform various tasks. The groups were introduced to a tool known as a flowchart. They used these flowcharts to map the programming instructions they would give the robot to complete the given task. This allowed them to off-load some of the cognitive work to the flowchart and then through its use, they were able to solve harder problems (Chambers, 2007). The above example shows that cognition takes place because of the cognitive abilities of the learner plus the augmentation of these capabilities by the use of the external technology (Bell & Winn, 2010).

Socially shared cognition

In Socially-Shared Cognition learners are participants in a community where the cognition is shared between the participants, the artifacts and tools they are using and the social institutions in which the learning occurs (Brown & Cole, 2000). The learners of this community are required to be active participants in order for cognition to occur (Bell & Winn, 2010). In this theory, cognition is also distributed, as sharing implies both that the learners are experiencing something together and that the learning which occurs is being divided and distributed between the participants in the learning community (Bell & Winn, 2010). These ideas of sharing are relevant to this theory because no two learners can ever experience a situation in the exact same way as another learner. To say that cognition is socially shared is to say that it is distributed (among artifacts as well as people) and that it is situated in time and space. Because it is distributed, and its assembly requires the active engagement of those involved, it is to some extent constructed (Brown & Cole, 2010).

Technology plays a part in this theory by being something which helps to share the cognition in the community of learning. In one example a computer and the games the children play on it, are at the heart of the system. The participants make use of the games as

the core activities for the learning of new skills. While the games are regular off the shelf type of games for computers, they are changed by a make believe activity system. In this system there are specific tasks set for the children to accomplish, many of which involve communicating with others in the learning community, either orally or in written format (Brown & Cole, 2010). The use of this learning theory could help to prepare our students for their lives in this new world.

Shared aspects of these learning theories

All of the above emerging theories share many of the same aspects. One strong aspect is they all suggest that learning occurs best in a community of learning or practice. The word community implies that the people within it are taking an active part in the process of learning. They all support communication amongst the learners and interaction with others, artifacts, and tools in order to assist cognition. In these theories technology plays an integral part, either by helping to assist the learning of new skill by providing scaffolding or by off-loading some cognitive work to make the learning process easier. These technologies may also help to maintain the vital interaction amongst the learners within the community. It is this interactive environment where the students are learning by doing, communicating and receiving feedback which helps to bring about the skills desired. All of the above mentioned theories help to create a learning environment which allows participants to use their knowledge and skillsby thinking critically, applying knowledge to new situations, analyzing information, comprehending new ideas, communicating, collaborating, solving problems, making decisions (Honey, 2003).

Technology has made a huge impact on people's lives. This impact has affected every aspect of society. It has also had an impact on the current student population. It has made our world increasingly complex which has changed the requirements for people entering into the work force. This change has made it necessary to create learning

environments which support higher level thinking skill development. Technology integration has also been shown to help create more authentic learning environments where the students are more motivated to attend, have a greater chance of communication and collaboration and have more opportunities to use higher order thinking and problem solving skills connected to real world applications (Fouts, 2000). This has led some to believe that new theories in learning needed to be developed that would help to support the creation of such learning environments. The three emerging theories discussed all possess the ability to support the creation of such learning environments. They all support the idea that learning is through action. They all support that cognition happens through communication and collaboration with others. They all support the use of technology to help in the creation of such learning environments. It is through these new theories that learning environments, which support the development of these higher-level learning skills, can be created.

2.4 Review of Empirical Studies

2.4.1 Empirical studies on Computer-Based Concept Mapping

Very few research work known to the researcher has been carried out onthe effectiveness of different modes of computer-based concept mapping instructional strategy for teaching physics in Nigeria.Chien-hsuntie(2007), carried out a study on integrating informationtechnology into instruction and computer-assisted concept mapping learning insocial studies. Four seventh-grade classes were involved in a quasi-experimentusing the pretest-posttest non-equivalent group design. According to the results,the conclusions are as follows: Integrating Information Technology Instruction (IITI) had positive and significant effects on the students social studies learning achievement,but didn't on learning retention; Computer Assisted Concept Mapping Learning (CCML) had positive andsignificant effects on the students' social studies learning; The students had positive responses to the use of IITI and CCML in social studies learning.

Yusuf and Afolabi (2010), investigated the effects of computer assistedinstruction on secondary school students' performance in biology. Also theinfluence of gender on the performance of students exposed to computerassisted instruction in individualized or cooperative learning settings wasexamined. The research was a quasi-experimental involving a 3*2 factorialdesign. The students pre-test and post test scores were subjected toAnalysis of Covariance (ANCOVA). The findings of the study showed that theperformance of students exposed to CBI either individually or cooperativelywere better than their counterparts exposed to conventional classroominstruction. However, no significant difference existed in the performance ofmale and female students exposed to CAI in either individual or cooperativesettings.

Agbo (2011), investigated the effect of activity techniques on SS II students' academic achievement in Physics. A quasi-experimental design was applied on 154 respondents (students) from four schools (two rural and two urban schools respectively) in Makurdi LGA. Three research questions and null hypotheses were formulated. Mean and Standard Deviation were used to analyzed the data with respect to the research questions while t-test was used to test the hypotheses. The results showed that although both teaching methods (lecture and demonstration) employed on the control and experimental group respectively exerted positive influence on the academic achievement of the students from the tests administered, the experimental group achieved more, implying there is a significant difference in the academic achievement of students taught Physics using lecture method and those taught using demonstration method.

Sani (2011), carried out a study on the effects of computer assisted concept mapping (CACM) and digital video instruction (DVI) instructional strategies on student's achievement in chemistry. A quasi experimental design, specifically the non-randomized control group design involving three intact classes was used. The sample of the study consisted of 210

senior secondary two (SSII) chemistry students from three government owned secondary schools drawn using purposive and simple random sampling techniques from 16 government schools that offer chemistry in Chanchaga and Bosso local government areas of Niger State. The three schools were assigned to the two experimental groups CACM and DVI and one control group (LM). One instrument, the Chemistry Achievement Test (CAT) was developed, validated and employed.Mean and standard deviations were used to answer the research questions. Hypotheses were tested using Analysis of Covariance (ANCOVA), at 0.05 level of significance. The result of the analysis indicated that CACM and DVI had significant effects on student's achievement in chemistry, but students in the CACM group achieved more.

Lou, Wen and Tseng (2013) investigated the effects of integrating concept mapping into computer assisted instruction in chemistry learning achievement. Quasi-experimental design was adopted. Two classes of first grade students at a comprehensive high school were chosen, one as experimental group and thLoe other class as the control group. The time period of the intervention was eight weeks. The study revealed that: the chemistry achievement of the students in the experimental group was significantly better than that in the control group; there was no significant difference in the academic achievement and learning retention between genders in the experimental group.

Gambari, Ezenwa and Anyanwu (2014) examined the effects of two modes of computer-assisted instructional package on solid geometry achievement amongst senior secondary school students in Minna, Niger State, Nigeria. The study adopted a pretest-posttest experimental design with 3 x 2 factorial design. Computer-Assisted Instructional package of two modes; Animation with Text (AT), and Animation with Narration (AN) were employed as treatment instruments and a Solid Geometry Achievement Test (SGAT) was used as test instrument. Analysis of Variance (ANOVA) and t-test was used in analysing data collected. The study revealed that, there were significant differences in the post-test mean

scores of CAI(AT), CAI(AN) and the control group and the Scheffe's post-hoc test revealed a significant difference between CAI(AN) and the lecture method groups, favoring CAI(AN).

Pei-Lin and Chiu-Jung (2014) investigated the effects of computer-assisted concept mapping on English for Foreign Language (EFL) students English reading comprehension. Ninety four freshmen who took the English course were divided into low-level and high-level group according to their English proficiency. Computer Assisted Concept Mapping strategy was introduced to the learners in the class to improve their reading ability. Through the analysis of ANOVA, the result showed that the effect of computer-based concept mapping reading strategy has more benefit on the high-level group than that on the low-level one.

Gambari and Shittu (2016) investigated the effectiveness of blended learning and E-learning modes of instruction on the performance of undergraduates in Kwara State, Nigeria. It also determined if the student performance would vary with gender. Quasi experimental that employs pretest, posttest, control group design was adopted for this study. This involves three groups, two experimental (blended learning, and E-learning) and a control group (traditional teaching method). Educational Materials and Methods Performance Test (EMPT) was used for data collection. Findings of this study showed that there was significant difference in the performance of the three groups in favour of Experimental group 1 (Blended learning).

2.4.2 Empirical studies on gender influence on Academic Performance inScience

Although many empirical researches on the influence of gender onStudents' achievement are conflicting and inconclusive, most of the literaturereviewed showed that male students still perform relatively better than their female counterpart in science.

Adigun, Irunokhai, Sada and Adesina (2015) studied the relationship between student's gender and academic performance in computer science in New Bussa, Borgu local government of Niger state. Questionnaire with items drawn from Senior School Certificate

Examination past questions as set by the West Africa Examination Council in 2014 multiple choice past question was used as the research instrument. The questionnaire was administered to students from both private and public schools in the study area. The students' responses were marked and scored, afterward analysed using independent t-test. The results of the study showed that even though the male students had slightly better performance compared to the female students, it was not significant.

Gambari (2017), investigated the effects of video type instructional packages on the achievement of students in the mathematics among senior secondary schools in Minna, Nigeria. The study adopted quasi-experimental design. Five research questions and corresponding hypotheses were formulated and tested. 120 students (60 male and 60 female) were randomly selected from four secondary schools that were purposively sampled based on five criteria. The schools were randomly assigned to experimental group I Text + Animation, TA), Experimental group II (Text + Narration, TA), Experimental Group III (Text + Animation + Narration, TAN) and control group (Text Only, TO). The treatment instrument for the study was researchers' developed video type instructional packages on trigonometry concept in Mathematics which was used as treatment. A validated Trigonometry Achievement Test (TRAT) was used for data collection. Data obtained were analysed using ANCOVA and Sidak Post-hoc test. The results revealed that gender were found to have no significant effect in the mean achievement score of students taught using TO, TA, and TN. However, there was a significant difference between male and female students taught Trigonometry with TAN.

Magone (2007) carried out a study on gender differences in response to amathematical performance. Assessment instrument consisting of extendedconstructed response tasks for an ethnically diverse group of middle schoolstudents who reside in low communities was used. The students were enrolledin innovative instructional programme in

which mathematics was taught withemphasis on problem solving, reasoning, conceptual understanding andcommunicating. Mathematically, gender difference was examined using aperformance assessment instrument consisting of extended constructedresponse tasks. From the study, the result suggested that males and femalesseem to have the same response style to the assessment. However, femalesattempted more tasks and displayed the work and justification more completelythan males. Little gender difference existed in rubric scores of the tasks, onefavoured male students and other one favoured females.

Ifamuyiwa (2004), examined the relationship between students' performance in JSS mathematics and SSS Mathematics, further- mathematics and physics. 288 senior secondary school students were selected from 4 public secondary schools in Eti-Osa Local Government Area of Lagos State. Results of the analysis of collected data for the study showed that a significant correlation exists between students' performance in JSS mathematics and their performance in SSS mathematics, further mathematics and physics respectively. A positive relationship was found between JSS mathematics and SSS physics, further mathematics and mathematics respectively. The study further found that while there is no significant gender difference in students' performance in JSS Mathematics, their performance in SSS Mathematics is significant in favour of the boys.

Iwendi (2009), investigated the influence of gender and age on the mathematics achievement of secondary school students in Minna Metropolis, Niger State. 195 students' intact classes selected by stratified random sampling from purposefully selected schools were used. 50 items Mathematics Achievement Test (MAT) was administered to the students. Mean, standard deviations and t-test statistic were used to analyze the data obtained. The findings showed that: younger male students performed better than the younger female students; the older male students performed better than older female students, and no significant difference in the performance of younger and older students (overall).

Agbo (2011), investigated the effect of activity techniques on SS II students' academic achievement in physics. A quasi-experimental design was applied on 154 respondents (students) from four schools (two rural and two urban schools respectively) in Makurdi Local Government Area of Benue State. Three research questions and null hypotheses were formulated. Mean and Standard Deviation were used to analyze the data with respect to the research questions while t-test was used to test the hypotheses. The results indicated that gender has no significant effect on the academic achievement of students taught using demonstration technique.

Inyang (2008), noted that boys achieve better result in science and show more positive attitude to the subject than girls. He went further to enumerate some factors that tend to contribute to this state of affairs:The preferential attention given to boys by teachers and less attention to girls; Teachers tend to reprimand boys more severely than girls, for poor performance in science subject because they expected the boys to do better; Many teachers are not bothered when girls contribute less to classroom discussion because girls seem to be expectedly quiet in nature.

Gbodi (2008) &Olorundare (2008), revealed from their findings thatthere are stereotypical disciplines associated with males and females, for example, the Spartans and theAristocrats of Medieval era taught the males military subjects while the femaleswere taught to learn domestic subjects, all in an attempt to prepare them for their roles in the society. Gender difference is one of the factors affecting learning and many researchers have focused their attention on studies relating to its effect on pupils' performance in science.

Joiner, Messer, Littleton and Light (2006), investigated the effect of gender, computer experience and computer-based problem solving. It examined the effect of software type by comparing children's performance on a male stereotyped version of the software with their performance on a structurally identical, but female stereotyped version of the software. It was

found that girls performed worse than boys on both versions of the software and this effect persisted even when the effect of computer experience was removed. There was also a gender difference in the children's preference. Girls preferred the female version more than the boys and there was also a significant relationship between the girls' preferences and their performance. There was no relationship between the boys' preferences and their performance.

Makrakis and Sawada (2006) conducted a study on gender, computers and other school subjects among Japanese and Swedish students. The study focused on gender, computers and other major schools subjects. The sample consisted of 773 ninth-grade school students both from the municipality of Tokyo. Japan and from Stockholm, Sweden. The measurement of gender-typing of computers and other major school subjects has been done on the basis of three dimensions: usefulness, aptitude and liking. The analysis focused upon the calculation of descriptive statistics and multivariate analysis of variance. In general, regardless of the country, males reported higher scores of usefulness, aptitude and liking to computers and more positive attitudes toward mathematics, and science than girls did. Girls consistently reported that computers, mathematics and sciences were the subjects which were less liked and languages the most liked. The persistence of gender differences in computers, despite a general rise in computer awareness, indicates a failure in the way gender issues are addressed and tackled in schools.

Orabi (2007) examined the gender differences in student academic performance and attitudes toward their education and themselves in an introductory engineering course. Students' academic performance was evaluated by comparing course work scores between the two genders using assignments, projects, exams and class participation. Analysis of the academic performance and attitude of male and female students enrolled in an introduction to engineering course taught by the same instructor was carried out in four semesters. The

results showed that there were no significant difference between mean scores in the academic performance of the genders in the course, and this was evident in the coursework and examination performance analysis. Average marks scored by students of either gender were almost equal. The results also indicated that academic performance in the course was affected by several factors such as student ability, motivation, the quality of secondary education obtained. The female students had a slightly higher overall course grade average than men and outperformed the male students on all class assignments except the final design project. The attitude survey showed that men reported higher gains than women on the technical skills, including confidence on engineering knowledge as a career and problem-solving skills while women indicated higher gains in teamwork and design skills. Female students were able to learn the material as effectively as the male students.

Shashaani (2013), carried out a study on gender-based differences in attitudes of secondary schools students toward computers. Ninth and twelfth grade students from five different school districts in Pittsburgh, Pennslvania, participated in the survey. A significant sex difference in attitudes towards computers was observed. Although both males and females alike were aware of the value and benefits of computers in daily life, girls showed less interest in learning about and using computers. Male and female differences were mostly realized with respect to self-confidence in using computers. Girls reported fear of using computers and feeling helpless around computers. Nevertheless females strongly showed that women have equal competencies in computer use. The results also revealed a strong relationship between students' computer attitudes and their perception of their parents' attitude toward computers. The statistical analysis supported the hypothesis that the differences in attitude (interest, confidence and stereotyping) about computers among girls and boys are significant and reflect gender-role socialization.

Anagbogu and Ezeliora (2007) conducted a research to examine sex differences in scientific performance of boys and girls in some selected secondary schools in Awka Education Zone, in Anambra State using the study of Anagbogu (1988). The boys and girls were assigned to experimental and control groups respectively. The research instrument was a combination of three level tests namely, cognitive skills test, affective skills test, and psychomotor skills test. The three levels were predominantly visual materials related to school science practical materials capable of eliciting student's attention. In order to test the hypothesis the scores of boys and girls were subjected to Analysis of Covariance (ANCOVA) on the pretest and posttest scores. The study showed that girls performed better than boys do using strategies that are human oriented.The influence of gender on pairing (grouping) is another area which has attracted attention. The majority of the research on computer assisted instruction supported that when students are paired with others in a structured format, students' performances are likely to increase, including the low achievers (Lane &Aleksic, 2002).

Adamson (2007) conducted a study on the effect of gender and group gender composition experience of seventh and eighth grade students' work with multimedia programme in Loess Hills interactive. In the study, 127 students were randomly assigned to cooperative instructional groups of five. ANOVA was used on the verbal interaction and attitudinal data to determine if significant difference occurred between male and female in the group varying gender composition. The result of the study showed that gender did not have any significant effect on either interaction or attitude of the students.

Contrary to expectations, other works showed that gender have no bearing on the learning of science. Okeke (2006) tested students in SS II, on the understanding of the concepts like reproduction, transport mechanism and growth, based on the Piagetian psychological method, using videotaped recording, oral interview and open-ended questions,

discovered that there is no significant difference in the performance of both male and female students.Adeniran's study (2001) showed that there was no significant difference in the performance as related to gender when he used 80 students, exposing them to video mediated instruction on ecological concepts. He showed that there was nosignificant difference in their performance as related to gender. Abolade (2000) also showed no significant difference in the mean achievement scores of male and female when taught science concepts using videotaped instruction.

2.5 Summary of Literatures Reviewed

The literatures reviewed above revealed the conceptual framework of science in which the need for science and technology education in Nigeria was reviewed. The review further examined the concept of physics, the importance of instructional media as well as the role of information and communication technology in the teaching and learning process.

Studies on computer based concept mapping instructional strategy and how they affect student's academic achievement were reviewed.It was noted that results of these studies were contradictory and inconclusive.Some authors reported that students taught with computer assisted instruction aswell as concept mapping performed significantly better in some subject areas.

The area of interest in this study is the comparative effect of two different modes of computer-based concept mapping as an instructional strategy and the computer based method using texts and graphics. It is envisaged that the computer based concept mapping instructional strategy would go a long way in enhancing performance more than the computer based method.

The theoretical framework on which the study is being anchored was examined. The Stimulus-Response (S-R) as well as cognitive theories of learning was reviewed. The theories are the Skinner's operant conditioning theory which support the use of teaching machine and

David Ausubel's theory of meaningful learning were looked into. Evidences from various studies on gender-related differences in student's achievement in sciences that were reviewed are inconclusive. Some researchers reported that males are superior to females in science achievement while others found that females outperformed their male counterparts in the sciences. Yet in some other reports, the researchers established that gender is not a significant factor in student's achievement in the sciences. However, from the review, it was observed that many of the studies were focused on some part of science,mathematics, social studies and language education. Not many researchers have looked into the effect of computer based concept mapping instructional strategies on student's academic achievement in physics. In addition, most studies did not examine the comparative effects of computer based concept mapping and conventional lecture method rather they compared either computer assisted concept mapping with traditional lecture method or withother forms of instructional strategies. This underscores the need, not only to explore the comparative effect of computer based concept mappings and lecture method in enhancing achievement in physics at secondary school level, but also the extent to which these effects depend on gender influences.

Furthermore, there are areas of difference between various literature reviewed and the present study. Such differences as geographical scope of the study, sample size, subject area, instructional strategies, computer software,and method of statistical analysis. Most of the studieswere conducted in developed countries and those conducted in Nigeria were carried out in towns different from where this current study will be conducted. Thisstudy therefore examined the effects of computer-based concept mapping instructional strategies on the academic performance of students in physics.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

In this chapter, the techniques and procedures used in carrying out the study is described under the following sub-headings: research design, population of the study, sample and sampling techniques, research instruments, validation of the instruments, pilot testing,reliability of the instruments, control of extraneous variables, experimental procedure, procedure for data collection and procedure for data analysis.

3.2 Research Design

The research designadopted for this study is a quasi-experimental design. It is a pretest, posttest, non-randomized, non-equivalent control group design (Sambo, 2008). A 3 x 2, multiple treatment factorial design was used in this study. This design represents three levels of treatment (computer-based concept mappings using hierarchical and spider modes respectively and computer assisted instruction method; and two levels of gender (male and female). Factorial design allowed the concurrent manipulation of two or more independent variables in order to assess the effects of their interaction on the dependent variable (Kareem, 2003). The illustration of the design is shown in Table 3.1.

Table 3.1: Research Design Layout

Groups	Pretest	Treatment	Posttest
Experimental Group 1	O_1	CBCM (X_1)	O_2
Experimental Group 2	O_1	CBCM (X_2)	O_2
Control Group	O_1	CBI (X_3)	O_2

Key:

O_1: pretest observations on Physics Performance Test of Experimental and Control groups.

O_2: posttest observations on Physics Performance Test of Experimental and Control groups.

X_1: treatment for Experimental group 1 (using CBCM hierarchical model).

X_2: treatment for Experimental group 2 (using CBCM spider model)

X_3: treatment for Control group (using CBI)

CBCM: Computer-based concept mapping

CBI: Computer Based Instruction

The study concerns itself with the following variables; independent variable and dependent variable. The independent variables in this study are the teaching methods and gender. The dependent variable is student's performance in physics concepts.

3.3 Population of the Study

The population for this study consist of all senior secondary two (SSII) physics students in all the senior secondary schools in Kaduna South Local Government Area of Kaduna State. The target population is 3,683 senior secondary school physics students in SS II. This population comprises 1,542 males and 2,141 females (see appendix H).

3.4 Sample and Sampling Techniques

A two-stage sampling technique was adopted. Firstly, a purposive random sampling was adopted to obtain threeprivate secondary schools in Kaduna South Local Government Area of Kaduna State. The schools were purposefully sampled based on equivalence in

(laboratories, facilities and manpower), school location (urban area, Kaduna metropolis), gender composition (mixed schools), well equipped computer laboratories, exposure (students and teachers exposure to the use of computer in their schools).

Secondly, the three sampled equivalent and co-educational schools were randomly assignedto the experimental groupsand the control group. The threeschools are co-educational schools that consist of both male and female students.The study adopted the use of intact class approach where all the students in the class were involved in teaching and testing sessions.Students in the intact classes are stratified along gender (male and female). The schools selected to be used in this study are tagged as school A, B and C respectively.The total number of students that wereused for this study from the three sampled schools is 110. The sample is illustrated in table 3.2.

Table 3.2: Distribution of Sample for the Study

School	Number of SS II Physics Students		
	Male	**Female**	**Total**
A	16	14	**30**
B	16	20	**36**
C	25	19	**44**
Total	**57**	**53**	**110**

Source: Field survey (2017)

3.5 Instrumentation

The instrument used in collecting data in this study is researcher adapted Physics Performance Test (PPT). The Physics Performance Test (PPT) consists of 20 multiple choice items adapted from past examination questions of West African Examination Council (WAEC) and National Examination Council (NECO) from 2011 to 2016. The Physics

Performance Test (PPT) is based on SSII curriculum on the concepts of: Centre of gravity and Newton's laws of motion.

These chosen topics were selected from the senior secondary two (SSII) physics syllabuses and scheme of work and correspond to what the students should be taught in their schools at the time of the study. Each item of the instrument is a multiple choice question with four options (A-D) as possible answers to the question. Only one of the four options was the correct answer. The students responded to the instrument in two sections. The first part (section A) is for eliciting information on the students' personal data, while section B contains multiple-choice objective questions for students to answer. This was administered to the experimental groups and control group as pretest and posttest. To reduce the effect of pretest and posttest, the questions were reshuffled and administered in a different random order in the posttest. On the scoring of the multiple choice items, five (5) marks was awarded for each correct answer and zero (0) mark for each wrong answer. The instrument was scored over 100 (5x20 items).

3.5.1 Development of the Treatment Instrument

The instrumentsused for the treatmentsareThe Computer-Based Concept Mapping Instructional Packages (CBCMIP) and Computer Based Instruction (CBI) package on Physics.They were developed by the researcher and a programmer. The Cognitive theory which integrates technology was employed in designing the packages. In order to prepare students for the demands of this new century change in the way teaching and learning occurs must take place, learning environments must become more authentic, by giving students the opportunities to use higher order thinking and problem solving skills connected to real world applications (Fouts, 2000). Because the commercially produced computer based instructional packages are not common, therewas need for the researcher to design his own package. Even where the commercially made packages are available, they may not be directly relevant to the

topic or objectives to be achieved in a lesson. Moreover, using imported software to implement physics instruction in Nigeria may not be culturally relevant. As a result of this, developing instructional packages for use by the researcher is inevitable.

The instructional packages; Computer Based Concept Mapping Instructional Package (CBCMIP) and Computer Based Instruction (CBI) package consist of two topics; "Newton's laws of Motion" and "Centre of Gravity". The main menu consists of the main topic, some sub-topics, objectives, drills and assignment. They adopted the tutorial modes of the computer-based instruction. They are individualized programmes in which the individuals who are interacting with the computer had to make some entries by clicking available options. The computer-based concept mapping and computer based instructional contents on Physics were placed in a folder on the computer desktop, the student were asked to open the folder named CBCMIP (for the experimental groups)or CBI (for the control group) and then the files in it (named "lesson One" and "lesson two" simultaneously) to commence the lesson. The computer presented information and displayed animation to the learners on each of the sub-units after which the students attempted some multiple choice objective questions. Each of the units were presented by the computer through interaction mode; that is, exposure to information, facts and practice on the topic and immediate response/feedback to the application questions. The students could proceed further or repeat a unit if they were not satisfied with the interaction, also, in the questions/evaluation section, students could only proceed to another question if the previous questions are satisfactorily answered. The students were expected to have 100% mastery of the course content before exiting the package. The production of the package was effected through a team of professionals and specialists including a system programmer and the instructional designer (the researcher).

3.5.2 Validity of Instrument

The developed “Computer Based Instructional Packages on Physics were given to two educational technology experts; the supervisors of this work who are senior lecturers in the Department of Educational Foundation and Curriculum, Ahmadu Bello University, Zaria, a Physics Education Specialist, twoComputer Science specialists and two physics teachers from secondary schools. They determined the appropriateness of the package for teaching the chosen topics/units, clarity and simplicity of the package as well as its suitability for the level of the students, the extent to which the contents cover the topics/units they are meant to cover, possible errors in suggested answers and the structuring of the package. The test items and content of the package were corrected or modified on the basis of suggestions and recommendations of the experts.

The Physics Performance Test (PPT) was given to one physics education expert and two physics teachers from secondary schools. These experts assessed the face and content validity of the instrument in relation to the background of Secondary School Students (SSII). The experts specifically examined the instrument along the following criteria:Clarity of questions asked; Appropriateness of the questions to the students’ level of understanding and experience; Agreement of the items with the test blueprint.

In addition, the experts critically examined all the items in the test instrument with reference to the appropriateness of the content, the relevance of the test items to the content and the extent to which the contents cover the topics/units they are meant to cover. Necessary amendments were made on the instrument based on their suggestions. (Appendix K)

3.5.3 Item Analysis

Each of the test items were analyzed to obtain its facility and discrimination index. Facility index refers to the item difficulty level because if items are too easy or too difficult, then the item is of no use in educational testing of attainment of students. Discrimination index refers to power or ability of a test item to distinguish between good student and a weak

student. A good test item or test instrument should be able to clearly discriminate or differentiate between good and weak students. Test item with facility indices in the range of 30-70% are usually recommended for use (Wood, 1990). The facility index of all the PAT fell between 30-70%.

Discrimination index ranging from 0.30 to 0.49 are described as moderately positive, those above 0.59 to 0.70 are highly positive or has high positive value (Furst, 1958). Following the suggestion of Furst, the test item with discrimination index which falls between 0.30 and 0.70 was included in the PPT for this study. (Appendix J)

The test blue print indicates that the cognitive levels of Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation are represented by the test items/questions of the instrument. The knowledge area has 2 items/questions, comprehension has 4 items/questions, application has 6 items/questions, analysis has 4 items/questions, synthesis has 2 items/questions and evaluation has 2 items/questions respectively (See Appendix B).

3.5.4 Pilot Testing

A pilot test was conducted in the study to ascertain the reliability and suitability of the physics performance test instrument and the computer-based instructional packages. The pilot test was carried out using twenty (20) students which were randomly sampled from Blessed Comprehensive College in Kaduna. Though this sample is part of the population of this study, but not part of the sample for this study. The Physics Performance Test (PPT) was administered before a field test trial was carried out using the same students; the trial served as the treatment (usingthe Computer-based Concept Mapping Instructional Package)to teach the students, after which a post-test was administered to the subjects.

3.3.5 Reliability of Instrument

After the Pilot Testing, the result of the test was analyzed using theKuder-Richardson formula (K-R 20). A reliability coefficient of 0.9 was obtained. This means that the test

instrument is reliable. Also, the mean performance in the post-test scores is slightly above that in the pre-test scores of the students, this justifies the use of the instructional package. (See Appendix I)

3.6 Procedure for Data Collection

The researcher visited the schools to check the facilities available in the schools. Also an approval was sought from the school authorities to carry out the study. The cooperation of the students and the staff in all selected schools were sought. The subject teachers were trained as research assistants in the use of the computer-based concept mapping instructional strategies. The study lasted for four weeks. There was orientation with the physics teachers, and students in each of the three schools that were involved in the study. This training and demonstration sessions on the procedure for carrying out the experiment lasted for one week.The training was done in each school according to the type of treatment that was given to such schools. The teachers and students were adequately briefed, trained and have demonstrated competence in the successful implementation of the Operational Guides to Instruction (OGI) (Appendix G).

During the second week, before the commencement of the experiment, the Physics Performance Test was administered on the sample in both experimental groups and the control group for the study as pre-test. The main objective of administering the pretest was to ascertain the academic equivalence of the students in Physics before the commencement of the experiment.In carrying out these activities, one physics teacher from each of the threeselected schools was employed to administer the pre-test at the appropriate time for each of this test.

During the experiments, three different treatments were applied. The treatment lasted for two weeks. The experiment was conducted using the schools timetables and at their normal lesson periods. Immediately after the treatment ends, posttest was administered to

measure performance of the sampled students in each school. The posttests (Physics Performance Test (PPT) was reshuffled and administered after the experiments. The test was conducted in all the selected schools for the study at the same time and the scripts were collected immediately for marking.

Experimental Groups 1 and 2: The computer based concept mapping instructional strategy (CBCMIS) using hierarchical and spider modesrespectively was used here. The classes were taught the concepts using the Computer Based Instruction (CBI) package. The computer presented instructions interactively with one student at a time only. Some students entered in sets depending on the number of computers available for use but they use the computers in an individualized sequence, and then proceeded at their own pace, within a maximum time of 40 minutes per lesson. Sets of questions were be given to the students via the computer after the instruction and the students provided answers to the questions without any teacher's or peer interaction. The teacher's role was to monitor the activities of the students so as to ensure strict compliance with instructions of non-interaction among members.

Control Group: The Computer Based Instruction method was used here. This took the shape of computer assisted instruction but concept mapping was not involved. This lesson was presented via the computer to individual students and in some cases in groups. The content of the lecture was the same as that of the computer-based concept mapping instructional package on Physics.

At the expiration of the treatment, the items in the Physics Performance Test (PPT) were reshuffled and re-administered to the students.The scores obtained from the second administration served as post-test scores in the study. The essence of item reshuffling was to distract the students from realizing that they had responded to such test items in the past.

3.7 Procedure for Data Analysis

The data obtained from the pre-test and post-test were marked and subjected to data analysis. The research questions were answered using mean and standard deviation while the hypotheses for the study were tested using ANCOVAwith Statistical Package for Social Sciences (SPSS) version 21. The significance of the various statistical analyses were ascertained at 0.05 alpha levels of significance. This choice of ANCOVA was to control errors of initial non-equivalent arising from the use of intact classes as subjects for the study.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

This chapter presents the analysis of data collected from administration of pre-test and post-test using Physics Performance Test (PPT). Descriptive statistics using mean and standard deviation were used to answer the three research questions while the hypotheses were tested using Analysis of covariance (ANCOVA) at 0.05 alpha level of significance.

4.2 Analyses of Research Questions

The study was guided by the search for answers to the three research questions raised in chapter one of this study. These research questions are answered as follows:

Research Question 1

What is the difference in the performance of students taught physics using computer-based concept mapping strategies and those taught using computer based instruction?

In answering research question one, mean scores of students in the experimental groups (computer-based concept mapping using hierarchical and spider modes) and the control (computer based instruction) groups were analyzed using mean and standard deviation as shown in Table 4.1.

Table 4.1: Mean and Standard Deviations of Students Scores Using Computer Based Concept Mapping Strategies and Computer Assisted Instruction

Group	N	Pre-test		Post-test		Mean Gain
		Mean	SD	Mean	SD	
CBCM (Hierarchical)	30	49.50	11.55	77.17	10.80	27.67
CBCM (Spider)	36	47.22	11.24	76.81	10.22	29.59
CBI	44	43.52	12.92	75.34	10.91	31.82

Table 4.1 showed the mean and standard deviation of the pre-test and post-test scores of all students in the experimental and control groups. From the result, it can be deduced that the mean score and standard deviation of the pre-test for the Computer-Based Concept Mapping (CBCM) of students in Hierarchical group are 49.50 and 11.55 while the mean score and standard deviation of the same students in the post-test are 77.17 and 10.80. The mean gain is 27.67 in favour of the post-test scores. Similarly, the mean score and standard deviation of the pre-test for the CBCM of students in Spider group are 47.22 and 11.24 while the mean score and standard deviation of the same students in the post-test are 76.81 and 10.22 respectively. The mean gain is 29.49 in favour of the post-test score. Also, the mean score and standard deviation of the pre-test for the CBI of students in Control Group are 43.52 and 12.92 while the mean score and standard deviation of the same students in the post-test are 75.34 and 10.91. The mean gain is 31.82 in favour of the post-test scores.

Research Question 2

What is the difference between the performance of male and female students taught physics using hierarchical mode of computer-based concept mapping instructional strategy?

In answering research question two, mean scores of male and female students in the experimental group 1 (computer-based concept mapping using hierarchical mode) were analyzed using mean and standard deviation as shown in Table 4.2.

Table 4.2: Pre-test and Post-test Scores of Male and Female Students taught Physics using

Hierarchical mode of computer-based concept mapping strategy

Group	N	Pre-test		Post-test		Mean Gain
		Mean	SD	Mean	SD	
Male	16	49.69	13.48	77.50	11.40	27.81
Female	14	49.29	9.38	76.79	10.49	27.50

Table 4.2 showed the mean and standard deviation of the pre-test and post-test scores of male and female students in the experimental group 1 (CBCM hierarchical). From the result, it can be deduced that the mean score and standard deviation of the pre-test for the male students are 49.69 and 13.48 while the mean score and standard deviation of the same students in the post-test are 77.50 and 11.40. The mean gain is 27.81 in favour of the post-test scores. Similarly, the mean score and standard deviation of the pre-test for the female students are 49.29 and 9.38 while the mean score and standard deviation of the same students in the post-test are 76.79 and 10.49 respectively. The mean gain is 27.50 in favour of the post-test score. Therefore, male students (27.81) had a higher mean gain score than the females (27.50).

Research Question 3

What is the difference in the performance of male and female students taught physics using spider mode of computer-based concept mapping instructional strategy?

In answering research question three, mean scores of male and female students in the experimental group 2 (computer-based concept mapping using spider mode) were analyzed using mean and standard deviation as shown in Table 4.3.

Table 4.3: Pre-test and post-test scores of male and female students taught physics using spider mode of computer-based concept mapping strategy

Group	N	Pre-test		Post-test		Mean Gain
		Mean	SD	Mean	SD	
Male	16	44.06	12.55	74.06	10.36	30.00
Female	20	49.75	9.66	79.00	9.81	29.25

Table 4.3 showed the mean and standard deviation of the pre-test and post-test scores of male and female students in the experimental group 2 (CBCM spider). From the result, it

can be deduced that the mean score and standard deviation of the pre-test for the male students are 44.06 and 12.55 while the mean score and standard deviation of the same students in the post-test are 74.06 and 10.36. The mean gain is 30.00 in favour of the post-test scores. Similarly, the mean score and standard deviation of the pre-test for the female students are 49.75 and 9.66 while the mean score and standard deviation of the same students in the post-test are 79.00 and 9.81 respectively. The mean gain is 29.25 in favour of the post-test score. Therefore, male students (30.00) had a higher mean gain score than the females (29.25).

4.3 Null Hypotheses Testing

Hypothesis One

HO_1: There is no significant difference in the mean performance of students taught physics using computer-based concept mapping strategies and those taught with computer based instruction.

Table 4.4: ANCOVA results of the treatment groups (CBCM and CBI)

Source	Type III Sum of Squares	df	Mean Square	F-value	p-value
Corrected Model	1343.845[a]	3	447.948	4.360	.006
Intercept	26383.944	1	26383.944	256.813	.000
Pre-test	1271.673	1	1271.673	12.378	.001
Groups	3.304	2	1.652	.016	.984[ns]
Error	10890.019	106	102.736		
Total	652925.000	110			
Corrected Total	12233.864	109			

ns: Not significant at 0.05 alpha level

Table 4.4 shows the ANCOVA results of the two experimental groups (CBCM Hierarchical, CBCM Spider) and the control group (CBI). As illustrated in the table, F(2, 106) = 0.016, p = 0.984. This implies there was no significant effect of the learning strategies on post-test performance of the students. The result indicates that the treatments using CBCM and CBI accounted for no difference in the post-test achievement scores of the students. Hence, hypothesis one is not rejected.

Hypothesis Two

HO_2: There is no significant difference in the mean performance of male and female students taught physics using hierarchical mode of computer-based concept mapping instructional strategy.

Table 4.5: ANCOVA results of male and female students in experimental group 1 (CBCM Hierarchical)

Source	Type III Sum of Squares	df	Mean Square	F-value	p-value
Corrected Model	252.394[a]	2	126.197	1.088	.351
Intercept	6256.675	1	6256.675	53.941	.000
Pre-test	248.584	1	248.584	2.143	.155
Gender	2.799	1	2.799	.024	.878[ns]
Error	3131.773	27	115.992		
Total	182025.000	30			
Corrected Total	3384.167	29			

ns: Not significant at 0.05 alpha level

Table 4.5 shows the ANCOVA results of male and female students in experimental group 1 (CBCM hierarchical). From the result, F(1, 29) = 0.024, p = 0.878. This implies that

there is no significant difference in the mean performance of male and female students taught physics using hierarchical mode of computer-based concept mapping instructional package. Hence, hypothesis two is not rejected.

Hypothesis Three

HO_6: There is no significant difference in the mean performance of male and female students taught physics using spider mode of computer-based concept mapping instructional strategy.

Table 4.6: ANCOVA results of male and female students in experimental group 2 (CBCM spider)

Source	Type III Sum of Squares	df	Mean Square	F-value	p-value
Corrected Model	694.769[a]	2	347.385	3.869	.031
Intercept	6550.784	1	6550.784	72.962	.000
Pre-test	478.068	1	478.068	5.325	.027
Gender	74.976	1	74.976	.835	.367[ns]
Error	2962.870	33	89.784		
Total	216025.000	36			
Corrected Total	3657.639	35			

ns: Not significant at 0.05 alpha level

Table 4.6 shows the ANCOVA results of male and female students in experimental group two (CBCM spider). From the result, $F(1, 35) = 0.835$, $p = 0.367$. This implies that there is no significant difference in the mean performance of male and female students taught physics using spider mode of computer-based concept mapping instructional package. Therefore, hypothesis three is not rejected.

4.4 Summary of Findings

1. Hypothesis one revealed that there was no significant difference in the performance of students exposed to computer based concept mapping hierarchical mode, spider mode and those taught with computer based instructional package.
2. Hypothesis two revealed that there is no significant difference in the mean performance of male and female students taught physics using hierarchical mode of computer-based concept mapping instructional package.
3. Hypothesis three revealed that there is no significant difference in the mean performance of male and female students taught physics using spider mode of computer-based concept mapping instructional package.

4.5 Discussion of the Findings

The findings of this study are discussed under two major sub-headings; the effect of treatment and the effect of gender on students' performance in Physics.

4.5.1 Effect of Treatment on Students' Performance in Physics

The findings of this study revealed that the use of computer-based concept mapping instructional strategy had no significant effect on students' performance in physics. This finding disagree with that of Tan and Seng (2000) who found out that computer assisted concept mapping enhanced students achievement in chemistry. The findings also contradicts the results of Lou, Wen and Tseng (2013) who investigated the effect of integrating concept mapping into computer assisted instruction in chemistry learning achievement and found out that the students in the experimental group who were treated with computer assisted concept mapping achieved significantly better than those in the control group. The finding is in agreement with the findings of Yusuf and Afolabi (2010), Tang and Seng (2008) and Wongasit (2006) who reported from their studies that computer assisted instruction had significant effect on students' performance in science.

The use of computer as a medium of instruction may be responsible for no significant difference among the three groups. The trend of performance by the treatment (CBCM) group could be as a result of self-evaluation and remedial activities provided by (CBCM) which helped students to master the physics concepts without much difficulty. It could also be as a result of excitement over the use of computers, and individualized learning by the students that cater for individual difference. Furthermore, the pictorial representations and concept maps provided by the computer can be a factor that contributed to the better performance of the groups.

4.5.2 Effect of Gender on Students' Performance in Physics

The study revealed that both the hierarchical and spider modes of Computer-Based Concept Mapping has no significant effect on gender. This finding is in agreement with the findings of Lou, Wen and Tseng (2013), who found out that there was no significant difference in the academic achievement and learning retention between genders in the experimental group (using concept mapping strategies). Gambari (2017) study which revealed no significant gender difference existed between the male and female students is also in tune with this study. Also, the result is in agreement with the findings of Agbo (2011), who found out that while there is no significant gender difference in students' performance in JSS Mathematics, their performance in SSS Mathematics is significant in favour of the boys. Furthermore, the results from the studies carried out by Adigun (2016) showed that gender did not have any significant effect on either interaction or attitude of the students. This is therefore in agreement with the present study.

The findings from the study disagrees with that of Adamson (2007) and Gambari, Ezenwa and Anyanwu (2014) who discovered that the male students tend to perform better than the female students especially in some mathematics and science concepts.These differences may be due to the fact that male students have similar response styles different

from the females; they prefer activity based lectures. This was also in tune with the claim of Inyang (2008), who noted that boys show more positive attitude to science subjects than girls. Furthermore, the preferential attention given to boys by teachers and less attention to girls; teachers tend to reprimand boys more severely than girls, for poor performance in science subject because they expected the boys to do better; Many teachers are not bothered when girls contribute less to classroom discussion because girls seem to be expectedly quiet in nature.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter present the summary of the study, conclusion drawn from the findings and recommendations based on the findings of this study.

5.2 Summary

The growth and development of most nations are highly dependent on science, technology and mathematics. A number of studies done in Nigeria have reported student's under-achievement in science and technology related subjects like chemistry, biology and physics. This explains why some science, technology and mathematics education researchers, among others, have in recent times concentrated their research efforts on finding teaching strategies that promotes teaching and learning of science so as to increase achievement and enrolment in science. Consequent upon the foregoing, this study sought to explore the effects of computer-based concept mapping (CBCM) instructional strategies on student's academic performance in physics. Two modes of CBCM instructional strategies (hierarchical and spider) were explored.

The study also examined the influence of gender on student's performance in physics when taught using the two mode (hierarchical and spider) of CBCM. To give a sense of direction to the study, three research questions were raised and corresponding three hypotheses were formulated and tested at 0.05 level of significance.

Related literatures were reviewed under conceptual framework, theoretical framework and review of empirical studies. The review showed among other things, that most of the works done were not on Physics and they were carried out outside the country of the present study.

A quasi-experimental, non-randomized and non-equivalent control group design was used. One hundred and ten students from three senior secondary schools were used as the sample for the study. The students in their intact classes were randomly assigned to the two experimental groups and a control group, and separately taught by the physics teachers who had earlier been trained for the purpose. Identified extraneous variables which could pose potential threat to the validity of the study were controlled. All the groups were pre-tested before the experiment and post-tested after the experiment.

The instrument used for data collection was the Physics Performance Test (PPT). This instrument was adopted from the past examinations of West African Examination Council (WAEC) and National Examination Council (NECO). The instrument was validated by educational technology experts, physics education specialists, physics teachers and computer programmers. The instrument was pilot tested and data obtained were analysed to determine the reliability of the instrument. The data generated from the study were analyzed using mean and standard deviation (SD) and Analysis of covariance (ANCOVA) was used to test all the hypotheses at 0.05 probability level.

5.3 Conclusion

Based on the outcome of the study, the following conclusions were made:

1. The treatments; (hierarchical mode of computer-based concept mapping, spider mode of computer-based concept mapping and computer based instruction) improved students' performance in physics but no significant difference was established on the performance of the students taught using these three modes.
2. There was no significant difference in the performance of male and female students taught with computer-based concept mapping strategies. Therefore, gender is not a militating factor against students' performance in physics when computer-based concept mapping were used.

5.4 Recommendations

Based on the results of this study, the following recommendations were made:

1. Since the use of CBCM in teaching has been found to enhance the quality of performance in physics, physics teachers should be encouraged to employ it more in the teaching of the subject. By so doing, the performance of students in the subject could be increased.
2. Workshops and seminars should be organized for teachers by education authorities of the Federal and State Ministries of Education, Institutes and Colleges of Education on the use of computer-based concept mapping strategies to improve students' performance in Physics.
3. Governments and non-governmental organization should assist in providing functional computers and ICT infrastructure to schools.
4. There should be computer literacy skills for secondary school students.

5.5 Limitations of the Study

The generalizations drawn from this study are subject to the following limitations:

1. The use of only SS 2 students and only two topics from their physics syllabus may affect the generalizability of the findings.
2. The limited number of schools that have well equipped computer laboratories made it difficult for the researcher to use a larger sample. Therefore, the findings of this study should not be generalized for teaching physics in the country.

5.6 Suggestions for Further Studies

The findings of this study had generated some areas for further research. Against this background, further research could be undertaken to:

1. Replicate the present study using a wider geographical area.

2. Examine the effect of CBCM on student performance in other subjects apart from physics.
3. Investigate the effect of CBCM on student performance in other units of physics.

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APPENDIX B
TABLE OF SPECIFICATION OF PHYSICS
PERFORMANCE TEST (PPT)

TOPIC	NO. OF PERIODS (40 mins. each)	TEST SCORE	COGNITIVE PROCESS		TOTAL
			LCP	HCP	
Centre of Gravity	1	50%	4	6	**10**
Newton's Laws of Motion	1	50%	2	8	**10**
Total	**2**	**100%**	**6**	**14**	**20**

KEY: LCP - Low Cognitive Process
- High Cognitive Process

	CONTENT	K	C	AP	AN	S	E	TOTAL
	Centre of Gravity							
1.	The concept of force	1	-	-	-	-	-	**1**
2.	Meaning of centre of gravity	-	1	-	1	-	-	**2**
3.	Factors that affect centre of gravity	-	-	1	1	-	-	**2**
4.	Relation between centre of gravity and stability	-	1	-	-	1	-	**2**
5.	Types of equilibrium and examples	-	1	1	-	-	1	**3**
	Newton's Laws of Motion							
6.	Cause(s) of Motion	1	-	-	-	-	-	**1**
7	Laws governing motion	-	-	1	-	-	-	**1**
8.	Newton's Laws of motion	-	-	1	-	-	-	**1**
9.	Relation between Newton's Law of motion	-	-	-	1	-	-	**1**
10.	Practical applications of Newton's laws of motion	-	1	2	1	1	1	**6**
	TOTAL ITEMS	**2**	**4**	**6**	**4**	**2**	**2**	**20**
	TOTAL (%)	**10%**	**20%**	**30%**	**20%**	**10%**	**10%**	**100%**

Total test items = 20 items or 100%
Knowledge = 2 items or 10%
Comprehension = 4 items or 20%
Application = 4 items or 20%
Analysis = 3 items or 15%
Synthesis = 2 items or 10%
Evaluation = 5 items or 25%

KEY:
K - Knowledge
C - Comprehension
AP - Application
AN - Analysis
S - Synthesis
E - Evaluation

APPENDIX C

PHYSICS PERFORMANCE TESTS (PPT) I AND II

PPT I (PRETEST)

Section A: Personal Data of Respondents

Please tick (✓) *or fill the correct information in this section*

Name of Student: ……

Name of School: ….…….

Sex: Male [ ] Female[ ]

Section B: Instructions

This is a 20-item instrument consisting of questions and options lettered (a) to (d). Circle the letter that answers the question. After you have finished circling the correct letters, return the paper to invigilator. Do not expose your answers to other students please.

Example: Which of these is NOT a fundamental quantity?
(a) Length (b) Mass (c) Velocity (d) Time
The correct answer is (c) (c)

1. What causes motion?
(a) Force (b) Strength (c) Wind (d) Mass

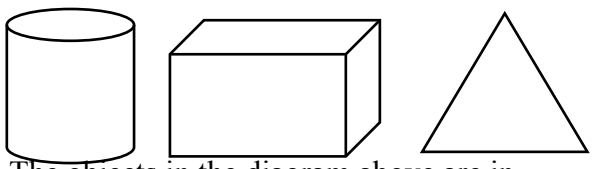
2. A cone resting on its slant height is in ……. Equilibrium
(a) unstable (b) stable (c) neutral (d) normal

3. Forces can be in the form of a pull or a …….
(a) fight (b) push (c) press (d) strike

4. The Newton's laws that relate action and reaction forces is ……..
(a) 1st law (b) 3rd law (c) 2nd law (d) none

5. Every object on earth is under the influence of ……
(a) pressure (b) forces (c) motion (d) sound

6. A deflated balloon demonstrates Newton's ……. Law of motion
(a) 3rd (b) 2nd (c) 1st (d) 4th

7. 
The objects in the diagram above are in ……. Equilibrium
(a) stable (b) neutral (c) unstable (d) free

8. Isaac Newton lived in the …… century
(a) 17th (b) 21st (c) 20th (d) 19th

9. According to Newton's 1st Law, a moving ball can only be stopped by ……..
(a) Defence (b) Force (c) attack (d) blocking

10. Which of these Scientist's works are on motion?
(a) Newton (b) Galileo (c) Paschal (d) Faraday

11. Newton propounded …… laws of motion
(a) two (b) four (c) three (d) five

12. The S. I unit of force is …….
(a) Farad (b) Kelvin (c) Paschal (d) Newton

13. Which of these equations describes Newton's 2nd law of motion?
(a) +F = -F (b) F = mΔv (c) F = ma (d) F = ms

14. ……. and ……. affect centre of gravity of a body.
(a) Weight and Mass (b) Shape and Size
(c) Impulse and Force (d) Force and pressure

15. Forces can be in contact of exist in ……...
(a) push (b) falls (c) pushes (d) fields

16. Centre of gravity of a body is a point at which its resultant …… acts.
(a) mass (b) pressure (c) weight (d) force

17. A uniform metre rule which has a length of 1m has its centre of gravity at the ……
(a) 0cm mark (b) 20cm mark (c) 50cm mark (d)100cm mark

18. Newton's second law of motion can be observed in a …….
(a) catapault (b) game (c) a falling object (d) a hanger

19. The centre of gravity of a circle is at its ……
(a) radius (b) circumference (c) centre (d) diameter

20. …….. is the change in position of a body with time.
(a) Change (b) Motion (c) Gravity (d) Mass

PPT II (POSTTEST)

Section A: Personal Data of Respondents

Please tick (✓) *or fill the correct information in this section*

Name of Student: ……

Name of School: ….…….

Sex: Male [ ] Female[ ]

Section B: Instructions

This is a 20-item instrument consisting of questions and options lettered (a) to (d). Circle the letter that answers the question. After you have finished circling the correct letters, return the paper to invigilator. Do not expose your answers to other students please.

Example: Which of these is NOT a fundamental quantity?
(a) Length (b) Mass (c) Velocity (d) Time
The correct answer is (c) (c)

1. Newton propounded …… laws of motion
(a) two (b) four (c) three (d) five

2. The S. I unit of force is …….
(a) Farad (b) Kelvin (c) Paschal (d) Newton

3. Which of these equations describes Newton's 2nd law of motion?
(a) +F = -F (b) F = mΔv (c) F = ma (d) F = ms

4. ……. and ……. affect centre of gravity of a body.
(a) Weight and Mass (b) Shape and Size
(c) Impulse and Force (d) Force and pressure

5. Forces can be in contact or exist in ……...
(a) push (b) falls (c) pushes (d) fields

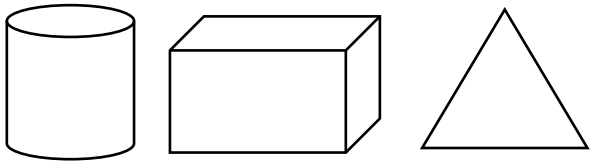
6. A deflated balloon demonstrates Newton's ……. Law of motion
(a) 3rd (b) 2nd (c) 1st (d) 4th

7. A uniform metre rule which has a length of 1m has its centre of gravity at the ……..
(a) 0cm mark (b) 20cm mark (c) 50cm mark (d) 100cm mark

8. Newton's second law of motion can be observed in a …….
(a) catapault (b) game (c) a falling object (d) a hanger

9. The centre of gravity of a circle is at its ……
(a) radius (b) circumference (c) centre (d) diameter

10. …….. is the change in position of a body with time.
(a) Change (b) Motion (c) Gravity (d) Mass

11. 

The objects in the diagram above are in ……. Equilibrium

(a) stable (b) neutral (c) unstable (d) free

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(a) 17th (b) 21st (c) 20th (d) 19th

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18. The Newton's laws that relate action and reaction forces is ……..

(a) 1st law (b) 3rd law (c) 2nd law (d) none

19. Every object on earth is under the influence of ……

(a) pressure (b) forces (c) motion (d) sound

20. Centre of gravity of a body is a point at which its resultant …… acts.

(a) mass (b) pressure (c) weight (d) force

APPENDIX D

MARKING SCHEME FOR PHYSICS PERFORMANCE TESTS

PPT I

Question No.	Answer
1.	A
2.	C
3.	B
4.	B
5.	B
6.	A
7.	B
8.	A
9.	B
10.	A
11.	C
12.	D
13.	B
14.	B
15.	D
16.	C
17.	C
18.	A
19.	C
20.	B

Note: Each question carries 5 marks

Total Marks = 5 x 20 = 100

PPT II

Question No.	Answer
1.	C
2.	D
3.	B
4.	B
5.	D
6.	A
7.	C
8.	A
9.	C
10.	B
11.	A
12.	A
13.	B
14.	A
15.	A
16.	C
17.	B
18.	B
19.	B
20.	C

Note: Each question carries 5 marks

Total Marks = 5 x 20 = 100

APPENDIX E
PRE-TEST AND POST-TEST SCORES OF SUBJECTS

EXPERIMENTAL GROUP 1

EXAM NO.	SEX	PRE-TEST	POST-TEST
001	M	45	65
002	M	65	75
003	M	45	45
004	M	30	80
005	F	55	75
006	M	65	85
007	M	60	80
008	M	55	95
009	M	35	90
010	M	60	85
011	M	45	80
012	F	35	65
013	F	45	65
014	F	60	75
015	F	45	90
016	F	50	90
017	F	50	80
018	F	60	90
019	F	55	65
020	M	45	80
021	M	50	75
022	F	40	85
023	F	40	80
024	F	35	60
025	M	80	85
026	M	35	70
027	F	60	85
028	M	40	75
029	F	60	70
030	M	40	75

EXPERIMENTAL GROUP 2

EXAM NO.	SEX	PRE-TEST	POST-TEST
001	M	45	80
002	M	55	75
003	M	35	60
004	M	35	80
005	M	40	60
006	M	35	60
007	M	80	85
008	M	35	70
009	F	60	65
010	F	40	65
011	F	60	60
012	F	40	75
013	F	50	90
014	F	35	80
015	F	60	90
016	F	45	65
017	F	50	75
018	F	60	90
019	F	55	85
020	F	40	75
021	M	45	75
022	M	40	80
023	M	50	75
024	M	50	75
025	M	25	55
026	M	40	90
027	M	55	85
028	M	40	80
029	F	50	80
030	F	45	90
031	F	30	75
032	F	55	80
033	F	60	80
034	F	50	95
035	F	45	80
036	F	65	85

CONTROL GROUP

EXAM NO.	SEX	PRE-TEST	POST-TEST
001	M	50	80
002	M	45	65
003	M	20	55
004	M	50	70
005	M	45	65
006	M	20	65
007	M	45	75
008	M	40	80
009	M	50	75
010	M	50	75
011	M	25	55
012	M	40	90
013	M	55	85
014	M	40	80
015	F	50	80
016	F	45	90
017	F	30	75
018	F	55	80
019	F	60	80
020	F	50	95
021	F	45	80
022	F	65	85
023	M	30	70
024	M	55	60
025	M	35	75
026	M	35	90
027	F	50	80
028	F	20	90
029	F	40	65
030	F	20	75
031	M	50	90
032	M	35	60
033	M	35	80
034	M	40	60
035	M	35	60
036	M	80	85
037	M	35	70
038	F	60	65
039	F	40	65
040	F	60	60
041	F	40	75
042	F	50	90
043	F	35	80
044	F	60	90

APPENDIX F
COMPUTATION OF MEAN AND STANDARD DEVIATION
FOR RESEARCH QUESTIONS

Mean and Standard Deviations of Students Scores Using Computer Based Concept Mapping and Computer Assisted Instruction.

Group		Pretest	Posttest
Computer-Based Concept Mapping Groups	N	66	66
	Mean	48.36	79.49
	Standard Deviation	22.789	17.73
Computer Assisted Group	N	44	44
	Mean	43.52	75.34
	Standard Deviation	12.921	10.912
Total	N	110	110
	Mean	91.88	154.83
	Standard Deviation	35.71	28.642

Pretest and Posttest Scores of Male and Female Students taught Physics using hierarchical mode of computer-based concept mapping strategy.

		Pretest	**Posttest**
Male	N	16	16
	Mean	49.69	82.19
	Standard Deviation	13.475	7.952
Female	N	14	14
	Mean	49.29	82.14
	Standard Deviation	9.376	7.263
Total	N	30	30
	Mean	98.98	164.33
	Standard Deviation	22.851	15.215

Pretest and Posttest Scores of Male and Female Students taught Physics using Spider mode of computer-based concept mapping strategy.

		Pretest	**Posttest**
Male	N	16	16
	Mean	44.06	74.06
	Standard Deviation	12.546	10.363
Female	N	20	20
	Mean	49.75	79.00
	Standard Deviation	9.662	9.81
Total	N	36	36
	Mean	93.81	153.06
	Standard Deviation	22.208	20.177

APPENDIX G

OPERATIONAL GUIDE TO INSTRUCTION (OGI) FOR COMPUTER-BASED CONCEPT MAPPING AND COMPUTER ASSISTED LESSONS

1. Boot the computer if it is not already booted
2. Right-click the folder named CBCMIP (for experimental groups) or CAIP (for control group) on the desktop, Click Open from the menu that appears.
3. Double-click the file named “Lesson One” or “Lesson Two” (containing the topic to be taught) in the folder, to open it; a screen will appear.
4. Click Objectives; start the lesson by clicking on the prompts as they appear and when necessary.
5. After each lesson, there are drills/practice questions which the student must answercorrectly before the student is allowed to move to the next question.
6. After the drills, there is an assignment question to be answered by the student.

NB: Each stage in the lesson can be repeated or skipped by the student.

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APPENDIX H

TOTAL PRIVATE SENIOR SECONDARY SCHOOLS AND ENROLMENT BY LOCAL GOVERNMENTS IN KADUNA STATE.

LOCAL GOVT. AREA	NUMBER OF SCHOOLS	ENROLMENT		
		BOYS	GIRLS	TOTAL
BirninGwari	-	-	-	**-**
Chikun	75	1,643	1,746	**3,389**
Giwa	3	172	63	**235**
Igabi	12	272	236	**508**
Ikara	-	-	-	**-**
Jaba	2	30	104	**134**
Jema'a	8	237	238	**475**
Kachia	5	114	40	**154**
Kaduna North	47	1,369	1,209	**2,578**
Kaduna South	**50**	**1,542**	**2,141**	**3,683**
Kagarko	2	20	19	**39**
Kajuru	1	4	5	**9**
Kaura	-	-	-	**-**
Kauru	2	4	41	**45**
Kubau	-	-	-	**-**
Kudan	-	-	-	**-**
Lere	4	100	134	**234**
Makarfi	-	-	-	**-**
SabonGari	32	873	777	**1,650**
Sanga	5	112	143	**255**
Soba	-	-	-	**-**
ZangonKataf	4	119	115	**314**
Zaria	19	548	507	**1,055**
Grand Total	**262**	**7,239**	**7,518**	**14,757**

Source: Kaduna State 2016 Annual School Census Report

APPENDIX I

COMPUTATION OF RELIABILITY COEFFICIENT USING KUDER-RICHARDSON (KR-20) FORMULA

SUBJECTS	SCORES
1	25
2	35
3	25
4	65
5	40
6	20
7	70
8	50
9	30
10	30
11	45
12	35
13	30
14	30
15	40
16	55
17	65
18	35
19	30
20	25

Mean of Scores (x) = 39
K = 20 items x 5 = 100
Variance of the Scores (σ^2) = 217.368

$$r_{xx} = \frac{K\sigma^2 - x(K - x)}{\sigma^2(K - 1)}$$

r_{xx} = 0.9

Where r_{xx} = the reliability of the whole test
K = the number of items
σ^2 = the variance of the scores
x = the mean of the scores

APPENDIX J

FACILITY AND DISCRIMINATION INDICES OF TEST INSTRUMENT

ITEM NO.	KEY		R_u(%)	R_1(%)	NO. OF RIGHT	P = R/T	R_u - R_1
	UPPER	LOWER					
1	4	1	58	2	7	35	56
2	3	0	48	2	6	30	44
3	4	0	59	1	7	35	58
4	5	1	71	27	8	40	44
5	4	1	51	7	10	50	44
6	4	0	62	4	12	60	58
7	5	1	71	13	7	35	42
8	4	0	42	0	8	40	42
9	5	0	42	0	7	35	42
10	3	2	85	42	7	35	43
11	3	1	57	13	9	45	44
12	6	2	71	16	10	50	55
13	4	0	77	6	10	50	71
14	5	0	72	28	8	40	44
15	4	1	43	0	12	60	43
16	3	1	65	10	7	35	55
17	4	2	74	26	8	40	48
18	4	1	49	0	8	40	49
19	5	3	71	27	11	55	44
20	4	0	74	18	6	30	56

APPENDIX K
EXPERTS VALIDATION REPORTS

APPENDIX L
ANALYSIS OF COVARIANCE FOR HYPOTHESES

Analysis of Covariance (ANCOVA) of Scores of the Treatment Groups (CBCM and CAI)

Source	Type III Sum of Squares	df	Mean Square	F-value	p-value
Corrected Model	1343.845[a]	3	447.948	4.360	.006
Intercept	26383.944	1	26383.944	256.813	.000
Pre-test	1271.673	1	1271.673	12.378	.001
Groups	3.304	2	1.652	.016	.984[ns]
Error	10890.019	106	102.736		
Total	652925.000	110			
Corrected Total	12233.864	109			

ns: Not significant at 0.05 alpha level

Analysis of Covariance (ANCOVA) of male and female students in experimental group 1 (CBCM Hierarchical)

Source	Type III Sum of Squares	df	Mean Square	F-value	p-value
Corrected Model	252.394[a]	2	126.197	1.088	.351
Intercept	6256.675	1	6256.675	53.941	.000
Pre-test	248.584	1	248.584	2.143	.155
Gender	2.799	1	2.799	.024	.878[ns]
Error	3131.773	27	115.992		
Total	182025.000	30			
Corrected Total	3384.167	29			

ns: Not significant at 0.05 alpha level

Analysis of Covariance (ANCOVA) of male and female students in experimental group 2 (CBCM Spider)

Source	Type III Sum of Squares	df	Mean Square	F-value	p-value
Corrected Model	694.769[a]	2	347.385	3.869	.031
Intercept	6550.784	1	6550.784	72.962	.000
Pre-test	478.068	1	478.068	5.325	.027
Gender	74.976	1	74.976	.835	.367[ns]
Error	2962.870	33	89.784		
Total	216025.000	36			
Corrected Total	3657.639	35			

ns: Not significant at 0.05 alpha level

APPENDIX M
STUDENTS DURING TEST SESSIONS



Experimental Group 1



Experimental Group 2

APPENDIX N
TREATMENT FOR EXPERIMENTAL AND CONTROL GROUPS



