EFFECTS OF INSTRUCTIONAL COMPUTER ANIMATION ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT ANDINTEREST IN CHEMISTRY IN AWKA EDUCATION ZONE

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CERTIFICATION

This is to certify that I am responsible for the work submitted in this dissertation. The original work is mine except as specified in the acknowledgments and references. No part of this work has been submitted to this University or any other institution for the award of a degree or diploma.

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DEDICATION

This work is dedicated to my husband, Patrick and our son, Tochukwu.

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This work would not have come out at all without the help of God Almighty. The researcher appreciates God for giving her the strength and good health to carry on with the rigoursof this research work. To Him be all the glory in Jesus name.

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ABSTRACT

This study investigated the effect of instructional computer animation on secondary school students' achievement and interest in chemistry in Awka Education Zone. The reason for the study is that there is a general poor achievement of students' in secondary school certificate chemistry examinations. The purpose of the study was to determine the effect of the use of instructional computer animation on students' achievement and interest in chemistry. Four research questions guided the study and six null hypotheses were tested. The study adopted a quasi-experimental design specifically, pretest-posttest non-equivalent control group design. Population of the study consisted of all the 2927 Senior Secondary Year Two chemistry students in the 61state owned secondary schools in Awka Educational Zone. The sample consisted of 186 students drawn from two co-educational secondary schools out of the 46 co-educational secondary schools in Awka Education Zone. One of the schools was randomly assigned to experimental group while the other was assigned to control group. Chemistry Achievement Test (CAT) and Chemistry Interest Scale (CIS) were the instruments used to collect data for the study. The CAT of 25 items and CIS of 17 items were trial tested on an intact class of 40 students outside the study area. The reliability coefficient of CAT was established to be 0.72 using Kuder Richardson (KR-20) while reliability coefficient of CIS was established to be 0.78 using Cronbach alpha. The CAT and the CIS were administered to the students as pretest and posttest for data collection. Mean and standard deviation were used to answer the research questions while Analysis of Covariance was used to test the null hypotheses at 0.05 level of significance. The result revealed that instructional computer animation had significant effect on students' achievement and interest in chemistry. Female students performed better than the male students taught using instructional computer animation. This implies that instructional computer animation enhances students' achievement and interest in chemistry. Based on the results of the study, it was recommended that instructional computer animation be adopted by chemistry teachers for teaching chemistry concepts to secondary school students. Curriculum planners should incorporate and emphasize the use of instructional computer animation as an alternative to conventional method.

CHAPTER ONE

INTRODUCTION

Background to the Study

Science is nature. It is man's attempts to investigate, explore, interpret and operate with the materials and the forces of universe that surround man. Science started as early as the time of the early man from his experiences with nature. The early man discovered how plants grow, which plant flowers and which seeds are edible. From the earliest time, therefore, man has concerned himself with the study and interpretation of the universe. Science truly is not just talking about manufactured goods but also it is concerned with finding out about nature and how to use the gifts of nature to better his life.

Science has branches which include the earth sciences, the life sciences and the physical sciences. Chemistry is a subject in the physical science. It is the science that deals with the composition, properties, reactions and structure of matter. The importance of chemistry in everyday life cannot be over emphasized. For all living things to function and survive their bodies perform various chemical processes such as respiration, digestion, producing new cells, filtering and removal of waste substances from their bodies. So all living things depend on chemical reactions to function and survive. Chemistry is the foundation of medicine. Human beings use chemical reactions to create medication for a broad spectrum of illness and they utilize medical plants and animals. Chemistry is needed for the advancement of technology. By using the principles of chemistry, we are able to extract different types of metal and also create different types of plastics. The metals and plastics created are used to build electronic devices such as phones, tablets, laptops and ahost of other products. cars, laboratory and hospital equipment (Solomon,2013). Unfortunately, many chemistry students in secondary schools find some chemistry concepts difficult to understand (WAEC chief examiner's report, 2009). Students' difficulties in learning these chemistry concepts have been attributed to their abstract nature which students find difficult to visualize (Ozmen, 2009). These abstract concepts include; particulate nature of mater, chemical equilibrium, chemical bonding, rates of reactions and energy effects, and conservation of mass (WAEC Chief Examiner's report, 2009).

The difficulty in understanding of science concepts especially concepts in chemistry by secondary school students is not peculiar to Nigerian students. In the United States of America, for example, attention has been drawn to United States of American students falling behind other countries in mathematics and science. Computer animation was used in their curriculum delivery to bridge the gap and achieve high academic standard (United States Department of Education, 2010).

The abstract nature of chemistry made many chemistry students learn chemistry by memorization of concepts, principles and theories without necessarily understanding what they are memorizing (Ozmen,2009). Under this condition, chemistry students do not learn chemistry concepts meaningfully, perform poorly in chemistry at both internal and external examinations, and cannot apply their knowledge to solve everyday problems in the society in which they live.

Available statistics from West African Examination Council (WAEC) on students' achievement in chemistry show that students' achievement in chemistry in Senior School Certificate Examination (SSCE) over the years has not been encouraging. Evidence of poor performance in chemistry has been reported by WAEC chief examiner's reports 2009—2011. The WAEC statistical analysis of the 2014 and 2015 May/June SSCE results revealed that only 42.2% and 44.1% respectively passed chemistry at credit level, showing that there has not been much improvement from what was reported by WAEC Chief Examiner's Report 2009 -2011 (see Appendix A, page 124).

The poor achievement of students in chemistry at SSCE has been attributed to a number of factors ranging from poor attitude of teachers and learners towards the teaching and learning of chemistry respectively, the broad chemistry curriculum, poor teaching methods used by chemistry teachers, inadequate instructional material, mathematical deficiencies in students and teachers amongst several other factors (WAEC Chief Examiner, 2009). In the past, several attempts have been made at solving these problems but such efforts had focused more on ways of improving the popular conventional methods of teaching chemistry. Little or no attention has been given to the use of innovative teaching methods such as the use of Information and Communication Technology (ICT) in chemistry curriculum delivery.

In recent years, computer technology has permeated into the society in such a way that almost everything being done involves the use of computer. So science teachers need to key in into the current trend. To achieve this, chemistry teachers need to change their lesson delivery through the use of conventional methods to innovative methods that suit the needs of the present time.

Conventional method of teaching is a teacher-led method of instruction which some teachers prefer to use in their lesson delivery. Conventional methods amongst others include; lecture method,discussion, project method, demonstration and discovery method. The methods are popular and often used by teachers to disseminate information, knowledge and skills to students (Eggari,2003).For the purposes of this research, conventional method simply means lecture method. The researcher chose this method because most chemistry teachers prefer using it to other conventional methods of instruction. Lecture method is commonly used by chemistry teachers in teaching chemistry.

Conventional method has some wonderful benefits. Lectures can present materials not otherwise available to students. It can present large amounts of information and be presented to a large audience (Bonwell,1996). In spite of the above advantages lecture method has a serious disadvantage of emphasizing only on superficial learning instead of indepth knowledge of the facts. According to Gordon (2002), superficial learning is characterized by a study behavior that enables students to reproduce information in a required form without analysis or integration, leading to low quality learning outcomes. The effectiveness of the use of electronic technology (like instructional computer animation) in teaching in present day science classrooms is a subject of research by many science educators and other researchers. Electronic technology in today's society is steadily and constantly advancing and finding its way into chemistry classrooms and laboratories. Chemistry teachers now have a variety of technologies available to them for use in chemistry curriculum delivery.

Instructional computer animation is a modern electronic technological instructional method that offers deep learning to students.Computer animation is traditionally defined as an inanimate entity that appears to take on dynamic attributes such as movement, growth and speech which are normally associated with living organisms (Ploatzner&Lowe, 2012). A typical example of computer animation could be likened to the robot which is seen on television performing the action of cooking or gathering items into a basket. Computer animation has been educationally defined by Lander and Lunderstorm (2013) as a set of varying images presented dynamically according to users' action in ways that help the user perceive a continuous change over time and develop a more appropriate mental model of a task.

Instructional computer animation has the potency of bringing down the difficult level of any concept taught with it to the barest minimum. It is a combination of graphics and text presentation in which each can strengthen memory through observation of the images. It is audio-visual in nature. The use of audio-visual materials is important for teaching chemistry concepts.

Benefits of instructional computer animation are enormous. Any learning associated with instructional computer animation provides a learning environment free of emotional stress and enhances emotional intelligence that provides fun. Instructional computer animation provides unique and interesting presentation given to each of the facts and concepts presented, making it beneficial to students. Modules aided with instructional computer animation, according to Aminordin (2007), is an effective way to attract attention and be able to provide concrete information on the movement and change of the object over time and this can reduce the level of abstract ideas. It attracts students' attention easily and delivery of message more appropriately. According to Jamalludin and Zaidatun (2003), the use of instructional computer animation facilitates explanation of a concept or demonstrates a skill and this enables students to utilize more senses in the process of gathering information as well as sustain the students' attention and interest for a longer period of time.

There exist some possible challenges associated with instructional computer animation. Instructional animation will not work well where there is epileptic supply of electricity.The students may be carried away and watch the video images as though they are watching film show without picking the important aspects of the lesson. The school may not have enough computers to go round the students at once. These notwithstanding, anyone using instructional computer animation shall bear these challenges in mind and make provisions to handle them so that students would not become frustrated and loose interest.

When thinking of positive changes in education, it is important to think of things like interest as an enhancer to students' achievement.Interest is the ability of an individual to show positive attitude towards an object, situation or value. Nwoye (2005) described interest as an internal state that influences individual's personal behaviour. The behaviour could be positive or negative.

Okeke (2016) stated that in psychological and educational measurement, interest is seen as a motivational construct. Okeke agreed with Njoku (2003) that interest is a response of liking or disliking of an activity. There is need therefore to foster students' interest in learning chemistry using appropriate instructional strategies and materials so as to enhance the achievement of students in chemistry in both internal and external examinations. In this study, the researcher defined interest as the eagerness of an individual to willingly take up a task or participate in a function with ease which could lead to improved achievement.

Academic achievement is the knowledge acquired and skills developed in schools (Vein, Parveen, Syed &Nazir, 2013). It describes the scholastic standing of the student at any given time. The scholastic standing could be expressed in terms of scores obtained in tests and examinations whether internal or external. Rivers (2006) operationalized academic achievement in his study as grade point average obtained from self-report questionnaires while Texas Education Agency (TEA) (2008) sees academic achievement as learners Standardize Value of Cumulative Grade Point Average (SVCGPA) in college. In this study, the researcher operationalizes academic achievement as students' scores in teacher made tests in chemistry.

Another variable of interest in this study is gender.Gender has been differently defined by various authors. Okeke (2001) defined gender as social differences and relations occurring between males and females which are learned and vary widely among cultures and societies. There has been conflicting findings on gender differences in achievement in science subjects. Adeyegbe (2010) found male students performing generally better than the females in physics, chemistry and biology. However, Agwagah as cited in Olom (2010) revealed significant differences in performance of male and female students in mathematics in favour of females. Adigwe (2014) observed that male students have higher academic achievement in chemistry than the females. Aiyedun (2000) found that there was no difference in performance between the males and females in mathematics. Jimoh (2004) also held the same view that differences exist in the academic achievement of boys and girls in chemistry. It does appear that these gender differences in students' achievement vary with the method of instruction. The present study is set to investigate the effect of the use of instructional computer animation on male and female students' achievement and interest in chemistry.

Statement of the Problem

Students achieve poorly in science related subjects including chemistry in secondary school external examinations in Nigeria. This observation was confirmed by WAEC Chief Examiners report of 2009. The analysis of the WAEC results for 2014 and 2015 equally revealed poor achievement though an improvement was seen but the problem is still not remedied (see appendix A, page 123). This points to the students lack of understanding of the subject. This situation is partly attributed to the teachers' poor method of lesson delivery, passivity and lack of interest by the students(Petress,2008).

The persistent low achievement has been a concern to many. Chemistry teachers are making effort to adjust the method of lesson delivery to improve the situation but they have not given time to technology driven method like instructional computer animation.

The results of the use of instructional computer animation in lesson delivery overseas yielded a marked improvement in the students understanding and academic achievement in chemistry(United States Development of Education,2010). One wonders if this instructional technique would also enhance students' achievement and interest in chemistry in Nigeria.Hence, thepresent study is set to investigate the effects of instructional computer animation on male and female students' achievement and interest in chemistry.

Purpose of the Study

The purpose of the study was to determine the effect of the use of instructional computer animation on students' achievement and interest in chemistry. Specifically, the study is designed to:

1. Determine the effect of instructional computer animation on students' academic achievement in chemistry when compared with those taught using conventional teaching method.
2. Determine the effect of instructional computer animation on the male and female students' achievements in chemistry.
3. Find out the interaction effect of instructional method and gender on students' achievement in chemistry.
4. Determine the effect of instructional computer animation on students' interest scores in chemistry when compared with those taught with conventional teaching method.
5. Find out the effect of instructional computer animation on the male and female students' interest in chemistry.

6. Determine the interaction effects of instructional method and gender on the students’ interest in chemistry.

Significance of the Study

The findings of the effects ofinstructional computer animations on students’ achievement and interest in chemistry will be beneficial to many people. The beneficiaries include teachers, learners, curriculum planners, and the society as a whole.

Instructional computer animation will help secondary school students to expel some of the phobia they have in learning chemistry. They will realize that their achievement depends to a great extent on their own active participation in the class. They will begin to appreciate their involvement in class activities which will help them gain some lasting skill that will enhance capacity building and sustainable development.

The findings from instructional computer animation will help chemistry teachers to properly implement the chemistry curriculum. The advantages of use of computer animation in learning chemistry in the classroom will motivate the teachers in teaching the subject well. The method will help the teachers to teach difficult concepts well, thus arousing the interest and active participation of the learners.

The curriculum planners will gain a better insight on how to develop the curriculum to incorporate computer animation at appropriate positions. This will make the subject activity oriented and student centred.

The general society will also gain from the findings of the study. If instructional computer animation or conventional method adequately improvestudents’ academic achievement and interest in chemistry, the subject and its related courses will gain attention by the students in tertiary institutions of higher learning, thus, achieving the nations dream of capacity building and sustainable development.

Scope of the Study

The scope of this study covered the five different types of animation which include traditional animation, 2D vector based animation,3D computer animation, motion graphics and stop motion animation. In this study, 3D computer animation was used for the experiment.

(SS2) chemistry students in Awka Education Zone were used for the study because they are not in examination class and the topics for the study are within the SS 2 syllabus. The interest of these students were tested even when they had chosen to do the subject in SS2 because it has been found that many chose the subject under peer influence or parental pressure.

The content scope includes chemical bonding and chemical equilibrium with their sub topics. These topics were taught to the experimental group using instructional computer animations while lecture method was used to teach students in the control group.

These topics were chosen because they are among the abstract concepts identified by WAEC Chief Examinar's report (2009).Ozmen (2009) stated that students find these topics difficult to understand.

Research Questions

The following research questions guided the study.

1. What are the mean achievement scores of students' taught chemistry concepts using instructional computer animation and those taught using the conventional method?

2. What are the mean achievement scores of male and female students' taught chemistry concepts using instructional animation?
3. What are the mean interest scores of students' taught chemistry concepts using instructional computer animation and those taught using conventional method?
4. What are the mean interest scores of male and female students' taught chemistry concepts using instructional computer animation?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance.

1. There is no significant difference between the mean achievement scores of secondary school students taught chemistry concepts using instructional computer animation and those taught using the conventional method as measured by their mean posttest scores in CAT.
2. There is no significant difference between the mean achievement scores of male and female students' taught chemistry concepts using instructional computer animation as measured by their mean posttest scores in CAT
3. There is no significant interaction effect of teaching method and gender on students' mean achievement scores.
4. There is no significant difference between the mean interest scores of students' taught chemistry concepts using instructional computer animations and those taught using the conventional method as measured by their mean posttest scores in CAT.

5. There is no significant difference in the mean interest scores of male and female students' taught chemistry concepts using instructional computer animation as measured by their mean posttest scores in CAT.
6. There is no significant interaction effect of teaching method and gender on students' mean interest scores.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter reviewed the related literature on animation in chemistry as well as other science subjects. The review presented theoretical and empirical framework on which this research work was based. Specifically, the review was discussed under the following sub headings; -

Conceptual Framework

Instructional Computer Animation

Interest

Academic Achievement

Theoretical Framework

Dual Coding Theory by Allan Paivio

Meaningful Learning and Subsumption Theory by David Paul

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Summary of Literature Review

Conceptual Framework

Instructional Computer Animation

The word animation has been traditionally defined as inanimate entities that appear to take on dynamic attributes such as motion and growth which are normally associated with living organisms (Ploatzne& Lowe, 2012). An example of animation could be likened to Mickey Mouse, an entertainment programme where inanimate objects perform functions of human beings. Animation is the process of making the illusion of motion and the illusion of change by means of the rapid succession of sequential images that minimally differ from each other. Animations are a set of varying images presented dynamically according to user action in ways that help the user perceive a continuous change over time and develop a more appropriate mental model of a task.

Computer animation is a general term for a visual digital display technology that stimulates moving objects on screen. It is animated film or video that is generated by computer. Computer is widely applied in various fields such as movie special effects, advertisements, cartoon, computer games etc (Jancheski, 2011). Many researchers claim that it is an interdisciplinary subject of several areas, such as image processing, digital signal processing, machine vision and artificial intelligence.

Instructional computer animations are animations that are used either to provide instruction for immediate performance of a task or to support more permanent learning of subject matter. Instructional computer animation is used in computer based instructions to accomplish one or more of the following: attention-gaining, presentation and practice (Rieber, 1990). Instructional computer animations as moving illustrated materials are used more often at schools to depict changes over time and location, and illustrate phenomena or concepts that might be difficult to visualize (Mayer & Moreno, 2002). They assist in understanding abstract and invisible processes.

Academic Achievement

Nominal and operational definitions of academic achievement have been given by many scholars. Parveen, Syed and Nazir (2013) defined academic achievement as the knowledge attained and skills developed in school subjects. Academic achievement, according to Ejesi (2014) is the outcome of education – the extent to which a student, teacher or institution have attained their educational goals. Academic achievement have been described as the scholastic standing of a student at a given moment.

The scholastic standing could be explained in terms of the grades obtained in a course or group of courses. Several researchers have defined academic achievement in different ways. Hanushek, Rivkin and Kain (2015) defined achievement as the level of attainment of a person in an examination, that is, how an individual is able to demonstrate his or her abilities in an examination.

Centre for Parents/Youths Understanding (2007) stated that achievement gap widens each year between students with most effective teachers and those with least effective teachers. This suggests that the most significant gains in students achievement will likely be realized when students receive instruction from good teachers over consecutive years. Academic achievement is a fundamental premium upon which all teaching-learning activities are measured using some criteria of excellence, e.g., good academic achievement, poor academic achievement and academic failure. Aremu (2000) stressed that academic failure is not only frustrating to the students and the parents, it's effects are equally grave on the society in terms of manpower in all spheres of the country's economy and politics.

Morakinyo (2003) believed that there is a fall in academic achievement which he attributed to teacher's non-use of verbal reinforcement strategy. Others found that the attitude of some teachers to their job is reflected in their poor attendance to lesson, lateness to school, poor method of teaching plus student passivity. They all affect students' academic achievement. According to Petress (2008), passively learned content is easily forgotten and ineffectively utilized. In contrast, synthesis of facts with prior knowledge, through active learning, creates a partnership between students and teachers. With particular reference to chemistry, observation over the years shows that students' academic achievement in chemistry at senior secondary school level has not been very encouraging.

Adeyegbe (2010) and Jimoh (2004) observed gender differences in achievement in both chemistry and other science subjects. What appears not to be very clear is whether these achievements vary with method of instruction, thus, there may be need to try to use instructional computer animation so as to be well informed of the achievement of male and female students. The purpose of the study was therefore, to investigate the effect of the use of instructional computer animation on students' achievement in senior secondary schools. In terms of actual measurement and operationalization of academic achievement in specific research context, Rivers (2006) operationalized academic achievement in his study as grade point average obtained from self-report questionnaires while Texas Education Agency (TEA)(2008) sees academic achievement as learners Standardized Value of Cumulative Grade Point Average (SVCGPA) in college. In this study, the researcher operationalizes academic achievement as students' scores in teacher made tests in chemistry.

Interest

From the psychological point of view, interest can be classified as individual interest and situational interest. Individual interest has a dispositional quality residing in the person across situation (Renninger 2000). In contrast, situational interest emerges in response to features in the environment (Hidi&Renninger, 2006). Hidi and Renninger further explained that situational interest (SI) can be differentiated into triggered-SI and maintained-SI. Triggered-SI involves heightening the effective experiences individuals associate with the environment. It involves arousing an individual's interest. Maintained-SI is a more involved, deeper form of situational interest in which individuals begin to forge a meaningful connection with the content of the material and realise its deeper significance (Hidi, 2001).

Interest is the tendency of an individual to react positively towards an object, situation or value. One's interest can easily be determined by his behavior. Every individual has values, which when expressed show the kind of interest the individual has. Bhatia (2003) defined interest as a powerful source of human motivation which is capable of arousing and sustaining concentrated effort. It is a disposition that prompts an individual to spontaneous action (Dandekar&Makhiji, 2002). Njoku (2003) stated that interest is a response to liking or disliking of an activity, object or a person. It is the degree of likeness an individual has for something. It is the preference of a person to a particular type of activity to the other. Nwoye (2005) also described interest as an internal state that influences the individual personal actions. Njoku (2003) argued that interest and motivation are components of attitude which can be influence by reinforcement; meaning that reinforcement or incentive can arouse interest of an individual to participate in certain kinds of activities. Conversely, negative reinforcement can inhibit one's interest to participate in an activity which may result into a dislike to an activity.

Anat (2007) stated that interest is a differential likelihood of invested energy in one set of stimuli over the other. The ability to arouse students' interest in science plays an important role in improving existing curriculum to meet their needs. The researcher defines interest as an innate drive that prompts an individual to action. The researcher would use chemistry interest scale adapted from psychological interest scale to measure interest in this study.

Theoretical Framework

The theories that support this study were Paivio's Dual Coding theory and Ausubel's Meaningful Learning and Subsumption theory.

Dual Coding Theory by Allan Paivio

Dual coding theory, a theory of cognition was hypothesized by Allan Paivio in 1965. The theory states that a person expands in knowledge through verbal association and visual imagery. Dual coding theory postulates that both visual and verbal information are used to represent information. The theory is talking of knowledge through imagery and pictures with verbal explanatory verses accompanying the pictures.

The theory has been in existence over 2500 years ago but gained popularity with the work of Allan Paivio 1965.

It emphasizes that pictures make the acquisition of knowledge easy especially when it is accompanied with explanation. It urges teachers to allow students to have direct experience with things and that both words and picture must be presented to the intellect at the same time. The verbal system is important in learning but not enough because verbal system gains knowledge from the non-verbal system; verbal system may be good at one task and non-verbal system better in the other. Both the verbal and non-verbal codes are functionally dependent of the other and can have additive effect on recall. Paivio was of the opinion that pictorial codes aid recall more than words.

Instructional computer animation would put chemistry concepts into pictures as advocated by dual coding theory. These pictures in motion would be accompanied with explanations that give these concepts and ideas meaning and make them more understandable to the student

Meaningful Learning and Subsumption Theory by David Paul Ausubel

Meaningful learning and Subsumption theory was propounded by David Paul Ausubel in 1963. The theory states that an individual's existing cognitive structure is the principal and basic factor influencing the learning and retention of meaningful materials. It describes the importance of relating new ideas to a student's existing knowledge base before the new material is presented. The new knowledge will be subsumed into the learners existing cognitive structure. When information is subsumed unto what the learner had already known, it will be transferred into the long term memory.

Ausubel propounded this theory alongside what he called advanced organizer. Advanced organizer is a preview of the information to be learned. The teacher does this by providing a brief introduction in the way they new information will be presented. The advanced organizer enables the student to start with a good picture of the upcoming content and link new ideas to the existing mental maps of the content area.

Chemistry with its abstract nature is difficult for students to understand. The students do not have any alternative than to adhere to rote memorization which do not give them the in-depth knowledge of what they learned and this is what Ausubel's theory opposes. Using instructional computer animation to teach involves putting these abstract concepts and ideas into motion pictures as though these pictures are life and active which will make the students see them as real objects. As the teacher explains the animated objects as they sequentially come up, the understanding of the subject matter becomes simple because the new knowledge will easily be subsumed into the old cognitive structure of the learners making retention and retrieval easy. The role of instructional computer animation is to make learning meaningful.

Theoretical Studies

The researcher gathered all the general works, observations and contributions people have made in this area of study.

Classification of Animations

Animations are classified according to techniques used in creating them. Classes of animation include traditional animation, stop motion animation, computer and mechanical animation. Other animation styles, techniques and approaches exist. Traditional animation also called cel or hand-drawn animation was the process used for most animated films of the 20th century. The individual frames of traditional animated films are photographs of drawings, first drawn on paper. To create the illusion of movement, each drawing differs slightly from the one before it. The animator's drawings are traced or photocopied into transparent acetate sheets called cels, which are filled in with paints in assigned colors or tones on the side opposite the line drawings.

The traditional cel animation process also became obsolete by the beginning of the 21st century. Today, animator’s drawings or the backgrounds are either scanned or drawn directly into a computer system. Some animation producers have used the term tradigital to describe cel animation which makes extensive use of computer technologies.

Stop-motion animation is used to describe animation created by physically manipulating real world objects and photographing them on frame of film at a time to create the illusion of movement. There are many different types of stop-motion animation usually named after the medium used to create the animation. Computer software is widely available to create this type of animation. Puppet animation, clay animation, cutout animation, model animation, object animation and pixilation are all examples of stop-motion animation. Puppet animation typically involves stop-motion puppet figures interacting in a constructed environment, in contrast to real world interaction in model animation. The puppets generally have an armature inside them to keep them still and steady as well as to constrain their motion to particular joints. Clay or plasticine animation often called Claymation uses figures made of clay or a similar malleable material to create non-stop animation. The figures may have an armature or wire frame inside, similar to the related puppet animation that can be manipulated to poise the figures. Alternatively, the figures may be made entirely of clay.

Cutout animation is a type of stop-motion animation produced by moving two dimensional pieces of material such as paper or cloth. Model animation refers to stop-motion animation created to interact with and exist as a part of a live action world. Object animation refers to the use of inanimate objects in stop-motion animation, as opposed to specially created items. Pixilation involves the use of live humans as stop-motion characters. This allows for number of surreal effects, including disappearances and reappearances, allowing people to appear to slide across the ground and other such effects.

Computer animation encompasses a variety of techniques, the unifying factor being that the animation is created digitally on a computer. Two dimensional (2D) animation techniques tend to focus on image manipulation while three dimensional (3D) techniques usually build virtual worlds in which characters and objects move and interact. 3D animations can create images that seem real to the viewer. 2D animation has many applications including analog computer animation, flash animation and power point animation. Final line advection animation is a technique used in 2D animation to give artists and animators more influence and control over the final product.

Mechanical animation usually called animatronics is the use of mechatronics to create machines which seem animate rather than robotic. Audio-animatronics and autonomatronics are forms of robotic animations, combined with 3D animation for shows and attractions, move and make noise usually a recorded speech or song, but are fixed to whatever that supports them. They can sit and stand but cannot walk. An audio-animation uses prerecorded movements and sounds rather than responding to external stimuli. Chuckimation is a kind of mechanical animation created by the makers of cartoon in which characters/props are thrown or chucked from off camera or wiggled around to simulate talking by unseen hands. Puppetry is a form of theatre of performance animation that involves the manipulation of puppets. It is very ancient and is believed to have originated 3000 years BC. Puppetry takes many forms but they all share the process of animating inanimate performing objects. Puppetry is used in almost all human societies both as entertainment – in performance – and ceremonially in rituals and celebrations such as carnivals. Most puppetry involves story telling.

Levels of Explanations Relevant to Animations

Cognitive Explanations

The intuitive appeal of animation has, at its heart, a cognitive explanation and many researchers base their arguments on this level of explanation. Tversky, Morrison &Betrancourt (2002) sum it up as the Congruence Principle. Consequently, if you want learners to form an accurate representation of a dynamic situation, then animation seems to many to be the natural choice.

The most extensive cognitive theory of the role of animation in learning is that of Mayer (2001). His theory has three fundamental cognitive assumptions: 1) that there are two separate channels for processing visual and verbal representations, 2) that each of these channels can only actively process a limited amount of information at any one time and 3) that meaningful learning results from learners selecting, organizing and integrating new material with old in order to actively construct their own knowledge. Consequently, this theory predicts that narrated animations are a very effective form of a representation as they allow complex information to be presented in ways that take maximum advantage of the limited capacity of cognitive system. Mayer has subsequently gone on to name this the multimedia principle “That students learn more deeply from animation and narration than from narration alone”, and has confirmed this in numerous studies. For example, a typical study (Mayer & Anderson, 1991) showed naive college students an animation concerning the operation of a bicycle tire pump. Subsequently those students who had been presented with animation and simultaneous narration did better on post-tests than those who had only heard narration.

Schnotz&Rasch (2005) discussed two ways that animations might facilitate cognitive processing. The first he calls the enabling function of animation. Animations can provide additional information that cannot be displayed in pictures. This additional information allows for additional cognitive processing. The second is referred to as the facilitating function. Animations are able to help learners build dynamic mental models of situations by providing external support. In this way animations make cognitive processing easier.

Bétrancourt (2005) identified a further cognitive function that animations can play to produce cognitive conflict. For example, famously people tend to hold naïve physical conceptions such as objects measuring different weights will fall at corresponding different speeds. However, it is hoped that if an animation showed these objects falling simultaneously, this could evoke conflict and ultimately lead to conceptual change (Chin & Brewer, 1993).

However, animations are not necessarily successful from a cognitive standpoint. Even though animations may make dynamic processes explicit, there are sufficient problems with interpreting them that this advantage can be lost (Price, 2002). Tversky et al. (2002) referred to this as the Apprehension Principle: the structure and content of the external representation should be readily and accurately perceived and comprehended. Unfortunately, there are a number of cognitive limitations in the processing of a dynamic animation.

Many researchers have identified the problems for memory that animations promote. Information in animations is presented transiently, so relevant previous states must be held in memory if they are to be integrated with new knowledge. As working memory has only limited capacity, animations will therefore often overwhelm this resource. In contrast, persistent media such as pictures are available to be rescanned at a learner’s will and so will reduce the amount of information that needs to be held in working memory.

In Lowe's terms (Lowe, 2004) many problems of animations are that they are overwhelming - characteristics of the animation are such that the learner's cognitive system is unable to process all information effectively. However, Lowe also draws attention to the underwhelming effects of animation - where learners are insufficiently engaged so that the available information is not given due active processing. Animations that provide a direct depiction of a dynamic system may lead learners to simply observe these dynamics as they are portrayed. There is no need to carry out the intensive cognitive processing that a static depiction might require learners to perform. Given the emphasis within cognitive theories on the active construction of knowledge, this raises doubts as to the benefits of making animations of dynamic systems too direct.

Motor Explanations

Little has been written about the role that physical action can play in learning with animations. However, there is a long tradition of considering the role of motor actions in educational and developmental theories more generally. Piaget &Inhelder (1969) believed that motor actions formed the basis of all learning. Infants begin with only sensori motor representations, (at birth just simple reflexes, to deliberate sensori motor actions to achieve effects in the world by two years). Only as children develop do they come to understand symbolic representations at first concretely and finally at eleven years they can master formal operations on abstract symbols. For Piaget, using one's body to imitate a phenomenon is fundamental to the latter development of mental symbols to stand for the phenomena.

Martin & Schwartz, (2005) argued that physical action can support learning in four ways; induction, offloading, repurposing and physically distributed learning. By induction, they argue that if learners act in stable environments that offer clear feedback and strong constraints on interpretation, then these consistencies help people uncover the structural regularities in these environments (for example, children pouring water between different shaped glasses). In off-loading, people rely on the environment to reduce the cognitive burden of a task and so increase their efficiency at doing the task. When repurposing people act upon the environment to adapt it so it can allow them to achieve their goals. For example, Kirsh&Maglio (1994) showed that expert players of the computer game Tetris repurposed their actions so that the movements of the pieces yielded information about where each will fit (as well as to move it to the appropriate location). Finally, in physically distributed learning (PDL), ideas and actions of the environment coevolved such that new ideas become possible (as in children learning fractions concepts (Martin & Schwartz, 2005).

A final area where the role of specific physical activities in learning has been explored is that of gesture. Goldin-Meadow & Wagner (2005) argue that gesture can contribute to learning by informing others about someone’s current understanding. If listeners then respond to this information, they can then help the learner. Listeners can take account of this information to adapt their strategies and when they do so, learning is more successful (Goldin-Meadow & Wagner, 2005). Secondly, gesturing can support learning through externalization of some of the cognitive processes. Thus, it can reduce the demands upon the cognitive architecture in the ways described above (cognitive explanations) and make an internal representation external allowing it to be reflected upon. There is certainly evidence that people do use gesture when they need to learn something demanding.

Consequently, there seems good reason to expect that learning with animations should be influenced by a motor level of explanation. There may be a role for animation in physical education, with animations available to demonstrate golf swings, track and field events, weight training and swimming amongst others. It could also be the case that animated and interactive graphics allow learners to adapt the learning environments in ways that are akin to physically distributed learning. It also seems plausible that watching animations of events (such as simulations of mechanical objects or the swimming motions of fish) will encourage learners to gesture. Gesturing could then help learning by either providing models for other learners, as in Schwartz's (1995) collaborative gears problem experiment, by exhibiting a source of information for teachers to allow them to debug learners' conceptions or act as a way of externalizing an individual's knowledge to reduce cognitive effort. However, it could also be the case that animations inhibit needed motoric responses. Learners working with computer animations rather than manipulating real objects may not be developing the appropriate sensory-motor schemata that theorists such as Piaget discuss.

Perceptual Explanations

Given that animations are visual images, surprisingly little has been written about the perceptual aspects of animations. Indeed, it is only within a specific range of perceptual criteria (e.g., displacement, frame rate, object being animated) that a sequence of static images is seen as an animation at all. However, recently there have been calls for increased attention to be paid to the basic perceptual characteristics of animation (Schnotz& Lowe, 2004).

Animations can be difficult for learners to perceive. The human visual system is extremely capable of predicting and detecting motion but yet it can still struggle to perceive interactions in fast moving displays. Perception is even more problematic when animations show complex dynamic processes, which require learners to watch simultaneously multiple events that are visuo-spatially separate. Consequently, there is a need to understand how to design animations (and indeed other forms of graphical representations) to align (where possible) the features of the animations that should be attended to patterns to which the visual system is attuned (Chabris&Kosslyn 2005; Schnotz& Lowe, 2004; Ware, 2004).

Another related approach is to try to identify ways to make elements of interest stand out from others in their surroundings by increasing the pre-attentive processing of those attributes. In this way learners could be led, almost against their will, to appropriate aspects of the visualization. This could be particularly beneficial if the animation is complex and fast moving. For example, colour is pre-attentively processed and so in a predominantly gray, blue and green display, representing something in red will attract visual attention. Other examples of attributes that are pre-attentively processed include orientation, size, basic shape, convexity and motion. Moreover, motion is processed well even in the periphery of vision and so the sudden inclusion of a moving target will draw attention even to the periphery of the screen (Bartram, Ware & Calvert, 2003). This normally leads to annoyance when viewing web pages but could be helpful in educational settings, suggesting a role for animation even in predominantly static displays.

Affective and Motivational Explanations

There is a tendency for all new forms of representation and technology to be greeted with naïve optimism for its affective or motivational benefits and animation has been no exception. Consequently, for many people it is self-evident that animations will help students learn because they are fun and increased fun will enhance learning. The truth is obviously more complex. Unfortunately, and perhaps because of either the perceived obviousness or naivety of the claim (depending on your perspective) there are few theoretical accounts of learning with animation that evoke these explanatory constructs. However, this picture is beginning to change (Price, 2002) and there is an increasing amount of empirical research exploring the affective impact of animation.

Animation has been extensively studied in algorithm animation (a dynamic visualization of a program's data, operations, and semantics). The introduction of algorithm animation was greeted with enthusiasm but empirical reports of the benefits are mixed or missing (Kehoe, Stasko& Taylor, 2001). Consequently, as well as exploring differences in learning outcomes, researchers have interviewed students about their experiences of working with animations. Stasko, Badre& Lewis, (1993) reported that students feel they help them learn and Kehoe et al. (2001) reported that students typically respond positively that they are “relaxed, more confident in their knowledge and more open to learning”.

Another area where the impact of animation upon emotion and motivation is receiving attention is that of animated pedagogical agents - an animated agent that cohabits a learning environment with students to help them learn. Animation in this case is used to demonstrate how to perform actions. Locomotion, gaze, and gestures are used to focus the student's attention and head nods and facial expressions can provide feedback on the student’s behavior.

Strategic Explanations

Ainsworth and Loizou (2003) found evidence that presenting information as either text or pictures impacted upon whether learners used an effective learning strategy self-explanation. A self-explanation is additional knowledge generated by learners that states something beyond the information they are given to study. Students in the diagram conditions learned more than students in the text condition. Moreover, diagrams students gave over one and a half times more self-explanations than students given text. It seems therefore that diagrams are more successful than text at inducing an effective learning strategy.

A small number of studies have looked at the relation between effective learning from animations and learning strategies. Lewalter (2003) looked at the strategies students used when learning about a complex astrophysical topic from text accompanied either by a picture or by an animation. He categorized learners' behavior into either rehearsal strategy (such as simple memorization techniques), elaboration strategies (which help learners connect new knowledge to existing knowledge) and control strategies (which refer to metacognitive strategies aimed at assessing one's own comprehension). Information about which strategies learners were performing was elicited by using verbal protocols. He found that learners used rehearsal strategies significantly more often when learning with pictures rather than animations, but no difference for either elaboration or control strategies which were both rarely used.

Lowe (2003, 2004) has studied the strategies that novice learners use to search for relevant information in weather map animations. He considered both spatial strategies, which refer to the area and location of the search and temporal strategies that look at when the search is conducted. Temporal strategies are defined as either: a) confined strategies that concentrate on a small and highly localized section of an animation; b) distributed strategies that also concentrate on a small proportion of the total animation but involve frames that are spread throughout the whole time period; c) abstractive strategies that survey the animation for occurrences of a particular feature to try to abstract a general principle; and d) integrative strategies that seek out combinations of feature events that change in association with each other.

Lowe (2004) explored learners' strategies by examining their drawings, interaction with the animation and spoken commentary and gesture about the animation.

He found evidence that learners mostly used low-level strategies that addressed only isolated aspects of the animation.

Metacognitive Explanations

Metacognition is often simply defined as the process of “thinking about one’s own thinking” and involves active control over the processes engaged in learning. Learning behaviors that are associated with metacognition include planning how to perform a task, monitoring how well you are learning and evaluating whether you are close to solving a problem. The relationship between metacognition and representation is most often evoked in terms of how these metacognitive activities can be enhanced by encouraging students to create their own representations, for example, by drawing diagrams, writing notes, or by annotating the existing representation.

Arguments for the presumed relationship between representation and metacognition for the most part are extrapolated from the relationship between representation and cognition. If graphical representations are typically more cognitively effective than textual ones, then we would expect graphical representations to also be more metacognitively effective and there is some limited evidence to support that statement (Ainsworth &Loizou, 2003). However, this does not mean that animations are likely to prove more effective in promoting appropriate metacognition. Because of the problem that animations create for working, it is reasonable to worry that learners will engage in less metacognition with animations than with other memory forms of representation.

Lewalter (2003) in his study of astrophysical animations also explored metacognitive actions which he called control strategies, i.e. those behaviors which plan and regulate learning or which monitor the learner’s actual level of comprehension. He found evidence of reducing planning with animations compared to static pictures which suggests that learners were not as metacognitively successful. However, he also found that animations increased the amounts of positive monitoring statements that learners made and as this correlated with learning outcomes, it is presumably an accurate metacognitive activity. Cromley, Azevedo and Olson (2005) explored the processes of self-regulated learning that learners engage in (e.g., planning, metacognitive monitoring and control) when learning from a multimedia environment on the circulatory system that included 14 animations. Compared to other forms of representation, learners engaged in less self-regulation with the animation. However, if they summarized the information in the animation as they watched they did learn more. There is also some evidence that training can help students use learning environments which include animations. Azevedo and Cromley (2004) trained students in the techniques of self-regulated learning including planning, metacognitive monitoring and control, and compared their performance to students who had not been trained when using multimedia environment. Trained students gain much greater conceptual understanding than untrained students. Similarly, students who had access to a human tutor who scaffolded their self-regulation also learned more (Azevedo, Cromley& Seibert, 2004).

Rhetorical Explanations

The final level of explanation considered is how animations can influence learning when people are learning in social situations. Learning is acknowledged to be a participatory process in which people learn by constructing knowledge through interactions with others. Representations play a fundamental role in social learning and there are a number of different roles that representations can serve. Suthers and Hundhausen (2003) suggested they can: a) lead to negotiation of meaning as when individuals act upon representations they may feel the need to obtain agreement from others; b) serve as the basis for non-verbal communication as collaborators can point to representations to make points; and c) serve as group memory, reminding the participants of previous ideas, which hopefully encourages elaboration on them.

Furthermore, full participation in a community of practice requires fluid use of representations. In particular, representations were used to support social interaction. An expert chemist and his assistant used the spontaneous construction of a structural diagram, the interpretation of a NMR spectrum and diagrams in a reference book to progress through disagreement to a shared understanding of their activity. Consequently, Kozma and Russell (2005) reserved the highest level of representational competence for those who can use representations effectively within social and rhetorical contexts. However, use of external representations does not guarantee the success of collaborative learning. For example, Fischer &Mandler(2005) found that providing learners with external representation tools did not help them share information more effectively.

Similarly, Munneke, Amelsvoort and Andriessen, (2003) also found that providing visual representations did not help collaborative argumentation based learning. There is relatively little work exploring the role of animations in social learning situations. However, there is a small body of work that has examined collaborative learning with either presented animations (Sangin, 2006) or constructed animations (Hübscher-Younger & Narayanan, 2003; Gelmini& O'Malley, 2005).

Gelmini and O'Malley (2005) studied children using KidPad - a shared drawing tool that enables children to collaborate synchronously by drawing images, hyperlinking them, zooming in and out and creating animations.

A final way that animations can be used within social learning situations is to replace one of the collaborators with an animated agent. The aim is to use lifelike autonomous characters which cohabit learning environments with students to create rich, face-to-face learning interactions. Steve (described in Johnson et al., 2000) works with teams to solve complex naval training tasks such as operating the engines aboard Navy ships. The team can consist of any combination of Steve agents and human students; each assigned a particular role in the team. The agent can be configured with its own shirt, hair, eye, and skin color. Animated agents can then help learners by demonstrating tasks, reacting to their responses (by nodding when they understand a communication) and helping learners navigate complex virtual worlds.

The Attributes of Effective Animations

A number of fundamental elements must be included to produce an effective instructional animation. Often, one of our failings as teachers is to overlook the abilities and interests of the students. The first step in being a good teacher is getting the students' attention and holding that attention. Discussing or lecturing on material that is beyond student comprehension will generate frustration in the students. This is also true for animations. It is well documented that the material provided to students must be appropriate to the topic at hand and to their educational status. The "Apprehension Principle" states that in order for a learner to gain a proper understanding of the material, the content must be easily and accurately perceived and understood.

Animations that move too quickly or contain excessive extraneous detail or realism may overwhelm the learner, leading to little comprehension (Tversky& Morrison, 2002,). Related to this is the inclusion of too much material. Animations are not very effective if they contain more information than is appropriate (Tversky& Morrison, 2002). This is the "Coherence Effect" (Mayer, 2003). Thus, it is essential to define one's goals and keep focused on those goals.

For complex processes, it is wiser to break up the content into smaller packages than attempt to cover it all in a single animation. In any field, terminology is critical. Specific components, structures, and events have specific names. Animations provide an effective way to link words or terms to components, structures, or events. Mayer (2003) presented evidence that students learn more effectively when printed words or terms are placed adjacent to corresponding pictures ("Spatial Contiguity Effect"). Furthermore, when words or terms are spoken at the same time in an animation, the learning value is further enhanced ("Multimedia Effect") compared to words or pictures alone.

Oral narration in general has been shown by others to be an effective complement that reinforces learning (Lowe, 2003). Mayer (2003) espoused an additional "Personalization Effect" that results when such narration is conversational as opposed to pedantic. These results are all consistent with the cognitive load theory that is based upon the concept that there is a limited amount of working memory, and by using both visual and auditory channels, working memory is increased (Mayer et al., 2001).

In an animation, changes and events can be signaled in a variety of ways, including the use of sounds as well as changes in the color and shape of displayed components. While the role of sounds as useful adjuncts remains to be clarified, visual cues (color, shape) have been shown to be effective elements that enhance learning when they are components of animations. Animations, as well as other teaching tools, are more effective when the student has an element of control. Many studies support the concept that interactivity reinforces the learning process, but little if anything has been done in applying this to educational animations used in a learning environment (Tversky& Morrison, 2002).

Interactivity may be as simple as the ability to stop, start, rewind, and replay an animation. It can be as complex as involving the students in answering questions correctly before they can progress. True interactivity engages the students, encouraging them to put the new material into context with previously-learned information, and to formulate new ideas about that material (Tversky& Morrison, 2002). While this may not seem to be an inherent quality of animations, the comments of some students suggest otherwise (O'Day, 2006). Results suggest that students who view educational animations are not doing so passively, but in fact are actively thinking about what they are viewing, especially when they know they will be tested on what they've viewed. Clearly, this point of view can be tested by asking students what thoughts they have as they view teaching animations or assessing the types of questions they ask in class after viewing an animation.

Potential Hurdles in Using Animations

While web-based software, such as Xtranormal, has made brief simple animations easy for the novice to use, creating complex instructional computeranimations can take considerable amounts of time. There may also be a steep learning curve and technical difficulties, depending on the type of software or application being used (Nash 2009). Courts and Tucker (2012) pointed out that resource constraints can also be an issue for some institutions, but with so many free and low cost options available, this a minimal deterrent.

Nash (2009) also noted that there might be cultural confusions depending on how content is depicted in animations. Being aware of the composition of your student body is key when beginning to design animations. As noted earlier, some populations may not be as familiar with technology and may have less connection or background with media content used (Nicholas 2008).

Animated elements can be difficult to understand for those with disabilities. ADA regulations require adaptation of websites for people with disabilities, particularly if your college or university is a public institution. Also, a May 7, 2013 settlement between the University of California, Berkeley and students represented by the Disability Rights Advocates (DRA) outlined new procedures that colleges and universities (and their libraries) must follow to ensure that disabled students have access to all written materials needed for their studies.

Creators of animation for instructional purposes need to also be aware of the potential for cognitive overload. Understanding that “meaningful learning involves cognitive processing including building connections between pictorial and verbal representations” (Mayer and Moreno 2003) is essential in designing animations; but are instructional librarians sufficiently educated in designing principles to understand how the mind works when using multimedia? It is essential that instructional librarians use animations intentionally, supported by sound pedagogical or andragogical principles, and not just because instructional computer animations are cute or fun. Some librarians may lack knowledge about considering learning styles in the creation of a learning object, such as an instructional computer animation. Mestre (2010) suggested creating scenarios that relate to student experiences, allowing student control of the organization, using sound design principles and giving students options to choose their preferred learning style.

Students Interest in Chemistry

The quality and effectiveness of educational goals and achievement are determined greatly by interests of students, teachers, parents and administration (Dandekar&Makhiji, 2002). This statement by Dandekar and Makhiyi is a powerful pointer to the importance of interest in teaching-learning process. It equally urges teachers to arouse the interest of students during classroom activities so that the students can be sensitized to learn.

Interest and motivation are correlates of academic achievement. Anaekwe (2002) placed interest after intelligence as factors that influence students’ achievement and equally posited that interest is determinant of success. To reduce underachievement in chemistry (Udeogu, 2007), teachers should stimulate and sustain their students interest through the use of varieties of teaching strategies. It goes a long way in promoting students interest in the sciences which would in turn enhance high academic achievement in the area. Research findings have revealed the effect of interest boosting on achievement. Interest boosting was positively and significantly correlated with achievement in chemistry. This revelation implies that student achievement in chemistry is significantly increased when teachers increasingly boost students interest, vary instructional procedures and get students involved in the teaching-learning transaction (Orji, 2010).

Efforts at improving the interest in chemistry have attracted the interest of researchers (Ifeakor, 2005; Udeogu, 2007). Inability of chemistry instructors to utilize electronic and other technological media has been a major cause of poor interest in chemistry. Research findings have noted that science graduates with no professional training go into the classroom to teach chemistry.

Anyanwu (2002) observed that majority of such teachers do not understand the nature of chemistry and the appropriate teaching strategies to apply in teaching the basic concepts of the subject so as to inculcate science culture and a proper appreciation of chemistry in students. In view of this, the current research work has been designed to use computer animation as instructional strategy in chemistry classroom believing it will be capable of boosting interest and achievement in chemistry students.

Gender Issue and Achievement in Science

Gender refers to the sex of an organism and it points to the biological differences between male and female which are generally seen in the structure of the genitals (Omotayo& Yusuf, 2002; Okeke, 2007). Gender clearly draws out roles and function of men and women alike. Okeke (2001) defines gender as social differences and relations occurring between men and women which are learned and vary widely among societies and cultures. Gender categorizes people into male and female. It is gender identity and gender role that Njoku (2003) and Okeke (2007) referred to as gender stereotype.

A collection of commonly held beliefs and opinion of people about what are appropriate behaviours, activities and characteristics for male and female in a particular society is gender stereotype (Okeke, 2007). Gender participation in science education though controversial is in favour of males more than females. There is a common belief that science is masculine oriented which creates a barrier to active participation of females in the field. According to Nworgu (2005) males have been found to be more in mathematics and physical sciences but both sexes are almost equally represented in biological science courses. Traditionally, sciences have been taken to be masculine oriented while arts subjects, according to Agu (2002) have been perceived as feminine subjects at school level. At O'level examinations boys do well in science subjects while girls excelled at art subjects. Agu opined that girls are striving to meet up with boys in science and mathematics but the gender difference is still evident.

Okeke (2007) stated that science has masculine image which becomes a barrier to active participation of females in science education. Societal and cultural beliefs show more support and interest in science for males than females (Clarkson, 2004).

Olagunju (2001) advanced reasons for gender inequality in science to include that:

i. Male receive more attention from their teachers and dominate in class activities

ii. Girls are treated differently from boys by teachers in their instructional strategy and expectations

iii. Role models are provided with more male science teachers and professionals than female

iv. In equalities occur inside and outside the classroom denying girls access to some subject and subtle differences in interest.

Again, other factors that cause girls low participation and achievement in science education as explained by Olagunju are inherent genetic differences and cultural limitation.

The genetic differences centre on biological imbalance due to fluctuation in hormonal secretions and psychological changes. The genetic issue notwithstanding, females are not deficient in science. The cultural limitation is caused by cultural and practices of the people due to the pattern of dominion and submission of the females to male which limit their participation in science activities.

Olagunju (2001) also proposed that girls generally underestimate their ability and show less confidence in their competence in science.

Gender issues have influence in achievement in chemistry. Result from research findings have revealed that male students perform better than females in physics, chemistry and biology generally (Danmole, 1998) while Agwagah as cited by Olom (2010) revealed significant differences in achievement in favour of the females. Researcher such as Aiyedun (2000), found no significant difference in the performance of boys and girls in mathematics.

Benefits of Instructional Computer Animation

One great benefit of instructional computer animation in the science classroom is the ability of students to learn at their own pace. Instructional computer animations allow students to learn and explore on their own. The students could access their account from any computer in school or complete the laboratory at home and transfer it to their account in school as opposed to traditional experimental laboratories in schools. In addition, students with special needs would be able to explore and learn on their own depending on their specific needs. On the other hand; gifted students could be placed in accelerated animation programmes or more complex animation programmes that would benefit their advanced learning style (Spitery 2011).

Spitery (2011) further explained that utilizing instructional computer animation laboratories reduce safety concerns for students. During traditional laboratories, safety is always a concern and requires the teacher to be present. This concern was eliminated as the only requirement for the laboratory was a computer. For instance, some slower working students could work on it during classroom where the science teacher was not needed for safety purposes. The students would simply save the power point presentation to a flash drive and turn it in the following day. In addition, laboratory equipment can be expensive and easily damaged. Instructional computer animation can reduce the need for laboratory equipment. Instructional computer animation laboratories should be used in conjunction with traditional laboratories. Again, it is reiterated that instructional animations laboratories are meant to supplement, but not replace, classroom and laboratory learning.

These laboratories appeal to many students because they are not only science based, but they could also exercise their creativity as well. “Although science is a creative endeavor, many students think they are not encouraged-or even allowed to be creative in the laboratory, when students think there is only one correct way to do a laboratory work, their creativity is inhibited” (Eyster, 2010). This laboratory allows students to exercise their creativity by allowing the laboratory to be completed with their resourcefulness and originality.

Creativity, a major benefit of instructional computer animation laboratories leads to self-motivation for some students as confirmed by Spitery (2011) that instructional animation laboratory was able to motivate one particular student who was difficult to motivate throughout the year with other types of teaching strategies. The student was quoted as saying, “this stuff is so cool, I had no idea all this was in Power Point”. Instructional computer animations was able to motivate the student which indicates a positive effect to the extent that other students were seeking assistance from him.

Traditional science laboratories are scarce with on-line courses, but instructional computer animation can be incorporated into online science courses. The use of instructional computer animation could greatly help the students because the use of laboratory is very important in science. Another benefit of instructional computer animation laboratories is the benefit to active learners. Instructional computer animation laboratories require students to become actively involved in learning process. “Anyone who has studied chemistry, or tried to teach others, knows that active students learn more than passive learners”, (Bodner, 1986). By creating these animations and actively participating in instructional computer animation laboratories, students begin to take ownership of their own education.

Empirical Studies

Effect of Instructional Computer Animation on Achievement

Athanassios and Vassilis (2001) investigated the effect of animation and multimedia teaching on academic achievements of students in sciences. The purpose of the study was to determine the effect of the use of computer animation and multimedia teaching on students’ academic performance in science subjects. The research design employed for the study was quasi-experimental research designs specifically, the pre-test, posttest control group. One hundred (100) students were randomly selected from

JS2 in junior secondary schools in Ado Ekiti Local Government Area of Ekiti State. Achievement test in cartoon animation was used to collect data on students achievement in the study. Treatment was administered to the experimental group with the use of Cartoon style animation while the control group was taught with conventional teaching approach. Means and standard deviation were used to answer the research questions while ANCOVA was used to test the hypotheses at 0.05 level of significance. The findings revealed that there was a significant difference in the performance of students exposed to cartoon style multimedia teaching and those that were conventionally taught in favour of the former group. It was therefore recommended that the use of cartoon style animation and multimedia teaching should be encouraged in secondary school so as to complement other methods of teaching science in schools and colleges. This work is similar to the current research work in that both investigated effect of animation on academic performance of students but differs from the present work in that the present work involved the interest of the students.

Akpinar and Ergin (2008) investigated fostering primary school students' understanding of cells and other related concepts with interactive computer animation. The purpose of the study was to investigate whether interactive computer animation accompanied by teacher and student-prepared concept maps enhance primary schoolstudents' biology achievement during instruction and as well enhance attitudes towards science as a school subject. A quasi-experimental pre-test/post-test control group design was used in this study. The sample of the study consisted 65 primary school students from Turkey. The experimental group received instruction including interactive computer animation accompanied by teacher and student prepared concept maps, while the control group received traditional instruction. A biology achievement test and an attitude scale toward science were used as data collection instruments. The two instruments were administered to the students. The research questions were answered using mean and standard deviation while the hypotheses were tested using ANCOVA. The study indicated that the experimental group had significantly higher scores than the control group in the biology achievement test (regarding cells and other related concepts). Regarding students' attitudes toward science as a school subject, there was no significant difference between the experimental and control groups in the pre- and post-test results. However there was a statistically significant difference between the gain scores of the control group and the experimental group in favor of the experimental group, hence interactive computer animation was recommended to support other teaching methods to enhance students' performance. This study used quasi experimental pretest, posttest design like the current research but differs from it in that the current work was done in secondary school while the former was done in primary school.

Chang, Quintana and Krajcik (2010) investigated the impact of designing and evaluating molecular animations on how well middle school students understand the particulate nature of matter. The purpose of the study was to determine whether the understanding of the particulate nature of matter by students was improved by allowing them to design and evaluate molecular animations of chemical phenomena. The design of the study was quasi-experimental with pretest and posttest. Eight classes comprising 271 students were randomly assigned to three treatments in which students used Chemation to (1) design, interpret, and evaluate animations, (2) only design and interpret animations, or (3) only view and interpret teacher-made animations. Chemation a learner-centered animation tool was developed and administered to seventh-grade students to allow them construct flipbook-like simple animations to show molecular models and dynamic processes. Two-factor analysis of covariance was used in the analysis to examine the impact of the three treatments on student posttest achievements and on student-generated animations and interpretations during class. Pretest data was used as a covariate to reduce a potential bias related to students' prior knowledge on their learning outcomes. The results indicated that designing animations coupled with peer evaluation is effective at improving student learning with instructional animation. On the other hand, the efficacy of allowing students to only design animations without peer evaluation is questionable compared with allowing students to view animations. It was recommended that designing animation coupled with peer evaluation should be adopted in schools to improve students’ achievement. The relationship between the study and the present study is that both investigated the effect of instructional computer animation on students’ achievementbut differs from each other in that the previous study involved students in construction of the animation used in the study unlike the present study.

Miri and Yehudit (2011) studied the integration of web-based animated mouse into primary school science curriculum and students learning out comes. The purpose of the study was to determine whether the integration of web-based animated mouse will enhance learning outcomes in primary school. Quasi-experimental pretest-posttest research design was employed. The sample of the study consisted of 15 teachers and 641 and 694 grade 4 and 5 pupils in Turkey. The instrument for data collection was informal discussion held with the 15 teachers and 1335 pupils. The method of data collection was oral interview. Method of data analysis employed was Analysis of Covariance. The sample of the study consisted of 15 teachers and 641 and 694 grade 4 and 5 pupils respectively. These students were divided into control and experimental groups. Experimental group students studied using animated movies and supplementary activities at least once a week. The control group used only textbooks and still pictures for learning science. Findings indicated that animated movies support the use of diverse teaching strategies and learning methods, and can promote various thinking skills among students; that animation can enhance scientific curiosity, the acquisition of scientific language and can also fosters scientific thinking. It was concluded that instructional computer animation promotes students scientific skill. This research was conducted using primary school pupil while the current work used secondary school students. They are similar because both used pretest, posttest research design.

Bulut, Ercan and Bilen (2013) studied the effect of web-based instruction with educational animation content at sensory organs subject on students' academic achievement and attitudes. The purpose of the study was to determine the effect of web-based instruction with educational animation content at sensory organs subject on the 7th grade students' academic achievement and attitudes in science and technology course. Quasi-experimental research design was applied. The sample of the study was 187 7th grade students from Antalya, Turkey. Science and Technology achievement test (STAT) was used. The instrument was administered to the 7th grade students. In experimental group, the sensory organs were explained with web-based instructional materials with educational animation content, and academic achievement test and attitude scale were applied as post-test. In the control group, subject of sensory organs were rendered in the traditional lecture method and application is finished with applying academic achievement test and attitude scale as post-test. ANCOVA was used for data analysis. Findings revealed that there was a meaningful difference in favour of experimental group on the academic achievement pre-test / post-test marks between experimental group instructed with web-based instructional materials with educational animation content and control group instructed with traditional lecture method. It was found that there was no significant difference on attitudes towards science and technology. The recommendation was that web-based instruction with educational animation content be used in schools to improve academic achievement. The study is related to the present study because both studies investigated academic achievement using instructional computer animation and they also applied the same quasi-experimental, pre-test-posttest research design. The difference is that the treatment has no significant effect on attitude but experimental treatment has effect on interest in the present study.

Achor and Ukwuru (2014) carried out a research to examine the facilitative effect of computer animation on students' achievement in chemical reaction and equilibrium. The purpose of the study was to determine whether computer animation has facilitative effect on students' achievement in chemical reaction and equilibrium. A quasi-experimental design involving pretest posttest non-randomized control group was adopted for the study. A total population of 240 Senior Secondary (SS) II students drawn from 10 public schools in Oju Local Government Area of Benue State. 128 students were taught chemical reaction and equilibrium and using instructional computer animation 112 were taught using conventional strategy. Chemistry achievement test was developed and administered to the students. The instrument was analysed using mean, standard deviation and analysis of covariance. The findings of the study revealed that the experimental group that received experimental treatment of instructional computer animation performed significantly better than those taught using conventional method. It was then concluded that instructional computer animation should be used in schools to promote academic achievement of students. This work is related to the present work because both used quasi experimental design with pretest, posttest method of data collection. They also examined influence of gender. It differs from the present work in area of student interest.

Falode, Sobowale, Saliu,Usman and Falode (2016) carried out a research to determine the effectiveness of Computer Animation Instructional Package (CAIP) on academic achievement of senior secondary school agricultural science students in animal physiology in Minna, Nigeria. The purpose of the study was to determine whether computer animation instructional package would improve academic achievement of secondary school agricultural science students in animal physiology. Influence of gender was also examined. Quasi experimental procedure of pretest, posttest, and nonrandomized nonequivalent design was adopted. The sample of the study was made up of 88 senior secondary school students selected from intact classes of two coeducational public schools within the study area. The experimental group which comprised 48students (30 male and18 female)was taught using instructional computer animation and control groupcomprised40students (26 males and 14 females) was taught using lecture method. A 30-item animal physiology achievement test which was validated by experts and whose reliability coefficient of 0.85 was obtained and administered as pretest and posttest on both groups. Data gathered were analyzed using t-test statistics. Findings revealed that there was significant difference between the mean achievement scores of the two groups in favour of those taught with CAIP. Also, the package improved the achievement of both male and female students taught. It was therefore recommended among others that, computer animation instructional package should be adopted in secondary schools to complement lecture method of teaching in order to improve students' achievement in agricultural science. This study investigated effect of instructional computer animation on students' achievement on Agricultural Science students in animal physiology in Minna but the present work investigated its effect on interest and achievement in Chemistry in Awka Education zone in Anambra State. Both used quasi experimental procedure of pretest and posttest research design.

Effect of Instructional Computer Animation on Interest

Akpinar and Ergin (2007) investigated the effect of interactive computer animations accompanied with experiments on grade 6th students achievements and interest toward science. The purpose of the study was to determine the effect of instruction with interactive computer animations accompanied with experiments over traditionally designed instruction in 6th grade students physics achievement and in science. A quasi-experimental pretest-posttest design was used. The sample of the study consisted of 271 secondary school students from Kassel, Germany. As a data collection instruments, physics achievement test and interest scale toward science were administered to experimental and control group. In the experimental group, the materials were used while doing the experiments and then they did the same experiments interactively on the computer. In the control group, the experiment was done only by materials and the students did not use the computer during the experiments. Data collected were analyzed using Analysis of Covariance (ANCOVA). The findings indicated that there was no significant difference between groups with respect to achievement before the treatment and there was a significant difference between the groups in favour of experimental group after the treatment. The means of interestin science showed no significant difference between the groups before and after treatment. On the basis of the findings, it was therefore recommended that instructional computer animation accompanied with experiment should be used in school to improve students' achievement and interest. The study is related to this study because both studies investigated the effect of computer animations on students' achievement and interest. Both employed quasi experimental type of research design and the same type of data analysis. The differences between them are the population used, where the study was carried out and the subject concept taught.

Giginna (2013) studied the effect of animation instructional strategy on students' achievement, interest, and retention in chemical bonding. The purpose of the study was to determine whether animation instructional strategy enhances students achievement, interest and retention in chemical bonding. The population for the study consisted 3221 senior secondary one (SS1) chemistry students in the fifty four (54) schools in Enugu Education Zone of Enugu State and a sample size of five hundred and fifty-four (554) SS1 chemistry students was used for the study. Quasi experimental design of pretest, posttest was adopted. Chemistry Achievement Test (CAT) and Interest Inventory for assessing students' Interest in chemical bonding (IIASICB) were used as instruments for data collection. The two instruments were administered to the students. The research questions were answered using mean and standard deviation of test scores. The hypotheses were tested at 0.05% level of significance using ANCOVA based on SPSS software for data analysis. Findings revealed that there was significant difference in the mean achievement scores of the two groups in favour of those taught with instructional computer animation. Also, the package improved the interest of both male and female students taught. It was therefore recommended among others that computer animation instructional package should be adopted in secondary schools to complement lecture method of teaching in order to improve students' achievement in chemistry. This work resembles the present research in that both of them studied student achievement and interest but the present did not involve retention. The two research works treated chemical bonding.

Gender Differences in Interest and Achievement

Onoh (2005) carried out an experimental research to find the effect of advance organizer on students' achievement, interest and retention in Algebra. The purpose of the study was to determine whether the use of advance organizer will enhance students' achievement, interest and retention in Algebra. The researcher employed quasi-experimental research design. A sample of two hundred and twenty-eight (228) students (109 boys and 119 girls) in Junior Secondary School (JSS II) in Orumba South Local Government Area of Anambra State was used for the study. Questionnaire was developed and administered to the students for data collection. The data was analysed using mean score and Analysis of Covariance (ANCOVA). The results of the study revealed that female students achieved more than male students in both the experimental and control groups but the differences in achievement is not significant. The findings equally showed that there is no difference in the mean interest scores of male and female students taught algebra in both the experimental and control group. The experimental findings also showed that females performed better than the male counterpart in both the experimental and control groups in their level of interest but the difference is not significant. It was therefore recommended that advance organizer should be used in teaching of Mathematics to increase students' academic achievement in the subject. This work investigated students' achievement and interest like the present research but the present research did not include retention as a variable of study.

Iweka (2006) investigated the effect of inquiry and laboratory approaches of teaching geometry on students' achievement and interest. The purpose of the study was to determine whether inquiry and labouratory approaches of teaching enhance students' academic achievement and interest in geometry. The research design employed was quasi-experimental research design. Iweka sampled ninety-eight (98) junior secondary school two (JSS II) students from three co-educational schools in Ika educational zone of Delta state. Five research questions were used in the study and six hypotheses were tested at 0.05 alpha level of significance. Geometry Interest Scale (GIS) and Geometry Achievement Test (GAT) served for the instrument for data collection and both were administered as pretest and posttest. The research questions were answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to analyze the hypotheses. The results of the study among others showed that there was no significant difference in the mean achievement and interest scores of the male and female students taught Geometry with laboratory approaches and those taught with inquiry, and the interaction between achievement and gender was significant. It was concluded that inquiry and laboratory approaches do not enhance students' achievement and interest in geometry. This work and the present research investigated interest and achievement of students but differs from each other in that one was on geometry in mathematics while the other was in chemistry.

Anaduaka (2007) investigated the effect of students' interaction patterns on cognitive achievement, retention and interest in chemistry. The purpose of the study was to determine whether student interaction patterns affect cognitive achievement, retention and interest of students in chemistry. Quasi-experimental design was employed. A sample of three hundred and seventy-three SS I students' were drawn from two government-owned secondary schools in Awka. Chemistry Achievement Test and Chemistry Interest Scale were developed and administered to the students for data collection. Six research questions guided the study and six hypotheses were tested at 0.05 level of significance. The research questions were answered using mean and standard derivation. The combined effect of students' interaction pattern and gender on students' interest in chemistry was measured by the mean score and result was found not significant. The hypotheses were tested with a 4 x 2 (interaction patterns x gender) research design ANCOVA at 0.05 level of significance. The results of the study among others were that the influence of gender on students' interest in chemistry was not significant. There was no significant effect on students' interaction pattern and gender for achievement and interest. On the basis of the findings of the study, it was concluded that student's interaction pattern has no effect on cognitive achievement and interest in chemistry. This work differs from the present work because the investigation included retention which the present work does not have. Both of them equally investigated achievement and interest.

Ugwuadu (2011) conducted an experiment on the effect of discourse patterns on students' achievement and interest in biology. The purpose of the study was to investigate the effect of discourse patterns on students' achievement and interest in biology. The design was quasi-experimental. A sample of one hundred and sixty-four (164) senior secondary (SS II) students from three intact classes in Yola educational zone of Adamawa state participated in the study. Six research questions guided the study and ten hypotheses were formulated and tested at 0.05 alpha level of significance. Biology Achievement Test (BAT) and Biology Interest Scale (BIS) were administered as the instruments for collection of data. The research questions were answered using mean and standard deviation. The hypotheses were analyzed using Analysis of covariance (ANCOVA). From all the findings, one of the results revealed that there was no difference in the mean achievement and interest of male and female students taught biology and there was no interaction effect between discourse patterns and gender in the achievement of the students taught biology using the selected discourse patterns. It was concluded that gender has no influence on achievement and interest of students taught biology using discourse patterns. The study is related to the present study in the sense that both investigated interest and achievement of learners but differs from each other in terms of location; the previous study was at Adamawa while the present study is in Anambra.

In a study conducted by Egbunonu (2012) on the Effect of Computer Assisted Instruction (CAI) on secondary school students' cognitive achievement and interest in Ecological concepts, the purpose was to determine whether computer assisted instruction will enhance students' cognitive achievement and interest in ecology. Quasi-experimental research design was employed. A sample of 66 students from two schools in Aguata Educational zone in Anambra state was used for the study. Biology Achievement Test(BAT) and Biology Interest Scale (BIS) were administered to the students for data collection. Four research questions were answered using mean and standard deviation while the hypotheses were analyzed using ANCOVA. Findings from the study showed that Computer Assisted Instruction (CAI) had no statistical significant difference on students' achievement due to gender, but there was a statistical significant difference on students' interest due to gender. It was therefore concluded that computer assisted instruction has no significant difference in student academic achievement in both male and female but has a significant difference in students' interest. The study is related to the present study in that both tested achievement and interest of the students in the research works with respect to gender but differs from each other in that the previous study was carried out in Aguata Education Zone while the present study is carried out in Awka.

Summary of Literature Review

Literature review was summarized under the following sections: instructional computer animation, theoretical framework, theoretical studies and empirical studies. Instructional computer animation involves using computer as a method of instruction to give life to objects and abstract concepts and make them function as life objects. Instructional computer animations show the motion of stimulated objects. They are utilized when there is need to show learners something not easily seen in real world such as shearing or transfer of electrons in chemical bonding.

Dual coding theory emphasized the need to associate verbal explanation with visual images so as to concretize knowledge and enhance retention and retrieval of learned materials. Meaningful learning and subsumption theory posited that new knowledge has to be subsumed into the previous knowledge of the learner for learning to be meaningful.

Studies in computer animation exposed some levels of explanations relevant to animations to include; cognitive, motor, perceptual, affective and motivational, strategic, metacognitive and rhetorical explanations. For animation to be effective as a method of instruction, it must not contain excessive details, must be interactive, able to catch attention of the students and complex processes must be broken into smaller packages for easy assimilation by the students.

Most empirical research works in instructional computer animation were done overseas. Findings from these studies reveal that instructional computer animations can provide a concrete material that can serve as a catalyst for the success of teaching and learning and at the same time reinforce students to understand the subject of study easily. Scanty or no attention has previously been given to using instructional computer animation to teach chemistry in Nigeria with particular reference to students' interest and achievement. This situation creates a gap, hence, the choice of the research topic.

CHAPTER THREE

METHOD

This chapter contains the general procedure that was adopted in carrying out the research. It describedthe research design, area of the study, population of the study, sample and sampling techniques, instruments for data collection, validation of the instrument, reliability of the instrument, experimental procedure, control of extraneous variables, method of data collection and method of data analysis.

Research Design

The study adopted a quasi-experimental research design. Specifically, non-equivalent control-group design was used. Quasi-experiment is an experiment where random assignment of subject to experimental and control groups is not possible rather intact or pre-existing groups are used (Nworgu, 2015). The researcher used two streams of a class as experimental and control groups respectively. This research design is considered suitable because participants were not randomly assigned to groups rather treatment condition was randomly assigned to two intact groups which were already organized. The design was chosen so as not to disrupt the school activities in terms of classroom arrangements and schedules of lessons. Nworgu explained that quasi-experimental research design could be used in a school setting where it is not always possible to use pure experimental design which is considered as a disruption of school activities. Intact classes were used. The design is diagramatically represented in figure 1.

Groups	**Pretest**	**Treatment**	**posttest**
E	O_1	54 X	O_2
	------	------	------
C	O_1	~X	O_2

Figure 1: Design of the Study

Where;

E = Experimental Group (instructional computer animation group)

C = Control Group (conventional method group)

O_1 = Pretest given to both experimental and control group.

O_2 = Posttest to the two groups

X= Treatment to experimental group

~X= No treatment to control group

------ = Dashed lines separating two rows show two groups not equated by random assignment.

Area of the Study

The area of the study was Awka Education Zone in Anambra State. Awka Education Zone consists of five local government areas namely; Awka North, Awka South, Njikoka, Anaocha and Dunukofia. The zone is the heart of Anambra State capital territory. It has basic modern facilities such as good roads and electricity. The people living in the zone have high value for education. The area has two universities and a teaching hospital with 61 public secondary schools. This study is better carried out here because it is an urban center, the seat of the government of the Anambra State. The people working there have value for qualitative education. They will implement the recommendations made from the findings of the study because the carrier of people living here are mainly academicians who know the importance of qualitative education.

Population of the Study

The population of the study comprised 2,927 senior secondary school year two (SS 2) chemistry students in 61 public secondary schools (46 coeducational schools and 15 single-sex schools) in Awka Education Zone of Anambra State. (Source: Post Primary School Services Commission 2016/2017).

Sample and Sampling Technique

The sample for the study consisted of 186 senior secondary year two (SS 2) chemistry students drawn from four classes in two coeducational schools in Awka Education Zone. Simple random sampling technique was used to select two co-educational schools out of the 46 co-educational secondary schools in Awka Education Zone. Using a lucky dip, one of the schools was designated the experimental school and the other, the control school. From the experimental school, two intact classes were chosen with 45 males and 50 females giving a total of 95 students. From the control school, another two intact classes were chosen with 40 males and 51 females giving a total of 91 students. The classes were chosen that way so that the same chemistry teacher would teach them, this was done to check teacher variable.

Instruments for Data Collection

Two instruments were used for data collection namely: Chemistry Achievement Test (CAT) and Chemistry Interest Scale (CIS).

The CAT is a 25-item multiple choice test developed by the researcher. The 25-item multiple choice testswas based on chemical bonding and chemical equilibrium which were the concepts taught to the students in this study. Thirteen (13) items were drawn from chemical bonding and twelve (12) items from chemical equilibrium. The weighting was based on the scope of the content area as the two topics appear to have equal weight (see Table of Specification, Appendix E, page 129). The CAT was used for both the pretest and the posttest.

CIS was adapted from Psychology Interest Scale developed by Linnenbrink-Garcia in 2010. It is a 17-item interest scale. The original reliability index of the scale was 0.95. The researcher modified some of the statements to suit her purpose by replacing the word psychology with chemistry in the items. She also included some of the concepts taught the students in the items. The CIS was measured on a four point interest scale of strongly agree (SA), agree (A), disagree (D) and strongly disagree (SD) to enable the students indicate their level of interest (see appendices C and D, pages 121 and 122). It was used for both the pretest and posttest.

Validation of the Instruments

The Chemistry Achievement Test (CAT) with 30 items was validated by three lecturers, one in the Department of Science Education, the other in Educational Foundations and the third lecturer was from the Department of Pure and Industrial Chemistry, all in NnamdiAzikiwe University Awka. The purpose of the study, scope of the study, research questions and hypotheses together with CAT were given to the validators to guide the validation exercise. The experts were asked to check the face validity of the items. Specifically, they were asked to find out the suitability and clarity of the language used in the construction of the CAT with regard to the students' age and level of understanding. For content validation, the validators were given table of specifications and lesson plans to guide them.The table of specification was developed based on the number of weeks used in teaching a topic.Some of the corrections made by the validators include: redrawing diagrams that were not properly sketched, inclusion of some omitted items that were supposed to be part of the questions, deletion of item that was not testing any of the concepts taught and restructuring of some questions. These corrections given by the validators were properly effected. The corrected items in the CAT were finally reduced from 30 to 25 items (see Appendices F and G, page 130 and 135).

The Chemistry Interest Scale (CIS) is a 17-item test sent to the experts in the Departments of Science Education, and Educational Foundation in NnamdiAzikiwe University, Awka for face validation. The experts were specifically requested to find out the suitability of the language used in the construction of the CIS with regard to the students' level of understanding; and extent to which the statements on the CIS assess interest of students in the area of study. After the validation, some of the items were modified, some deleted and some negatively worded items were included.

Reliability of the Instruments

Reliability is concerned with the degree of consistency of the measuring instrument. The CAT was administered on 40 SS 2 students in a secondary school in Ogidi Education Zone outside the research area which has a homogenous culture as the research area. The scores for CAT obtained from trial testing exercise carried out with 40 students were used to estimate the reliability coefficient of the instrument using Kudder Richardson Formular (KR-20) which yielded a reliability index of 0.72.KR-20 was used because the items vary in their strength of difficulty (see Appendix K, page 173). This shows that the instrument is reliable.

The CIS items were also trial-tested. CIS was administered on the same 40 SS2 students in the same secondary school in Ogidi Education Zone in Anambra State. The original reliability index of the psychological instrument was 0.95 but because it was adapted a new reliability was established using Cronbach Alpha method and a reliability index of 0.78 was obtained (see Appendix L, page 176).

Experimental Procedure

This was done in two stages:

Stage 1: Training Programme for Research Assistants in Experimental Group

The researcher introduced herself to the two research assistants who were the chemistry teachers of the sampled schools. The researcher explained the aim of the research to the research assistants and introduced the method as instructional computer animation. She gave them detailed tutorial on how to use instructional computer animation in teaching chemistry concepts. She gave lesson plan to the research assistants to guide them. The training was done for one week of three hours in four contacts.

Control Group

The conventional method was used for the control group. No serious training was given to the two research assistants in this group because they were allowed to use the conventional method they were conversant with. The researcher gave them the lesson plan that guided them during the lesson periods.

Both the teachers in the experimental and control groups hadBachelors of Science (B.Sc.) degree in education/ chemistry. They had all taught chemistry for not less than five years.

Stage 2: Treatment Procedure

Before the experiment began, the CAT and CIS were administered as pretests to the experimental group and control group. At the end of the test, the experimental group was taught some chemistry concepts using computer animation involving pictorial designs of animated chemistry concepts by one of the two chemistry teachers for the experimental group while the other teacher was a standby or reserve.This was done so that in case of any accident or illness the standby teacher would take over to avoid stopping the experiment abruptly. The teacher introduced the topic as chemical bonding, explained the periodic table of Group O elements as noble gases with stable atomic structure. She showed animated moving images of different shapes and colours of Group O elements carrying two or eight electrons in their outer most shells. Students seeing these moving images smiled and began to whisper to one another.

The teacher listed types of bonding differentiating each with moving pictures of varying colours indicating different bonds. The students seeing them widened their eyes, touching one another, discussing their observances. The teacher discussed electrovalent bonding using animated Na and Cl atoms that were flapping their wings. Students watching them started flapping their two hands like birds on flight. As Na atom was donating its electron to Cl atom, students dived as someone who wants to catch a ball. They shouted, clapped and laughed. Students hands were up to ask questions, discuss their observations, to demonstrate the actions and to make contributions. They were allowed to air their views one by one. So it continued till the end of the lesson.

DAY 2

The teacher introduced the topic of the day as co-ordinate covalency bonding. She explained that the shared pair of electrons is contributed by one of the atoms involved in sharing rather than by each atom. The teacher displayed animated structure of ammonia and hydrogen as examples with three hydrogen atoms sharing three pairs of electrons with nitrogen atom forming covalent bonds. The students were pointing to the remaining lone pair of electrons on nitrogen arguing why it was not bonded. Animated proton (H^+) danced across to bond with the lone pair of electrons forming co-ordinate bond. The students nodded in apprehension. A student from behind shouted “parasite!”. The whole class busted into laughter. When asked what she meant by that, she said that the proton was being parasitic to ammonia because it gained or shared two electrons with ammonia without contributing anything to the combination.

With many more examples and displays using instructional computer animation the class lively continued with other types of bonding.

DAY 3

The teacher introduced the lesson as chemical equilibrium and explained it with Le Chaterliers’ principle saying that Le Chatelier gave three conditions that affect equilibrium to be pressure, concentration and temperature. The teacher displayed three animated objects that danced out representing pressure, concentration and temperature. The students made bodily movement as if they themselves wanted to dance too.

The teacher explaining effect of concentration on equilibrium said that a definite concentration of A, B, C and D exist together in equilibrium.

$$A+B \rightleftharpoons C+D$$

The teacher explained that if the concentration of A is increased the equilibrium is disturbed and it will shift to oppose the increase. To oppose the increase B reacted with A producing more C and D making equilibrium position shift to the right. The teacher displayed animated A which increased and increased with B reacting with it, producing more C and D. The students were interacting, watching and discussing, pointing to the direction of the increase. Many were excited when B began to react with A to form C and D.

A student suggested that C should be reduced so that they would see the effect. The students were talking in low voices sharing their observations. In the same manner, effect of pressure was discussed and displayed.

DAY 4

The teacher discussed and interactively displayed the effect of temperature on equilibrium. She explained that effect of temperature on equilibrium is either exothermic or endothermic. She explained that if the forward reaction is exothermic, the reverse reaction must be endothermic and vice-versa.

$$A+B \rightleftharpoons C,\ \Delta H = -ve$$

Animated alphabets A, B and C were shown flapping their wings and the students flapped their hands as if they were about to fly with the birds.

The teacher explained that if the equilibrium of the above reaction is disturbed by increase in temperature, according to Le Chartalier, the equilibrium must shift to oppose the increase in the direction from where the heat is coming favouring backward reaction to produce A and B. If forward reaction is to be favoured heat has to be decreased. The students were pointing to the direction of the increase. A student asked for the reduction of heat to see how C would be produced. The teacher explained that decrease in temperature slows down the rate of reaction but to increase the rate of chemical reaction without disturbing the equilibrium, catalyst is introduced at optimum temperature of 450^{0c} --500^{0c}. A student demanded to see and feel the catalyst.

It is important to note that at any point where the students indicated difficulty, the teacher would pause and replayed the stage. Both the teacher and the students would ask questions for clarity. The lesson lasted for 90mins (double periods) each day.

The control group was taught by one of the other two class teachers using conventional method of instruction. The researcher observed the class, taking note on classroom processes. The lesson lasted for 90 minutes (double periods) as well. The whole experiment lasted for four weeks using the normal school time table of 90 minutes. At the end of the experiment, the CAT and CIS were reshuffled and administered again to both the experimental and control groups as post-test by the class teacher.

Control of Extraneous Variables

In experimental research of this nature, there is likelihood that some extraneous variables may introduce some bias into the study. This the researcher checkmated by adopting the following strategies:

Experimenter Bias: The presence of the researcher sometimes brings in faking by subjects. To avoid this, the normal class teachers in the selected schools taught their own students in both the experimental and control groups. They equally administered the research instrument to the students as class test. The researcher came in as external observer.

Non-Randomization Effect: It was not possible to assign participants at random to both experimental and control groups, hence, the researcher employed Analysis of Co-variance (ANCOVA) for data analysis in order to eliminate the error of non-equivalence. This controlled the initial differences of the participants in the intact groups. In this case, the pretest scores were used as covariate measures

Testing Effect: The effect of pre-test and post-test were checked. Influence of memory and forgetfulness were minimized by the time lag between the pretest and post-test. A period of four weeks was used for the experiment which was not too short or too long.

The relatively short period for the experiment controlled the pretest sensitization and as well minimized the effect of maturation by the students.

Teacher Variable: Normal chemistry teacher in each of the schools under study was used. The researcher specified and operationalized the two teaching methods by outlining their distinctive procedural steps as well as developed edited lesson plan that served as operational guides for each method.

Method of Data Collection

The instruments for data collection were chemistry achievement test (CAT) and chemistry interest scale (CIS). The CAT and CIS were administered on the research participants (experimental and control groups) before the actual experiment began. The experiment started after the pretest and lasted for four weeks of eight lesson periods. Each lesson period was forty five minutes. At the end of the treatment, the items were reshuffled and administered again to the students as posttest.

The chemistry teachers in both experimental and control groups were used to administer the CAT and CIS to their students.

Method of Data Analysis

Mean and standard deviation scores were used to answer the research questions while two-way analysis of variance (ANCOVA) was used to test the hypotheses at 0.05 alpha levels. Two-way ANCOVA was used to analyse the experiment because the experiment has two independent variables and because there are three basic types of effects that are tested; main effect for independent variable A, main effect for independent variable B, and effect for the interaction of A and B.

Decision Rule

For the hypotheses, when the P-value was greater than 0.05, null hypothesis was not rejected. When p-value was less than 0.05, null hypothesis was rejected

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF DATA

This chapter presents the results and analysis of data. The presentation is based on the six research questions and eight null hypotheses of the study.

Research Question 1: What are the mean achievement scores of students' taught chemistry concepts using instructional computer animation and those taught using conventional method?

Table 1: Mean Pretest and Posttest Achievement Scores of Students Taught using Computer Animation and Conventional Method

Method	N	Pretest mean	Posttest mean	Gain in Mean	SD pretest	SD posttest
Instructional Computer Animation	95	31.79	76.89	45.10	11.55	11.69
Conventional method	91	31.81	54.43	22.62	12.39	10.01

Table 1 shows that the group taught chemistry concepts using instructional computer animation has a gain in mean achievement score of 45.10, while those taught using conventional method has a gain in mean of 22.62. Students taught chemistry concepts using instructional computer animation therefore, have higher gain in mean achievement than their counterparts taught using the conventional method. The use of instructional computer animation increases the spread of scores among the students while the conventional method reduced the spread of scores among the students.

Research Question 2: What are the mean achievement scores of male and female students' taught chemistry concepts using computer animation?

Table 2:Mean Pretest and Posttest Achievement Scores of Male and Female Students Taught using Computer Animation

Method	Gender	N	Pretest mean	Posttest mean	Gain in mean	SD pretest	SD posttest
Computer Animation	Male	45	31.56	75.67	44.11	12.70	7.04
	Female	50	32.00	76.20	44.20	10.55	13.80

Table 2 shows that the female students taught chemistry concepts using instructional computer animation method have higher mean achievement gain score of 44.20 while their male counterparts have gain in mean score of 44.11.The use of computer animation increases the spread of scores for females but decreases the spread of scores for males.

Research Question 3: What are the mean interest scores of students taught chemistry concepts using instructional computer animation and those taught using conventional method?

Table 3: Mean Pretest and Posttest Interest Scores of Students Taught using Computer Animation and Conventional Methods

Method	N	Pretest mean	Posttest mean	Gain in mean	SD pretest	SD posttest
Instructional computer animation	95	39.23	77.57	38.34	9.89	7.50

Conventional method	91	36.26	59.72	23.46	13.33	7.19

Table 3 shows that the group taught chemistry concepts using instructional computer animation has a gain in mean interest score of 38.34, while those taught using conventional method has a gain in mean interest score of 23.46. This reveals that students taught chemistry concepts using instructional computer animation technique have higher mean interest gain scores in chemistry than students taught using the conventional method. The use of instructional computer animation decreases the spread of scores among the students from pretest to posttest.The use of conventional method also decreases the spread of scores amongthe students.

Research Question 4: What are the mean interest scores of male and female students taught chemistry concepts using instructional computer animation?

Table 4: Mean Pretest and Posttest Interest Scores of Male and Female Students Taught using Computer Animation

Method	**Gender**	**N**	**Pretest mean**	**Posttest mean**	**Gain in mean**	**Pretest SD**	**Posttest SD**
Instructional computer animation	Male	45	45.71	79.42	33.71	8.106	7.70
	Female	50	33.40	75.90	42.50	7.431	6.97

Table 4 shows that the male students taught chemistry concepts using computer animation have a gain in mean interest score of 33.71, while the females havea gain in mean score of 42.50.Female students taught chemistry concepts using instructional computer animation have higher mean interest scores in chemistry than their male counterparts. The use of instructional computer animation decrease the spread of scores in both males and females students.

Hypothesis 1: The is no significant difference between the mean achievement scores of secondary school students taught chemistry concepts using instructional computer animation and those taught using conventional method.

Table 5: Analysis of Covariance for Test of Difference in Achievement of Students Taught Chemistry Concepts using Computer Animation and those Taught with Conventional Method.

Source	SS	Df	Mean Square	F	P-value	Decision
Corrected Model	9643.763[a]	4	2410.941	24.032	.000	
Intercept	46343.196	1	46343.196	461.940	.000	
Pretest	910.721	1	910.721	9.078	.003	S
Gender	1096.850	1	1096.850	10.933	.001	S
Method	6650.190	1	6650.190	66.288	.000	S
Method * Gender	511.375	1	511.375	5.097	.025	S
Error	18158.473	181	100.323			
Total	507720.000	186				
Corrected Total	27802.237	185				

Table 5 shows that at 0.05 level of significance,there was significant main effect of the treatment in the achievement scores of the students with respect to post achievement, $F(1,185) = 66.288$, $P\text{-}(0.000) < 0.05$.Thus, the null hypothesis is rejected. Therefore, the effect of instructional computer animation on students' achievement in chemistry is significant when compared with that of conventional method.

Hypothesis 2: There is no significant difference between the mean achievement scores of male and female students taught chemistry concepts using instructional computer animation.

Data relating to hypothesis 2 is contained in Table 5

Table 5 also shows that at 0.05 level of significance, there was significant main effect of the treatment in achievement scores of the male and female students with respect to post achievement, F (1,185) = 10.933, P- (0.001) < 0.05. Therefore, the null hypothesis is rejected. Thus, there is significant difference between the mean achievement scores of male and female students taught chemistry concepts using instructional computer animation.

Hypothesis 3: There is no significant interaction effect of teaching method and genders on students' mean achievement scores.

Data relating to hypothesis 3 is contained in Table 5

Table 5 shows that at 0.05 level of significance, there was significant interaction effect of teaching method and gender on the achievement scores of the students, F (1,185) = 5.097, P-(0.026) < 0.05. Therefore, the null hypothesis is rejected. Thus, there is significant interaction of teaching methods and gender onthe achievement of the students in chemistry. The interaction is shown in figure 2.

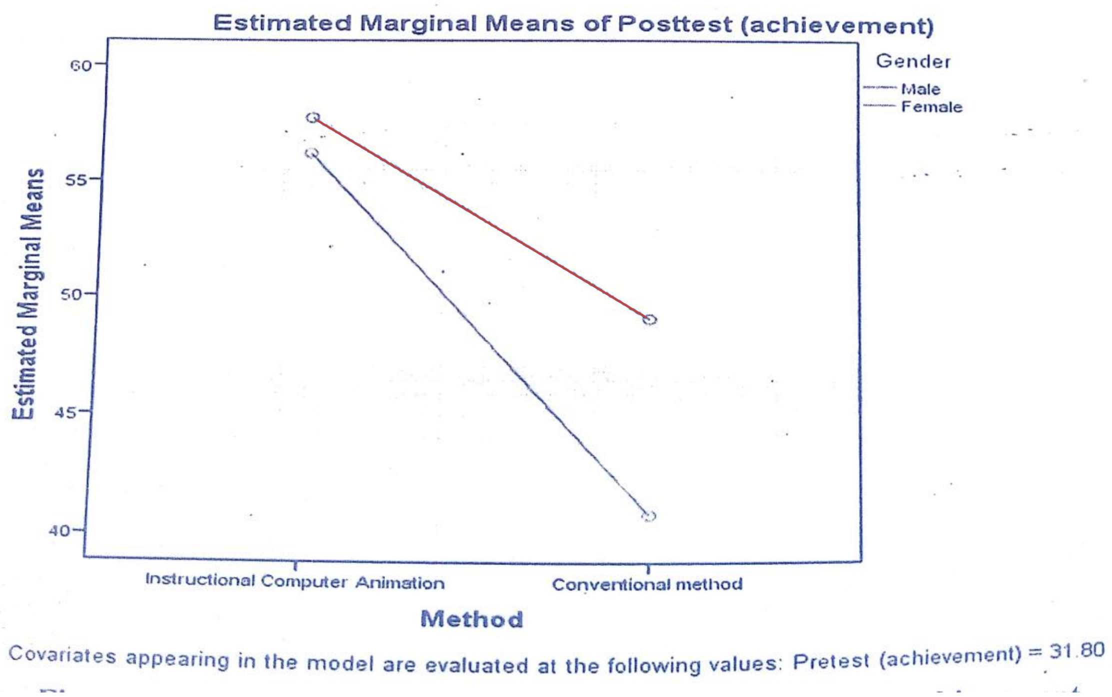

Figure 2: Interaction of teaching methods and gender on achievement

The plot of the interaction of gender and teaching method is significant and ordinal. This shows that the effect of teaching method is greater in one category of variable (gender), for example, the effect of teaching is greater in males than females or otherwise. This implies the teaching method is gender biased.

Hypothesis 4: There is no significant difference between the mean interest scores of students taught chemistry concepts using instructional computer animations and those taught using conventional method.

Table 6: Analysis of Covariance for the Test of Difference in Interest of Students Taught Chemistry Concepts using Instructional Computer Animation and those Taught with Conventional Method

Source	SS	Df	Mean Square	F	P-value	Decision
Corrected Model	15675.358[a]	4	3918.839	79.203	.000	
Intercept	39553.507	1	39553.507	799.414	.000	
Pretest	412.084	1	412.084	8.329	.004	S
Gender	381.270	1	381.270	7.706	.006	S
Method	13221.419	1	13221.419	267.217	.000	S
Method * Gender	51.148	1	51.148	1.034	.311	NS
Error	8955.546	181	49.478			
Total	669268.000	186				
Corrected Total	24630.903	185				

Table 6shows that at 0.05 level of significance, there was significant main effect of the treatment in the interest scores of the students, F (1,185) = 267.217, P-(0.000) < 0.05. Thus, the null hypothesis is rejected. Therefore, the effect of instructional computer animation on students' interest in chemistry is significant when compared with thosetaught with conventional method.

Hypothesis 5: There is no significant difference in the mean interest scores of male and female students taught chemistry concepts using instructional computer animation.

Data relating to hypothesis 5 is contained in Table 6

Table 5 also shows that at 0.05 level of significance, there was significant main effect of the treatment in the interest scores of the male and female students, F (1,185) = 7.706, P- (0.006). Therefore, the null hypothesis is rejected. Therefore, there is significant difference between the mean interest scores of male and female students taught chemistry concepts using instructional computer animation.

Hypothesis 6: There is no significant interaction effect of teaching method and gender on students' mean interest score.

Data relating to hypothesis 8 is contained in Table 6

Table 6 also shows that at 0.05 level of significance, there was no significantinteractioneffect of teaching method and gender on the interest scores of the students, F (1,185) =1.034 P- (0.311) > 0.05. Therefore, the null hypothesis eight is not rejected. Therefore, there is no significant interactioneffect of teaching method and gender on students' mean interest score.

Summary of Findings

The findings of this study are as follows:

1. Mean achievement scores of students taught chemistry using instructional computer animation was significantly greater than the mean achievement scores of those taught using conventional method.
2. Male and female students taught chemistry using instructional computer animation differ significantly in their mean achievement 3There was significant interaction effect of teaching method and gender on students' mean achievement scores in chemistry.

4.Mean interest scores of students taught chemistry using instructional computer animation was significantly greater than the mean interest scores of those taught using conventional method.

5 There was significant difference in the mean interest scores of male and female students taught chemistry using instructional computer animation.

6 There was no significant interaction effect of teaching method and gender on students' mean interest in chemistry.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATION

This chapter presents a discussion of the results of data analysis\. It is discussed under the following sub-headings: discussion of findings, conclusions, implications of the study, recommendations, limitation of the study, suggestions for further study.

Discussion of Findings

The findings of this study are discussed in line with the research questions and hypotheses alongside relevant literature. Under the following sub-headings:

1. Effect of Instructional Computer animation on students' achievement and interest in chemistry.
2. Gender influence on students' achievement and interest in chemistry.
3. Interaction effects of gender and teaching method on students' achievement and interest in chemistry.

Effect of Instructional Computer Animation on Students Achievement and Interest in Chemistry

One of the major purpose of this study was to determine whether instructional computer animation provides better students' academic achievements in chemistry than the conventional method of instruction. It was found that instructional computer animation provides a better academic achievement in chemistry. The mean score of students taught with computer instructional computer animation is higher than those taught with conventional method. The finding is further confirmed by the result of table 5 which indicates that the teaching approach was a significant factor in the achievement of students taught chemistry. This is shown by the rejection of null hypothesis of no statistical significant difference in the mean academic achievement scores in chemistry students taught with instructional computer animation and those taught with conventional lecture method. Thus, this findingconfirms that the group taught chemistry with instructional computer animation achieved better than the group taught with conventional method.

The findingof this study is supported by the earlier findings of Gambari, Folade and Adegbenro (2014) who proved that instructional computer animation improved the academic achievement of chemistry students more than the conventional method. The difference may be as a result of the interactive nature of computer animation providing the students an opportunity to be actively involved in the learning process.

This finding had support from what had been found by other researchers such as Chang, Quintans and Krajcik (2010) and Ercan, Bilen and Bulut (2013).Chang,Quintans and Krajcik found that instructional animations improved students learning. Ercan, Bilen and Bulut revealed that there was a meaningful difference in favour of the experimental group on the academic achievement when taught with instructional animation content. Gigninna (2013) found that there was significant difference in the achievement of students taught chemical bonding with instructional computer animation against those taught with conventional method. Those taught with instructional computer animation achieved significantly higher than their counterparts.

It is important to know that the higher achievement gain in mean of students in the experimental group is a reflection of the enhanced interest exhibited by the students. The findings of the study equally showed that the mean interest gain of students taught with instructional computer animation was higher than that of those students taught with conventional method. The findings in Table 3 showed that there was statistically significant difference in the mean academic achievement score of students taught with instructional computer animation than that of those taught with conventional method of instruction. The academic achievement of those taught with computer animation was better than those taught with conventional method. This finding is in line with that of Falode, Sabowale, Saliu, Usman and Falode (2016) who reported that students perform better through the use of innovative method of instructional computer animation.

In contrast to the findings of other researchers Akpina and Ergin (2008) reported that instructional computer animation does not enhance students' interest. However, he found out that it enhances student academic achievement.

Gender influence on Students' Achievement and Interest in Chemistry

Another major finding of this study is that there is gender difference in the academic achievement of students taught with instructional computer animation and those taught with conventional method. The result indicated that differences existed between the gain in mean scores of the male students and that of the female students. That is to say that female students achieved better than the males in Chemistry when taught with instructional computer animation. This notwithstanding, researchers have revealed significant gender differences in science achievement across educational systems but there is conflicting evidence on gender difference in science achievement (Nwogu, 2005; Olom, 2010). In line with findings of this study is the result of Egbunonu (2012) on the effect of computer assisted instruction on secondary school students' cognitive achievement and interest on Ecological concepts. The study showed that computer assisted instruction had a statistical significant difference on students' interest due to gender.

The result of the study on male and female students' mean interest score in chemistry revealed that female students had higher interest score in chemistry than their male counterparts. The finding is in contrast with Onoh (2005) who carried out an experimental research on the effect of advance organizer on students' achievement, interest and retention on Algebra and found out that female students achieved more than male students in both the experimental and control groups but the differences in achievement is not significant. The study also revealed that female students performed better than the male counterparts in both the experimental and control groups in their level of interest.

Iweka (2006) who investigated the effect of inquiry and laboratory approaches of teaching geometry on students achievement and interest observed no significant difference in the mean achievement and interest scores of the male and female students which is not in line with this study.

Interaction Effects of Gender and Teaching Methods on Students' Achievement and Interest in Chemistry

The findings of this study showed that there is significant interaction effect of method and gender on students' mean achievement in chemistry. The test of hypothesis showed that there is significant interaction effect of instructional method and gender on students' achievement in chemistry. The achievement of the female students is higher than that of their male counterparts. The difference in the female students achieving better than the male students must have come from the female students paying higher attention and interest in the lesson than the male students.

In line with this study, Iweka (2006), found a significant interaction effect of treatment and gender on the effect of inquiry and laboratory approaches of teaching geometry on students achievement and interest.

Contrary to the findings of this study, Anaduaka (2007) in his study on students' interaction patterns on cognitive achievement, retention and interest in chemistry, found no interaction effect of gender and instructional treatment on students' achievement and interest. Ugwuadu (2011) also found no interaction effect between instructional method and gender on the effect of discourse patterns on students' achievement and interest in biology.

The female students had higher interest scores than their male counterparts. The interaction effect of instructional methods and gender on students mean interest scores in chemistry was not significant. The findings of this study with respect to instructional method isin line with the findings of Anaduaka (2007) who found no significant interaction effect between gender and instructional treatment on students' achievement and interest in chemistry.

Conclusion

From the findings obtained from the investigation into the effects of instructional computer animation on students' achievement and interest in chemistry conclusions were drawn:

The instructional computer animation used in teaching senior secondary school students was more effective than the conventional method in enhancing students achievement in chemistry. This is evident from the fact that the experimental group taught with computer animation achieved better than the control group taught with the conventional method.

Again gender was found to play a role in determining the achievement of the students. Female students taught with instructional computer animation achieved more thantheir malecounterparts. Animation also improved female students' interest more than the male students.

There was significant interaction between gender and teaching method on achievement but no significant interaction effect exist between gender and teaching method on interest.

Implications of the Study

The findings of this study have practical implication for education and science education particularly, the teachers, students and writers of science text books.

The findings of this study revealed that instructional computer animation enhances the achievement of chemistry students. This implies that the students will do better in chemistry when they are taught with the method that is interactive like computer animation. Instructional computer animation was able to engage the students actively during the learning process thereby improving the academic achievement.

Computer animation will help students to overcome the impression that chemistry is abstract and difficult. The attitude of absenting themselves from lesson will be drastically reduced because the interactive and interesting nature of instructional computer animation will entice them.

The findings of this study have great implications for the chemistry teachers. The findings show that chemistry teachers do not adequately make use of effective pedagogical approaches in teaching the subject which has resulted in consistent poor achievement of the students in both internal and external examinations in chemistry. The chemistry teachers need to use the innovative, interactive, student-centered instructional method of computer animation more in teaching of chemistry.

The curriculum planners should bear in mind the introduction of this innovative method when revising chemistry curriculum. The implication for the government is the need to provide schools with adequate manpower and other facilities that will help to enhance effective classroom delivery especially provision of functional computers and stand by generator to support epileptic power supply.

Recommendations

Based on the findings of this study the following recommendations are put forward:

1. Instructional computer animation should be adopted in the chemistry curriculum delivery in all public secondary schools. This will help to foster interest of students in the study of the subject.
2. Since many serving teachers are not very familiar with instructional computer animation and its benefits, conferences, seminars and workshops should be organized by relevant professional bodies to educate them on computer animation.
3. The ministry of education and other government bodies should mandate and help the professional bodies in terms of providing adequate fund to ensure that the workshops and seminars do not end on paper. Curriculum planners should incorporate and lay emphasis on computer animation as an alternative to conventional lecture method.

Limitations of the Study

The generalizations made with respect to this study are subject to the limitation below:

1. The participants were not randomized. Intact classes were used.
2. School Effect: The different schools operate at different levels in terms of exposure and background of the school. The differences in those schools could compound the effect.

Suggestions for Further Studies

Based on the findings and limitations of this study the following suggestions for further research are made:

1. Examine the effect of instructional computer animation on students' achievement and interest in other branches of science such as physics or biology.
2. A replication of this study could be done in another geographical location.
3. A replication of this study could be done based on time lag to see if there are new findings.
4. The researcher also suggests an in-depth research on the perception of chemistry teachers on computer animation as a method of instruction.

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Appendix A

WAEC Statistical Analysis 2009-2015 for May/June SSCE.

Year	% of passes at credit level	% of failure	% of ordinary pass
2009	37.86	32.76	29.38
2010	50.94	27.28	21.78
2011	44.90	30.11	24.99
2014	42.2	30.16	27.20
2015	41.1	13.86	45.04

Source: WAEC Annual Report 2009 to 2015

Appendix B

Sample Distribution by Group and Gender

Group	No of Participant	Males	Females
Experimental	95	45	50
Control	91	40	57
Total	186	85	101

Appendix C

Psychology Interest Scale (Initial Pool)

1. I think the field of psychology is very interesting.
2. Psychology fascinates me.
3. I'm excited about psychology.
4. I think that what we learning this course is important.
5. I think that what we are studying in introductory psychology is useful for me to know.
6. I think the field of psychology is an important disciple.
7. To be honest, I don't find psychology interesting.

8. I find the content of this course personally meaningful.
9. I think this class is interesting.
10. I see how I can apply what we are learning in introductory psychology to real life.
11. This class has been a waste of my time.
12. I don’t like the lectures very much.
13. The lectures in class aren’t very interesting.
14. I enjoy coming to the lectures.
15. I like my instructor.
16. I’m enjoying this psychology class very much.
17. I’m enjoying this chemistry class very much.

Appendix D

Chemistry Interest Scale (CIS)

The statement in the questionnaires seeks to find out how you feel about chemistry. Select freely the option that expresses you feeling towards chemistry. There is no right or wrong answers.

Instruction: please tick in the appropriate column to show your feelings towards the statement.

SA= Strongly; A= Agree; D= Disagree; SA= Strongly Disagree;

Name of student________________

Sex________________ Class________________

Chemistry Interest Scale

S/N	CHEMISTRY INTEREST STATEMENT	SA	A	D	SD
1	I think the field of chemistry is very interest.				
2	Chemistryfascinates me				
3	I'm excited about chemistry.				
4	I think what we are learning in chemical bounding is important				
5	I think what we are studying in chemical equilibrium is useful to me to know				
6	I think the field of chemistry is not an important discipline				
7	To be honest, I just don't find chemistry interesting				
8	I find the content of this course personally meaningful				
9	I don't think this class is interesting				
10	I see how I apply what we are learning in chemistry to real life				
11	This chemical equilibrium has been a waste of time				
12	I don't like the lecture very much				
13	The lecture in class aren't very interesting				
14	I enjoy coming to chemistry lectures				
15	The lectures in this class really seem to drag on forever				
16	I like my chemistry teacher				
17	I am enjoying this chemistry class very much				

Appendix E

TABLE OF SPECIFICATION ON CHEMISTRY ACHIEVEMENT TEST (CAT)

Content Area	**Sub-Units**	**MENTAL SKILLS**						
		Lower Order		**Higher Order**				
		Knowledge (36%)	**Comprehension (16%)**	**Application (24%)**	**Analysis (12%)**	**Synthesis (8%)**	**Evaluation (4%)**	**Total (100%)**
Chemical bonding	Electrovalent bond	2 (1,2)	0	1 (3)	0	0	0	3
	Covalent bond	0	1 (4)	1	0	0	0	2
	Co-ordinate bond	0	0	0	0	1 (9)	0	1

	Metallic bond	2 (10,19)	0	0	0	0	0	2
	Hydrogen bond	2 (5,15)	1 (16)	0	1 (13)	0	0	4
	Van Der Waals forces	1 (17)	0	0	0	0	0	1
Chemical equilibrium	Reversible reaction	1	1 (6)	0	1 (20)	1 (8)	0	4
	Pressure on equilibrium	0	0	1 (11)	1 (7)	0	0	2
	Temperature on equilibrium	1 (14)	0	1 (24)	0	0	1 (12)	3
	Application of chemical equilibrium	0	1 (22)	2 (18,21)	0	0	0	3
	Total	9	4	6	3	2	1	25

Appendix F

Chemistry Achievement Test (Initial Draft)

The items in the questionnaire below seek to find out how far you have understood the lesson taught .Select the option that best answers each question.

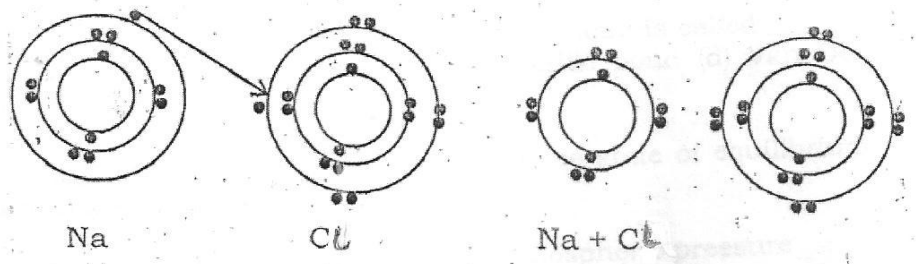
Name of student____________________________________

Sex______________ **Class** ______________

1. The donor atom is always a ________ (a) metal (b) nonmetal (c) metalloid (d) hydrocarbon

2. Any atom that loses electron becomes ________ (a) neutral (b) negatively charged (c) positively charge (d) none of the above

Using the Diagram below answer question 3-5



3. In the above reaction, sodium (Na) atom is electron ________ (a) donor (b) acceptor (c) rejector (d) none at all

4. The diagram shows a typical __________ bonding (a) covalent (b) co-ordinate covalency (c) electrovalent (d) Van Der Waals force

5. To attain a noble gas structure, the element must have ______ electrons at the outermost shell (a) 6 (b) 4 (c) 7 (d)2 or 8

6. Hydrogen gas is ______ in nature. (a) diatomic (b) monatomic (c) triatomic (d) electrovalent

7. Organic compounds are soluble in ______ (a) water (b) organic solvents (c) acids (d) base

8. A reversible reaction can only occur (a) under atmospheric pressure, (b) in an open system, (c) in a closed system, (d) none of the above

9. Equilibrium state is dependent on the following except (a) affinity (b) temperature, (c)pressure (d) concentration

10. What law states that for a reversible reaction in equilibrium, if one of the factors keeping the system in equilibrium is altered, the equilibrium will shift to oppose the change?

11. Boyles law, (b) Gay's law (c) Archimedes principle (d) Le Chantelier's principle

12. Co-ordinate covalency shares the principles of both covalent and ______ bonding (a) ionic (b) metallic (c) hydrogen (d) Van Der Waals

13. The bond that holds atom together in a metal is called ______ (a) ionic bond (b) bonding force (c) metallic bond (d) Van Der Waals force

14. To consider the effect of pressure on the state of equilibrium the reaction must involve

(a)Solids, (b) Liquids, (c) Gases, (d) Atmospheric pressure

15. Effect of change in temperature in chemical equilibrium can be achieved under ______ reactions (a)Exothermic and

endothermic, (b) Reversible and irreversible, (c) Physical and chemical (d) Decomposition

16. The attachment of a hydrogen atom to a strongly electronegative atom results in the formation of __________ (a) dative bond (b) covalent bond (c) metallic bond (d) hydrogen bond

17. Consider the equilibrium reaction represented by the equation $A_2 + 3B_2 \rightleftharpoons 2AB_3$; $\Delta H = -v$

What happens to the equilibrium if the temperature at equilibrium is increased?

(A) More AB_3 will form
(B) More A_g will react with B_2
(C) AB_3 will decompose to form more A_2 and B_2
(D) Equilibrium will be unaffected.

18. The strongest hydrogen bond is in ________ (a) hydrogen fluoride HF (b) water H_2O (c) ammonia NH_2 (d) methane CH_4

19. Water has a rather high boiling point despite its low molecular mass because of the presence of ________ (a) hydrogen bonding (b) covalent bonding (c) ionic bonding (d) metallic bonding

20. The elements that try to attain structure of a stable octet of electrons include ____________ (a) sodium (b) chlorine (c) nitrogen (d) all of the above.

21. What is the effect of freely divided iron catalyst to the equilibrium system represented by the equation?

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\Delta H = -ve$

(A) Equilibrium will shift to the right
(B) Equilibrium will shift to the left
(C) Equilibrium is attained at a shorter time
(D) More heat is given off

22. The type of bonding where all the valence electrons are donated to a common electron pool is called __________ (a) metallic bond (b) Van Der Waals forces (c) electrovalent bond (d) co-ionic bond

23. Equilibrium is attained when the rate of forward reaction is equal to the rate of

(A) Equilibrium constant
(B) Reversible reaction
(C) Backward reaction
(D) Chemical equilibrium

24. Industrially, Sulphur (vi) oxide (SO_3) is obtained in contact process under the following conditions except one

(A) Optimum temperature of 450°C
(B) Finely divided iron
(C) Vanadium (v) oxide
(D) 200 – 5000 atmospheric pressure

25. Lech atelier's principles applies to

(A) All chemical reactions
(B) Only exothermic reactions
(C) Only endothermic reaction
(D) Only reversible

26. In the manufacturing of ammonia, a catalyst is used to

a. Increase the amount of ammonia produced
b. Increase the rate of production of ammonia
c. Make the reaction proceed smoothly
d. Prevent the reaction from proceeding in the reverse direction

27. In the reaction $M + N \rightleftharpoons P$, $\Delta H = +$ QKJ mol^{-1}

Which of the following would increase the concentration of the product?

(a) Decreasing the concentration of N
(b) Increasing the concentration of P
(c) Decreasing the temperature
(d) Adding a suitable catalyst

28. A reaction is said to be in a state of dynamic equilibrium when

(a) All the products are changed back to reactants

(b) The reaction does not go to completion

(c) Neither the reactants nor products are soluble

(d) The rate of the forward reaction equals to the rate of the backward reaction.

29. The production of ammonia by the Haber Process is presented by the equation

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{2(g)}$ $\Delta H = -50KJmol^{-1}$

To produce more ammonia,

i. Only high temperature is required
ii. Only high pressure is required
iii. Ammonia produced is liquefied
iv. high concentrations of hydrogen and nitrogen are used

(a) i only (b) i and ii only (c) iii and iv (d) i and iv

30. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

How will the state of equilibrium be affected by increasing temperature of the reaction above?

(A) $2NH_3$ reacts fast to produce more $N_2 + 3H_2$
(B) $N_g + 3H_2$ react fast to produce more $2NH_3$
(C) The reactants and product lower the rate of reaction
(D) Equilibrium remains constant

Appendix G

Chemistry Achievement Test (CAT)

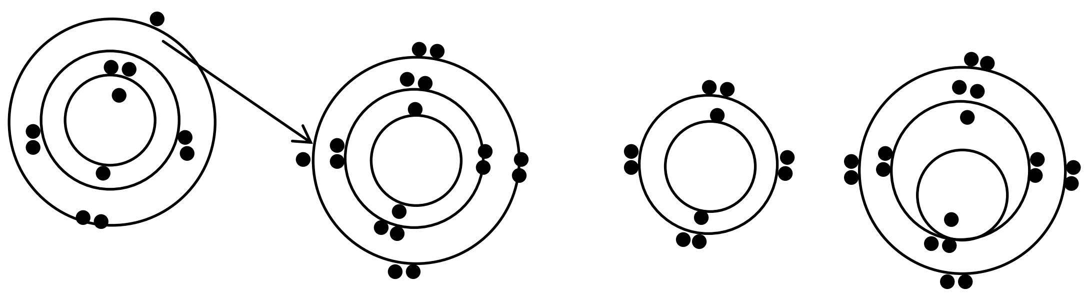
The items in the questionnaire below seek to find out how far you have understood the lesson taught.Select the option that best answers each question.

Name of student_____________________________________

Sex______________Class______________

1. The donor atom is always a __________ (a) metal (b) nonmetal (c) metalloid (d) hydrocarbon

Using theDiagram below answer question 2-4



Na Cl Na + Cl

2. In the above reaction, sodium (Na) atom is electron __________ (a) donor (b) acceptor (c) rejector (d) none at all

3. The diagram shows a typical ____________ bonding (a) covalent (b) co-ordinate covalency (c) electrovalent (d) Van Der Waals force

4. To attain a noble gas structure, the element must have __________ electrons at the outermost shell (a) 6 (b) 4 (c) 7 (d)2 or 8
5. Atoms in covalent bond attain stable electronic configuration by ______________ (a) sharing (b) transfer (c) loss (d) gain
6. A reversible reaction can only occur (a) under atmospheric pressure, (b) in an open system, (c) in a closed system, (d) none of the above
7. Equilibrium state is dependent on the following except (a) affinity (b) temperature, (c)pressure (d) concentration
8. The law which states that for a reversible reaction in equilibrium, if one of the factors keeping the system in equilibrium is altered, the equilibrium will shift to oppose the change is---------------

   Boyles law, (b) Gay's law (c) Archimedes principle (d) Le Chantelier's principle
9. Co-ordinate covalency shares the principles of both covalent and _________ bonding (a) ionic (b) metallic (c) hydrogen (d) Van Der Waals
10. The bond that holds atom together in a metal is called ________ (a) ionic bond (b) bonding force (c) metallic bond (d) Van Der Waals force
11. To consider the effect of pressure on the state of equilibrium the reaction must involve

    (a)Solids, (b) Liquids, (c) Gases, (d) Atmospheric pressure
12. Effect of change in temperature in chemical equilibrium can be achieved under_______________reactions (a)Exothermic and endothermic, (b) Reversible and irreversible, (c) Physical and chemical (d) Decomposition
13. The attachment of a hydrogen atom to a strongly electronegative atom results in the formation of ___________ (a) dative bond (b) covalent bond (c) metallic bond (d) hydrogen bond

14. Consider the equilibrium reaction represented by the equation $A_2 + 3B_2 \rightleftharpoons 2AB_3$; $\Delta H = -v$

What happens to the equilibrium if the temperature at equilibrium is increased?

(A) More AB_3will form

(B) MoreA_g will react with B_2

(C) AB_3 will decompose to form more A_2 and B_2

(D) Equilibrium will be unaffected.

15. The strongest hydrogen bond is in ________ (a) hydrogen fluoride HF (b) water H_2O (c) ammonia NH_2 (d) methane CH_4

16. Water has a rather high boiling point despite its low molecular mass because of the presence of ________ (a) hydrogen bonding (b) covalent bonding (c) ionic bonding (d) metallic bonding

17. Van Der Waals force exists in the following gases except _________ (a) argon (b) nitrogen (c) oxygen (d) chlorine

18. What is the effect of freely divided iron catalyst to the equilibrium system represented by the equation?

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\Delta H = -ve$

(A) Equilibrium will shift to the right

(B) Equilibrium will shift to the left

(C) Equilibrium is attained at a shorter time

(D) More heat is given off

19. The type of bonding where all the valence electrons are donated to a common electron pool is called ____________ (a) metallic bond (b) Van Der Waals forces (c) electrovalent bond (d) co-ionic bond

20. Equilibrium is attained when the rate of forward reaction is equal to the rate of

(A) Equilibrium constant

(B) Reversible reaction

(C) Backward reaction

(D) Chemical equilibrium

21. Industrially, Sulphur (vi) oxide (SO_3) is obtained in contact process under the following conditions except one

(A) Optimum temperature of 450^0C

(B) Finely divided iron

(C) Vanadium (v) oxide

(D) 200 – 5000 atmospheric pressure

22. Lech atelier's principles applies to

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23. In the manufacturing of ammonia, a catalyst is used to

a. Increase the amount of ammonia produced

b. Increase the rate of production of ammonia

c. Make the reaction proceed smoothly

d. Prevent the reaction from proceeding in the reverse direction

24. In the reaction $M + N \rightleftharpoons P$, $\Delta H = + QKJ\ mol^{-1}$

Which of the following would increase the concentration of the product?

(a) Decreasing the concentration of N

(b) Increasing the concentration of P

(c) Decreasing the temperature of a suitable catalyst

25. The production of ammonia by the Haber Process is presented by the equation

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{2(g)} \Delta H = -50KJmol^{-1}$

To produce more ammonia,

i. Only high temperature is required

ii. Only high pressure is required

iii. Ammonia produced is liquefied

iv. high concentrations of hydrogen and nitrogen are used

(a) i only (b) i and ii only (c) iii and iv (d) i and iv

Appendix H

Marking Scheme for CAT

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

Appendix I

LESSON PLAN ON CHEMISTRY USING INSTRUCTIONAL COMPUTER ANIMATION METHOD

WEEK I

Class: SS II

Age: 17 years plus

Date:

Duration: 2 periods of 90 minutes

Topic: Chemical Combination/bonding

Specific Objectives: By the end of the lesson, about 85% of the students should be able to;

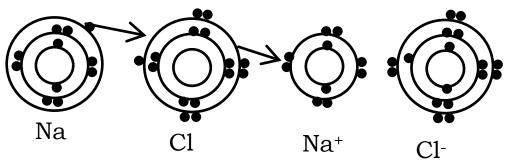
1. Explain chemical bonding in a nutshell.
2. List at least three types of chemical combination.
3. State the main principle of electrovalent bonding.
4. Draw the formation of sodium chloride in chemical bonding.

Entry Behavior: The students knew that it is the joining together of some ingredients that form a soup. Again, eating garri with soup gives a meal.

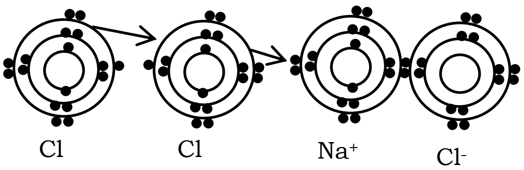
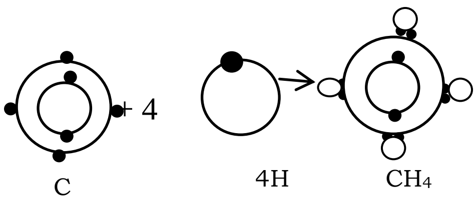
Set Induction: The teacher arouses the interest of the student thus: (1) when you hear of combination what comes to your mind? (2) Does combination involve one thing, two things or more things?

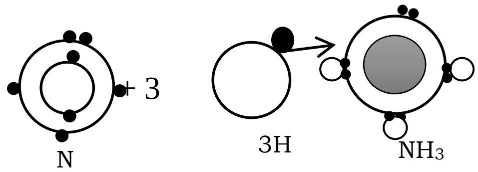
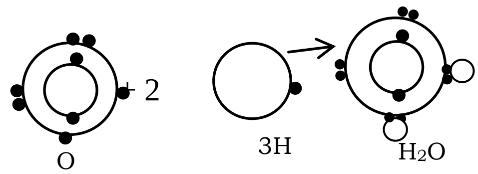
Instructional Procedure

Instructional contents	**Teacher's Activities**	**Student's Activities**	**Instructional Materials**	**Instructional Techniques**
Step 1: Explanation of chemical combination	The teacher explains that in the periodic table the Group O elements which are known as rare noble gases have stable atomic structure. In the periodic table, all other elements except the Group O elements try to attain structure of a stable octet of electrons. She shows animated pictures of Group O elements He, Ne and Ar with Helium (He – 2) carrying two electrons in its shell,	Listen Watch the images and smile	Moving images of different shapes and colours	Animation and explanation
	Neon (Ne – 2,8) and Argon (Ar – 2,8,8) each carrying eight electrons on the outermost shell. The rest of the elements from Group I to 7 combine with one another in various ways to attain the stable octet structure. It is the combination that is known as bonding.	Listen watch	Pictures of He, Ne and Ar with 2; 8 and 8 electrons respectively	Animation
Types of bonding	The teacher lists types of bonding as followings: 1. Electrovalent (ionic) bond 2. Covalent bond 3. Co-ordinate covalency or co-ionic bond 4. Metallic bond 5. Hydrogen bond 6. Van Der Waal's force	Listen, watch and widen their eyes	Pictures of varying colours showing different bonds	
Step 2: Electrovalent bond	The teacher explains that electrovalent bond also called ionic bond is based on the principle of donor-acceptor principle in which there is complete electron transfer, meaning that atoms forming bond are usually present as ions. She shows animated pictures of NaCl atoms. The teacher explains that the donor atom is usually a metal of relatively	Listen, flap the two	Picture of Na	

	big size (in this case N_a metal), which loses electrons from its outermost shell, the number of electrons equal to its valency to attain the stable configuration. It then becomes positively (+) charged ion known as cations.	hands like a bird on flight	followed by picture of Cl Picture of Naloosing electron	Animation Animation
	$Na - e^- \rightarrow Na^+$ $\downarrow$ donor She goes further to explain that the lost electron is gained or accepted by the non-metallic atom (in this case Cl) and becomes negatively charged. It is called acceptor or anions. $Cl - e^- cl^- \rightarrow$	Dive like one that wants to catch a ball. Listen and ask questions	Picture of Cl accepting electron	Animation
	She shows the picture of N_a and Cl loosing and accepting electron to form sodium chloride (NaCl)  **formation of sodium chloride**	Listen and watch	Animated pictures of N_a and Cl forming NaCl	Animation
Before combination	She shows more examples of electrovalent compounds with calcium chloride and calcium oxide. Calcium atom 20 = 2,8,8,2 Two chlorine atoms 17 = 2,8,7 17 = 2,8,7	watch and interacter		
After combination	The valency electron pass to chloride Calcium ion^{++} 18 = 2,8,8 Two chloride ions 18 = 2,8,8 18 = 2,8,8	watch and ask questions		Animations

		They share ideas		

Step 3: Covalent bond Examples More examples of compound or molecule exhibiting covalent bond	The teacher explains covalent bond involves sharing of electrons between atoms such that each of the atoms in the molecule has electron arrangement of a noble gas. The two main atoms involved in covalent bond information are of similar size and they are always small. She gives examples with two chlorine atoms, each having the electron structure 2,8,7. She explains that in covalency, the atoms contribute one electron each to a shared-pair. Molecules are produced and not ions.  The teacher gives more animated structures of compounds or molecules that undergo covalent bonds e.g methane  Formation of ammonia: Ammonia has the formula NH_3 ✓ Nitrogen has seven protons in the nucleus compared with one in the hydrogen. ✓ Nitrogen has one lone pair of	Listen Listen The students touch each others body indicating sharing. Watch the image an giggle Watch the images as they combine and shout	Moving structure of 2 chlorine atom Images of two chlorine atoms coming together and sharing their electrons Animated structures of carbon and four hydrogen atoms forming tetrahedral shape of methane	Animation And Explanatio n Animation Animation and explanation Animation

	electron. ✓ The molecule is asymmetric.	Widen the eyes		
		Watch the animated pictures and clap and shout.	Animated structures of carbon moving to share the three electrons in the three hydrogen atoms to form ammonia molecule	Animation
	Formation of water: The formula of water is H_2O. ✓ Oxygen has 8 protons in the nucleus compared with one in the hydrogen nucleus ✓ Oxygen has two lone pairs of electrons ✓ The molecule is asymmetric	They nod in affirmation		
			One atom of oxygen moves to share electron with two atoms of hydrogen to form one molecule of water	Animation
			Animated pictures	Animation and explanation
Step 4 Questions/reactions from students	She asks the students to ask questions. She answers the questions students ask, pause and replay the animated pictures as she explains. The teacher evaluates the students using the following questions. 1. List at least three types of chemical	Ask questions, share ideas among themselves		

Evaluation **Conclusion**	combination 2. What is the main principle of electrovalent bonding? 3. Give two examples of atoms or molecules that exhibit covalent bond. 4. Using methane molecule, show how covalent bond occur. The teacher replays each of the animated pictures and watch the students to see how they react to one another.	The students answer the questions Students interact as they appear		

LESSON PLAN ON CHEMISTRY USING INSTRUCTIONAL COMPUTER ANIMATION

WEEK 2

Class: SS II

Age: 17 years

Date:

Duration: 2 periods of 90 minutes

Topic: Co-ordinate covalency and metallic bond

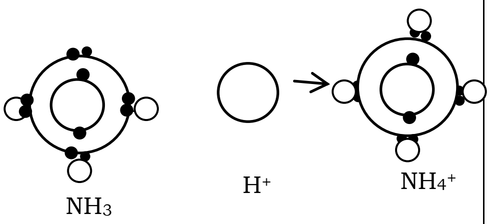
Specific Objectives: By the end of the lesson, about 85% of the students should be able to answer the following questions.

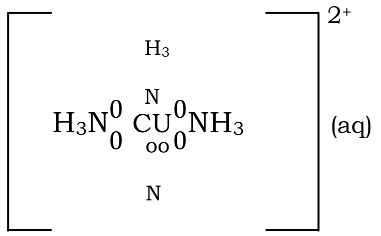
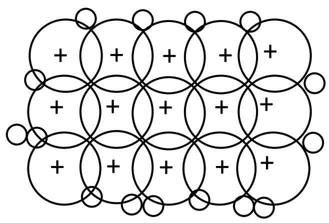
1. What principle exist in co-ordinate covalency?
2. Describe how metallic bond is formed.
3. Draw the structure of tetraamino copper (II) ion.

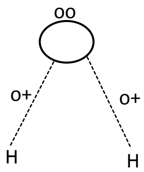
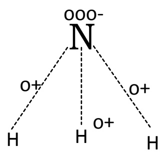
Entry Behaviour: The student have known that electrovalent bond involves electron transfer while covalent bond involves sharing of electrons.

Set Induction: The teacher asks the students the following questions: In electrovalent bond, what happens to the electrons in the outer shell of an atom? What also happens to the electrons in the outer shell of an atom that undergoes a covalent bonding?

Instructional Procedure

Instructional contents	**Teacher's Activities**	**Student's Activities**	**Instructional Materials**	**Instructional Techniques**
Step 1 Co-ordinate covalency	The teacher explains that co-ordinate covalency combines the principle of both covalent and ionic bonding and it is a special type of covalent bonding in which the shared pair of electrons is contributed by one of the atoms involved in the sharing rather than by each atom contributing one electron.	Listen		
Examples	Using ammonia as an example, three hydrogen atoms share three pairs of electrons with a nitrogen atom by normal covalent bonding. The nitrogen atom has a lone pair of electrons in its outermost shell. If it shares the lone pair with a proton (a hydrogen without an electron), then a co-ordinate, or dative bond, results	Listen Students point to the lone pair of electron.	Animated structure of ammonia and hydrogen (proton) appear	Animation
		A student moves to touch the animated proton (NH^+_4)	Animated images of NH_3 $+H^+$ joining to form NH_4^+	Animation
Formation of complexes	The teacher explains that complexes are formed by co-ordinate bonding. The central atom (usually a metal) shares pairs of electrons contributed by ligands (ions, molecules) such as ammonia, water or cynide ion. E.g. ammonia molecule participates by co-ordinate bonding in the formation of tetraaminocopper (II) ion. In this copper transfers its valency and the outer electron shell of copper ion becomes vacant. Four NH_3	The students whisper to one another discussing the formation of the complex		

	molecules form co-ordinate bonds with the CU^{2+} ion by means of their lone pair electrons to create a shared electron octet in the vacant valency electron shell of the copper (II) ion. CU^{2+} (aq) + $4H_3N^{0}_{0}$(eq) $\longrightarrow$  Formation to tetramino copper (II) ion		Pictures of $CU^{2+} + 4NH_3$ sharing electron to form tetra-amino copper (II) ion.	Animation
Step 2: Metallic bond	She explains that metallic bond is the bond holding atoms together in a metal. Each metallic atom contributes its valence electron to a general pool called electron cloud, thus becoming positively charged. The force of attraction that exist between the positively charged metallic ion and the electron cloud moving round the whole ions is called metallic bond. 	Students interact among themselves sharing their view of what they observe.	Pictures of metals donating their valency electrons to the electron cloud	Animations
	She explains that the larger the number of electrons in the outer shell of the metal, the stronger the bonding and the stronger the metal	They raise their hands as though they are throwing a ball.	Animated metals donate valence electrons	Animations

Step 3: Hydrogen bonding	Hydrogen bonding is an inter-molecular force that arises when a highly electronegative atom like fluorine, oxygen or nitrogen is involved in covalency with hydrogen. The highly electronegative atom attracts the shared pair of electrons towards itself leaving a partial positive charge (+) on the hydrogen atom and a partial negative charge on the electronegative atom. This is not a true bond. It is weak bond.	They raise hand sin the air as though they are pulling some objects to themselves.		Animation accompanied with explanation
Pictures of Hydrogen	She plays animated pictures or structures: 1. Hydrogen with fluorine o+ o- H---F----H 2. Hydrogen bonding with oxygen 	Watch and laugh	Moving image of hydrogen and fluorine Animated structure of oxygen and hydrogen	Animation
	3. Hydrogen bonding with nitrogen 			
	The attraction (denoted with broken lines) is known as hydrogen bonding. The presence of hydrogen bonding in a substance leads to increase in its melting and boiling points	The students make bodily movement in the direction of the	Moving images of nitrogen and hydrogen	Animation

		moving images.		
Step 4: Vander Waal's Force	This is the type of force that arises in gases such as nitrogen, oxygen, chlorine which are diatomic and non-polar molecules. They arise from fluctuations in dipole moments of the molecules brought about by motion of electrons around the atomic nuclei			Animation
Evaluation	The teacher asks the students the following questions: 1. What principle exists in co-ordinate covalency? 2. Describe how metallic bond is formed. 3. Explain hydrogen bond. 4. Where do we find Van Der Waal's forces?			
Conclusion	The teacher replays each step of the animation pointing to important concepts she wants the students to grasp.	The students smile, nod their heads and talk to one another.	Animated objects	Animation

LESSON PLAN ON CHEMISTRYUSING INSTRUCTIONAL COMPUTER ANIMATION

WEEK 3

Class: SS II

Age: 17 years plus

Date:

Duration: 2 periods of 90 minutes

Topic: chemical equilibrium

Specific objectives: By the end of the lesson about 85% of the students should be able to:

1. Explain what chemical equilibrium is.
2. Discuss effect of pressure on chemical equilibrium.
3. Illustrate the effect of introducing more reactant into a system at equilibriums.

Entry Behaviour: The students have known that when you say that two things are equal, it means that non is greater than the other.

Set Induction: The teacher asks the students the question below. What does it mean to say that A = B; or A+B = C+D?

Instructional Procedure:

Content	Teacher's Activities	Students Activities	Instructional materials	Instructional Technique
Step I Explanation of chemical equilibrium	The teacher explains that chemical equilibrium is a reversible reaction involving gases and the reaction must occur in a closed system. She explains that the scientist who studied reversible reactions in equilibrium was Le Chatelier. Le Chatelier gave three factors or conditions that affect equilibrium state to be pressure, concentration and temperature. He states that for a reversible reaction in equilibrium, if one of the factors keeping the system in equilibrium is altered, the equilibrium will shift to oppose the change.	Listen The students make bodily movement as if they themselves want to dance too.	Three animated objects dance out representing pressure, concentration and temperature.	Explanation
Step 2 Effect of Pressure	The teacher explains that when considering pressure one has to know whether there is increase or decrease in volume. For any reversible reaction in which the forward reaction takes place by an increase in volume, the backward reaction takes place by decrease in volume. For e.g. $2A_{(g)}+B_{(g)}\leftrightarrows 2C_{(g)}$ 3vols 2vols The forward reaction is taking place by decrease in volume, hence the backward reaction is taking place by increase in volume. If the pressure at equilibrium is disturbed, Le Chatelier requires that equilibrium will oppose the decrease in pressure. Equilibrium will shift in the direction of increase in volume favouring the	The students show one another the direction of the forward reaction and also the direction of the backward reaction. The students point out to the disturbed equilibrium position.	Animated picture of C will be moving to A and B	Animation Animation and explanation

	backward reaction. To shift equilibrium in the forward direction, the pressure at equilibrium must be increased. For a reaction in which there is no volume change or in which there is no change in the number of moles of reactants and products pressure has no effect on the equilibrium. E.g. $2A_{(g)}+2B_{(g)} \leftrightarrows 4C_{(g)}$ 4moles 4moles			
Step 3 Effect of concentration **Evaluation** **Conclusion**	Consider this reaction: $A+B \leftrightarrows C+D$ At equilibrium there is a definite concentration of A, B, C and D existing together. If the concentration of A is increased, the equilibrium is disturbed and it will shift to oppose the increase. To oppose the increase B will react with A to produce more of C and D making equilibrium postion shift to the right (forward). If C is decreased, equilibrium is disturbed, A reacts with B to form more C and D favouring again forward reaction. The teacher evaluates the students thus: 1. Define chemical equilibrium 2. What effect has pressure on a reaction at equilibrium? 3. What effect has concentration on a system at equilibrium? She gradually replays the animated objects, and gives brief explanation.	Watch and interact They discuss the direction of the increase. They feel exited when B begins to react with A to form C and D. A student suggests that C should be reduced so that they will see the effect. The students were talking in low voices sharing their observations	Animated A increasing and increasing, react with B, gives more C and D Animated C removed, Animated A and B reacting Animated objects appear	Animation Animation Animation

LESSON PLAN ON CHEMISTRY USING INSTRUCTIONAL COMPUTER ANIMATION

Week 4

Class: SSII

Age: 17 years plus

Date:

Duration: 2 periods of 90 minutes

Topic: Chemical equilibrium

Specific Objectives: By the end of the lesson about 85% of the students should be able to answer the following questions.

1. What is exothermic and endothermic reaction?
2. Explain the effect of introduction of more heat into a system that is in equilibrium.
3. Illustrate the conditions under which NH_3 is commercially obtained using Haber Process.

Entry Behaviour: The students have been taught effects of pressure and concentration on a system in a state of equilibrium.

Set Induction: The teacher set inducts the students by asking them; what will be the effect of increasing the contraction of the reactants in a reaction that is in equilibrium?

Instructional Procedure

Content	Teacher's Activities	Students Activities	Instructional material	Instructional techniques
Step I Effect of temperature on equilibrium	The teacher explains that effect of temperature on equilibrium system must either be exothermic or endothermic reaction. She explains that if the forward reaction is exothermic, the reverse will be endothermic and vice-versa . Eg. A + B -- C, $\Delta H = ve$If the equilibrium of the above reaction is disturbed by increase in temperature, according to Le Chatelier, the equilibrium must shift to oppose the increase. The equilibrium shifts in the direction from where the heat is coming favouring the backward reaction to produce more A and B. If forward reaction is to be favoured (ie production of C) heat has to be decreased. Note that decrease in temperature slows down the rate of reaction. To increase the rate of chemical reaction without disturbing the	Listen and watch The students flap their hands as if they are about to fly. The students point to the left indicating backward reaction that produces A and B. Students ask for reduction of heat to see how C will be produced. A student	Animated alphabets A, B, and C appear flapping their wings Animated picture of C producing more A and B. Animated finely divided iron and vanadium (V) oxide Catalyst added.	Animation Animation and explanation Animation

	equilibrium, catalyst is introduced at optimum temperature of $450^{o}C$ – $500^{o}C$	demands to see and feel the catalyst.		
Step 2 Life application of Le Chatelier's principle in industries.	The teacher explains that most chemical reactions in industries are reversible reactions and equilibrium is attained in the systems. Le Chatelier's principle is used to determine optimum conditions (temperature, pressure and concentration) with the aim of i. Minimizing yield of product ii. Maximizing yield of product iii. Attaining equilibrium within the shortest possible time. The principle is applied in: i. Haber Process for production of ammonia ($NH_{3(g)}$) ii. Contact process for production of sulphur(iv)oxide (SO_3). Production of Amonia ($NH_{3(g)}$) $N_{2(g)} + 3H_{2(g)} \leftrightarrows 2NH_{2(g)}$, $\Delta H = -ve$ The forward reaction is exothermic and also takes	Listen The students take down these salient points in their books. The talk about the effect of the iron fillings in equilibrium reaction. Listen Watching and interacting They discuss the effect they observe as the ammonia is removed.	Temperature reduction Animated iron fillings appear. Pressure added Removal of NH_3	Animation

	place by decrease in the number of moles. To obtain a favourable yield of ammonia gas, Le Chatelier's following principles apply: The forward reaction is exothermic, high yield of ammonia requires low temperature. Low temperature reduces the rate of a reaction. To increase the rate of production of NH_3 introuduce a catalyst (finely divided iron) at a temperature of 450^{o}C. Again the forward reaction has a decreased number of moles ie the forward reaction takes place by a decrease in volume of NH_3. Higher yield of ammonia is favoured by high pressure, therefore increase pressure to the level of 200-500 atmosphere. Finally to obtain a high yield of ammonia, the ammonia is removed as it is formed to shift equilibrium forward.	A student asks that the temperature be lowered. The other asks for the introduction of a catalyst so as to see its effect. The students curve their hand as if they are removing $NH^{+}{}_{3}$		
Step 3 Manufacture of SO_3	The teacher explains that contact process involves direct combination of sulphur(IV)oxide and oxygen gas. $2SO_{2(g)}+O_{2(g)}\leftrightarrows 2SO_{3(g)}$; 3vols 2vols $\Delta H = -ve$ Like in the Haber Process, the forward reaction is	The students swing their hands like birds and laugh. They ask	Animated SO_2 and O_2 move in. Reduce temperature, add	Animation

	exothermic and reaction takes place by decrease in volume. To obtain a high yield of SO_3, the same conditons that applied in the production of ammonia also apply. The conditons are temperature; 450^oC0-500^oC. Catalyst: vanadum(v)oxide Pressure: 200 atmosphere	the teacher to indicate when the temperature is reduced and when pressure is increase.	more pressure and catalyst, remove SO_3.	
Evaluation **Conclusion**	The teacher asks the students the following questions; 1. What is exothermic reaction and endothermic reaction? 2. What will be the effect of increased temperature to a system in equilibrium? 3. Give the conditions under which high yield of ammonia is obtained in Haber Process? She briefly goes through the lesson, replays some of the animations and gives the assignment.	Answer question Watch, interact and copy assignment	 Animated pictures	 Animation and explanation

Appendix J

LESSON PLAN ON CHEMISTRY USING CONVENTIONAL METHOD OF INSTRUCTION

WEEK I

Class: SS II

Age: 17 years plus

Date:

Duration: 2 periods of 90 minutes

Topic: Chemical Combination/bonding

Specific Objectives: By the end of the lesson, about 85% of the students should be able to:

5. Explain chemical bonding in a nutshell.
6. List at least three types of chemical combination.
7. State the main principle of electrovalent bonding.
8. Draw the formation of sodium chloride in chemical bonding.

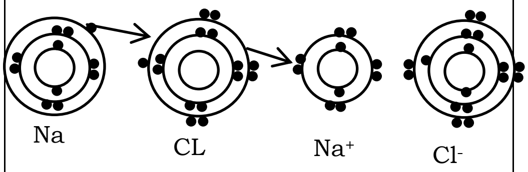
Entry Behavior: The students knew that it is the joining together of some ingredients that form a soup. Again, eating garri with soup gives a meal.

Set Induction: The teacher arouses the interest of the student thus: (1) when you hear of combination what comes to your mind? (2) Does combination involve one thing, two things or more things?

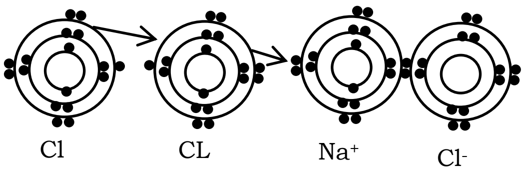
Instructional Procedure

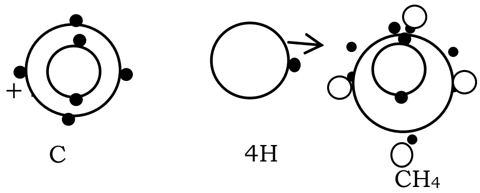
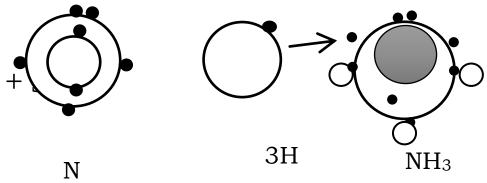
Instructional contents	Teacher's Activities	Student's Activities	Instructional Materials	Instructional Techniques
Step 1: Explanation of chemical combination	The teacher explains that in the periodic table the Group O elements which are known as rare noble gases have stable atomic structure. In the periodic table, all other elements except the Group O elements try to attain structure of a stable octet of electrons. She shows them the chart on periodic table and points to the noble gases which includes Helium (H_e – 2) carrying two electrons in its shell,	Listen Watch the chart Listen	Chart on periodic table	Explanation
Types of bonding	Neon (N_e – 2,8) and Argon (A_r – 2,8,8) each carrying eight electrons on the outermost shell. The rest of the elements from Group I to 7 combine with one another in various ways to attain the stable octet structure of the noble gas. It is the combination that is known as bonding.	watch Listen and		Discussion,

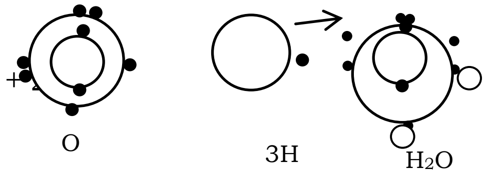
Step 2: Electrovalent bond	The teacher lists types of bonding as followings: 7. Electrovalent (ionic) bond 8. Covalent bond 9. Co-ordinate covalency or co-ionic bond 10. Metallic bond 11. Hydrogen bond 12. Van Der Waal's force	jot important points Listen Watch	Chart showing where Na is donating electron to Cl	stimulus variation.
	The teacher explains that electrovalent bond also called ionic bond is based on the principle of donor-acceptor principle in which there is complete electron transfer, meaning that atoms forming bond are usually present as ions. She shows the students diagram of Na donating electron to chlorine atom. The teacher explains that the donor atom is usually a metal of relatively big size (in this case Na metal), which loses electrons from its outermost shell, the number of electrons equal to its valency to attain the stable configuration. It then becomes positively (+) charged ion known as cations. $Na - e^- \rightarrow Na^+$ $\downarrow$ donor	Listen and ask questions Listen and watch watch and interact	Diagram of Cl accepting electron	Discussion Use of example

Before combination After combination	She goes further to explain that the lost electron is gained or accepted by the non-metallic atom (in this case Cl) and becomes negatively charged. It is called acceptor or anions. $Cl - e^{-} cl^{-} \rightarrow$ She shows the diagram of Na and cl loosing and accepting electron to form sodium chloride (NaCl)  **formation of sodium chloride** She shows more examples of electrovalent compounds with calcium chloride and calcium oxide. Calcium atom 20 = 2,8,8,2 Two chlorine atoms 17 = 2,8,7 17 = 2,8,7. The valency electron pass to chloride	watch and ask questions	Diagram of Na and Cl forming $N_a$cl	Use of example, stimulus variation Use of example

	Calcium ion^{++} 18 = 2,8,8 Two chloride ions 18 = 2,8,8 18 = 2,8,8			

Step 3: Covalent bond	The teacher explains that covalent bond involves sharing of electrons between atoms such that each of the atoms in the molecule has electron arrangement of a noble gas. The two main atoms involved in covalent bond information are of similar size and they are always small.	Listen		Discussion And Explanation
Examples	She gives examples with two chlorine atoms, each having the electron structure 2,8,7. She explains that in covalency, the atoms contribute one electron each to a shared-pair. Molecules are produced and not ions.	Listen	Diagram of two chlorine atoms	Use of examples
		Watch the structures	Diagrams of 2 chlorine atoms joined together and sharing their electrons	Explanation
More examples of compound or	The teacher gives more examples of compounds or molecules that undergo			

molecule exhibiting covalent bond	covalent bonds e.g methane  			
	Formation of ammonia: Ammonia has the formula NH_3 ✓ Nitrogen has seven protons in the nucleus compared with one in the hydrogen. ✓ Nitrogen has one lone pair of electron. ✓ The molecule is asymmetric.	Watch the images as they combine	Diagrams of carbon and four hydrogen atoms forming tetrahedral shape of methane	Use of example
	 	Watch the diagrams	Diagrams of carbon sharing three electrons in the three hydrogen atoms to form ammonia molecule	Discussion
	Formation of water: The formula of water is H_2O. ✓ Oxygen has 8 protons in the nucleus compared with one in the hydrogen nucleus ✓ Oxygen has two lone pairs of electrons		One atom of	

	✓ The molecule is asymmetric 	Watch the diagram	oxygen joined in sharing electron with two atoms of hydrogen to form one molecule of water	repetition
Step 4 Questions/reactions from students	She asks the students to ask questions. She answers the questions students ask, pause and replay the animated pictures as she explains.	Ask questions, share ideas among themselves	Charts	explanation
Evaluation	The teacher evaluates the students using the following questions. 5. List at least three types of chemical combination. 6. What is the main principle of electrovalent bonding? 7. Give two examples of atoms or molecules that exhibit covalent bond. 8. Using methane molecule, show how covalent bond occur.	The students answer the questions		questioning
Conclusion	The teacher briefly goes through the lesson and gives assignment	Listen and take down the assignment		

LESSON PLAN ON CHEMISTRY USING CONVENTIONAL METHOD OF INTRUCTION

WEEK 2

Class: SS II

Age: 17 years

Date:

Duration: 2 periods of 90 minutes

Topic: Co-ordinate covalency and metallic bond

Specific Objectives: By the end of the lesson, about 85% of the students should be able to answer the following questions.

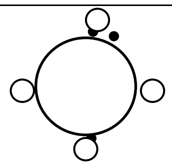
4. What principle exist in co-ordinate covalency?
5. Describe how metallic bond is formed.
6. Draw the structure of tetraamino copper (II) ion.

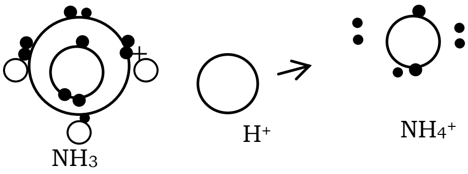
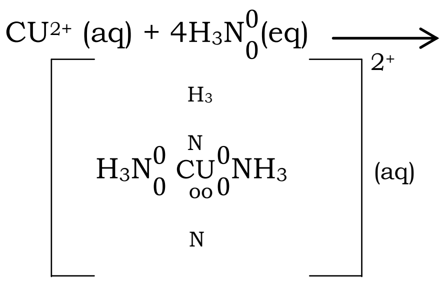
Entry Behaviour: The student have known that electrovalent bond involves electron transfer while covalent bond involves sharing of electrons.

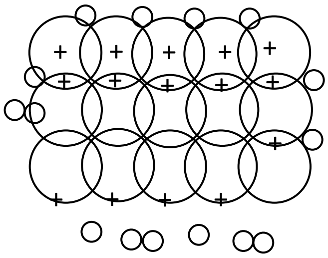
Set Induction: The teacher asks the students the following questions: In electrovalent bond, what happens to the electrons in the outer shell of an atom? What also happens to the electrons in the outer shell of an atom that undergoes a covalent bonding?

Instructional Procedure

Instructional contents	**Teacher's Activities**	**Student's Activities**	**Instructional Materials**	**Instructional Techniques**
Step 1: Co-ordinate covalency	The teacher explains that co-ordinate covalency otherwise called dative bond combines the principle of both covalent and ionic bonding and it is a special type of covalent bonding in which the shared pair of electrons is contributed by one of the atoms involved in the sharing rather than by each atom contributing one electron.	Listen		explanation
Examples	Using ammonia as an example, three hydrogen atoms share three pairs of electrons with a nitrogen atom by normal covalent bonding. The nitrogen atom has a lone pair of electrons in its outermost shell. If it sha es the lone pair with a proton (a hydrogen without an electron), then a co-ordinate, or dative bond, results	Listen Watch	Diagram of ammonia and hydrogen (proton) appear Diagram of NH_3 $+H^+$	Explanation and use of examples

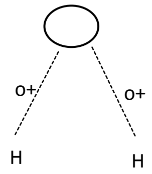
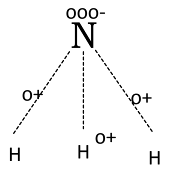


			joined to form NH_4^+	
Formation of complexes	The teacher explains that complexes are formed by co-ordinate bonding. The central atom (usually a metal) shares pairs of electrons contributed by ligands (ions, molecules) such as ammonia, water or cynide ion. E.g. ammonia molecule participates by co-ordinate bonding in the formation of tetraamine copper (II) ion. In this copper transfers its valency and the outer electron shell of copper ion becomes vacant. Four NH_3 molecules form co-ordinate bonds with the CU^{2+} ion by means of their lone pair electrons to create a shared electron octet in the vacant valency electron shell of the copper (II) ion.	Listen		Explanation, stimulus variation Planned repetition
	 Formation to tetramino copper (II) ion	watch	Diagrams of $CU^{2+} + 4NH_3$ sharing electrons to form tetra-amino copper (II) ion.	explanation
Step 2: Metallic bond	She explains that metallic bond is the bond holding atoms together in a metal. Each metallic atom contributes its valence electron to a general pool called electron cloud, thus becoming positively charged. The force of	Listen	Diagram showing electron cloud	Discussion

	attraction that exist between the positively charged metallic ion and the electron cloud moving round the whole ions is called metallic bond.  **Metallic bond** She explains that the larger the number of electrons in the outer shell of the metal, the stronger the bonding and the stronger the metal	Watch	Diagram of metals that have lost their valence electrons to the electron cloud	Explanation

Step 3: Hydrogen bonding Pictures of Hydrogen	Hydrogen bonding is an inter-molecular force that arises when a highly electronegative atom like fluorine, oxygen or nitrogen is involved in covalency with hydrogen. The highly electronegative atom attracts the shared pair of electrons towards itself leaving a partial positive charge (+) on the hydrogen atom and a partial negative charge on the electronegative atom. This is not a true bond. It is weak bond. She draws diagrams of: 4. Hydrogen with fluorine $^{\delta+}$H---$^{\delta-}$F----H 5. Hydrogen bonding with	Listen Listen and watch Watch and draw	Diagram of hydrogen and fluorine in bonding Diagram of oxygen and hydrogen bonding	Discussion explanation Discussion and example

oo

<table>
<tr>
<td></td>
<td>oxygen

6. Hydrogen bonding with nitrogen
</td>
<td>Watch and draw

Listen</td>
<td>Diagram of nitrogen and hydrogen bonding</td>
<td>Discussion

Stimulus variation</td>
</tr>
<tr>
<td>Step 4:
Vander Waal's Force</td>
<td>The attraction (denoted with broken lines) is known as hydrogen bonding. The presence of hydrogen bonding in a substance leads to increase in its melting and boiling points</td>
<td>Listen</td>
<td>Animated structure of oxygen and hydrogen</td>
<td>Planned repetition</td>
</tr>
<tr>
<td>Evaluation</td>
<td>This is the type of force that arises in gases such as nitrogen, oxygen, chlorine which are diatomic and non-polar molecules. They arise from fluctuations in dipole moments of the molecules brought about by motion of electrons around the atomic nuclei</td>
<td>Answer questions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conclusion</td>
<td>The teacher asks the students the following questions:
5. What principle exists in co-ordinate covalency?
6. Describe how metallic bond is formed.</td>
<td>Listen and copy the note.</td>
<td></td>
<td></td>
</tr>
</table>

	7. Explain hydrogen bond 8. Where do we find Van Der Waal's forces? She summarizes the lesson and gives note to the students.			

LESSON PLAN ON CHEMISTRY USING CONVENTIONALMETHOD OF INSTRUCTION

WEEK 3

Class: SS II

Age: 17 years plus

Date:

Duration: 2 periods of 90 minutes

Topic: chemical equilibrium

Specific objectives: By the end of the lesson about 85% of the students should be able to:

4. Explain what chemical equilibrium is.
5. Discuss effect of pressure on chemical equilibrium.
6. Illustrate the effect of introducing more reactant into a system at equilibriums.

Entry Behaviour: The students have known that when you say that two things are equal, it means that non is greater than the other.

Set Induction: The teacher asks the students the question below. what does it mean to say that A = B; or A+B = C+D?

Instructional Procedure:

Content	**Teacher's Activities**	**Students Activities**	**Instructional materials**	**Instructional Technique**
Step 1 Explanation of chemical equilibrium	The teacher explains that chemical equilibrium is a reversible reaction involving gases and the reaction must occur in a closed system. She explains that the scientist who studied reversible reactions in equilibrium was Le Chatelier. Le Chatelier gave three factors or conditions that affect equilibrium state to be pressure, concentration and temperature. He states that for a reversible reaction in equilibrium, if one of the factors keeping the system in equilibrium is altered, the equilibrium will shift to oppose the change.	Listen	Charts	Explanation
Step II Effect of Pressure	The teacher explains that when considering pressure one has to know whether there is increase or decrease in volume. For any reversible reaction in which the forward reaction takes place by an increase in volume, the backward reaction takes place by decrease in volume. For e.g. $2A_{(g)}+B_{(g)} \leftrightarrows 2C_{(g)}$ 3vols 2vols	Listen	Charts showing $A+B \rightarrow C$	Discussion,and planed repetition Explanation

	The forward reaction is taking place by decrease in volume, hence the backward reaction is taking place by increase in volume. If the pressure at equilibrium is disturbed, Le that equilibrium will Chatelier requires oppose the decrease in pressure. Equilibrium will shift in the direction of increase in volume favouring the backward reaction. To shift equilibrium in the forward direction, the pressure at equilibrium must be increased. For a reaction in which there is no volume change or in which there is no change in the number of moles of reactants and products pressure has no effect on the equilibrium. E.g. $2A_{(g)}+2B_{(g)} \leftrightarrows 4C_{(g)}$ 4moles 4moles			
Step 3 Effect of concentration **Evaluation**	Consider this reaction: $A+B \leftrightarrows C+D$ At equilibrium there is a definite concentration of A, B, C and D existing together. If the concentration of A is increased, the equilibrium is disturbed and it will shift to oppose the increase. To oppose the increase B will react with A to produce more of C and D making equilibrium position shift to the right (forward). If C is decreased, equilibrium is disturbed, A reacts with B to form more C and D favouring again forward reaction. The teacher evaluates the students thus: 4. Define chemical equilibrium 5. What effect has pressure on a reaction at equilibrium? 6. What effect has concentration on a	Listen and jot down points Listen And ask question Listen and answer question Listen, take down note	Chart showing The reaction: A+B=C+D	Stimulus variation Discussion and explanation questioning

Conclusion	system at equilibrium? She briefly goes through the lesson, gives note and assignment.	and assignment.	Displayed chart	Explanation and discussion

LESSON PLAN ON CHEMISTRY USING CONVENTIONAL METHOD OF INSTRUCION

Week 4

Class: SSII

Age: 17 years plus

Date:

Duration: 2 periods of 90 minutes

Topic: Chemical equilibrium

Specific Objectives: By the end of the lesson about 85% of the students should be able to answer the following questions.

4. Explain the concept of exothermic and endothermic reactions?
5. What will be the effect of introduction of more heat into a system that is in equilibrium?
6. Illustrate the conditions under which NH_3 is commercially **obtained using Haber Process.**

Entry Behaviour: The students have been taught effects of pressure and concentration on a system in a state of equilibrium.

Set Induction: The teacher set inducts the students by asking them; what will be the effect of increasing the contraction of the reactants in a reaction that is in equilibrium?

Instructional Procedure

Content	Teacher's Activities	Students Activities	Instructional material	Instructional techniques
Step1: Effect of temperature on equilibrium	The teacher explains that effect of temperature on equilibrium system must either be exothermic or endothermic reaction. She explains that if the forward reaction is exothermic, the reverse will be endothermic and vice-versa . Eg. A + B -- C, ΔH = ve If the equilibrium of the above reaction is disturbed by increase in temperature, according to Le Chatelier, the equilibrium must shift to oppose the increase. The equilibrium shifts in the direction from where the heat is coming favouring the backward reaction to produce more A and B. If forward reaction is to be favoured (ie production of C) heat has to be decreased. Note that decrease in temperature slows down the rate of reaction. To increase the rate of chemical reaction	Listen Listen and jot down points Watch the diagram	Charts showing reaction in equilibrium. A+B---C Chart of C producing A+B Diagram of finely divided iron and vanadium (V) oxide	Explanation Discussion, planned repetition and use of example. Discussion, stimulus variation and questioning.

	without disturbing the equilibrium, catalyst is introduced at optimum temperature of 450^oC – 500^oC			
Step 2: Life application of Le Chatelier's principle in industries.	The teacher explains that most chemical reactions in industries are reversible reactions and equilibrium is attained in the systems. Le Chatelier's principle is used to determine optimum conditions (temperature, pressure and concentration) with the aim of iv. Minimizing yield of product v. Maximizing yield of product vi. Attaining equilibrium within the shortest possible time. The principle is applied in: iii. Haber Process for production of ammonia ($NH_{3(g)}$) iv. Contact process for production of sulphur(iv)oxide (SO_3). Production of Amonia ($NH_{3(g)}$) $N_{2(g)} + 3H_{2(g)} \leftrightarrows 2NH_{2(g)},$ $\Delta H = -ve$ The forward reaction is exothermic and also takes place by decrease in the number of moles. To obtain a favourable yield of ammonia gas, Le Chatelier's following principles apply: The forward reaction is exothermic, high yield of ammonia requires low temperature. Low temperature reduces the rate of a reaction. To increase the rate of production of NH_3	Listen Listen and jot down note. Listen Watching and interacting	Temperature reduction Particles of iron fillings Removal of NH_3	Discussion and planned repetition Explanation and use of example

	introuduce a catalyst (finely divided iron) at a temperature of 450°C. Again the forward reaction has a decreased number of moles ie the forward reaction takes place by a decrease in volume of NH_3. Higher yield of ammonia is favoured by high pressure, therefore increase pressure to the level of 200-500 atmosphere. Finally to obtain a high yield of ammonia, the ammonia is removed as it is formed to shift equilibrium forward.			
Step 3: Manufacture of SO_3	The teacher explains that contact process involves direct combination of sulphur(IV)oxide and oxygen gas. $2SO_{2(g)}+O_{2(g)}\leftrightarrows 2SO_{3(g)}$; 3vols 2vols $\Delta H = -ve$ Like in the Haber Process, the forward reaction is exothermic and reaction takes place by decrease in volume. To obtain a high yield of SO_3, the same conditons that applied in the production of ammonia also apply. The conditons are temperature; 450°C0-500°C. Catalyst: vanadum(v)oxide Pressure: 200 atmosphere	Listen and watch Listen	Diagram of the reaction of $2SO_{2(g)}+O_{2(g)}\leftrightarrows 2SO_{3(g)}$; Catalyst (vanadium v oxide)	Discussion Use of example.
Evaluation	The teacher asks the students the following questions; 4. What is exothermic reaction and endothermic reaction? 5. What will be the effect of increased temperature to a system in equilibrium? 6. Give the conditions	Answer questions		Questioning

	under which high yield of ammonia is obtained in Haber process	Listen, copy note and assignment.		Explanation and discussion
Conclusion	She briefly goes through the lesson, gives note and assignment.			

Appendix K

Reliability Analysis of CAT Using Kuder-Richardson 20

Formula= $Kr20 = \frac{N}{N-1}\left(\frac{V - \sum pq}{V}\right)$

Table 1. Determination *pq*

No of items	No. of Students that answered item correctly	No. of Students that did not answered incorrectly	Proportion of Students that answered item it correctly (*p*)	Proportion of Students that answered incorrectly (*q*)	*p x q*
1	34	6	.85	.15	.13
2	32	8	.80	.20	.16
3	30	10	.75	.25	.19
4	35	5	.88	.13	.11
5	30	10	.75	.25	.19
6	31	9	.78	.23	.18
7	33	7	.83	.18	.15
8	39	1	.98	.03	.03
9	26	14	.65	.35	.23
10	28	12	.70	.30	.21
11	34	6	.85	.15	.13
12	30	10	.75	.25	.19
13	31	9	.78	.23	.18
14	34	6	.85	.15	.13
15	32	8	.80	.20	.16
16	28	12	.70	.30	.21

17	29	11	.73	.28	.20
18	26	14	.65	.35	.23
19	36	4	.90	.10	.22
20	28	12	.70	.30	.21
21	30	10	.75	.25	.19
22	35	5	.88	.13	.09
23	34	6	.85	.15	.13
24	36	4	.90	.10	.09
25	32	8	.80	.20	.16
					Σ 4.1

Table 2. Determination of Variance (V)

Student_No	**Score**	**Mean**	**Score - Mean**	**(Score - Mean)^2**
01	19	18.35	.65	.42
02	21	18.35	2.65	7.02
03	22	18.35	3.65	13.32
04	17	18.35	-1.35	1.82
05	23	18.35	4.65	21.62
06	9	18.35	-9.35	87.42
07	20	18.35	1.65	2.72
08	20	18.35	1.65	2.72
09	16	18.35	-2.35	5.52
10	23	18.35	4.65	21.62
11	24	18.35	5.65	31.92
12	23	18.35	4.65	21.62
13	20	18.35	1.65	2.72
14	17	18.35	-1.35	1.82
15	15	18.35	-3.35	11.22
16	17	18.35	-1.35	1.82
17	21	18.35	2.65	7.02
18	22	18.35	3.65	13.32
19	19	18.35	.65	.42
20	14	18.35	-4.35	18.92

21	19	18.35	.65	.42
22	20	18.35	1.65	2.72
23	20	18.35	1.65	2.72
24	15	18.35	-3.35	11.22
25	15	18.35	-3.35	11.22
26	18	18.35	-.35	.12
27	17	18.35	-1.35	1.82
28	14	18.35	-4.35	18.92
29	22	18.35	3.65	13.32
30	21	18.35	2.65	7.02
31	22	18.35	3.65	13.32
32	18	18.35	-.35	.12
33	18	18.35	-.35	.12
34	9	18.35	-9.35	87.42
35	14	18.35	-4.35	18.92
36	19	18.35	.65	.42
37	23	18.35	4.65	21.62
38	18	18.35	-.35	.12
39	15	18.35	-3.35	11.22
40	15	18.35	-3.35	11.22
	Σ734			**Σ509**
		Mean = **734/40=18.35**		**Variance =** **509/39 = 13.05**

$$Kr20 = \frac{N}{N-1}\left(\frac{V - \sum pq}{V}\right)$$

$$Kr20 = \frac{25}{24}\left(\frac{13.05 - 4.1}{13.05}\right)$$

$$Kr20 = 1.04\left(\frac{8.95}{13.05}\right)$$

$$Kr20 = 1.04 \times 0.69$$

$$Kr20 = 0.718$$

Appendix L

TEST OF RELIABILITY OF CHEMISTRY INTEREST SCALE

RELIABILITY

/VARIABLES=q1 q2 q3 q4 q5 q6 q7 q8 q9 q10 q11 q12 q13 q14 q15 q16 q17

/SCALE (‘CRONBACH ALPHA’) ALL

/MODEL=ALPHA

/STATISTICS=SCALE

/SUMMARY=TOTAL MEANS VARIANCE

Reliability-CHEM alpha

[DATAset] C: \Users\HP\Documents\cronbach ‘Chem.sav

Scale: CRONBACH ALPHA

Case Processing Summary

	N	%
Cases Valid	17	
Excluded[a]		100.0
Total	0	
	17	.0
		100.0

a. Listwise deletion based on all variables in the procedure

Reliability statistics

Cronbach's Alpha	Cronbach's Alpha Based On Standardized Items	N of items
0.780	0.783	17

Appendix M

Validators Comments

Validation of instrument on the Topic:

~~The~~ Effect of Instructional Computer ~~Animation~~ Animation on Students' Interest and Achievement in Chemistry

This is to certify that I Prof. Patrice-Anthony C. Okoye

Validated the above mentioned instrument and made corrections/recommendations on the following areas:

1. including ideas emanating from conventional chemistry teaching and computer animation
2. Designing the interest scale to include Some of the Concepts taught.

After the amendments, I considered the instruments fit/unfit for the study which it is designed for.

Signature: [signature]

Date: 25/10/16.

Validation of instrument on the Topic:

EFFECT OF INSTRUCTIONAL COMPUTER ANIMATION ON STUDENTS INTEREST AND ACHIEVEMENT IN CHEMISTRY

This is to certify that I ~~CHIKENDU REBECCA C~~ Prof Romy Okoye

Validated the above mentioned instrument and made corrections/recommendations on the following areas:

Interest item should be one to which a person with interest will agree while a person without interest will disagree with. Any item which will be agreed to, by those who are interested and those not interested will not serve as a good item. Some items in this instrument belong to the later group. For example, if we say that chemistry is important for technological development of a nation, it is a statement of fact, and as such people will agree with it whether or not they have interest in chemistry. On the other hand, a statement reads "During my free period I like to read chemistry" it is only those who like chemistry that will agree with it. Another observation is that almost all the items in this instrument are positively worded. About half of the items should be positive and half negative. This is to avoid acquiescence

After the amendments, I considered the instruments fit/unfit for the study which it is designed for.

The interest inventory therefore needs some modifications. Some items need to be deleted, some modified, and some negatively-worded items added. It is after that, that the instrument could be considered valid enough for use

The CAT could be used after correction provided an expert in chemistry goes through it to ascertain the correctness of the information contained in it

Signature: [signature]

Date: 20/10/16

Validation of instrument on the Topic:

EFFECT OF INSTRUCTIONAL COMPUTER ANIMATION ON STUDENTS' INTEREST AND ACHIEVEMENT IN CHEMISTRY

This is to certify that I ~~CHIKENDU REBECCA E~~ Prof N. Agu

Validated the above mentioned instrument and made corrections/recommendations on the following areas:

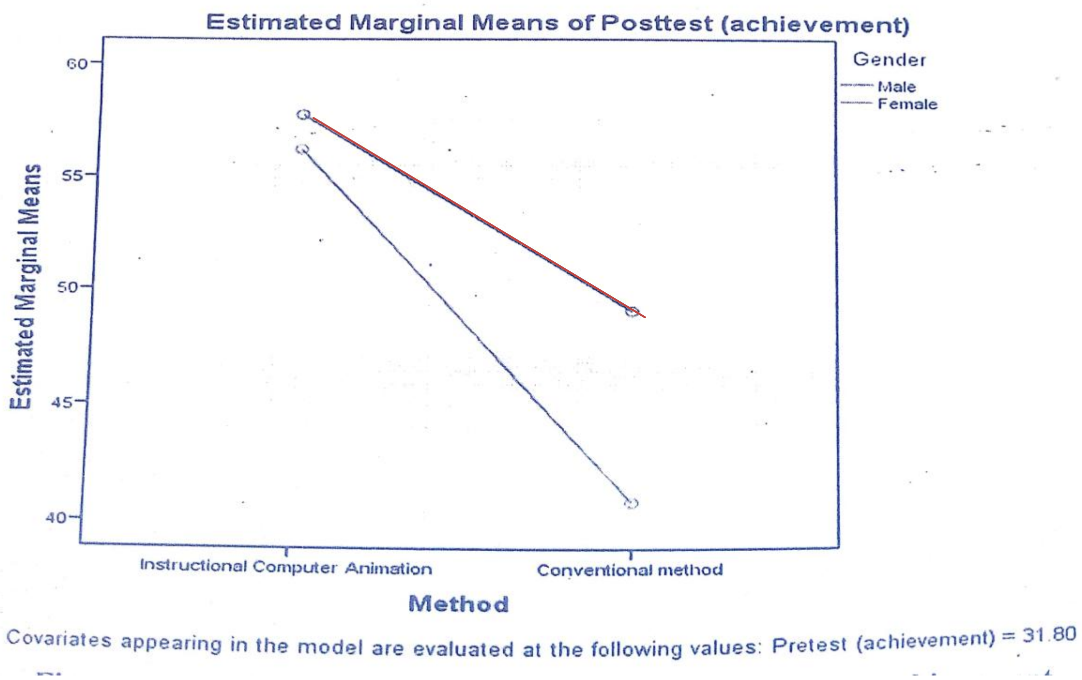
1. Restructure some of the specific purposes as suggested in the body of the work.
2. The restructuring of the specific purposes should be used to correct the research questions.
3. The interest scale should be restructured to have a combination of both negative and positive statements in order to avoid bias.

After the amendments, I considered the instruments fit/~~unfit~~ for the study which it is designed for.

Signature:

Date: 13/10/16

Appendix N



Interaction of gender and teaching method on Achievement

Appendix O

SPSS OUTPUT

Hypotheses 1, 2 & 3

[DataSet1] C:\Users\JOYD\Documents\SSPS.SAV\Rebecca.sav

Between-Subjects Factors

		Value Label	N
Gender	1	Male	85
	2	Female	101
Method	1	Instructional Computer Animation	95
	2	Conventional method	91

Descriptive Statistics

Dependent Variable: Posttest (achievement)

Gender	Method	Mean	Std. Deviation	N
Male	Instructional Computer Animation	57.67	7.039	45
	Conventional method	48.95	7.168	40
	Total	53.56	8.304	85
Female	Instructional Computer Animation	56.20	13.797	50
	Conventional method	40.88	10.543	51
	Total	48.47	14.425	101
Total	Instructional Computer Animation	56.89	11.089	95
	Conventional method	44.43	10.011	91
	Total	50.80	12.259	186

Tests of Between-Subjects Effects

Dependent Variable: Posttest (achievement)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	9643.763[a]	4	2410.941	24.032	.000
Intercept	46343.196	1	46343.196	461.940	.000
PreA	910.721	1	910.721	9.078	.003
Gender	1096.850	1	1096.850	10.933	.001
Method	6650.190	1	6650.190	66.288	.000
Gender * Method	511.375	1	511.375	5.097	.025
Error	18158.473	181	100.323		
Total	507720.000	186			
Corrected Total	27802.237	185			

a. R Squared = .347 (Adjusted R Squared = .332)

Estimated Marginal Means

1. Grand Mean

Dependent Variable: Posttest (achievement)

Mean	Std. Error	95% Confidence Interval	
		Lower Bound	Upper Bound
50.930[a]	.738	49.474	52.386

a. Covariates appearing in the model are evaluated at the following values: Pretest (achievement) = 31.80.

2. Gender

Estimates

Dependent Variable: Posttest (achievement)

Gender	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Male	53.371[a]	1.088	51.223	55.519
Female	48.490[a]	.997	46.523	50.457

a. Covariates appearing in the model are evaluated at the following values: Pretest (achievement) = 31.80.

Pairwise Comparisons

Dependent Variable: Posttest (achievement)

(I) Gender	(J) Gender	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
Male	Female	4.881*	1.476	.001	1.968	7.794
Female	Male	-4.881*	1.476	.001	-7.794	-1.968

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Univariate Tests

Dependent Variable: Posttest (achievement)

	Sum of Squares	df	Mean Square	F	Sig.
Contrast	1096.850	1	1096.850	10.933	.001
Error	18158.473	181	100.323		

The F tests the effect of Gender. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

3. Method

Estimates

Dependent Variable: Posttest (achievement)

Method	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Instructional Computer Animation	56.938[a]	1.029	54.907	58.968
Conventional method	44.923[a]	1.058	42.836	47.010

a. Covariates appearing in the model are evaluated at the following values: Pretest (achievement) = 31.80.

Pairwise Comparisons

Dependent Variable: Posttest (achievement)

(I) Method	(J) Method	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
Instructional Computer Animation	Conventional method	12.015*	1.476	.000	9.103	14.927
Conventional method	Instructional Computer Animation	-12.015*	1.476	.000	-14.927	-9.103

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Univariate Tests

Dependent Variable: Posttest (achievement)

	Sum of Squares	df	Mean Square	F	Sig.
Contrast	6650.190	1	6650.190	66.288	.000
Error	18158.473	181	100.323		

The F tests the effect of Method. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

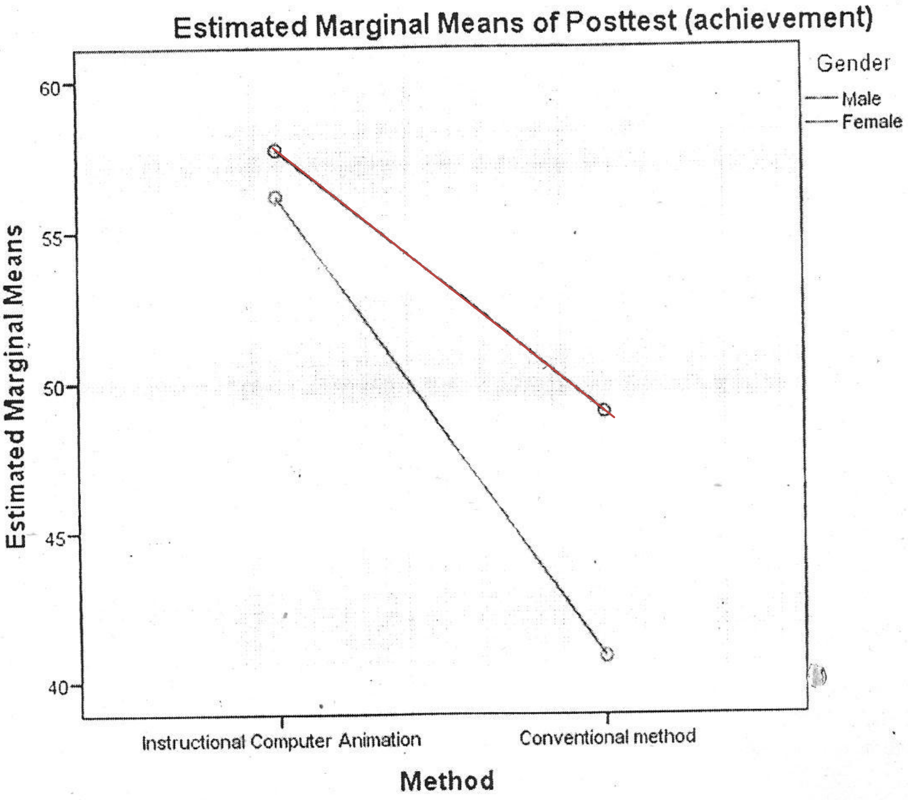
4. Gender * Method

Dependent Variable: Posttest (achievement)

Gender	Method	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Male	Instructional Computer Animation	57.712[a]	1.493	54.766	60.659
	Conventional method	49.029[a]	1.584	45.904	52.155
Female	Instructional Computer Animation	56.163[a]	1.417	53.368	58.958
	Conventional method	40.816[a]	1.403	38.048	43.584

a. Covariates appearing in the model are evaluated at the following values: Pretest (achievement) = 31.80.

Profile Plots



Covariates appearing in the model are evaluated at the following values: Pretest (achievement) = 31.80

Hypotheses ~~3, 4~~ 4,5 & 6

Between-Subjects Factors

		Value Label	N
Gender	1	Male	85
	2	Female	101
Method	1	Instructional Computer Animation	95
	2	Conventional method	91

Descriptive Statistics

Dependent Variable: Posttest (Interest)

Gender	Method	Mean	Std. Deviation	N
Male	Instructional Computer Animation	69.42	7.700	45
	Conventional method	51.78	5.461	40
	Total	61.12	11.109	85
Female	Instructional Computer Animation	65.90	6.973	50
	Conventional method	48.24	8.016	51
	Total	56.98	11.608	101
Total	Instructional Computer Animation	67.57	7.498	95
	Conventional method	49.79	7.193	91
	Total	58.87	11.539	186

Tests of Between-Subjects Effects

Dependent Variable: Posttest (Interest)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	15675.358[a]	4	3918.839	79.203	.000
Intercept	39553.507	1	39553.507	799.414	.000
Prel	412.084	1	412.084	8.329	.004
Gender	381.270	1	381.270	7.706	.006
Method	13221.419	1	13221.419	267.217	.000
Gender * Method	51.148	1	51.148	1.034	.311
Error	8955.546	181	49.478		
Total	669268.000	186			
Corrected Total	24630.903	185			

a. R Squared = .636 (Adjusted R Squared = .628)

Estimated Marginal Means

1. Grand Mean

Dependent Variable: Posttest (Interest)

Mean	Std. Error	95% Confidence Interval	
		Lower Bound	Upper Bound
58.831[a]	.518	57.808	59.853

a. Covariates appearing in the model are evaluated at the following values: Pretest (Interest) = 37.78.

2. Gender

Estimates

Dependent Variable: Posttest (Interest)

Gender	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Male	60.298[a]	.771	58.776	61.820
Female	57.364[a]	.707	55.968	58.760

a. Covariates appearing in the model are evaluated at the following values: Pretest (Interest) = 37.78.

Pairwise Comparisons

Dependent Variable: Posttest (Interest)

(I) Gender	(J) Gender	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
Male	Female	2.934*	1.057	.006	.848	5.019
Female	Male	-2.934*	1.057	.006	-5.019	-.848

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Univariate Tests

Dependent Variable: Posttest (Interest)

	Sum of Squares	df	Mean Square	F	Sig.
Contrast	381.270	1	381.270	7.706	.006
Error	8955.546	181	49.478		

The F tests the effect of Gender. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

3. Method

Estimates

Dependent Variable: Posttest (Interest)

Method	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Instructional Computer Animation	67.414[a]	.728	65.978	68.850
Conventional method	50.247[a]	.748	48.772	51.722

a. Covariates appearing in the model are evaluated at the following values: Pretest (Interest) = 37.78.

Pairwise Comparisons

Dependent Variable: Posttest (Interest)

(I) Method	(J) Method	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
Instructional Computer Animation	Conventional method	17.167*	1.050	.000	15.094	19.239
Conventional method	Instructional Computer Animation	-17.167*	1.050	.000	-19.239	-15.094

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Univariate Tests

Dependent Variable: Posttest (Interest)

	Sum of Squares	df	Mean Square	F	Sig.
Contrast	13221.419	1	13221.419	267.217	.000
Error	8955.546	181	49.478		

The F tests the effect of Method. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

4. Gender * Method

Dependent Variable: Posttest (Interest)

Gender	Method	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Male	Instructional Computer Animation	68.318[a]	1.116	66.116	70.521
	Conventional method	52.277[a]	1.126	50.055	54.498
Female	Instructional Computer Animation	66.509[a]	1.017	64.503	68.516
	Conventional method	48.218[a]	.985	46.275	50.162

a. Covariates appearing in the model are evaluated at the following values: Pretest (Interest) = 37.78.