EFFECT OF COMPUTER-ASSISTED INSTRUCTION AND LECTURE METHOD ON KATSINA STATE SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND RETENTION IN ELECTROLYSIS CONCEPT

BY

Jamilu Gachi, ABDULLAHI
MED/EDUC/2808/2011-2012

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FACULTY OF EDUCTION
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A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES AHMADU BELLO UNIVERSITY ZARIA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTERS DEGREE IN SCIENCE EDUCATION

DEPARTMENT OF SCIENCE EDUCATION
FACULTY OF EDUCTION
AHMADU BELLO UNIVERSITY ZARIA, NIGERIA

APRIL, 2015

DECLARATION

I hereby declare that this thesis entitle “EFFECT OF COMPUTER-ASSISTED INSTRUCTION AND LECTURE METHOD ON KATSINA STATE SECONDARY SCHOOL STUDENTS’ ACHIEVEMENT AND RETENTION IN ELECTROLYSIS CONCEPT” has been written by me and it is a record of my own research work. It has not been presented in any previous application for a higher degree. All quotations and sources of information are fully acknowledged by means of references.

....

Jamilu Gachi ABDULLAHI Date

CERTIFICATION

This thesis entitle "EFFECT OF COMPUTER-ASSISTED INSTRUCTION AND LECTURE METHOD ON KATSINA STATE SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND RETENTION IN ELECTROLYSIS CONCEPT" by Jamilu Gachi ABDULLAHI meet the regulation governing the award of Masters Degree in science Education Ahmadu Bello University Zaria and is approved for its Contributions to the knowledge and literary presentation

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DEDICATION

This work is dedicated to my parents Alhaji Abdullahi Isah Gachi and Hajia Bilkisu Abdullahi Gachi and to all the Gachi families for their moral, spiritual and financial support.

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OPERATIONAL DEFINITION OF TERMS

The terms that were used in this study are defined operationally in this section.

Academic Achievement	Reaching a particular goal or stand after an Educational Experience
Attitudes	Are expression when an individual makes statement about their feelings or opinion.
Effects	Is the result or outcome of a cause. Effect is a change that occurs and leads to modification in Behavior.
Experience	Collection of event or activities from which an individual or group may gather knowledge, opinions and skills.
Computer Assisted Instruction (CAI)	Is an application of computer software package to instructional process.
Retention	This is the ability of the learner to store information which can be recalled at a later time after exposure to series of instruction or training.

ABBREVIATION USED

▪ ABU	Ahmadu Bello University Zaria
▪ CAI	Computer Assisted Instruction
▪ ECAT	Electrolysis Concept Achievement Test
▪ GIMP	Graphic Image Processing Software
▪ GGSS	Government Girls Secondary School
▪ GSS	Government Secondary School
▪ NECO	National Examination Council
▪ SATEQ	Students Attitude Towards Electrolysis Concept Questionaire
▪ SPSS	Statistical Package for Social Science
▪ WAEC	West African Examination Council

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ABSTRACT

This study was carried out to investigate the relative effectiveness of Computer-Assisted Instruction on academic achievements, retention and attitude in electrolysis concept among senior secondary school students in Kankia education zone, Katsina State, Nigeria. The study had four research objectives, four research questions and four null hypotheses. A total number of 123 students consisting of 78 males and 45 female selected using Simple random sampling techniques formed the sample of the study. The study adopted the pretest, posttest, and post post-test quasi experimental and control group design. The subjects in the experimental group were taught using Computer-Assisted Instruction (CAI), while the control group was exposed to lecture method for a period of six weeks. Two validated research instruments, with reliability coefficient of 0.9 and 0.7, namely Electrolysis Concept Achievement Test and Students' Attitude towards Electrolysis Concept Questionnaire were used in data collection. Three null hypotheses were tested using t-test statistic and the other, using Mann-Whitney U-test at 0.05 level of significance. The major findings from the study revealed that there is significant difference in the posttest mean scores of experimental and control groups in favour of experimental group. It also revealed significant difference in the retention ability of chemistry students taught electrolysis Concept using Computer-Assisted Instruction and those taught using lecture method in favour of experimental group. Furthermore, students exposed to computer-assisted instruction developed positive attitude towards electrolysis Concept than lecture group. The study found CAI an affective teaching method, and based on that findings emanating from this study it was recommended that Federal and State Governments should adequately trained chemistry teachers on using Computer-Assisted Instruction in teaching Chemistry.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

Chemistry as a branch of science deals with the study of composition, properties and uses of matter. It probes into the principles governing the changes matter undergoes (Ababio, 2011) Chemistry, like the other science disciplines, operates at three thought levels: the macroscopic, the sub-microscopic and the symbolic (Johnstone, 1991). The macroscopic refers to the phenomenological: what can be perceived by the senses without the aid of instruments Examples include change in the physical properties of matter, mass and volume changes, colour changes, pH of aqueous solution, formation of gases, solubility of substances, precipitates in chemical reactions, and residue of the precipitate, these are usually physical processes. The Sub-microscopic refers to that which can only be perceived with the aid of instruments. "Sub microscopic" implies detail at the atomic or subatomic levels which cannot be seen directly with naked eyes, example movement or transfers of electrons, this is often abstract. The symbolic levels refers to chemical symbols, formulas and equation as well as molecular structure, to symbolize matter, these are often representational. The macroscopic, sub-microscopic and symbolic levels interact, and these interactions have to be manipulated skilfully by the teachers for understanding to take place (Johnstone, 1991).

Chemistry is one of the most important subjects in science and contains a number of abstract concepts that students often find difficult to understand. Thus students sometimes lose interest in learning chemistry as a subject (Garnett & Treagust 1992; Stieff & Wilensky, 2003). One of the objectives of science education is to develop students' interest in science and technology as today's society depends largely on developments in science and technology (FGN, 2013). Teachers are expected to devise ways of making their students to develop positive attitude and interest towards science and science-related disciplines (Dohn & Wagne 1999).

There has been a great shift in emphasis in science teaching and learning over the years worldwide. The concern in recent times is to have science classrooms that are student- centred, activity oriented and which focus on understanding rather than rote learning and simple recall of knowledge (Owolabi, 2007) in Olorukooba, Lawal & Jiya, 2012). Students tend to memorize facts and principles, most of which they do not understand but only to regurgitate them during examination. Thus the retention of ideas, facts and principles learned in this way might not be worthwhile. (Usman, 2000; Bichi, 2002; Njoku, 2004). It is in line with this view that Okolocha (2010) contended that the present teaching and learning of science in Nigeria seems inadequate. He stressed that the level of academic and professional competence of science teachers need to be raised to the level that teachers can teach students with a focus on understanding rather than frequent use of only lecture that often lead to rote learning. Moreover, recall of knowledge and memorization are not appropriate focus of science learning (Okolocha 2010). The contemporary problem and need of the society today centred on sound development of science and technology for which chemistry education is pivotal.

Garnett and Treagust, (1992) reported that the concept of electrolysis in chemistry is one of the topics that students find difficult to deal with, in Senior Secondary Certificate Examination (SSCE). Thompson & Soyibo (2002) supported this view when they observed that, the difficulty in electrolysis concept of chemistry is because of the conceptual demand in writing and balancing chemical equation, the mathematical calculations and other factors contributed to the poor performance of students in electrolysis concepts of chemistry and if electrolysis concepts of chemistry are by nature difficult, the problem could be compounded by the teachers' failure to adopt appropriate instructional strategies and methodologies that could promote or enhance students understanding of the concepts.

The teaching method used by teachers is very vital in any teaching-learning situation as this may promote or hinder learning. It may sharpen mental abilities and encourage students to learn effectively or may discourage initiatives and curiosity of the students to learn effectively (Paul & Dantani 2012). Instructional strategy adopted by the teacher at all level of education in imparting knowledge and skills to the learners are determine by the teachers abilities, topic to be taught, learners age, and available resource (Atadoga & Onaolapo, 2008). There is however the need for science teachers to understand that different topics in science may require different teaching approaches depending on the complexity and structure of the topics. Many strategies like inquiry method, demonstration method, problem solving method, and discussion method have been used in teaching chemistry but still the performance of students is still very low (Adenekan, Adewopo, & Ogunjobi, 2006) It is in this regard that this study is aimed at investigating the relative effectiveness of Computer-Assisted Instruction (CAI) on students' academic achievement in electrolysis concepts.

Electrolysis is an important aspect of secondary school chemistry curriculum (FGN, 2013). The concepts, as observed by Silberberg (2000), deal with the study of the relationship between chemical change and electrical work. Electrolysis has been reported to be one of the topics that students find difficult to understand in secondary school chemistry (Onwu & Moneme, 1986, Thompson & Soyibo, 2002; Oyelekan, 2011). Onwu and Moneme, (1986) investigate the competence of selected Nigerian chemistry students to solve electrolysis problems through the use of problem solving model. The results show that the students generally found solving problems in electrolysis more difficult. In another study Thompson & Soyibo (2002) investigated the attitude of students towards chemistry and their conceptual understanding of electrolysis. The result of their study revealed that 50% of the students regarded electrolysis as one of the most difficult concepts to understand. Oyelekan (2011) carried out a study to find out the level of understanding of selected chemistry concepts by senior secondary school students in Osun State, Nigeria. The result of his study indicated that electrolysis is one of the topics in which the students find difficult to understand.

There is evidence that suggest the effectiveness of the use of computer in facilitating the teaching and learning of, not only difficult concepts in chemistry, but of chemistry generally. For instance, researchers claim that computer-mediated instruction, in comparison to the conventional methods of teaching, can enhance student's academic achievement (Reid, 2003). According to Oloruntegbe and Odutuyi (2003), the often- perceived difficult and abstract concepts in chemistry such as radioactivity, mole concept, stoichiometry and electrolysis, among others can be encoded or programmed into computer software that teachers and students can utilize to make their teaching and learning more effective rather than using only lecture method.

Lecture Method is widely used in the secondary and tertiary levels of education. Lecture Method is a method of teaching in which teacher talk, while students take note of some key points and is used primarily to introduce students to a new subject. It is also a valuable method for summarizing ideas, showing relationships between theory and practice (Mills, 1979). Many teachers use this teaching method almost exclusively, as it is considered the simplest, and one can cover large amounts of material in a short period of time. However, this is not the most effective teaching method to teach students, especially younger ones, who often need a more engaging, hands-on strategy in order to learn effectively (Paul & Dantani 2012). According to Keshinro, (2006) a lecture can be an effective method for communicating theories, ideas, and facts to students. The primary aim of every lecturer is to ensure that he/she communicate effectively with their students. Oloruntegbe, (2003) opined that Lecture Method is teacher-centred and encourages rote learning. Emphasis therefore should be shifted to activity-based learning such as used of Computer Assisted Instruction (CAI).

Computer-Assisted Instruction is an application of computer software package to instructional process (Kulik & Kulik, 1991). Computer-Assisted Instruction (CAI) is one such area recently consider to have capacity to improve the teaching of difficult and abstract science concepts and to stimulate students interest in learning (Allessi & Trollip, 1991). The term Computer-Assisted Instruction (CAI) in this study means a process whereby instruction in electrolysis concepts will be delivered to the selected students using computer software. Microsoft power point slides Standard Edition 2010" which will be projected on the board for students to be able to observe and learn some of the abstract contents of electrolysis through graphic animations and simulation developed using "graphic image processing software (GIMP)", Adobe flash files (soft files), macro media flash player 8.0 and “adobe acrobat” embedded into Microsoft power point slides.

According to Ardac & Akaygun, (2004) information can be delivered by computer to students in a manner similar to programmed learning. And this is aimed at student’s achievement of specific educational goals through step-by-step instruction. Several uses of computers such as providing visualised and animated instruction revision, teaching and problem- solving, simulations during the applications and immediate feedback make computers useful instructional devices for achieving desired learning outcomes (Allesi & Trollip, 1991).

An additional advantage of Computer-Assisted Instruction is that the teacher can use computers at different times and places according to the characteristics of the subject matter, the students, and available software and hardware (Morgil, Yavuz, Oskay, & Arda, 2005). Information Communication Technology (ICT) - based learning intervention can either be used to enhance practical investigation or as a virtual alternative to real practical work where a simulation supports exploration of the investigation model, through a computerized representation of the phenomena under study. Interesting and well designed programmes can help learners achieve mastery of concepts taught (Wodi & Dokubo, 2006). In most Nigerian schools where laboratory apparatus and equipments for practical are unavailable or insufficient, Computer-Assisted Instruction can help students to understand abstract concepts, therefore the use of computer in teaching and learning tends to holds much prospect for teaching and learning chemistry and also improve students’ academic achievement (Njoku, 2004).

Academic achievement is a variable in this research. It is defined as the extent by which learners performed in the lesson taught or examination result (Mari, 1994). Researchers (Mari, 1994; Shaibu, 1998; Bichi, 2002; Olajide, 2007; Lawal 2009; Obeka, 2009; Usman 2010; Olorukooba, Lawal & Jiya, 2012; Abdulkarim & Lawal 2012; Lakpini, & Atadoga, 2013) worked on teaching method and academic achievement in science education. The overwhelming view of these researchers agreed that there is relationship between the type of method adopted in teaching and students' academic achievement and retention level.

Retention work together with academic achievements and it is defined as the ability to retain things, experienced previously learned. Several factors are known to influence retention of learned materials. Bichi (2002) revealed that anything aiding learning should improved retention while things that course interference among learned materials decrease efficiency of learning and accelerate forgetting.

Considerable number of researchers has focused on gender differences in school science learning. Gender is one of the factors interacting with students' academic achievements in science learning process and studies on gender differences have been unresolved in their conclusions. Some researchers found that male students have a higher performance than female students, for example Usman (2000) reported that boys perform better than girls on activities that require manipulations and also boys are more mechanically and scientifically inclined than girls. Other studies confirmed the superiority of female students' performance over male students (Mari, 1994; Shaibu & Mari, 1997). Yet other researchers found no significant difference between male and female academic performances.

Attitude as a variable in this study may be defined as a predisposition to respond in a favourable or unfavourable manner with respect to a given attitude object (Oskamp and Schultz 2005) Attitudes, like academic achievement, are important outcomes of science education in secondary school. The development of students' positive attitudes regarding science as a school subject is one of the major responsibilities of every science teacher. Research has shown that attitudes are linked with academic achievement. Bennett, Rollnick, Green and White (2001) also found that undergraduate students who had a less positive attitude to chemistry almost invariably obtained lower examination marks. In view of the foregoing attitude in relation to its role in academic achievement is also being investigated in this study.

1.1.1 Theoretical framework

This study is based on the theoretical foundations of constructivist learning theory. Constructivism is basically a theory based on observation and scientific study of how people learn. It says that people construct their own understanding and knowledge of the world through experiencing things and reflecting on those experiences (Shaibu, 2012) Constructivist theories have been widely used in ICT instructional strategies and the relevance of constructivism lies in the fact that knowledge is actively constructed in the mind of learners. (Dawson, Forster & Reid 2006). A central point in constructivism is that learning is always a unique product "constructed" as each individual learner combines new information with existing knowledge and experiences. Individuals have learned when they have constructed new interpretations of the social, cultural, physical and intellectual environments in which they live (Saunders, 1992). A primary role of the teacher therefore is to create appropriate learning environment in which students' learning experiences are authentic representations of real practices in applied settings (Kearney & Treagust, 2001). Thus, the basic principles of constructivism theory is applied in this study in which learners construct meaning and create appropriate learning experience of electrolysis concept through the Computer-Assisted Instruction developed by the researcher. The interactive property of the Computer-Assisted Instruction (CAI) coupled with the simulations and animations projected on the screen students should hopefully be able to observe and learn some of the abstract concepts of electrolysis. This is aimed at helping them in the learning experiences that would enhance retention and improve their academic achievements in electrolysis concepts in line with the theoretical stipulations of constructivist principles.

1.2 Statement of the Problem

This study is prompted by the challenges that chemistry students face in their final year examinations. Chemistry as a subject has been criticised by scholars as not having adequate provision for improving the performance of Nigerian secondary school students in school leaving examinations, despite the significant role played by the subject in science based courses like Medicine, Biochemistry, Nursing, Petrochemical Engineering among others. For instance, the West African Examination council (WAEC) chief examiners' report from 2005 to 2012 reveals that students performance in chemistry examination are relatively low when compared with the percentage failure (Grade 7-9) against passes at credit level (Grade 1-6). In the year 2005, for instance, 50.94 % pass the subject at credit level as against 49.06% of failures. In the year 2006, 44.90 % pass the subject at credit level as against 55.10% of failures. In the year 2007, 45.96 % pass the subject at credit level as against 55.56 % of failures. In the year 2008, 44.44 % pass the subject at credit level as against 54.04% of failures. In the year 2009, 43.69 % pass the subject at credit level as against 56.31% of failures. The situation changed slightly in the year 2010, with 50.69 % pass at credit level against 49.31% failures. In the year 2011, the performance of students decrease with 49.54 % pass at credit level and 50.46% failed. In the year 2012, significant decrease again with 43.13 % passes the subject at credit level as against 46.87% of failures. This can be seen in the table 1.1 below

Table 1.1 Candidates' performance in Chemistry in the May/June 2005 to 2012 WASSCE Examination in Nigeria

Year	No. of students Registered	No. of students Pass(Grade 1-6)	No. of students Fail(Grade 7-9)	%Pass (Grade 1-6)	%Fail (Grade 7-9)
2005	357658	178274	179384	50.94%	49.06%
2006	389462	170670	218792	44.90%	55.10%
2007	432230	194284	237946	45.96%	54.04%
2008	428513	185949	242564	44.44%	55.56%
2009	478235	204725	273510	43.69%	56.31%
2010	477573	236059	241514	50.69%	49.31%
2011	575757	280250	295507	49.54%	50.46%
2012	641622	270570	371052	43.13%	46 87%

Source :(Research Division, West African Examinations Council, WAEC, Lagos, 2013).

A critical examination of Table 1:1 reveals that the highest performance in Chemistry was in the year 2005 when the percentage Credit pass (grade 1-6) was 50.94%. The lowest performance was in the year 2012, when the percentage credit pass (grade 1-6) went down as low as 46.87%. This was attributed to lack of appropriate teaching method, laboratory facilities, equipment, and apparatus. For a country that is yearning for technological advancement, these results figures are not encouraging. If we are to have better results, there is need to make frantic efforts at improving our pedagogical styles to enhance a better understanding of difficult Chemistry concepts.

The results of the previous studies observations in Nigeria show that there are a number of factors that can be attributed to students' failure in chemistry. These include: a lack of qualified science teachers, lack of laboratory equipment and instructional materials such as textbooks, models and audio visual aids to demonstrate scientific principles, Large class sizes and a limited range of teaching strategies resulting into only Lecture Method with few or no practical activities, The problem is further compounded by irregular in-service teacher training to update science teachers' pedagogical and content knowledge, (Akintunde & Lawal, 2008). Teachers lack the laboratory facilities and molecular models needed to make the abstract concepts of chemistry real and learnable for students (Oloyede, 2013).

In Nigerian schools where materials and apparatus for practical are either unavailable or insufficient, the use of computer simulations could be a welcome solution. For instance, Ardac & Akaygun (2004) investigated the effectiveness of multimedia-based instruction that emphasizes molecular representations on students' understanding of chemical change. The findings showed that the strategy was effective in enhancing students understanding of the concept. Thus, the problem of this study is to investigate the relative effectiveness of a Computer-Assisted Instruction on students' academic achievement, retention and attitude in electrolysis concepts at senior secondary school level in the identified study area.

1.3 Objectives of the Study

The Objectives of this study are to:

1. determine the relative effectiveness of Computer- Assisted Instruction and lecture instructional method on the academic achievement of senior secondary school chemistry students when taught electrolysis concepts.

2. find out if Computer-Assisted Instruction has any effect on gender-related differences when exposed to learning electrolysis concepts using the method.

3. determine the relative effectiveness of Computer-Assisted Instruction and lecture method on students' retention level when taught electrolysis concepts using both methods.

4. investigate if Computer-Assisted Instruction has any effect on students' attitude change when exposed to learning electrolysis concepts.

1.4 Research Questions

To guide the study the following research questions were formulated for answering:

1**.** What is the difference in the mean academic scores of students exposed to Computer-Assisted Instruction and those exposed to Lecture Method when taught electrolysis concepts?

2**.** What is the difference in the mean academic scores of male and female students taught electrolysis concepts of chemistry using Computer-Assisted Instruction only?

3. Does Computer-Assisted Instruction and lecture methods affect students' retention ability differently when taught Electrolysis concepts?

4**.** Does the use of Computer-Assisted Instruction have any effect on students' attitude towards electrolysis concepts?

1.5 Research Hypotheses

The following null hypotheses are formulated and tested at 0.05 level of Significance:

$HO_{1:}$ There is no significant difference in the mean score of students exposed to Computer-Assisted Instruction and those exposed to Lecture Method when taught Electrolysis concepts.

$HO_{2:}$ There is no significant difference in the mean score of male and female students taught electrolysis concepts using Computer-Assisted Instruction.

$HO_{3:}$ There is no significant difference in the retention level of students taught electrolysis concepts using Computer-Assisted Instruction and those taught using lecture method.

$HO_{4:}$ There is no significant difference in the attitude of students exposed to Computer-Assisted Instruction and those exposed to Lecture Method when taught electrolysis concepts.

1.6 Basic Assumptions

In carrying out this research, the following assumptions were made:

1. Both Computer-Assisted Instruction and conventional lecture methods are appropriate for teaching electrolysis concept of chemistry.

2. The schools used prescribed syllabus of West African examination council (WAEC) and National examination council (NECO).

1.7 Significance of the Study

It is hoped that the result of this study would benefit chemistry teachers, students, Curriculum planners, policy makers in education, text book publishers as well as other researchers undertaking research in similar field in various ways. It is hoped that the findings from the study will:

1. encourage chemistry teachers to plan sequence, and organise properly, the content of electrolysis in order to enhance and encourage students to avail themselves to the learning opportunities that are available in the study of chemistry. This will also benefit them in adapting to the best strategies in teaching chemistry in our secondary schools. Hence, this will make lesson interesting and real and meaningful learning can be ascertained.

2. avail curriculum developers and education planners the opportunity to plan the process of evaluation of teaching and learning electrolysis concepts in the senior secondary schools. This will also help in suggesting the way forward in the inculcation of Computer-Assisted Instruction or Lecture Method in the learning electrolysis concepts.
3. contribute to the existing literature that is already available on the methods of teaching science in the schools and prepare ground for interested researchers who may wish to conduct further research in related areas.
4. help Science-based organizations like Science Teachers Association of Nigeria (STAN), Mathematics Association of Nigeria (MAN), National Educational Research and Development Centre (NERDC), among others, in realising their various mandates.

1.8 Scope of the Study

This study is delimited to the investigation of relative effectiveness of Computer-Assisted Instruction on students' academic achievements, retention and attitude in electrolysis concepts among senior secondary school students. It was conducted in secondary schools of Kankia Education zone Katsina state. The zone is located geographically within the Central Katsina State bordered with Charanchi

Local Government Area to the North, Bindawa Local Government Area to the East, Musawa Local government Area to the South and Dutsinma Local Government Area to the west. The study covered a total of eight secondary schools in the zone. The schools are government public schools having similar characteristics of funding, teachers, and similar curriculum, co-educational and are running as day and boarding schools.

Senior Secondary Schools (SSII) students of average age of 16 years were used for the study. This category of students were targeted for the study because they are relatively established and stable in secondary education more than (SS1) students who have not yet settled down, and the (SSIII) students who are busy preparing to write their final year examination (SSCE/NECO). The period for the study covered a total of six weeks. The topic used is electrolysis concepts of chemistry, derived from the national curriculum for senior secondary school chemistry and it was selected because it features in (SSII) chemistry curriculum. These include the following; Definition of electrolysis concept, ionic theory, mechanism of electrolysis, uses of electrolysis, Faraday laws of electrolysis, and electrical conductivity.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This study is an attempt to examine the relative effectiveness of Computer-Assisted Instruction on Academic achievement in electrolysis concepts among senior secondary school students in kankia educational zone. In this chapter the literature were reviewed based on the following sub-headings

- The Historical Development of Chemistry Teaching in Nigeria
- The Concept of Chemistry Teaching in Nigerian Secondary Schools
- Electrolysis Concept of Chemistry
- Method of Teaching Chemistry
- Computer Assisted Instruction in Teaching Chemistry
- Factors Affecting Academic Achievement in Chemistry
- Gender and Academic Achievement in Chemistry
- Retention and Academic Achievement in Chemistry
- Attitude and Academic Achievement in Chemistry
- An Overveiw of Similar Studies
- Implication of the Literature Reviewed for the Present Study

2.2 The Historical Development of Chemistry Teaching in Nigeria

The Origin and development of chemistry teaching in Nigeria is closely associated with the history of science education, which was largely dictated by the nation's colonial past (Oraifor, 1986). According to Okeke, (1983), "The genesis of science teaching in Nigeria is one of evolutions rather than revolution". Prior to 1859, science was not included in the elementary and secondary school curricula in Nigeria. Oriafor (1986) claimed that the establishment of the church missionary secondary schools in Lagos in 1859 was the significant step which resulted in the introduction of the rudiments of science in the school curriculum. Other schools where these rudiments of science were also introduced included St. Gregorys College, Lagos, Hope Wadde instituted, calabar, and Baptist training college Ogbomosho (Oraifor, 1986). This rudiment of science was Nature study and it involves the teacher and his pupils “Learning about the environment in the form of an out-door observation of plants, animals and non living objects” (Bajah, 1982).

According to Bajah (1982), the enthusiasm for nature study was beginning to decline. The influence of the new designs in curricular for science was beginning to be felt, the dissatisfaction with nature study was vehemently expressed by Chiappetta, (1982), when he appealed to all science teachers to protest against nature study, which he described as a “shambles”, According to Okeke, (1983). It was clear that the nature study was no longer consistent with the psychology and methodology of the present time. He also observed that the nature study was no longer adequate for the social and economic realities of the period, thus a change was imminent, the effect was that nature was changed to general science, which was taught in the first two years of secondary school. Later, general science was divided into three major branches of science these are Chemistry, Biology and Physics. These three branches of science were introduced in the last three years of secondary school. However, with the introduction of 6-3-3-4 system, the senior secondary school chemistry curriculum was revised. This brought about introduction of the new senior secondary school Chemistry Core-Curriculum in 1985.

2.3 The Concept of Chemistry Teaching in Nigerian Secondary Schools

Chemistry is one of the most important subjects in science, not only because of its numerous and fundamental connections with other branches of science, but also because of its wide ranging influence on the way we live (Wellington, 1989). Fashola (2008) views chemistry as the science of materials in the natural and built environment and that it is pivotal to the development in the natural world. Chemistry is one of the means by which humans describe reality. It deals with all of the substances making up the environment and with the changes these substances undergo.

According to Gilbert (2009), chemistry in particular comprises four components. These are:

i) The processes used to obtain (discover or create) chemical knowledge;

ii) The general concepts and specific ideas so produced;

iii) The applications of that knowledge in understanding and changing the world;

iv) And the implications of that understanding and change for individuals and societies.

Gilbert (2009) added that understanding chemistry requires understanding: the nature of chemistry, its norms, values and methods, the key theories, concepts and model of chemistry, how chemistry and chemistry-based technologies relate to each other, and appreciating the impact of chemistry and chemistry-related technologies on society.

The revised edition of the Nigerian Senior Secondary School Chemistry Curriculum (Federal Ministry of Education, 2007) expects among other things that chemistry will enable students to:

i. develop interest in the subject of chemistry;

ii. acquire basic theoretical and practical knowledge and skills;

iii. develop interest in science, technology and mathematics;

iv. acquire basic STM knowledge and skills;

v. develop reasonable level of competence in ICT applications that will engender entrepreneurial skills;

vi. apply skills to meet societal needs of creating employment and wealth;

vii. be positioned to take advantage of the numerous career opportunities offered in chemistry;

viii. be adequately prepared for further studies in chemistry.

FGN (2007) also added that, it is expected that the revised curriculum:

- Will facilitate a smooth transition in the use of scientific concepts and techniques acquired in the new Basic Science and Technology curriculum with chemistry;
- Provide students with the basic knowledge in chemical concepts and principles through efficient selection of contents and sequencing; Show chemistry in its inter-relationship with other subjects;
- Show chemistry and its link with industry, everyday life activities and hazards;
- Provide a course which is complete for students not proceeding to higher education while at the same time provides a reasonably adequate foundation for a post-secondary chemistry course.

When compared to other curriculum documents, it is evident that the Nigerian Chemistry curriculum has given an opportunity for students to develop scientific skills and attitude and apply their knowledge for personal decisions when faced with everyday issues and problems. (Akintunde & Lawal, 2008; Olaleye, 2005). Science in general and chemistry in particular, needs to be taught in engaging students to develop scientific skills and attitude. However, chemistry has been taught over the last 40 years, in Nigeria but still students have difficulty understanding the relevance of the curriculum content to their everyday lives. (Salau, 1996).

Furthermore, research has revealed that students in Nigerian secondary schools have difficulties in learning abstract concepts of chemistry such as radioactivity, mole concept, stoichiometry and electrolysis thus students found the subject boring (Odubunmi, 1997; Keshinro, 1998; Olaleye, 2005). A common theme emerging from these studies is that students' perceive chemistry as a subject that demands much effort for little success and they believe that the only way to pass examinations is by rote learning. Also, chemistry is not made relevant to their lives and does not encourage independent learning since the teaching has been characterized by the chalk and talk method with little or no activities. Teachers present a typically theoretical teacher-directed and extremely didactic lesson resulting in students not having a deep understanding of the concepts taught. (Olaleye, 2005).

In making efforts to reform chemistry teaching and learning in Nigeria, various studies have been carried out with the aim of improving student‘s performance and attitudes towards chemistry. Shaibu (1998) investigated the relationship between the laboratory practical competence of senior secondary school students in Kaduna state and their academic achievement in chemistry. He found out that there is a significant positive relationship ($r = 0.52$) between the two variables. He concluded that laboratory based instruction involving practical activities should receive higher premium to improve academic achievement. In another related study.

Awolade (2010) investigated the relationship between science resource availability and secondary school student's chemistry achievement in Kaduna state, she found a significant relationship ($r = 0.50$ at $p< 0.05$) between availability of material resource and student academic achievement in chemistry. She also found out a highly significant and positive relationship ($r = 0.70$; at $p< 0.05$) between availability of human resources and students academic achievement

Igboegwu, (2012) investigated the effects of guided discovery and demonstration teaching method on achievement of chemistry student of different level of scientific literacy secondary. They used a quasi experimental design. Their sample for the study covered 145 (SSS II) students in Anambra State. The students were pre-tested and Posttested, Analysis of Covariance (ANCOVA) was used for data analysis. The findings of their study showed that the performance of students exposed to guided discovery method produce highest mean achievement score in chemistry for the high scientific literacy level better than their counterparts exposed to the demonstration method.

A research study in Nigeria indicates that teachers are faced with problems of large classes and they lack adequate resources to make concepts concrete and accessible to students lack appropriate instructional strategies to teach abstract topics in chemistry (Adewumi & Akiniyi, 2010). Despite various suggestions for improvement, the low standards remain (Ikeobi, 1995; Keshinro, 1998; Ogunmade, 2006 Akintunde & Lawal, 2008). From these perspectives, it appears that the low standards in student's performance especially in WAEC/NECO Examinations could be attributed to the subsequent factors outlined above:

The teaching of chemistry in the Senior Secondary School of Nigeria has significance as pointed out by Olatoye, & Affuwape (2004), Ibrahim (2006) and Mohammed, (2007) are as follows:

- Chemistry helps in improving the quality of our life today, studying chemical processes around us, such as lightening matches, cooking, burning of fire wood, rusting of metals among others. Chemistry allow man to understand his environment and concept of matter and different changes that matter undergoes (Ibrahim 2006). All the house hold materials such as soaps and detergents for washing, hair cream and perfumes and majority of cooking utensils, plastic material for wide variety of uses are all products of chemical process,(Olatoye, & Affuwape 2004)

- Chemistry provides vocational preparation of individuals who will become personnel in the various fields such as medicine, pharmacy, chemical engineering, textiles environmental monitoring and petroleum industry; among others, these are essential particularly in the developing country like Nigeria.
- Chemistry education is of practical aesthetic and intellectual value to students. It provides useful chemistry concepts and principles. Chemistry is also directly related to other natural sciences such as physics and biology. Hence, the encouragements of the learning of chemistry especially at the senior secondary school level is of paramount importance and one way by which this can be achieved is through the use of appropriate instructional strategy (Ibrahim 2006).
- Chemistry contributes towards providing our basic needs and improving the quality of our lives in the following areas;

a. Agriculture: The production of different type of fertilizers and insecticides has been possible by chemical means, these increases food production greatly. The preservation and storage of food for long period of time is made possible as a result of chemical process, so that food can be stored and exported to a distance place and made available for more people (Olatoye & Affuwape 2004).

b. Health: The variety of medicine that is available are result of advance chemical researches in chemistry, this researches are financed by pharmaceutical firms, governmental and non-governmental organisation and conducted by chemist.
c. Education: Teaching service laboratory assistants/technicians, teachers and lecturers in secondary and tertiary institutions are always of increasing demand; career in chemistry can help you to get employed in these fields (Mohammed, 2007).

The teaching and learning chemistry in Nigerian secondary school is guided by a curriculum and curriculum innovations in chemistry

Curriculum is a plan for ordering and directing the teaching-learning experiences that students encounter in an educational institution. The process of providing the plan and keeping it running smoothly is known as curriculum development. Curriculum development is the more comprehensive term, which includes planning (determination of aims and goals), design, implementation and evaluation (Shaibu, 2012).

Obeka (2013) observed that curriculum innovation and innovative teaching strategies are further steps towards access and quality education in Nigeria (Anthony, (2004) opined that every school curriculum must be learner-centred and leaner's friendly, in developing the course content of a learner-centred curriculum special consideration must be given to course content, student activities, method of evaluation, learners abilities, aptitude, interest and motivation levels.

Therefore, any meaningful curriculum innovation or strategy that is planned and implemented must address the following issues: The underlying philosophy and goals, Work plans, New and relevant topics, teaching method, inclusion of psychological, mental and socio-technical background. Others are budgetary consideration for curriculum and innovative teaching method, instructional resources, sources of content / topic whom the curriculum and innovative strategy is meant and expert validation advice (Obeka, 2013)

Gilbert (2006) observed that curriculum innovation requires a professional development programme that actively engages teachers in the design of new context-based units. Science curriculum innovations generally also require changes in pedagogy. Over the years, several context-based courses were developed to motivate students for school chemistry and to induce a ‘need to know’ among students, which is a need for chemistry knowledge justifying the chemistry concepts to be learned

Mbajiorgu & Reid (2006) Stated that curriculum innovation in chemistry attempts to bring together the outcomes from the research evidence to offer a set of specific guidelines for chemistry curriculum construction. The aims include:

- To develop a chemistry curriculum which will meet the needs of learners and societal demands
- To develop a curriculum which is a sound reflection of the nature and methods of chemistry as a discipline, with its important place in a modern society
- To develop not only an informed population but also one which has developed informed attitudes relating to the study of chemistry and its practical implications for society.

Thus the chemistry curriculum at school level should:

- be designed to meet the needs of the majority of students who will become chemists (or even scientists), seeking to educate through chemistry as well as in chemistry;
- be strongly ‘applications-led’ in its construction, the applications being related to the lifestyle of the students and being used to define the curriculum: fundamentally, the content is determined not by the logic of chemistry but by the needs of students;
- reflect attempts to answer questions like: what are the questions that chemistry asks? How does chemistry obtain its answers? How does this chemistry relate to life?
- not be too ‘content-laden’, so that there is adequate time to pursue misconceptions, to aim at deep understanding of ideas rather than content coverage, and to develop the appreciation of chemistry as a major influence on lifestyle and social progress; avoid using analogies or models (or multiple models) in a way which causes information overload;
- not introduce sub-micro and symbolic ideas too soon or too rapidly; avoid developing topics with high information demand before the underpinning ideas are adequately established to overload and confusion;
- be set in language which is accessible to the students, avoiding the use of unnecessary jargon and offering careful clarification of words where the normal contextual meaning can cause confusion;
- be couched in terms of aims which seek to develop conceptual understanding rather than recall of information, being aware of likely alternative conceptions and misconceptions;

- offer experiences of graded problem solving situations starting from the more algorithmic and moving on to the more open-ended;

  Involve laboratory work with very clear aims: these should emphasise the role of laboratory work in making chemistry real as well as developing (or challenging) ideas rather than a focus on practical hands-on skills; laboratory work should offer opportunities for genuine problem solving;
- require assessment which is integrated into the curriculum and reflects curriculum purpose, is formative as well as summative and aims to give credit for understanding rather than recall, for thinking rather than memorisation.

As an extra, the curriculum should be taught by teachers who are qualified as chemists and are committed to the place of the discipline in its social context. This is an important factor in the developing of a soundly taught pupil population with positive attitudes towards chemistry. This has manpower and resource implications as well as implications for pre-service and in-service support (Mbajiorgu & Reid 2006).

2.4 Electrolysis Concept of Chemistry

Electrolysis is the chemical decomposition of compound by direct current passing through either a solution of the compound or the molten state (Ababio, 2011). Electrolysis also dealt with the study of the inter-conversion of electrical and chemical energy which involves many examples of chemical observations, chemical reactions and symbols (Garnet & Treagust, 1992).

However, many studies on electrolysis focus more on the student perception of selected chemistry concepts, while others on comparing the chemical reactions in the electrolytic cell with the voltaic cell (Garnet & Treagust, 1992, Sanger & Greenbowe, 1997). Thus, students need to be taught very well in order to understand and appreciate the structure, chemical processes and reactions of electrolysis concepts. Also, students often find it difficult to relate macroscopic observation with sub-microscopic entities, and cannot represent the chemical changes and reactions using symbolic entities (e.g. half cell equation). Thus, teaching should be designed to improve the students' understanding of these aspects in particular.

Mustapha (2001) conducted study on students' perception of selected chemistry concepts in Taraba state using the sample of One hundred and four SSII science students randomly selected from five different schools that offer chemistry in Taraba state A 34-item researcher design questionnaire which is an adaptation of 5 – point Likert scale was administered to respondents. Mean, Standard deviation and variance statistics were used to analyze the data collected. The findings showed that electrolysis is the most difficult concept in chemistry the difficulties are attributed to lack of appropriate instructional strategies, Teacher's professional qualification area of specialization influenced their difficulties to understand the concepts of electrolysis

Nneji (1998) conducted study on perception of difficult topics in applied electricity. Two hundred (200) SS III students, 10 teachers and 5 WAEC examiners in the subject constituted the sample. A-21 item applied electricity topics questionnaire were administered to respondents. Mean, percentage and standard deviation statistics were used to analyze the data collected. Findings revealed that students and examiners perceived 7 topics as difficult, while teachers perceived 8 topics as difficult in applied electricity. The study also showed that inadequacy of teaching materials, textbooks, poor student-teacher mathematics ability were variables responsible for perceived difficulties.

Adewumi & Akinniyi (2010) investigated the effects of guided inquiry on secondary school students' performance in electrochemistry. They used a quasi experimental design. Their sample for the study covered 90 (SS II) students in Kogi State. The students' were pre-tested and Posttested, Analysis of Covariance (ANCOVA) was used for data analysis. The findings of their study showed that the performance of students exposed to guided discovery were better than their counterparts exposed to the lecture method.

Aderogba, & Aanu, (2011) investigated the main and interaction effects of co-operative and individualized teaching methods on senior secondary school students' achievement in electrochemistry using gender and self-concept as moderating variables. This study employed 3x2x2 randomized pre-test, post-test quasi-experimental factorial design. The experimental groups were exposed to co-operative and individualized teaching methods and control group was exposed to traditional teaching methods. One hundred and fifty-six (156) students formed the sample of the study. Results of their studies revealed that there is significant main effect of treatment on students' achievement in electrochemistry. This shows that the treatment is effective in enhancing student achievement in electrochemistry. However, the interaction effect of treatment, gender and self-concept on students' achievement in electrochemistry is not significant. However, in this study computer assisted instruction were used as a treatment for experimental group to examine student's academic achievement, retention and attitude of chemistry students exposed to electrolysis concept.

2.5 Methods of Teaching Chemistry

Teaching method is very important in the impartation of knowledge in teaching-learning processes and the type adopted determines to a great extent what the students' assimilate. Scholars (Dienye & Gbamanja 1990: Atadoga & Onaolapo

2008; Usman, 2010 ; Obeka, 2010; Abdulkarim & Lawal, 2012; Olorukooba, Lawal and Jiya, 2012) opined that there have been a variety of methods and techniques for teaching science, and each of them provides is associated with a number of advantages and disadvantages. These methods and approaches include: lecture method, inquiry method, laboratory technique, demonstration, discussion method, project method, activity method, simulation method, and fieldtrip method, co-operative learning method, guided discovery method, Concept Mapping among others.

2.5.1 Lecture Instructional Method

Lecture Method is a teaching technique in which one person, usually the teacher, presents a spoken discourse on a particular subject (Dienye and Gbamanja, 1990 in Atadoga and Onaolapo 2008). Lecture is used for elaborating; simplifying, clarifying and discussing new materials to learners the material may include facts or views on issues and problem to relate to the learners which provide an aesthetically stimulating experience. Effectiveness of Lecture Method depends on the type of students, circumstances of the class, the subject, educational purposes and teachers own characteristic and skills (Abdullahi, 1982). At least eighty percent (80%) of scientific information or principle are passed on the students through Lecture Method (Atadoga & Onaolapo, 2008).

According to Paul & Dantani (2012), a lecture can be an effective method for communicating theories, ideas, and facts to students. The primary aim of lecturers is to make sure that they communicate effectively with their students. In order to do so, a lecturer should try to achieve clarity of delivery, clarity of expression and clarity of structure. Further stated that many teachers use this teaching method almost exclusively, as it is considered the simplest, and one can cover large amounts of material in a short period of time. However, this is not the most effective teaching method to teach all students, especially younger ones, who often need a more engaging, hands-on strategy in order to learn effectively.

According to Dienye and Gbamanja (1990), many teachers have accepted Lecture Method as a way of imparting a body of knowledge since our educational system puts so much premium on external examinations. Lecture Method helps a science teacher covers large amount of material (syllabus) to a large class size within short period of time. This is however, detriment to students learning, but the teacher may not have choice being driven by the pressure to cover the syllabus and thus prepare students for the external examination which is only qualifying measure to the next level or employment. However, Atadoga & Onaolapo (2008) observed that there are basic problems common to Lecture Method and this are: The teacher disposition, Communication problems, and the preparation, organisation and presentation

The Teacher disposition; Since the Lecture Method places the teacher as the authority of the subject matter and the controller of students' behaviour, the communication is only one way. The students have limited opportunities to express their problems conflicts, needs among others, It is difficult to know if the teacher is being understood, there is little chance of correcting students' misgivings and thus students are alienated.

Communication problems; Delivery is the personal problem in a Lecture Method and with individual differences; it's difficult to recommend some particular techniques as the most effective. For effective teaching and learning, good communication must be maintained between the teacher and the students. This will include clarity of voice, simple and understandable language style, monitoring the students by regularly pausing to explain and ask questions.

The preparation, organisation and presentation; Clear aims and objective of the course and the students previous knowledge will enhance good preparation, lecture material should be put together a head of the class, updating it is necessary. Inadequate or lack of preparation will surely affect the organisation and subsequent delivery of the subject matter. The teachers' presentations should be such as will aid students to develop and maintain interest in the course.

Advantages of Lecture Method

- It saves time and energy. It is not expensive as only the chalkboard and chalks are required.
- Good command of English and boldness saves the teacher alot of the challenges in the class.
- It offers easy coverage of syllabus and faster dissemination of scientific information and facts
- It allows easy handling of large classes without much stress.

Disadvantages of Lecture Method

- Meaningful learning of science is never promoted as it appeals to only the sense of hearing.
- The different ability groups present in any given class are not taking care of. Those students who will learn better by handling and manipulating of objects are completely left out. This can be frustrating for this group of students.

- It is stressful for student to sit still for a long time at once listening and writing. it can lead to restlessness and disruptions of normal class procedures.
- Talk and chalk (lecture) method encourages only rote learning without necessarily aiding understanding.

However, in order to improve lecture method, Atadoga and Onaolapo (2008) went further Suggested that For effectiveness, there must be loud and clear pronunciation of every word the teacher must be audible for all students; the teacher's position should be at a point in the class where the entire student can see his/her face watching the teacher expression and behaviour can help understanding of the students; Lectures should not just be verbal presentation of facts, student should be involved by regularly asking them question which will provoke critical thinking; Lecture should be used to develop scientific concepts principle and generalisations, not just present scientific facts; and; Lecture Method as much as possible should be continued with other method like demonstration, discussion, and overhead projectors can also be use to highlight important point procedure.

2.5.2 Computer-Assisted Instruction (CAI) In Teaching Chemistry

Computer asisted instruction is an application of computer software package in instructional process it is the integration of hardware and software (Asultant & Abdullahi, 2006). Thus computer asisted instruction package represent some aspect of reality that one is unable to present directly to the learners. Becouse it present images, sound and action. In using computer assisted instruction student learn faster by seeing, observing and hearing sound. According to Nsofor and Nasiru (2013) any instructional process which evokes the involvement of as many of human sensory organ tend to facilitate the permanency in learning and meaninful learning will be achieved, the use of computers as observed by Yusuf (2005) dominated human activities especially in the last two decades. Its use is complemented by a whole lot of other electronic devices, all of which are now collectively regarded as Information and Communication Technology (ICT). Computer is an electronic device used for storing, processing, and retrieving information at high speed and accuracy. The global adoption of the computer has been the landmark of the educational system for the last two decades. The adoption of the computer into education in Nigeria has often been premised on the potential of this 'new' technological tool to revolutionalize an out-model educational system, to enhance teaching and learning processes, and to achieve the aims of the national objectives of teaching science.

However, Reid (2008) stated that Computer-Assisted Instruction is relatively new educational innovation. It is used in primary, secondary and tertiary levels. Computer-Assisted Instruction (CAI) is a powerful combination of early technologies' that constitutes an extraordinary advancement in the capability of machine to assists the educational process. Computer-Assisted Instruction combines computer hard ware, software and peripheral equipment to provide a rich mixture of text, graphics, sound, animation, simulations, and full-motion video and other devices to convey information to the students effectively. However, students take an active role in learning processes and much more attentive to programmes where animations and narratives are used (Albirini, 2006).

Kingsley (2009) asserted that, Computer-Assisted Instruction (CAI) plays an important role in contemporary teaching and learning of science concepts. Thus, effective use of computers in science classroom needs to be developed. Computers can be used as a supplementary tool in order to reach educational goals. Many science teachers, researchers and other educators have recommended using (CAI) in science classrooms. Some researchers argued that students' achievement increases with the use of computers in science education. In addition, it is reported that students' abilities and skills in scientific investigations are affected positively by Computer-Assisted Instruction (CAI).

Kulik & Kulik (1991) stated that the use of computers makes students feel confident and helps them to discover interactions among the components of a complex system. Reid (2008) asserted that Computer Aided Instruction (CAI) when used to complement the conventional teaching method would encourage chemistry teaching and learning. They concluded by stating that chemistry teaching should be advantageously innovated by the use of the computer in association with practical experiment. According to Kulik & Kulik (1991) computer assisted instruction (CAI) can be used to simulate practical experiments in chemistry, and it has been found to be educationally effective.

Kolawale & Abiodun (2011) investigated the effects of computer assisted instruction (CAI) on secondary school students' performance in chemical bonding concept of chemistry. They used a quasi experimental design their sample for the study covered 150 (SS II) in Osun State, Nigeria. The students' were pre-tested and Posttested, Analysis of Covariance (ANCOVA) was used for data analysis. The findings of their study showed that the performance of students exposed to computer assisted instruction CAI were better than their counterparts exposed to the conventional classroom instruction

Kausar & Ahmed (2008) investigated the effectiveness of computer assisted instruction and lecture instructional method for computer science. The objectives were to compare the learning effects of two groups with class room lecture and computer assisted instruction studying the same curriculum and the effects of computer assisted instruction (CAI) and classroom lecture (CRL) in terms of cognitive development. Their research was based on six levels of blooms taxonomy. The sample for the study covered 140 (SS II) in Lagos State Nigeria, they used quasi experimental Pre-test - Posttest Equivalent groups Deign. Their Findings indicate that total gain in cognitive domain by (CAI) was significantly superior to the total gain in cognitive domain by classroom lecture (CRL) teaching method. This study concluded that the skills of knowledge, analysis and synthesis assured significant increase. The (CAI) proved to be very much effective in increasing the evaluation and application skills of students to experimental group. Comprehension skill, however, not much affected by the computer assisted instruction (CAI). According to the results of this study it was suggested that (CAI) as an effective teaching method should be applied to improve teaching quality and by using (CAI) it will be possible to eliminate lingual, regional and ethical biases between teacher and students.

Ertepmar (1995) compared the effects of the two different teaching methods involving logical thinking skills, Computer-Assisted Instruction and students' portfolios on the achievements of high school chemistry students. The results of the study showed that the application with two methods and the logical thinking skills of the students had a significant contribution to the achievement of the students in chemistry.

A particular active area of research for remedying students' difficulties in learning is electrolysis concept of chemistry. And is one of the most important topics in secondary school chemistry curriculum that students often find difficult to understand. Studies show that the students in all levels do not learn electrolysis with traditional teaching methods as expected. This suggests that alternative teaching methods are required to remedy the problem (Bayraktar, 2010).

However, in this study computer assisted instruction was used as a treatment for experimental group to examine students' academic achievement, retention and attitude of students towards electrolysis concept of chemistry.

2.6 Factors Affecting Academic Achievements in Chemistry

Academic achievements in chemistry is an indication of the types of learning and its environment in a teaching and learning process many research work have been carried out in chemistry that identified factors that affect students academic achievement in chemistry. These factors ranged from class size, practical equipments, laboratories, instructional strategies, textbooks, guidance and counselling services, academic and professional qualification of teachers in science are also among the variables that affect students' academic achievement in chemistry and in general science science (Abdullah, 1982; Oloyede, 2013).

Ajewole, Ajebasile and Okebukola (2000) reiterated that the quality of any educational programme is a function of the quality of those who teach it. They observed that teacher's effectiveness is measured by how successful a teacher can impart knowledge and how much the students achieve. They therefore, suggested that the education of science teachers should be strethened in the field of subject methodology.

Akin (2008) also stated that any performance that expects excellence and high achievement requires qualified and committed teachers. And he suggested some factors that contribute to the level of students academic achievement in chemistry is class size which he saw as a problem in the teaching of science especially in chemistry. Most of the Nigerian secondary school are having 55- 65 students in a class thus, place limits on the provision of facilities for the effective teaching of science and also lower the students-teacher ratio every year, teacher cannot interact with many students and at the same time diagnose their difficulties more easily, in addition to managing the limited material resources available in the laboratory for the large number of students

Ayodele (1999) went further to talk about the approaches to science teacher which he emphasis on the method used by teacher in science teaching. He said that the ultimate aim of curriculum innovation and improvement effort is to implement and disseminate the innovation to the users. Namely, the teacher and students however given the emphasis placed on educational change. It is necessary to re-examine the potential factors that can affect the effectiveness (acceptability and favourable student's outcomes) of innovative science curricular of educational programme. Such factors could provide the necessary re-orientation for an intelligent approach to the task of improving and implementing curriculum in science teaching and also reduce possible waste; researchers found that the persistent low academic achievement in science subjects is attributed to instructional strategies among others. Every child is born with certain potential in him and under conducive and enabling environment with relevant and appropriate instructional strategies, the tendency for their realisation and high academic achievement is high (Atadoga & Lakpini, 2013).

Shaibu (2000) noted that in classroom practice, a science teacher needs the used of one or more philosophy of science and that the basic ingredient of philosophical basis of science teaching in this respect can be broadly viewed along this dimension, that is teacher understanding of the meaning and nature of science. He explained further that the meaningful teaching of science is partly based on a clear understanding of the meaning and nature of science the teacher have, as effective teaching involve interaction between teacher and the subject through both in the practical and theoretical context.

Ayodele (1999) also noted student's negative attitude toward science learning affect their academic achievements. He said that some of the things we teach in science have no bearing in their practical life or their own goals and that career incentives and opportunities are not provided for students to appreciate the role of scientist, which can lead to variations in goals between pupil's parent and industries. However in this study academic achievements were used as a variable. Teaching using computer-Assisted-Instruction was used as treatment which was measured with the aid of achievement test called electrolysis concept achievement test (ECAT).

2.7 Gender and Academic Achievement in Chemistry

The concept of "Gender" in teaching and learning process has attracted the attention of many researchers. Several studies have also examined the influence of gender on students' academic achievement. For example, Olatoye and Adekoya (2010) found no gender difference in academic achievement of students exposed to different teaching strategies in science. Okebukola (1985) found no gender difference in academic achievement in cooperative and competitive learning groups. However, Oyedeji (1991) reported the significant influence of gender on academic achievement with boys having better scores than girls in the study.

On the issue of gender, Ogunkola (1999) and Usman, (2007) found out from their various studies that, boys perform well in any rigorous work while girl shows to settle for less rigorous work. Mari (1994) and Bichi (2008) in their separate studies believed that girls perform better than boys in problem solving type of activities. In another dimension, if boys and girls are giving the equal opportunities, they will perform equally well (Yoloye 2004 & Nworgun, 2005). The issue of gender in science teaching seems to be a controversial. The differences in the scholastic achievements of boys and girls are generally attributed to biological causes, cultural and stereotypes (Nworgun, 2005). The last two decades have been devoted to addressing gender inequality in education. Some studies have shown an all time low participation of women in education. Researchers have therefore expended tremendous efforts in the study of the personal factors affecting academic achievement especially in the sciences and social sciences. Notable among these variables is the study of the phenomenon of gender or sex equity in education.

Okebukola (1993) coined that a rich harvest of explanation of causes, understanding of cost to the society and possible intervention have brought about several researches, workshops, seminars and training in this area. In Nigeria, gender issues abound in all spheres of the society. The educational conditions of the girl-child vis-à-vis the boy-child constitute an important gender issue. In our cultural setting, the cultural and traditional responsibilities of men and women are different; hence the influences in the upbringing of the female child and male child.

However, this study is particularly interested in determining the effectiveness of Computer-Assisted Instruction on gender when taught Electrolysis concept of chemistry.

2.8 Retention and Academic Achievement in Chemistry

Retention means storage of information over some period of time; this time period is called retention interval (Bichi, 2002). If for some reason, the subject is unable to produce the response at the end of the retention interval, forgetting has accured. The more active the learner is in the learning process the better he/she retains what is taught (Paul, 1999).

According to Caplan (1973) Retention is the ability to retain and consequently remember things experience or learned by the individual at a later time. It takes place when learning is coded into memory. Thus appropriate coding of incoming information provides the index that may be consulted so that retention takes place without an elaborate search in the memory lane. The nature of the material to be coded contributes to the level of retention. Material are related to the quality of retention in terms of their meaningfulness, familiarity, concreteness and image evolving characteristics (Adeniyi 1997)

Retention works together with academic achievements, Retention which is the ability to retain things experienced or learned, has an area of focus to some science educators in recent years. Several factors are known to influence retention.

Bichi (2002), Reports that anything aids learning should improved retention while things that course confusion or interference among learned materials decrease the speed of efficiency of learning and accelerate forgetting. Retention level in relation to age has been investigated by several researchers. Jimerson Carlson, Robert, England and Shroufe (1997) reported that retention increases from infancy throughout the teenage years followed by a slow recession in middle age. Studies on retention and instructional strategy have attracted the attention of many researchers in recent years for instance, Olourukoba, lawal and Jiya (2012) investigated the effect of the use of analogy teaching strategy on academic performance and retention in evolution concepts among NCE biology students' teachers on training in the college of education in Niger state. Analysis of the result showed a significant difference between the analogy teaching strategy and Lecture method post post-test score in favour of analogy teaching strategy it follows that the analogy teaching strategy enable students to have a better understanding of concepts taught and retain more knowledge of evolution concepts than the lecture method.

Maikano (2007) compares the effectiveness of outdoor laboratory teaching method and the indoor laboratory method with reference to achievements and retention and attitude. He found that students exposed to outdoor laboratory teaching method have higher cognitive achievements, more positive attitude and higher retention level than their counterparts' taught using the indoor laboratory teaching method.

A large proportion of the literature reviewed showed that emphasis in science education is no longer on the transmission of factual knowledge, but on teaching students how to learn. According to Anderson, (1970), the introduction of inquiry based programme into schools prompted the teaching of science through inquiry approach, by this approach; students were expected to acquire scientific knowledge through the scientific process of observing, comparing, classifying, experimenting communicating and inferring as they try to find things for themselves.

McCoy and Raynolds (1992) also opined that retention can hardly be exact even in the rudimentary case of rote learning the problem therefore. Is how to maximise the level of retention and future recall of what is learned. This is issue of retention cannot be well address until one has insight into the factor contributing to retention. In essence, any form of learning that encourages rote-learning, cramming and regurgitation and memorization should be minimised or eliminated, and this will usher us in new ways of learning for retention of facts.

Permanent and meaningful learning is the ultimate target of our educational endeavour. Understanding and retention are products of meaningful learning when teaching is effective and meaningful to the students, (Bichi, 2002). However this study seeks to examine how Computer-Assisted Instruction and lecture methods affect students' retention ability when taught Electrolysis concept of chemistry.

2.9 Attitude and Academic Achivement in chemistry

According to Adey & Shayer (2001), attitudes have been described as comprising cognitive, affective and behavioural components. Once an attitude has been established it tends to be stable over time. Technically, there is a difference between attitude and other affective concepts such as interest and motivation, Attitudes have been demonstrated to influence and be influenced by academic achievement and by cognition respectively (Bologun, 1985).

For the present study, the term attitude is used to refer to ones feelings thought and predisposition to behave or respond to in some particular manner. According to Mukherje (1978), attitudes are best expressed when individuals makes statement about their feelings or opinion. The study of student's attitude to learning and instruction is important. Bologun (1985) asserted that the possession of a favourable attitude towards science is an important characteristic of scientifically literate person. She also found out from her study that attitude was significantly related to academic achievements in science, even when ability was taken to consideration.

Studies by Brown (1991) and Anderson (1990) have shown that students attitude toward science seems to improve through the use of some instructional procedure and models. This support Nwagbo (1999) assertion that attitude may be modified by instruction. This means that the method of instruction could affect performance and attitude as well. Bennett, Rollnick, Green and White, (2001) stated that researchers demonstrate that there is a link between the cognitive and affective domain. Therefore, chemistry education goals should embrace the two and not treat them as mutually exclusive domains. The implication is that attitudes can be developed and much of the studies in literature indicates that the approach to presentation and organisation of the curriculum goes a long way to determining the development of desired attitudes in students. There are four areas where attitudes are important:

- Attitudes towards chemistry;
- Attitudes towards topics and themes in chemistry;
- Attitudes towards the learning of chemistry;
- Scientific attitudes.

Zacharia (2005) stated that much research has shown clearly that a negative attitude towards chemistry is the dominant factor affecting students' willingness to study chemistry further. Based on social psychological models, it has been shown that attitudes towards topics and themes in chemistry are developed by means of interactive teaching materials (teaching materials where the learners have to cognitively relate new input to previously held attitudes. (Bennett, Rollnick, Green and White 2001). However, it is against this background that this study seeks to determine whether Computer-Assisted Instruction can be used to improve student's attitude towards electrolysis concept.

2.10 Overview of Similar Studies

In Computer-Assisted Instruction literature, there have been numerous studies on the use of computers in science education (Geban, 1992: Windschitl & Andre, 1998: Kausar and Ahmed 2008 ; Kolawale & Abiodun 2011). Such studies suggest that the use of computer is successful in improving students' academic achievements, promoting positive attitude of students toward science and in particular that students' motivation is enhanced by cooperative learning involving student-computer interactions. According to Zacharia (2005) computer-assisted curricula also provide opportunities for inquiry-based approaches to the teaching of chemistry, and it seems they discourage rote memorization and algorithmic problem-solving while encouraging conceptual understanding and critical thinking (Garnett & Kenneth, 1988). For this reason, many researchers now advocate the use of computers in chemistry classrooms and computer-assisted learning environments attempt to make explicit the information embedded in traditional molecular representations as well as to provide a visual representation of molecular interactions for students. In this way, students can learn chemistry by viewing molecular animations. Such an approach is in contrast to traditional chemistry lectures that rely almost entirely on verbal explanation of concepts meaning students have little opportunity to observe molecular interactions (Stieff & Wilensky, 2003).

Bolaji (2005) under took a study on effectiveness of computer- assisted instruction in teaching introductory statistics. The researcher used quasi-experimental design and his sample population covered 205 students. After analysis with t-test, the results of finding shows that students taught with computer assisted instruction performed significantly better than lecture group. In another study Yusuf & Afolabi (2010) investigated the effects of computer assisted instruction (CAI) on secondary school students' performance in biology. The researchers used gender as variable. Quasi-experimental involving 3 x 2 factorial design were used in the study. Their sample for the study covered 120 (SSS I) in Oyo State, Nigeria. The students were pre-tested and Posttested, and Analysis of Covariance (ANCOVA) was used for data analysis. The findings of their study showed that the performance of students exposed to CAI either individually or cooperatively were better than their counterparts exposed to the conventional classroom instruction. However, no significant difference existed in the performance of male and female students exposed to computer assisted instruction (CAI) in either individual or cooperative settings.

Akcay and Unal, (2009) compared the effect of computer assisted instruction on the learning of black body, Compton, x-rays topics by pre-service science teachers with the method of traditional teaching. Their sample covered 70 students from two different classes. t-test was used for data analysis. The time extent covered a period of two weeks. Computer assisted instruction (CAI) was used in experimental treatment while the instruction of same subjects in control group was performed by using a traditional instruction method. The result of their study showed that students taught with Computer assisted instruction performed higher than those in traditional teaching group ($p<0.05$). This study is not in Nigeria and covered within two weeks only. The present study therefore is set to compare computer assisted instruction (CAI) and Lecture Method in Nigerian secondary schools covering a period of six weeks.

2.11 Implication of the Literature Reviewed for the Present Study

Researchers (Garnett & Treagust 1992; Odubunmi, 1997; Keshinro, 1998; Thompson & Soyibo 2002; Olaleye, 2005; Oloyede, 2013) revealed that students in Nigerian secondary schools have difficulties in learning abstract concepts of chemistry such as radioactivity, mole concept, stoichiometry and electrolysis thus students found the subject boring. To ensure meaningful learning and therefore, improve academic achievement and retention, several and specific instructional strategies that are suitable to bring readiness to the problem have been found in the literature. One of such instructional strategies that is gradually gaining research attention of recent time, is Computer-Assisted Instruction for students learning scientific abstract concepts. From the literature cited, most of the studies carried out, were using different concepts, different instructional strategies, and different study area. A similar study is hereby being undertaken on the Electrolysis concept of chemistry to find out the relative effectiveness of Computer-Assisted Instruction on students' academic achievement, retention and attitude in electrolysis concept among senior secondary school students in Kankia education zone, Katsina state-Nigeria.

CHAPTER THREE

METHODOLOGY

3.1. Introduction

This study investigated the relative effectiveness of Computer-Assisted Instruction on students' academic achievements, retention and attitude in electrolysis concepts among senior secondary school students in Kankia education zone, Katsina state-Nigeria. In chapter two, an attempt was made to review the literature that is relevant to the study. In this chapter the methodology of the study is presented under the following sub-headings:

- Research Design
- Population of the Study
- Sample and Sampling Technique
- Instrumentation
- Validity of The Research Instruments
- Pilot Testing
- Reliability of The Research instruments
- Administration of the Treatment
- Data Collection Procedure
- Data Analysis

3.2 Research Design

The study utilized quasi experimental and control groups design involving pretest, posttest and postpost-test. This is made of two groups; experimental and control. The Experimental Group (EG) were exposed to Computer-Assisted Instruction and the Control Group (CG) were exposed to lecture method. A pretest (O_1) was administered to the two groups to determine the equivalence of performance of students prior to the treatment. This is followed by a posttest (O_2) which was administered after the treatment for a period of six weeks to determine the relative effectiveness of Computer-Assisted Instruction on students' academic achievements in electrolysis concepts. After an interval of two weeks of the post-test, postpost-test (O_3) was administered to students to determine retention ability in both groups. The illustration of the research design can be presented in figure 3.1.

$$EG \rightarrow O_1 \rightarrow X_1 \rightarrow O_2 \rightarrow O_3$$

$$CG \rightarrow O_1 \rightarrow X_0 \rightarrow O_2 \rightarrow O_3$$

Source: Adapted from (kerlinger 1973).

Figure: 3.1 Schematic Illustrations of the Research Design

KEY

EG= Experimental group

CG=Control group

X_1= Teaching using Computer-Assisted Instruction (treatment)

X_0=Teaching using conventional Lecture Method only (no treatment).

O_1= Pretest

O_2= Posttest

O_3= Postpost-test

3.3 Population of the study

The population of this study covered all senior secondary year two (SSII) students studying chemistry as a subject in the eight public senior secondary schools of Kankia Education Zone. There is total number of one thousand and eight (1008) senior secondary schools students in these schools as presented in the following table.

Table 3.1 **Population of the Study**

S/N School	Type of school	Boys	Girl's	Total
1. Govt. Day Secondary School Kankia	Day/Boys	115	0	115
2. Govt. Girls Secondary School Kankia	Day/Girls	0	108	108
3. Govt. Secondary School Kanti Kankia	Day/Boys	112	0	112
4. Govt. Secondary School Kafinsoli	Day/Co-ed	71	55	126
5. Govt. Pilot Secondary School Musawa	Day/Co-ed	107	66	173
6. Govt. Day Secondary School Matazu	Day/Co-ed	79	54	133
7. Govt. Day Secondary School Rimaye	Day/Co-ed	68	49	117
8. Government Secondary School, Ingawa	Day/Co-ed	76	48	124
Total		**628**	**380**	**1008**

Source: (Katsina State Ministry of Education, 2014).

3.4 Sample and Sampling technique

The sample of this study involved 123 (SS II) chemistry students selected from two public co-educational secondary schools in the study area. This is in line with the central limit theorem that recommended minimum of 30 subjects as adequate sample size for experimental study of this nature (Kerlinger 1973 & Sambo 2008). In selecting the sample for the study, four out of the eight schools namely, Government Secondary School, Kankia, Govt. Day Secondary School Kafinsoli, Government Secondary School, Ingawa, Govt. Secondary School Rimaye were randomly selected and pretested to select schools that are not different significantly in terms of their academic achievement. Their scores data obtained were subjected to data analysis using Analysis of variance (ANOVA), and Scheffe's post-hoc test. Two schools were found not significantly different in terms of their mean scores. Simple random sampling technique involving balloting without replacement was used in assigning the schools into experimental and control condition. However, in selecting students' sample, intact classes were used for experimental and control groups.

Table 3.2 Sampled Schools for the Study

S/N Name of school	Group	Males	Females	Total
1. Government Secondary School, Rimaye	Experimental	37	22	59
2. Government Secondary School, Kafinsoli.	Control	41	23	64
Total		78	45	123

3.5. Instrumentation

Two research instruments were developed by the researcher and used for this study. These are:

1. Electrolysis concepts Achievement Test (ECAT)
2. Students 'Attitude towards Electrolysis Questionnaire (SATEQ)

3.5.1 Electrolysis concepts Achievement Test (ECAT)

Electrolysis concepts Achievement Test (ECAT) is an instrument developed by the researcher consisting of 50 objective test items using content on electrolysis concepts. This topic is derived from the National Curriculum for senior secondary school chemistry and it was selected because it features in (SSII) chemistry curriculum. It was used to determine the achievement of students in electrolysis concepts of chemistry. It was also used in determining students' retention ability. The instrument was developed using six levels of mental processes of the cognitive domain as outline by Bloom. The test blue print adopted from bloom's taxonomy of educational objectives covered knowledge, comprehension, application, synthesis, analysis and evaluation respectively. Details of test blue print were shown in the table of specification for electrolysis concepts achievement test construction and table of topics and questions distribution according to cognitive levels below.

Table: 3.3 Table of specifications for Electrolysis concepts Achievement Test (ECAT) Construction.

Content	Weight **(100 %)**	Know. **(33%)**	Comp. **(22%)**	Appl. **(15%)**	Anal. **(10%)**	Synth. **(10%)**.	Eval. . **(10%)**	Total. **(100%)**
1. Definition of the concept of electrolysis and identification electrodes, cations and Anions	**(18%)**	**3**	**2**	**2**	**1**	**1**	**1**	**10**
2. Concept of ionic theory, electrolytic reactions and preferential discharge of ions	**(16%)**	**2**	**2**	**1**	**1**	**1**	**1**	**8**
3. Mechanism of electrolysis, movement and transfer of ions towards positive or negative electrodes	**(16%)**	**2**	**2**	**1**	**1**	**1**	**1**	**8**
4. Uses of Electrolysis, and Electrolysis of Dilute hydrogen tetraoxosulphate (iv) acid	**(20%)**	**2**	**2**	**3**	**2**	**2**	**1**	**12**
5. Faradays laws of electrolysis with calculation work examples	**(15%)**	**1**	**1**	**1**	**1**	**1**	**1**	**6**
6 Electrical Conductivity, Electroplating, Standard Electrons potentials, Daniel cell and lead Accumulator.	**(15%)**	**1**	**1**	**1**	**1**	**1**	**1**	**6**
TOTAL	**(100%)**	**11**	**10**	**9**	**7**	**7**	**6**	**50**

Source: adapted from Bloom et al.'s taxonomy of the cognitive domain. (1956).

Table: 3.4 Topics and Questions Distribution According to Cognitive Levels in Blooms Taxonomy of Educational Objectives.

Content	Weight **(100 %)**	Know. **(33%)**	Comp. **(22%)**	Appl. **(15%)**	Anal. **(10%)**	Synth. **(10%)**.	Eval. . **(10%)**	Total. **(100%)**
1. Definition of the concept of electrolysis and identification electrodes, cations and Anions	**(18%)**	**1,2,4**	**10,11**	**5,9**	**6**	**3**	**8**	**(10)**
2. Concept of ionic theory, electrolytic reactions and preferential discharge of ions	**(16%)**	**12,16**	**24,38**	**18**	**25**	**20**	**15**	**(8)**
3. Mechanism of electrolysis, movement and transfer of ions towards positive or negative electrodes	**(16%)**	**23,26**	**49,29**	**32**	**14**	**7**	**29**	**(8)**
4. Uses of Electrolysis, and Electrolysis of Dilute hydrogen tetraoxosulphate (iv) acid	**(20%)**	**30,36**	**33,31**	**35,42,19**	**21.34**	**39,12**	**41**	**(12)**
5. Faradays laws of electrolysis with calculation work examples	**(15%)**	**41**	**44**	**43**	**50**	**37**	**40**	**(6)**
6 Electrical Conductivity, Electroplating, Standard Electrons potentials, Daniel cell and lead Accumulator.	**(15%)**	**47**	**48**	**46**	**22**	**17**	**45**	**(6)**
TOTAL	**(100%)**	**11**	**10**	**9**	**7**	**7**	**6**	**50**

Source: adapted from Bloom et al.'s taxonomy of the cognitive domain. (1956).

3.5.2 Students 'Attitude towards Electrolysis Questionnaire (SATEQ).

This include 20 items attitude questionnaire developed by the researcher to determine the attitude of students towards electrolysis concepts the development of the items focus attention on Likert 5- point rating scale. The rating of the 5-points Likert scale (Likert, 1973) is as follows:

Strongly Agreed (SA) 5

Agreed (A) 4

Undecided (UD) 3

Disagreed (D)   2

Strongly Disagree (SD)   1

The highest score is 100, the lowest score is 20 and the average score is 50. Scores below 50 were considered as negative attitude while score of 50 and above were regarded as positive attitude.

3.5.3 Validity of the Research Instruments

The Electrolysis Concepts Achievement Test (ECAT) was validated by presenting copies of (ECAT) to three qualified experts, PhD holders with minimum rank of senior lecturers in chemistry department and science education department, Ahmadu Bello University Zaria, for validation. The experts examined the instrument and observed:

- If the instrument is appropriate for the target group.
- The language, spellings, appropriate chemical equations and symbols
- The weaknesses of the instrument
- Suggested possible solution to the observed errors

The Students 'Attitude towards Electrolysis Questionnaire (SATEQ) was presented to three experts in guidance and counselling department, with minimum qualification of PhD and senior lecturers in Ahmadu Bello University, Zaria, for validation. The experts checked the instrument and corrected some of the errors observed and certified that the instrument is relevant in measuring attitude of students toward electrolysis concepts.

3.5.4 Pilot Testing

In order to refine the test item and to determine the reliability coefficient of the two research instruments, pilot study was carried out in one of the secondary school within the target population but did not form part of the sample(Government Secondary School, Kanti Kankia). Electrolysis concepts achievement test and students' attitude toward electrolysis concept questionnaires was administered to a group of twenty five students by the researcher, which lasted for one and half hour. Instruction on how to answer the question was read and explained to the students. This was done to ensure that students answered the items carefully; problems and difficulties arising from the pilot study were carefully noted in order to improve upon the final instrument. According to Sambo (2008), the purposes of pilot study are:

- To determine the reliability coefficient of the instrument before administration
- To identify possible problems or difficulties that respondent may encounter with a view of eliminating them
- To determine the appropriateness of the instrument
- To determine the approximate time duration which the subject would need to answer the test items properly.

3.5.5 Reliability of the Instruments

The reliability coefficient of Electrolysis concepts Achievement Test (ECAT) was determined after pilot testing using test, re-test method. The two results of the tests were compared and computed using Pearson product moment correlation with the aid of (SPSS) software package and the reliability coefficient was found to be 0.97. This implies that there is strong positive relationship between the first and second administration of ECAT, hence the instrument is consistent and reliable for the study. Details of the calculation are presented in Appendix H.

The reliability coefficient of Students 'Attitude towards Electrolysis Questionnaire (SATEQ) was determined by administering the SATEQ once to the group of 25 students in (Government secondary school Kanti Kankia). Spearman Rank Order Correlation was used to estimate the reliability for the (SATEQ) the result obtained was 0.70. This shows a positive relationship. Thus the instrument is reliable to measure the attitude of students toward electrolysis concepts. Details of the calculation are presented in Appendix H

3.5.6 Item Analysis

The electrolysis concepts achievement test items were analysed to determine the item difficulty index and the item discrimination index. According to Furst (1958), Wood (1990) and Sambo (2008) the items difficulty index is the percentage of the students that got an item right over the total number of students that attempted the item and it is determined by using the formula:

$$\mathbf{P} = \frac{\mathbf{R}}{\mathbf{T}} \times \mathbf{100}$$

Where P = item difficulty index

R = Number of students who answer the items correctly

T = Total number of students tested.

According to Sambo (2008). In the normal research literature, item with index between 40 - 60% are accepted. In this study, items with facility index of 40 – 60% were accepted. And items with facility index below or higher than 40 - 60 % were changed and modified for being too difficult or too simple. Details were shown in Appendix E.

While the discrimination index (DI) of a test is the capacity of such a test to discriminate or distinguish between high and low achievers among students in the sample. It gives room for the ranking of students in a given test. If an item shows positive discrimination index, it implies that large proportion of more competent students than poor ones got the item right. And in a situation whereby the items value is Zero, it implies that the item has zero discrimination indexes. This means that the items are unable to distinguish between high and low achievers in a given sample of students. While the negative value of discrimination index is indicating that more poor students got the items right compared to more competent students. The Calculation was done using scores of the top twenty seven percent (27%) and bottom twenty seven percent (27%) of the total respondents. This was calculated using the formula given by Furst (1958), and used by Sambo, (2008) which is:

$$\mathbf{DI = \frac{RU - RL}{T}}$$

Where:

DI= Discrimination Index

RU – Number among upper 27% who responded correctly to the item.

RL = Number among lower 27% who responded correctly to the item.

T= number of respondents in each of the lower 27%

According to Furst (1958) and Sambo (2008) the discrimination index which ranges between 0.40 and 0.70 is regarded as moderately positive and is accepted for the present study. And item which did not fall within the accepted range of 0.40 and 0.70 were rejected. This was used in selecting the final items of the electrolysis concepts achievement test (ECAT). Details were shown in Appendix E.

3.5.7 Computer-Assisted Instruction Software

Computer assisted instruction software is an instrument developed by the researcher on electrolysis concept and used as an instructional approach for teaching experimental group, the computer assisted instruction software was developed using Graphic Image Processing tool (GIMP), Macromedia Flash 8 , Adobe flash creator version 8.0, Adobe acrobat and Microsoft power point 2007. The graphic image processing tool (GIMP) version 2.0 was used in converting a stationary image from Jpg, Bitmap, Png, Gif format into virtual images. The Adobe acrobat provide an add-on link to the Microsoft power point for importing and playing Adobe flash files (soft file) in the Microsoft power point plat form. The Adobe flash creator was used in creating flash model (soft file) which is imported into Microsoft power point plat form using adobe acrobat tool. However, all the software components used in creating Computer assisted instruction software were embedded into Microsoft power point and projected on screen for students to be able to visualise, observe and learned some of the abstract content of electrolysis. The software contains six electrolysis concept lessons, These include the following; Definition of electrolysis concept, ionic theory, mechanism of electrolysis, uses of electrolysis, Faraday laws of electrolysis, and electrical conductivity, the screen shots of the software packages are shown in Appendix I.

3.6 Administration of the Treatment

The two research instruments were administered before treatment as pre-test. Students in experimental group received instruction using Computer-Assisted Instruction as a treatment while students in control group received instruction using Lecture Method only, the teaching last for a period of six weeks after which the same instruments were re-administered to student as a post-test to determine students' academic achievement in electrolysis concept, and to determine students' attitude change towards electrolysis concept. After two weeks of posttest, the electrolysis concept achievement test was re-administered to both groups as a postpost-test to determine the students' retention ability differences.

3.6.1 Treatment for the Experimental Group

The experimental group received treatment using Computer assisted instruction software developed by the researcher using graphic image processing tool (GIMP), Macromedia Flash 8, Adobe flash creator version 8.0, and Adobe acrobat installed into the computers using Flash-Drive or CD-Rom Drive and projected on the screen, the treatment follows the subsequent steps: system set up phase, introduction phase, content delivery phase, summary phase and evaluation phase

Step 1

System set up Phase: In this step the teacher provide the instruments needed for Computer- Assisted Instruction which include the system (computer or laptop) the electrolysis concept software package, the projector and power supply, the teacher installed the software into the system, connect the projector and ensure students' proper sitting arrangement enables projection view clearly.

Step 2

Introduction Phase: The teacher introduces the lesson by stating clearly the main objectives of the lesson and asks students questions based on their previous knowledge of the subject matter.

Step 3

Content Delivery Phase: The teacher presents the lesson using the computer Assisted Instruction software package installed into the system through power point/slide projection, abstract concept are demonstrated using simulation, the teacher guide and explained the main point of the lesson step by step while the students partook actively in visualising, observing and learning some of the abstract contents of electrolysis projected on the screen. Chalk and board were also used to write and give examples where necessary.

Step 4

Summary Phase: The teacher revises the lesson and summarises the main points of the lesson, the subjects were referred to relevant chemistry text books for more information. Written assignment was given to the subjects after each lesson as demand by the lesson plan.

Step 5

Evaluation Phase:

The teacher evaluates the lesson by asking students questions relevant to the lesson taught to ensure attainment of the lesson objectives. This treatment administration can be illustrated in Flowchart model figure 3.2 below:

Figure 3.2 Computer-Assisted Instruction Flow Chart Model

Source: Adapted from Glynn, (1995)

3.6.2 Teaching of the Control Group

The control group were taught the same concepts by the researcher using lecture method. For six weeks. The pretest was administered to the subjects prior to the teaching. The lesson was presented by defining the electrolysis concept then followed by the explanation and important points were written on the chalkboard. No computer software was used in teaching the control group. The subjects were referred to relevant chemistry text books for more information. Written assignment was given to the subjects after each lesson as demand by the lesson plan. After teaching the experimental and control group posttest was administered using Electrolysis Concept Achievement Test (ECAT) to both groups. After two weeks postpost test was administered. The subjects scores were collected for both the control and experimental groups and subdivided into male and female scores to test for gender effect. Later, the data collected was subjected to computer analysis. Using Statistical Package for Social Science (SPSS)

3.7 Data Collection Procedure

The Electrolysis Concept Achievement Test (ECAT) Data was obtained from the pre-test, post-test and post post-test academic achievement test administered to the students in the experimental and control groups. The students Attitude towards electrolysis concept questionnaire (SATEQ) Data was obtained from the pre-test, post-test attitude questionnaire test administered to the students in the experimental and control groups.

3.8 Data analysis

The data obtained from the study was analysed using descriptive and inferential statistics to answer research questions and test the null hypotheses raised. All the four null hypotheses stated were analyzed using t-test independent statistics and Mann Witney U-test. This is for the purpose of determining significant different (if any) between the experimental and control groups performances. Significant level of $P \leq 0.05$ was used to retain or reject the hypotheses tested.

Answering Research Questions

Research Questions 1. What is the difference in the mean academic scores of students exposed to Computer-Assisted Instruction and those exposed to Lecture Method when taught electrolysis concepts?

This research question was answered by computing and comparing the Mean and standard deviation of posttest academic achievement scores of students in the experimental and control groups.

Research Questions 2. What is the difference in the mean scores of male and female students taught electrolysis concept of chemistry using Computer-Assisted Instruction only?

This research question was answered by comparing the Mean and standard deviation of posttest score of male and female students' academic achievement scores of students in the experimental group only

Research Questions 3. Does Computer-Assisted Instruction and lecture method affect students' retention ability when taught Electrolysis concept of chemistry?

This research question was answered by comparing the Mean and standard deviation of postpost-test academic achievement scores of students in the experimental and control groups.

Research Questions 4. Does the use of Computer-Assisted Instruction have any effect on students' attitude towards electrolysis concepts?

This research question was answered by comparing the Mean Rank scores and sum of Rank scores of the posttest students' attitude score of experimental and control groups

Testing the Stated Null Hypotheses

The null hypotheses formulated were tested at 0.05 level of Significance: using inferential statistics as follows:

Hypothesis 1: There is no significant difference between the mean scores of students exposed to Computer-Assisted Instruction and those exposed to Lecture Method when taught Electrolysis concepts.

This hypothesis was analyzed using t-test independent statistic at 0.05 level of significance. Data of Posttest academic achievement scores of students in experimental and control groups were used.

Hypothesis 2: There is no significant difference between the mean scores of male and female students taught electrolysis concepts using Computer-Assisted Instruction.

This hypothesis was analyzed using t-test independent statistic at 0.05 level of significance. Data of Posttest academic achievement scores of male and female students in experimental group were used.

Hypothesis 3: There is no significant difference in the retention level between students taught electrolysis concepts using Computer-Assisted Instruction and those taught using lecture method.

This hypothesis was analyzed using t-test independent statistic at 0.05 level of significance. Data of Postpost-test retention scores of students in experimental and control groups were used.

Hypothesis 4: There is no significant difference in the attitude of students exposed to Computer-Assisted Instruction and those exposed to lecture method when taught electrolysis concepts.

This hypothesis was analyzed using Mann-Whitney U-test statistic at 0.05 level of significance. Data of Posttest attitude scores of students in experimental and control groups were used.

CHAPTER FOUR

ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

The analyses and results of the data collected and their discussions are presented in this chapter. The data collected were analysed using the Statistical Package for Social Science (SPSS) and the level of significance adopted for rejecting or retaining the stated null hypotheses was $p \leq 0.05$.

Research Instrument called Electrolysis Concepts Achievement Test (ECAT) and Students Attitude towards Electrolysis Concepts Questionnaire (SATEQ) were used in collecting the following data:

- Posttest data which were analysed and to determine the academic achievement level of both the experimental and control groups
- Posttest data of experimental group only which were analysed to determine the gender differences in the performance of male and female students in the experimental group
- Postpost-test data which were analysed to determine the retention ability of both experimental and control groups
- Posttest Attitude scores data which were analysed to determine the Students 'Attitude change towards electrolysis concepts

4.2 The Results

This section presents the result and interpretation of the data collected from the study subject.

Research Question 1: What is the difference in the mean academic scores of students exposed to Computer-Assisted Instruction and those exposed to Lecture Method when taught electrolysis concepts?

Table 4.1 Mean and Standard Deviation of Posttest Scores for the Experimental and Control Groups

Groups	N	$\overline{X}$	SD	Mean Difference
Experimental	59	31.55	6.91	9.68
Control	64	21.87	7.84	

Table 4.1 presented data on the mean and standard deviation of academic achievement of students in experimental and control groups. From the result obtained, there is difference in the mean academic scores of experimental and control groups the students exposed to Computer-Assisted Instruction have mean scores of (31.55) while the students exposed to Lecture Method have mean scores of (21.87).

Research Question 2: What is the difference in the mean academic achievement scores of male and female students taught Electrolysis concepts of chemistry using Computer-Assisted Instruction?

Table 4.2 Mean and Standard Deviation of Posttest Scores of Male and Female Students exposed to Computer-Assisted Instruction only.

Gender	N	$\overline{X}$	SD	Mean Difference
Male	37	32.56	6.38	0.37
Female	22	32.13	7.04	

Table 4.2 presented the mean and standard deviation of academic achievement of male and female students exposed to Computer-Assisted Instruction only. From the result, there is difference in the mean scores of male and female students. The male students exposed to Computer-Assisted Instruction have mean scores of (32.56) while a female student exposed to Computer-Assisted Instruction have mean scores of (32.13).

Research Question 3: Does Computer-Assisted Instruction and lecture methods affect students' retention level when taught Electrolysis concepts?

Table 4.3 Mean and Standard Deviation of Postpost-test Scores for the Experimental and control Groups

Groups	N	$\overline{X}$	SD	Mean Difference
Experimental	59	27.50	8.56	6.85
Control	64	20.65	6.55	

Table 4.3 presented data on the mean and standard deviation of the post-post-test score of students in experimental and control groups. From the result obtained, there is difference in the mean scores of experimental and control groups students exposed to Computer-Assisted Instruction have mean scores of (27.20) while the students exposed to Lecture Method have mean scores of (22.00).

Research Question 4: Does the use of Computer-Assisted Instruction have any affect on students' attitude towards electrolysis concepts of chemistry?

Table 4.4 Mean Rank and Sum of Rank Post-test Attitude Scores of Experimental and Control Groups

Groups	N	Mean Rank	Sum of Rank	Mean Difference
Experimental	59	80.64	475.52	32.82
Control	64	44.82	286.52	

The result of the U-test presented in Table 4.4 shows that mean rank of experimental group is (80.64) and the mean rank of control group is (44.82). This implies that experimental group taught electrolysis concepts using Computer-Assisted Instruction have higher mean rank scores and has more positive attitude towards electrolysis concepts than the control group taught the same concepts using lecture method.

Testing the Stated Null Hypotheses

The following null hypotheses formulated were tested at 0.05 level of Significance:

$H_{O1:}$ There is no significant difference between the mean academic score of students exposed to Computer-Assisted Instruction and those exposed to Lecture Method when taught Electrolysis concepts.

The posttest data generated through Electrolysis concepts Achievement Test (ECAT) were subjected to t-test statistic to determine if there is any significant difference between the academic achievement of the experimental group and the control group. Summary of the analysis is shown in Table 4.5

Table 4.5 Results of t-test Analysis of the Posttest Mean Academic Achievement Scores of the Experimental and Control Groups

Groups	N	$\overline{X}$	SD	Df	t-value	p- value	Decision

Experimental	59	31.55	6.91	121	0.28	0.00	Significant
Control	64	21.87	7.84				

Significant at P ≤ less than 0.05; and df = 121

The result of the t-test shown in Table 4.5 shows that t-value calculated (0.28) and p-value of (0.000) were observed at df= 121. Since the p-value is less than the alpha value of 0.05, there is significant difference between the two groups in terms of their mean academic achievement scores in the Posttest. This indicates that experimental group has higher score than the control group. Therefore, the null hypothesis that stated. There is no significant difference between the mean academic score of students exposed to Computer-Assisted Instruction and those exposed to Lecture Method when taught Electrolysis concept is rejected.

Ho_2: There is no significant difference between the mean scores of male and female students taught electrolysis concepts using Computer-Assisted Instruction.

The posttest data generated through Electrolysis concepts Achievement Test (ECAT) were subjected to t-test statistic to determine if there is any significant difference between the academic achievement of the male and female students. Summary of the analysis is shown in Table 4.6.

Table 4:6 Results of t-test Analysis of the Posttest Mean Scores of Male and Female Students in the Experimental Group.

Gender	N	$\overline{X}$	SD	Df	t-value	p- value	Decision
Male students	37	32.56	6.38				

				57	0.28	0.81	Not Significant
Female students	22	32.13	7.04				

Not Significant at P > greater than 0.05; df =57

To determine whether the performance of the boys and girls differs following the respective treatments, the post-test mean academic scores were subjected to t-test. The result shown in table 4.6 shows that t-value calculated (0.28) and p- value of (0.81) is observed at df= 57. Since the p-value is greater than the alpha value = 0.05, it is evident that there is no significant difference in the post-test mean academic achievement scores between males and females taught using Computer-Assisted Instruction. Based on this result, the null hypothesis which states, "there is no significant difference between the mean scores of male and female students taught electrolysis concepts using Computer-Assisted Instruction" is retained.

$H_{o3:}$ There is no significant difference in the retention ability between students taught electrolysis concepts using Computer-Assisted Instruction and those taught using lecture methods.

The post-Posttest data generated through Electrolysis Concepts Achievement Test (ECAT) were subjected to t-test statistic to determine if there is any significant difference between the achievement of the experimental group and the control group. Summary of the analysis is shown in Table 4.7.

Table 4.7 Results of t-test Analysis of the Postpost-test Mean Scores of the Experimental and Control Groups

Groups	N	$\overline{X}$	SD	Df	t-value	p- value	Decision
Experimental	59	27.50	8.56				
				121	0.03	0.00	Significant

Control	64	20.65	6.55

There is significant difference at P ≤ less than 0.05; df = 121

To determine whether Computer-Assisted Instruction and Lecture Method affect students' retention level following the respective treatments, the post- post-test mean academic scores of experimental and control group were subjected to t-test. The result is shown in table 4.7 t-value calculated (0.03) and p- value of (0.00) is observed at df= 121. Since the p-value is less than the alpha value = 0.05, it is evident from the results obtained, that there is significant difference in the post-post-test mean academic achievement scores between experimental and control groups. Based on this result, the null hypothesis which stated, "there is no significant difference in the retention ability between students taught electrolysis concepts using Computer-Assisted Instruction and those taught using lecture methods" is rejected.

$H_{04:}$ There is no significant difference between the attitude of students exposed to Computer-Assisted Instruction and those exposed to lecture when taught electrolysis concepts.

The posttest data generated through Students' Attitude towards Electrolysis Concepts (SATEQ) were subjected to Mann-Witney U-test statistic to determine if there is any significant difference between the attitude of students exposed to Computer-Assisted Instruction and those exposed to lecture methods. Summary of the analysis is shown in Table 4.8

Table 4.8 Results of u-test Analysis of the Posttest Attitude Scores of the Experimental and Control Groups

Groups	N	Mean Rank	Sum of Rank	Mann-Witney U	p-value	Decision
Experimental	59	80.64	4757.52			
				788.50	0.00	Significant

Control	64	44.82	2868.52

Significant difference at $P \leq 0.05$

To determine whether Computer-Assisted Instruction or Lecture Method can produce change in students' attitude towards electrolysis concept following the respective treatments, the post-test attitude scores of experimental and control groups were subjected to U-test. The result presented in table 4.8 shows that Mann-Whitney U-test obtained is (788.50) and p- value of (0.00) is observed. Since the p-value = 0.00 is less than the alpha value = 0.05, there is significant difference in the post-test attitude scores between experimental and control groups. The significant difference is in favour of experimental group. Based on this result, the null hypothesis which states "there is no significant difference between the attitude of students exposed to Computer-Assisted Instruction and those exposed to Lecture Methods when taught electrolysis concepts is rejected.

4.3 Summary of the findings

In this study, the following findings were made:

- There is significant difference between the post-test mean academic achievement score of experimental and control groups in favour of experimental group. This implies that experimental groups taught electrolysis concepts using Computer-Assisted Instruction achieved higher than the control group taught the same electrolysis concepts using lecture method.

- There is no significant difference between the mean academic achievement scores of male and female students taught electrolysis concepts using Computer-Assisted Instruction. The male and female students performed equally well.
- There is significant difference between the post-post-test mean academic achievement score of experimental and control groups in favour of experimental group. This implies that experimental groups taught electrolysis concepts using Computer-Assisted Instruction retained better than the control group taught the same electrolysis concepts using lecture method.
- There is significant difference in the attitude of the students exposed to Computer-Assisted Instruction and those exposed to Lecture Method when taught electrolysis concepts.

4.4 Discussion of the Results

This study investigated the relative effectiveness of Computer-Assisted Instruction on students' academic achievements in electrolysis concepts among senior secondary school students in kankia education zone, katsina state Nigeria. To achieve this aim, students in the experimental group were taught electrolysis concept using the Computer-Assisted Instruction while students in the control group were taught the same concepts using Lecture Method.

The students in the experimental group and control group were then post-tested, and post-post-tested and their academic achievement, retention abilities and Attitude changes were compared and measured.

The result of testing hypothesis one shows that the students in the experimental groups who were taught electrolysis concepts using Computer-Assisted Instruction performed significantly better and achieved higher than their counterparts in the control group. The significant difference in academic achievement is in favour of experimental group, suggesting a greater effectiveness of Computer-Assisted Instruction over the Lecture Method in teaching electrolysis concepts. This shows that the use of Computer-Assisted Instruction in teaching electrolysis concepts is viable in enhancing students' academic achievement at senior secondary level of education.

Therefore, the result of this study have shown that the use of technology in constructivist teaching and learning environment has significantly improved students academic achievement scores in electrolysis concepts. The findings emanating from this study are in agreement with the findings of Kolawale & Abiodun (2011) who found and reported that there was significant difference in the performance of students taught chemistry using CAI. These findings are in conformity with Nakleh (2010) who opined that computerized molecular modelling improves tenth grade students' spatial ability, understanding of new concepts and achievement about structure and chemical bonding, and Supported by Stieff and Wilensky (2003) who added that computer-based instruction, visual, audio and synchronized multimedia not only arouses students interest when used in teaching but it also stimulates several human senses, thus making the learners more involved in the learning processes.

Hypothesis two centred on gender related differences on academic achievement of male and female exposed to electrolysis concepts using Computer-Assisted Instruction the Posttest result of testing hypothesis two shows there is statistically no significant difference between the Posttest mean score of male students and the Posttest mean score of female students. This implies that the level of academic achievement in electrolysis concepts of male and female students expose to Computer-Assisted Instruction is relatively the same. This finding agrees with the finding of Yusuf and Afolabi, (2010) who in their study found out that male and female students did not differ significantly in their performance when they are taught biology concept using computer aided instructional package. The finding of this research is also in contrast with the finding of Nakaka and Okwo (2011) who opined that male students found computer aided instruction to be more interesting than their female's counter-parts.

Hypothesis three focus on retention ability between students taught electrolysis concepts using Computer-Assisted Instruction and those taught using Lecture Methods. The post-Posttest score results showed that experimental group taught electrolysis concepts using Computer-Assisted Instruction retained better than their counterpart in the control group. This finding agrees with that of Efe & Efe (2011); Alhassan Victoria & Danteni (2013) who investigates on the effects of Computer Assisted Instructional Package on junior secondary school students achievements and retention in Geometry Concepts. Their results shows that there is significant difference between the post-post-test mean score of experimental and control in favour of experimental group who have higher mean score and higher retention ability. This shows that the Computer-Assisted Instructional Package used enable subjects in the experimental group to retain more knowledge of concept taught than the subject taught using lecture instructional method Also this finding in this study is in agreement with the finding of Bichi (2002) who observed that understanding and retention are product of meaningful learning: When teaching is effective and meaningful to the students, retention will improve.

Hypothesis four focus on students’ attitude towards electrolysis concepts. The post-test Attitude score results showed that experimental group taught electrolysis concepts using Computer-Assisted Instruction developed more positive attitude towards electrolysis concepts better than their counterpart in the control group. The subjects taught electrolysis concepts using Computer-Assisted Instruction developed more positive attitude toward electrolysis concepts than the subjects taught using Lecture Method only. This finding is in agreement with that of Paul (2010) who conducted a research on the effect of Computer-Base Instruction on students’ performance and attitude towards wave concepts and reported that subject taught with Computer-Based Instructions performed better and developed positive attitude towards wave concepts than the subjects taught with lecture method. This finding is in conformity with Keshinro (1998) who reported that students' perception and attitude towards learning chemistry in senior secondary schools improves when activity based teaching and learning are involved

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

In this study the relative effectiveness of two instructional strategies in teaching electrolysis concepts among senior secondary students was investigated. In the last chapter, data collected via electrolysis concept achievement test and students attitude towards electrolysis concepts questionnaire, were analysed in relation to four null hypotheses outlined to guide the investigation. The results were subsequently discussed. This chapter is organised and presented under the following subheadings:

- Summary
- Summary of the Major Findings
- Conclusion
- Recommendations
- Limitation
- Suggestion for further studies

5.2 Summary

In chapter one, background of the study was discussed, problems that prompted the researcher to carry out the study, theoretical framework and significance of the study were discussed accordingly. The study has four research objectives; four research question, four research hypotheses respectively.

Chapter two focused on the review of the relevant and related literatures which were reviewed based on the following sub-headings. The historical development of chemistry teaching in Nigeria, The concept of chemistry teaching in Nigerian secondary schools, Electrolysis concept of chemistry, Method of teaching chemistry, Computer-Assisted Instruction in Teaching chemistry, Gender and academic achievement in chemistry, Retention and academic achievement in chemistry, Implication of the literature reviewed for the present study.

Chapter three focused on the research design, research methodology, population of the study, sample and sampling technique used. The sample for this study comprised a total number of one thousand and eight chemistry students drawn from the two public co-educational senior secondary school in kankia education zone;

They are selected using a simple random sampling technique. A-50 items multiple choice research instrument tagged Electrolysis Concepts Achievements Test (ECAT) with reliability coefficient of 0.97 and A-20 item Students Attitude towards Electrolysis concept Questionnaire (SATEQ) with reliability coefficient of 0.70 was used to collect relevant data which were analysed using t-test, and Mann-Witney U-test with the aid Statistical Package for Social Science Software (SPSS).

In Chapter four the analysis of data collected, the results obtained, the findings and discussion of the result are presented. Table 4.1 is the Comparison of the Mean Scores of the Post-test for the Experimental and Control Groups Table 4.2 is the Comparison of the Mean Scores of Male and Female Students exposed to Computer-Assisted Instruction only. Table 4.3 is the Comparison of the Mean Scores of the Post-Post-Test for the Experimental and control Groups. Table 4.4 is the Comparison of the Post-test Mean Rank Attitude Scores of the Experimental and Control Groups Table 4.5 is the results of t-test Analysis of the Posttest Mean Scores of the Experimental and Control Groups. Table 4:6 is the results of t-test Analysis of the Posttest Mean Scores of Male and Female Students in the Experimental Group.

Table 4.7 is the results of t-test Analysis of the Postpost-test Mean Scores of the Experimental and Control Groups. Table 4.8 is the results of u-test Analysis of the Posttest Attitude Scores of the Experimental and Control Groups.

Chapter five focuses on the summary of the entire research work, summary of the major findings, conclusion, recommendations, contributions to knowledge, limitations and suggestion for further studies.

5.3 Summary of the Major Findings

The following comprise the major findings from the study:

i. There is significant difference between the mean academic achievement score of students taught electrolysis concept using Computer-Assisted Instruction (experimental group) and their counterparts who were taught the same concept using Lecture Method (control group) The experimental group (EG) achieved significantly higher than the control group (CG).

ii. There is no significant difference between the mean academic achievement scores of male and female students taught electrolysis concepts using Computer-Assisted Instruction. The male and female student performed relatively equal. Thus Computer-Assisted Instruction is gender friendly.

iii. There is significant difference in the retention ability between students taught electrolysis concepts using Computer-Assisted Instruction and those taught using lecture methods. The students taught electrolysis concepts using Computer-Assisted Instruction retained better than their counterpart taught using Lecture Method.

iv. There is significant difference between the attitude of students exposed to Computer-Assisted Instruction and those exposed to lecture methods, students exposed to Computer-Assisted Instruction have more positive attitude towards learning electrolysis concept better than their counterpart exposed to Lecture Method.

v. Lecture Method of teaching appears to be less effective in teaching electrolysis concepts as they tend to negatively affect the students' academic achievements, retention level and attitude towards electrolysis concepts.

5.4 Conclusion

Based on the findings from this study, the following conclusions were made:

- Computer-Assisted Instruction method is more effective instructional approach in teaching the concept of electrolysis to secondary school students.
- The Computer-Assisted mode of Instruction appears to promote students attitude towards the teaching and learning of electrolysis concepts among senior secondary school students in katsina state.

5.5 Recommendations

Based on the findings, the following recommendations were made:

1) The teaching of chemistry and electrolysis concept in particular should be conducted in such a way that students effectively learn and retain the concepts presented to them. The use of Computer-Assisted method of Instruction seems to be relevant in achieving this aims it should therefore be incorporated in to the teaching of electrolysis at the secondary school level
2) The use of Lecture Method in teaching has been found, in this study to be relatively less effective in enhancing students' academic achievement in electrolysis concepts compare to the lecture method approach.

3) The Federal and State Governments should provide conducive learning environment by providing adequate chemistry classrooms as well as properly equipped chemistry laboratories, with adequate ICT facilities including computers and projectors to enhance the students' acquisition of modern science learning using computer assisted instruction and improve science process skills.
4) The Federal and State Governments should utilize the services of various professional bodies such as Science Teacher Association of Nigeria (STAN), Faculties and Institutes of Education in the universities to organize in-service training programmes, workshops, seminars and conferences for serving chemistry teachers to update their knowledge on the use of innovative teaching methods like (Computer-Assisted Instruction) that can enhance students' academic achievement, retention level and acquisition of science process skills.
5) Science educators and curriculum planners should incorporate innovative teaching strategies such as the Computer-Assisted Instruction into their various teaching/ learning evaluation process.

5.6 Contributions to Knowledge

This study has the following contributions to knowledge:

- The Computer-Assisted Instruction software Adapted from (Allessi & Trollip, 1991) was modified by the researcher and used to develop Computer-Assisted Instruction software package for electrolysis concept of chemistry. Thus unique in this field and serves as contribution to knowledge since its found effective in increasing students' understanding of the abstract nature of electrolysis concepts. Beside this is not commonly used in schools.

- The Computer-Assisted Instruction Flow Chart Model Adapted from (Glynn, 1995) and modified by the Researcher and used as a treatment model for the Experimental Group it was found very effective. Therefore this contributed to knowledge.
- The students Attitude towards electrolysis concepts Questioneer (SATEQ) was developed by the researcher for the purpose of testing attitude of students in electrolysis concepts, and students taught using CAI developed positive attitude toward electrolysis concept this served as contribution to knowledge.
- The Electrolysis Concepts Achievement Test (ECAT) was purposely designed and developed by the researcher using six levels of mental process of the cognitive domain outline by Bloom, to test students' academic achievements in electrolysis concepts and found to be effectual. Thus, unique in this field.

5.7 Limitations

This study has some limitations which include the following:

- The restriction of the study to only senior secondary schools in kankia education zone of katsina state made the scope of the generalization that can be made from this study fairly narrow.
- A sample size of only 123 chemistry students was involved in this study. It may be possible that if larger sample size were used different results may be obtained.

5.8 Suggestion for Further Studies

This study may be expanded in the following ways:

1. A similar study should be carried out on the teaching of abstract concepts of chemistry such as radioactivity, mole concept, and stoichiometry using

Computer-Assisted Instruction with a view to finding out if similar or different results may be obtained

2. There is need to conduct similar studies to investigate the effect of other teaching strategies like concepts mapping and problem solving method among others, on the teaching of electrolysis concepts with a view to finding out if similar results or different results may be obtained
3. There is need to further investigate the roles, if any gender differences play in the interactions between teaching strategy and kind of curriculum taught at the different level of education

References

Ababio, O (2011). *New School Chemistry for Senior Secondary Schools.* Onitsa, Anambra State: Revised Sixth Edition 2011 Africana First Publishers PLC.

Abdullahi, A. (1982). *Science Teaching in Nigeria* Ilorin: Atoto Press Ltd.

Abdulkarim, B. & Lawal,T.E. (2012). Seasonal Variations and Academic Performance in Basic Science among Junior Secondary School Students in Anchau and Zaria Education Zones, Kaduna state, Nigeria. *International Journal of Applied Science and Technology.* 2(8). 140-148.

Adeniyi, E. O. (1997). An Analysis of the Relationship among Intended Curriculum-in used Curriculum and Students' Cognitive Structure Associated with Ecology Unit. Ph.D Dissertation, University of Wisconsin – Madison. *Retrieveved on 5th may 2013*

Adenekan, J. A., Adewopo, A., & Ogunjobi, O. M. (2006). Strategies for Effective Teaching of Chemistry. *Journal of Educational Research and Development,* 39(1), 96-102.

Adewumi, A. & Akinniyi, H. (2010). The Effects of Guided Inquiry on Secondary School Students' Performance in Electrochemistry *Journal of Science Teachers Association of Nigeria*, 23 (1&2), 60-65.

Aderogba, A.A. & Aanu, E.M.(2011). Effect of Co-operative and Individualized Teaching Methods on Senior Secondary School Students' Achievement in Organic Chemistry. *The Pacific Journal of Science and Technology, 12 (2). Retrieveved on 5th may 2013*

Adey, P & Shayer, M. (2001). Learning Intelligence: Cognitive Acceleration Across the Curriculum, from 5 -15 years *International Journal of Science Education, 23(8),*846- 852.

Ajewole, C.A Ajeybasile, O; Okebukola, P.A. (2000). Improving Socio-cultural Aspect of classroom *International Journal of Science Education, 21(8),*742-748.

Akintunde, D. G., & Lawal, R. F. (2008). Attitude and Performance of Student in Mathematics and Chemistry in some selected Secondary Schools in Lagos state. *Akoka Journal of Pure & Applied Science Education, 8* (1), 45 - 54.

Akin, S.A. (2008). Apparent Deficiencies in the Teaching of Chemistry at the Secondary Level *Akoka Journal of Pure & Applied Science Education, 8*(1), 55 - 62.

Akcay, N. & Unal, I. (2009). The effect of Computer-Assisted Instruction on the Learning of black body, Compton and X-rays Western Anatolia, *Journal of Educational Science* 3 (2), 18-26.

Allessi, S.R. Trollip, S (1991). *Computer Based Instruction Methods and Development (second ed.)* Prentice-Hall: Englewood Cliffs, NJ

Albirini, A. (2006). Cultural Perceptions: The missing Element in the implementation of ICT in developing countries. *International Journal of Education and Development using ICT,* 2 (1), 49-65.

Alhassan, D. S Victoria, I. E & Danteni, I. W (2013). Effects of Computer Assisted Instructional Package on Junior Secondary School Students Achievements and Retention In Geometry in Minna, Niger State Nigeria. *International Journal of Humanities and Social Science Invention ISSN (Online): 2319 – 7722, ISSN (Print): 2319 – 7714 www.ijhssi.org Volume 2 Issue 5 ǁ May. 2013ǁ PP.69-74 Retrieved on 10th October 2014.*

Anthony, A. (2004). Curriculum Innovation Instructional Material Production and Utilisation A key Note Paper Presented at the 22nd – 25th September 2004 second National Conference Organised by CUDIMAC *Journal of "CUDIMAC" faculty* of Education University of Nigeria Nsuka. 1 (1), 369-382.

Anderson, V. (1990). Training Teacher of foster Active Reading in Disable Adolescent, Paper Presented at the Annual Meeting of American Educational Research Association, Chicago.

Ardac, D. & Akaygun, S. (2004). Effectiveness of Multimedia-Based Instruction that Emphasizes Molecular Representations on Students' Understanding of

Chemical Change. *Journal of Research in Science Teaching,* 12 (41), 317-337.

Asultant, A. & Abdullahi, K. (2006). Developed a Computer Aided Instruction Package in a Remote Sensing *Educational International Archives of the Photogrammetry, Remote Sensing and Spatial Information Science* 36 (6), 1-6

Atadoga, M.M & Onaolapo, M.A.O. (2008). *A hand Book on Science Teaching Method*, Zaria: Shola press.

Atadoga, M.M (2011) Developmental Changes in Integrated Science for Effective Teaching and Learning Process of the Subject. *Nigeria Education forum* 19 (1), 25-34

Atadoga, M.M & Lakpini, M.A. (2013). A Comparison of Numeracy Achievement of Primary School Pupil Taught Using Whole Class and Varied Classroom Organisation Instruction, *Proceeding of multicultural African conference (2013)* Faculty of Education Ahmadu Bello university Zaria, 1(1), 142-150.

Ayodele O.O (1999). History of Science Education in Nigeria A philosophical Research in Education Pp. 120.

Awolade, O. (2010). A study of the Relationship between Science Resource Availability and Secondary School Student's Chemistry Achievement in Kaduna Metropolis. An published M.ed thesis Submitted to the Faculty of Education Ahmadu Bello University, zaria.

Bichi.S.S. (2002). Effect of Problem Solving Strategy and Enriched Curriculum on Students Achievements in Evolution Concepts among Secondary School Students, Ph.D thesis Unpublished A.B.U Zaria.

Braimoh, D. S. (2008). The Nature and Quality of Pre-service Science Teacher Education and Transistion of Teaching in Lagos State, Nigeria. Unpublished Doctoral Dissertation, Edith Cowan University, Perth.

Brunner, J.S. (1960). Process of Education New York. Alfred, A. Knop. Inc

Bayraktar, M. (2008). Effects of Computer Simulation Programs on University students' Achievement in Physics. *Turkish online journal of Distance Education,* 9(5), 53-62 *Retrieved on 10th january 2014.*

Bayraktar, M. (2010). A Meta-analysis on the Effectiveness of Computer-Assisted Instruction in Science Education, Unpublished Master Dissertation, Ohio University, United State of America.

Bayraktar, M. (2008). Effects of Computer Simulation Programs on University students' Achievement in Physics. *Turkish online journal of Distance Education,* 9(5), 53-62 *Retrieved on 10th October 2014.*

Bolaji, R. (2005). The Effectiveness of Computer-Assisted Instruction in Teaching Introductory Statistics. *Educational Technology & Society*, 8 (2), 170-178.

Bajah, S.T (1982). Preparation of the Secondary Physical Science Teacher for the African Environment. *West African Journal of Education,* 19 (1), 85-90.

Bennett, J., Rollnick, M., Green, G. & White, M. (2001). The Development and use of an Instrument to Assess Students' Attitude to the Study of Chemistry. *International Journal of Science Education, 23 (8),* 833- 845.

Berg, C. A., Bergendahl, V. C. B. & Lundberg, B. K. S. (2003). Benefiting from an Open-ended Experiment? A comparison of Attitudes to, and Outcomes of an Expository versus an Open-ended Version of the same Experiment. *International Journal of Science Education, 25(3)*, 351-372.

Bologun, T.A. (1985). A Review of Research in Biology Education in Nigeria. *Paper Presented at the Conference on Review of Current Trends in Nigeria Educational Research.* University of Ibadan Conference centre, Ibadan. On 22nd -24th may.1985

Brown, B. (1994). Sceince Education and Science Technology Society (STS) Theme Science Education, 71, 667-683.

Caplan, P. (1973). The Role of Class Room Conduct in Promotion and Retention of Elementary School Children. *Journal of Experimental Education, 14 (1), 8-11.*

Capon, N. & Kuhn D., (2004). What's so Good about Problem-based Learning? *Cognition and Instruction*, 22 (1), 61–79.

Chiappetta, E.L & Russel, J.M. (1982). The Relationship among Logical Thinking Problem Solving Instruction, and Knowledge and Application of Earth Science Subject Matter. *Journal of Science Education.* 66 (1), 85-93

Dohn, H. & Wagne K.D. (1999). Strategies and Methods of Teaching in Contemporary Higher Education with Reference to Project work. *Innovations in Educations and Training.* 36 (4), 285-291.

Dawson, V., Forster, P., & Reid, D. (2006). Information Communication Technology (ICT) Integration in a Science Education Unit for Preservice Science Teachers; Students' Perceptions of their ICT Skills, Knowledge and Pedagogy. *International Journal of Science and Mathematics Education, 2 (4), 345-363.*

Dienye, N.E & Gbamanja, S.P. (1990). *Science Education Theory and Practice* Pp 146-168

Efe, H. & Efe, R. (2011). Evaluating the Effect of Computer Simulation on Secondary Biology Instruction; An Application to Blooms Taxonomy *Academic Journals on scientific Research and Essays*, 6(10), 2137-2146

Ertepmar, H. (1995). The Relationship between Formal Reasoning Ability, Computer-Assisted Instruction, and Chemistry Achievement *Hacettepe Journal of Education,* 11 (19), 21–24.

Ezenwa, V.I. (1996). Learning using the Concept Mapping and Guided Discovery Strategies Effect on the Academic Achievement of Gender and Levels of Achievers. *Journal of science Teaching and Learning* 2(1&2), 23-30.

Federal Republic of Nigeria (2013). National Policy on Education; Abuja, Federal Ministry of Information.

Fashola, M. (2008). Chemistry: A key Driver for National Development. Paper Presented at the Annual Conference of Chemical Society of Nigeria, Abuja.

Federal Ministry of Educaton (2007). Senior Secondary Education Curriculum Chemistry for SS 1 - 3. Lagos: Nigerian Educational Research and Development Council Press (NERDC Press).

Furst, E.J. (1958). *Constructing Evaluation Instruments*. New York: Longman,

Garnett, P. J., & Treagust, D. F. (1992). Conceptual Difficulties Experienced by Senior High School Students of Electrochemistry: Electrochemical (galvanic) and electrolytic cells. *Journal of Research in Science Teaching, 29*(2), 1079-1099.

Garnett, P.J & Kenneth, T. (1988). Teaching for understanding: Exemplary practice in High School Chemistry *Journal of Research in Science Teaching,* 26 (19), 1–14.

Gilbert, J. K. (2006). On the Nature of 'Context' in Chemical Education. *International Journal of Science Education,* 28 (2), 957–976.

Geban, O. (1992). Effects of Computer Simulations and Problem Solving Approaches on High School Students *Journal of Educational Research,* 86 (92), 5–10.

Glynn, S.M. (1995). Conceptual Bridges. Using Analogies to Explain Scientific Concepts. *Journal of Research in Science Teaching*, 62 (9), 25-27.

Ibrahim A. (2006). The Role of Laboratory in the Teaching of Chemistry in Nigeria Paper Present at Kano State Polytechnic.

Igboegwu, E.N. (2012). The Effects of Quided Discovery and Demonstration Teaching Method on Achievement of Chemistry Student of Different Level of Scientific Literacy *journal of Research in Curriculum and Teaching* 6 (1), 445-458.

Jimmerson, S Carlson, E; Retord, M Engeland, B. And shroufe, L.A. (1997). A Perspective Longitudinal Study of the Correlates and Consequences of Early Grade Retention. *Journal of School Psychology, 3(3,) 3-25.*

Kerlinger, F.N. (1973). *Foundation of Behavioural Research,* London Holt Rinehart and Wiston.

Kulik, C.C & Kulik, J.A. (1991). Effectiveness of Computer- Based Instruction: An Updated Analysis. *Computers in Human Behaviour,* 7 (1-2), 75-94.

Kearney, M., & Treagust, D. F. (2001). Constructivism as a referent in the design and development of a computer program using interactive digital video to enhance learning in physics. *Australian Journal of Educational Technology,* 17(1), 64 - 79.

Keshinro, O. (1998). Students' Perception and Attitude Towards Learning Chemistry in Senior Secondary Schools in Nigeria. *Journal of Pure & Applied Science Education.* 1(1), 71- 77.

Keshinro, O. (2006). Delivery of chemistry for Self-Reliance. *Journal of Pure & Applied Science Education, 7*(1), 107 - 111.

Kingsley, C.-Y. (2009). Comparing the Impacts of a Problem-based Computer-Assisted Instruction and the Direct-interactive Teaching Method on Student Science Achievement. *Journal of Science Education and Technology,* 10(2), 201-210.

Kulik, C.C & Kulik, J.A. (1991). Effectiveness of computer- Based Instruction: An Updated Analysis. Computers in Human Behaviour, 7 (1-2), 75-94.

Kausar, T. & Ahmed, G. (2008). A Comparative Study to Evaluate the Effectiveness of Computer Assisted Instruction (CAI) Versus Class room Lecture (CRL) for Computer Science at ICS. Level *Turkish Online Journal of Educational Technology 7 (4), Article 2*

Kim, C.E. & Kellough, D.R. (2008). *A Resource Guide for Secondary School Teaching Planning for Competence.* New York: Macmillan.

Kolawale, A & Abiodun, O. (2011). Effects of Computer Assisted Instruction (CAI) on Secondary School Students' Performance in Chemical Bonding Concept of Chemistry. *Journal of Educational Technology* 7 (4), 33-39.

Lawal, T.E. (2007). "Think and Do" Activity and its Effect on the Performance of Pupil in Primary Science in Selected Primary School in Zaria Municipality, Nigeria. *Journal of Science and Mathematics Education, University of Cape Coast,* 3 (1), 87-92.

Lawal, F.K (2009) Effectiveness of Conceptual Change Instructional Strategy in Remidiating Misconceptions in Genetic Concept Among Senior Secondary School Students in Kano State. An Unpublished Ph.D Dissertation, Ahmadu Bello University Zaria. Nigeria

Lawal, F.K. Olorukooba, B.S. & Jiya, A. (2012). Effect of the Use of Analogy Teaching Strategy on Academic Performance in Evolution Concepts among

NCE Biology Students *Journal of Research in Curriculum and* Teaching 6(1), 484-492.

Lakpini, M.A & Atadoga, M.M (2013) A Comparison of Numeracy Achievement of Primary School Pupil Taught Using hole Class and Varied Classroom Organisation Instruction, *proceeding of multicultural African conference (2013) faculty of Education Ahmadu Bello university Zaria* 1(1), 142-150.

Mari, J.S. (1994). The Understanding of Science Processes and its Relationship to Achievement in Integrated Science an Unpublished M.ed. Thesis Department of Education. Ahmadu Bello Univresity Zaria.

Muhammad, Z. (2007). Effect of Inquiry Teaching on Academic Achievement of Biology Class Unpublished P.G.D.E. Thesis F.C.E. Kano.

Mustapha, M.T. (2001). Students' Perception of some Selected Chemistry Concepts and its Relationship to Classroom Principles. *Journal of* Science Teachers Association of Nigeria, 36 (1&2), 18-28.

Maikano, S. (2007). Effects of Outdoor and Indoor Laboratory Experience on Secondary School Students' Academic Achievement and Retention in Ecology in Kaduna State. An Unpublished M.ed Thesis Department to Education, Ahmadu Bello University, Zaria.

Morgil, S. Yavuz, O. Oskay, S and Arda, C. (2005). Traditional and Computer-Assisted Learning in Teaching Acids and Bases *Chemistry Education Research and Practice.* 6 (1), 52–63.

Mills, H. R. (1979). Teaching and Training a Hand book for Instruction, the MacMillan Press Limited London.

McCoy, A. & Renolds, A. (1992) Grade Retention and School Performance *Journal of School Psychology,* 37 (1), 275-295.

Mukherje, A. (1978). *Educational Psychology, Basu Coy*: India.

Nakaka, M.D. & Okwo, F.A. (2011). Effect of computer aided instructional package on the Performance of Senior Secondary School Students in History. *Journal of science Technology, Mathematics Education (JOSTMED),* 7(3), 2 45- 252

Nsofor, C.C. & Nasiru, A.A. (2013). Effect of Computer Aided Instructional Package on Biology Students Achievement in Genetic Concepts In Katagun Educational Zone, Bauchi State Nigeria. *Proceedings of Multi-Cultural African Conference (2013*) faculty of Education Ahmadu Bello University Zaria, 1 (1), 159-169.

Nneji, N.G. (1998). Students' Teachers' and Examination Perception of Difficult Topics in applied electricity and Factors Responsible for the Difficulty Levels. *Journal of Science Teachers Association of Nigeria,* 23 (1&2), 56-60.

Ngozi Mbajiorgu and Norman Reid (2006). Factors Influencing Curriculum Development in Chemistry Published by the Higher Education Academy Physical Sciences Centre 2006.

Nwagbo, C. (1999). Effects of Guided-Discovery and Expository Teaching Methods on the Attitudes Towards Biology of Student with Different Levels of Scientific Literacy. *journal. Science Teachers Association of Nigeria.* (36), 43-51.

Nworgun, I.N. (2005). Effect of Gender Sensitization Packaged on Students Achievement in Integrated Science *Journal of Science Teachers Association of Nigeria* 40 (1&2), 74-78.

Njoku, Z. C. (2004). Fostering the Application of Science Education Research Findings in Nigerian Classrooms: Strategies and Need for Teachers' Professional Development. *Proceedings of* 45th *Annual Conference of Science Teachers Association of Nigeria*. *(STAN*), 217-222.

Obeka, S.S. (2010).The Effect of Inquiry and Demonstration Methods on Student Achievement and Retention in Some Environmental Education Concept of Geography. *Journal of Studies in Science and Mathematics Education*, Faculty of Education Ahmadu Bello University Zaria, Nigeria.1 (1), 52-58.

Obeka, S.S. (2013). Effect of Innovative Teaching Strategies with Integrated Resource Material on Academic Achievement for Access and Quality Environmental Education in Otukpo Educational Zone, Benue state, *Proceeding of Multicultural African Conference 2013 Faculty of Education Ahmadu Bello University Zaria.* 1 (1), 135-150.

Olorukooba, S.B Lawal, F.K & Jiya, A. (2012). Effect of the Use of Analogy Teaching Strategy on Academic Performance in Evolution Concepts among NCE Biology Students *Journal of Research in Curriculum and* Teaching 6(1), 484-492.

Olorukooba, S.B. (2001). The Relative Effects of Cooperative Instructional Strategy and Traditional Method on the Performance of Senior Secondary School Chemistry Students. An Unpublished PhD Dissertation, Ahmadu Bello University, Zaria.

Olajide, J. O. (2007). Effect of Combination of Extended wait-Time and Analogical Reasoning on Classroom Interaction and Communication Skill in Science Lesson among Nigerian Secondary School Students *Journal of Science and Mathematics Education, University of Cape Coast,* 3 (1), 93-103.

Olajide, J. O. and James, T, (2009). Role of Inquiry Teaching in Promoting Entrepreneurship. *International Journal of Education and Science,* 3(2), 74-78.

Owolabi, T (2007). The Use of Analogy as a Vehicle for Achieving Effective Physic Delivery. In Olorunkooba, S.B, Lawal F.K & Jiya, A (2012) Effect of the Use of Analogy teaching Strategy on Academic Performance in Evolution Concepts among NCE Biology Students *Journal of Research in Curriculum and Teaching* 6 (1), 484.

Okolocha, C. C. (2010). E-learning: A veritable Tool for Preparing Business Education Teachers in Tertiary Institutions in Anambra State. Nigeria. *African Research Review*, 4 (4), 260-276.

Oloruntegbe, K. O. & Odutuyi, M. O. (2003). An Innovative ICT-Based Approach to the Teaching and Learning of Chemistry. *Proceedings of the 44th Annual Conference of the Science Teachers Association of Nigeria* (STAN), 135-138.

Onwu, G. O. & Moneme, C. O. (1986). A Network Analysis of Students' Problem Solving Difficulties in Electrolysis. *Journal of the Science Teachers Association of Nigeria*. 2 (1), 103 -114.

Oyelekan, A. (2011). Survey of the level of Understanding of Selected Chemistry Concepts by Senior Secondary School Students in Osun State, Nigeria. *African Research Review*, 4 (6), 155- 163.

Ogunmade, T. O. (2006). The Status and Quality of Secondary Science Teaching and Learning in Lagos State, Nigeria. Unpublished Doctoral Thesis, Edith Cowan University, Perth, Western Australia.

Okebukola, P.A. (1993). Effect of Cooperative, Competitive and Individualistic Laboratory Interaction Pattern on Students' Performance in Biology". Unpublished Ph.D Thesis. University of Ibadan: Ibadan, Nigeria.

Okebukola, P. A. (2010). Trends in Academic Rankings in the Nigerian University System and the Emergence of the African Quality Rating Mechanism. 5th Meeting of the Internationa Rankings Expert Group (IREG-5). Retrieved on 30th February 2013 from http:/www.Unilorin.edu.ng/publiclectures.

Olaleye, B. O. (2005). Articulating the Effect of Analogies Teaching Strategies on Learning of Chemical Bonding in Chemistry. *Journal of Unity and Development Education*, 1(1), 72-81.

Olaleye, B. O., Adewumi, A. A., & Akinniyi, F. E. (2009). Tearchers' Pedagogical Knowledge and Assessment Practices in Selected Secondary Science Classroom. Paper Presented at the 2009 School of Science Seminar, Adeniran Ogunsanya College of Education,Lagos.

Oloyede, O. I. (2013). Enhanced Mastery Learning Strategy of the Achievement and Self Concept in Senior Secondary School Chemistry. *Journal of Humanity and Social Sciences 5*(1), 19 - 24.

Olatoye, R.A and Affuwape M.O. (2004). Students Integrated Science Academic Achievements as Predicator of the Later Achievements in Biology, Chemistry and Physics. *Journal of Science Teachers Association of Nigeria* (1&2), 10-15.

Olatoye, R.A. & Adekoya, Y.M. 2010. "Effect of Project-Based, Demonstration and Lecture Teaching Strategies on Senior Secondary Students' Achievement in an Aspect of Chemistry". *International Journal of Educational Research and Technology*.1 (1), 19-29.

Ogunkola, B.J. (1999). Interaction Pattern in Primary School Science Classroom Ijebu-Ode Ogun State *African Journal of Educational Research* 5(1), 51-61.

Oyedeji, N.B. (1991). Business Education Facilities and Students Academic Performance in Ilorin Metropolis. *Journal of Business Education* 2(3),61-66.

Oriafor, C.N. (1986). "Cognitive Style: A study of Comparative Educational Study and Adaptation Centre (CESAC) Curricullum Material and its Graduates" Unpublished M.Ed thesis A.B.U., Zaria.

Oskamp, S., & Schultz, P. W. (2005). Attitudes and Opinions (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Paul, H.K. (1999). The Relationship Between Active Learning and Long Term Retention, Inductor Statistics Course International Statistics Institute 52^{nd} Session.

Paul, O.A. & Dantani, Y.M. (2012). Effects of Lecture and Demonstration Methods on the Academic Achievement of Students in Chemistry in Nassarawa Local Government Area of Kano State *International Journal of Modern Social Sciences*, 1(1), 29-37.

Paul, N.O (2010). The Effect of Computer-Base Instruction on Students' Performance and Attitude towards Wave Concepts *Journal of Educational Research,* 95 (19), 43–48.

Reid D. (2008). Simulation-Based Scientific Discovery Learning: a Research on the Effects of Experimental Support and Learners' Reasoning Ability. *Journal of Computer Assisted Learning*, 1 (19), 9-20.

Stieff, U. Wilensky, W. (2003). Connected Chemistry-Incorporating Interactive Simulations into the Chemistry Classroom *Journal of Science Education and Technology,* 12 (3), 285–302.

Saunders, W.L. (1992). "The Constructivist Perspective: Implications and Strategies in Science." *School Science and Mathematics.* 92 (2), 136-141.

Salau, M. O. (1996). The Effect of Class Size on the Achievement of Different Ability Groups in Mathematics. *Journal of Science Teachers Association of Nigeria, 31*(1&2), 55 - 61.

Shaibu, A.A.M. (2013). Resource for Science Laboratory and Science Teaching in Schools. Pre-Conference Workshop Paper, *Proceedings of Multicultural African Conference 2013*. Faculty of Education Ahmadu Bello University Zaria.1 (1), 25-30.

Shaibu, A.A.M. (2012). Lecture -Notes on the Foundation of Science Education. Science Education Department Faculty of Education Ahmadu Bello University Zaria.

Shaibu, A.A.M. (2000). Enriching the Quality of Science to the Schools, Philosophical Implication for the Teacher, *Journal of Science Teachers Association of Nigeria (4), 87.*

Shaibu, A.A.M. (1998). A Study of Student Academic Achievement as Correlated of their Competence in Practical Activities in Chemistry *Nigeria Educational Forum* 14 (2), 33-39.

Shaibu, A.A.M & Mari, J.S (1997) Gender-Related Differences in the Understanding of science process Skills Among Junior Secondary School Students in Some Nigerian Schools Journal of Science Teachers Association of Nigeria 32, (1&2), 21-27.

Silberberg, M. S. (2000). Chemistry the Molecular Nature of Matter. McGraw Hill, United State of America.

Sambo, A.A. (2008). *Research Method in Education*. Stirling-Horden Publishers (Nigeria) Ltd.

Thompson, J., & Soyibo, K. (2002). Effect of Lecture, Teacher Demonstration, Discussion and Practical Work on 10th Graders Attitudes to Chemistry and Understanding of Electrolysis *Research in Science and Technological Education,* 20 (1), 25-35.

Urevbu, A.O. (2010). Methodology of Science Teaching Benin City: Juland Educational Publisher.

Usman I.A. (2000). The Relationship Between Students Performances in Practical Activities and their Academic Achievement in Integrated Science. NISTEP Mode of Teaching Unpublished Ph.D Thesis Department of Education Ahmadu Bello University Zaria.

Usman I.A. (2010).The Effect of Indoor and Outdoor Laboratory Instructional Method on Academic Achievement of Junior Secondary School Integrated Science Students in Zaria local Government Area of Kaduna State. *Journal of Studies in Science and Mathematics Education,* Faculty of Education Ahmadu Bello University Zaria,Nigeria. 1 (1), 60-67.

Yusuf, M. O. (2005). Information and Communication Technology and Education: Analysing the Nigerian National Policy for Information Technology. *International Education Journal*, 6 (3), 316-321.

Yusuf. Y & Afolabi, O. (2010). Effects of Computer Assisted Instruction on Secondary School Students' Performance in Biology *Turkish Online Journal of Educational Technology 9 (1), 23-28.*

Yoloye, T.W. (2004). That We May learn Better: an Inaugural Lectures Delivered at University of Ibadan, Ibadan University Press Ibadan Nigeria.

Windschitl, M. Andre, T. (1998). Using Computer Simulations to Enhance Conceptual Change: The Roles of Constructivist Instruction and Student Epistemological Beliefs *Journal of Research in Science Teaching,* 35 (1998), 145–160.

Weinburgh, M. (1995). Gender Differences in Student Attitudes towards Science: A meta-analysis

West African Examination council (2013). WAEC Chief Examiner Report http//www.researchdivision/westafricanexaminationcouncil/chiefexaminerreport/2010/ng.htm Retrieved on 30th February 2013.

Wodi, S. W. & Dokubo, A. (2006). The Relevance of ICT in Science and Technology. *Journal of Curriculum Organization of Nigeria*, 13 (1), 200-206.

Wellington, J. (1989). Skills and Process in Science Education a Critical Analysis Routledge: London, United Kingdom.

Wood, R (1990). Item Analysis*;* In Walbbeng, H.J.& Wearter G.O. (eds). The International Encyclopedia of Education Evaluation. Oxford.

Zacharia, Z. (2005). Beliefs, Attitudes, and Intentions of Science Teachers Regarding the Educational Use of Computer Simulations and Inquiry-Based Experiments in Chemistry *Journal of Research in Science Teaching,* 40 (8) (2003), 792–82.

APPENDIX A

ELECTROLYSIS CONCEPTS ACHIEVEMENT TEST (ECAT)

Dear respondent

Below are electrolysis concepts achievement test (ECAT) 50 items multiple choice questions designed by the postgraduate students for academic research purpose. You are therefore requested to answer the questions based on your understanding knowledge of electrolysis concept of chemistry; the researcher is here by assured you that, your answer script and respond will be kept under strict confidentiality and sincerity.

SECTION A: BIODATA

Name of School ………………………………………….

Class………………………………………………………….

Age……………………………………………………………….

Gender MALE ☐ FEMALE ☐

Section B; General instructions

Please read the following instructions carefully before you begin to answer the questions

1. **Use HP pencil provided for the examination**
2. **Write your school name, class and identification number provide for the examination in the space provided in the answer sheet**
3. **Read each question carefully before answering and if you find a question difficult, go on to next question**

4. **After you have selected the correct answer, go to your answer sheet and shade the appropriate alphabet in the space provided that corresponds to your choice.**
5. **Shade only one letter for each answer in the multiple choice questions**
6. **If you change your mind on any answer, completely erase the first shading.**

ELECTROLYSIS CONCEPTS ACHIEVEMENT TEST (ECAT)

Instruction; This test contains 50 multiple-choice questions you are required to fill in the correct answers in blanks spaces provided in the answer sheet

Q1. The chemical decomposition of a compound by a direct current passing through either a solution of the compound or its molten state is known as

a. hydrolysis
b. electrolysis
c. volumetric analysis
d. qualitative analysis

Q2. A method of coating the surface of one metal with another metal by means of electrolysis is called

a) purifiction of metal
b) extraction of metal
c) electroplating
d) electrolytic cell

Q3. Half cell electrode of hydrogen is represented as

a) $2\ H^+$ (aq) / H_2 (g)
b) $2\ H^+$ (aq) // H_2 (g)
c) $2\ H^+$ (g) / $2H_2$ (g)
d) $2\ H^+$ (aq) / / H_2 (g)

Q4. The positive electrode by which the conventional current enters the electrolyte or by which electrons leave an electrolyte is called

a. positive electrode
b. cathode
c. anode
d. negative electrode

Q5. Calculate the mass of silver deposited when a current of 2.6A is passed through a solution a silver salt ($AgCl_2$) for 70 minutes (Ag = 108, 1 Faraday = 96500C)

a) 22.12g
b) 12.22g
c) 13.23g
d) 21.12g

Q6. Electrolyte in the dry Leclanche cell is

a) anhydrous $ZnSO_4$

b) calcium hydroxide $Ca(OH)_2$

c) ammonium chloride NH_4Cl paste

d) muslin bag

Q7. Reduction Reaction occurs at the cathode where the cations gain an electron, this reaction is known as?

a) redox reaction
b) anodic half reaction
c) neutralization reaction
d) cathodic half reaction

Q8. The discharge of ions in electrolysis is govern by three conditions Except?

a) the position of the ions in electrochemical series
b) the concentration of the ion in the electrolyte
c) the pressure of the ions in the electrolyte
d) the nature of electrode

Q9. An electrolyte that ionises only slightly and do not conduct electricity is called?

a) strong electrolytes
b) weak electrolytes
c) partial electrolytes
d) ionic electrolytes

Q10. Which o f the following is an example of strong electrolyte

a) ethanoic acid CH_3COOH
b) hydrogen peroxide H_2O_2
c) sodium chloride $NaCl$
d) calcium hydroxide $Ca(OH)_2$

Q11. Oxidation in electrolysis occurs at the

a) electrolyte
b) electrodes
c) cathode
d) anode

Q12. A compound which conducts electricity and decomposes in the process is known as

a. electrolysis
b. electrode
c. electrolyte
d. conductor

Q13 Lead accumulator is an example of secondary cell therefore, it must be charged by passing

a) stabilized circuit through it

b) direct current through it

c) alternating current through it

d) back current through it

Q14. An example of weak electrolyte is

a) H_2SO_4
b) H_3PO_4
c) CH_3COOH
d) NaCl

Q15 Which of the following can generate a large amount of electricity?

a) batteries

b) dry cell

c) dynamo

d) daniel cell

Q16. A circuit which has one or more gaps along its conducting path is called?

a) a half circuit

b) a series circuit

c) a closed circuit

d) an open circuit

Q17. The Satndard electrode potential of $2H^+$ (aq) / H_2 (g) is given as

a) – 2.71V
b) 0.00V
c) – 2.92V
d) + 1.68V

Q18.The ionic theory that explain the concept of electrolysis is proposed by who?

a) Arrhenus in 1887
b) Micheal farraday in 1833
c) Grahams in 1850
d) Thompson in 1888

Q19. Which of the following is commonly used as car battery

a) daniel cell
b) lead accumulator
c) leclanche cell
d) metalic cell

Q20. Potential Difference set up when a metal is in contact with one molar solution of its ions at 25 ^{0C} is called

a) inert standard potential
b) electrochemical cell
c) galvanic cell
d) Standard electrode potential

Q21. Electrolysis can be use in the following ways except

a) extraction of the element
b) electroplating
c) soponification
d) purification of metals

Q22. Electrolyte that ionizes completely and conducts electricity readily is known as

a. electrolytic cell
b. strong electrode
c. strong electrolyte
d. electrolyte

Q23. When an electric current is passing through an electrolyte the free ions lose their random movement, the positive ions will be attracted to what?

a) cathode
b) anode
c) electrons
d) electrolyte

Q24. The overall Redox reaction occurring at the electrode is represented for a copper zinc cell) as Cu^{2+} (aq) / Cu (s) // Zn (s) / Zn^{2+} (aq) the double line (//) represents?

a) capacitor

b) battery

c) salt bridge

d) inert conductor

Q25.When the same quantity of electricity is passed through different eletrolytes the relative number of moles of the element discharged are inversely proportional to the charges on the ions of the elements. These stetement is refered to as

a) law of definite proportion
b) law of multiple proportion
c) faradays first law of electrolysis
d) faradays second law of electrolysis

Q26 An electrical circuit that has a complete conducting path is called?

a) a closed circuit

b) a parallel circuit

c) an open circuit

d) a half circuit

Q27. The electrolytic cell in industrial electrolysis of brine is known as

a) kellner- solvay cell
b) electrochemical cell
c) brine cell
d) batery cell

Q28. substances that can conduct electricity are called?

a) insulators

b) conductors

c) capacitors

d) radiators

Q29. The quantity of the product liberated at electrodes during an electrolysis is dependent on the following Except.?

a) the magnitude of the steady current passed
b) the time flow of the steady current passed
c) the ionic charge of the liberated element
d) concentration of the liberated element

Q30 which of the following is an example of metalic conductors?

a) water

b) metal wires

c) sodium chloride solution

d) dilute hydrochloric acid

Q31. Half cell electrode of copper is represented as
a) Cu^{2+} (aq) // Cu (s)
b) Cu^{2+} (aq) / Cu (aq)
c) Cu^{2+} (g) / Cu (l)
d) Cu^{2+} (aq) / Cu (s)

Q32. The potential difference between the two half reaction is known as
a) electromotive force (Emf)
b) metalic voltage
c) electrode potential
d) elecrolysis potential

Q33. The Standard electrode potential of Na^{+} (aq) / Na (s) is given as

a) – 2.71V
b) 0.00V
c) – 2.92V
d) + 1.68V

Q34. When two electrodes of lead accumulator are connected to an external circiut it produces?

a) electricity by discharging
b) daniel cell
c) leclanche cell
d) salt bridge

Q35. Calculate the mass of aluminium deposited when a current of 3.0 amperes is passed through an Aluminium electrolyte for 2hours (Al=27, 1faraday = 96500 C/mol)

a) 1.0g
b) 6.04g
c) 4.02g
d) 3.02g

Q36. One Faraday is equal to

a) 9650 coulombs
b) 95600 coulombs
c) 96566 coulombs
d) 96500 coulombs

Q37. A flow of current in electrolysis is due to the movement of

a) electrons
b) current
c) ions
d) charges

Q38Two half cells which are capable of converting chemical energy to electrical energy is called

a) a cell
b) electrochemical cell

c) metallic cell

d) chemical cell

Q39. At which of the electrodes does reduction occur?

a) cathode

b) anode

c) electrolyte

d) half electrode

Q40 There are Two types of conductors in electrolysis these are?

a) insulators and radiators

b) paralel conductors and series conductors

c) inert conductors and non metalic conductors

d) metalic conductors and Electrolytic conductors

Q41. Corrosion in iron is called

a) tarnishing

b) rusting

c) electrode corrosion

d) galvanisation

Q42. The mass of an element discharged during an electrolysis is directly proportiional to the quantity of electricity passing through it This refer to as

a) daltons law of partial pressure
b) faradays first law of electrolysis
c) grahams law of diffusion of gasses
d) faradays second law of electrolysis

Q43. Electromotive force of an electrochemical cell is given by

a) algebraic difference between the electrode potential of the electrodes

b) algebraic Sum between the electrode potential of the electrodes

c) algebraic Zero between the electrode potential of the electrodes

d) algebraic Product between the electrode potential of the electrodes

Q44.Electrolytes conduct electricity only when molten or in solution as a result of the movement of

a. ions
b. electrons
c. atoms
d. molecules

Q45. Electrode potential of a given system depend on the followings Except?

a) pressure
b) the overall energy change
c) the concentration of ions in solution
d) temperature

Q46. Oxidation occurs at the anode where the anions lose electrons this reaction is known as

a) electrolytic reaction
b) anodic half reaction
c) cathodic half reaction
d) oxidation reaction

Q47 In an electrical cicuit cells can be arranged

a) in series only
b) in parallel only
c) series or in parallel
d) in vertical or horizontal line

Q 48. Electrolysis of brine yeilds?

a) hydrogen and chlorine at the electrode
b) hydrogen and oxygen at the electrode
c) hydrogen and sulphur at the electode
d) hydrogen an copper at the electrode

Q49. A flow of current (i.e electric current) can be set up between two electrode which have different

a) electromotive force (Emf)
b) speed
c) watts
d) electrode potential

Q50.The negative electrode by which the conventional current leave the electrolyte or by which an electric current enters the electrolyte is called

a. the negative electrode
b. cathode
c. anode
d. positive electrode

APPENDIX B

MARKING SCHEME FOR ELECTROLYSIS CONCEPTS ACHIEVEMENT TEST

1. B	21. C	41. B
2. C	22. C	42. B
3. A	23. B	43. A
4. C	24. C	44. A
5. B	25. D	45. A
6. C	26. C	46. B
7. D	27. A	47. C
8. C	28. B	48. A
9. B	29. D	49. D
10. C	30. A	50. B
11. D	31. D	
12. C	32. A	
13. B	33. A	
14. C	34. A	
15. C	35. B	
16. D	36. D	
17. B	37. C	
18. B	38. B	
19. B	39. A	
20. D	40. D	

APPENDIX C

ELECTROLYSIS CONCEPT ACHIEVEMENT TEST (ECAT) ANSWER SHEET

SECTION A: BIODATA

Name of School…………………………………………………..

Class…………………………………………………………..

Gender: Male [ ] Female [ ]

Age…………………………………………………………….

Research Identification Number……………………………………

SECTION B

Please shade the correct answer appropriately

1. =A= =B= =C= =D=
2. =A= =B= =C= =D=
3. =A= =B= =C= =D=
4. =A= =B= =C= =D=
5. =A= =B= =C= =D=
6. =A= =B= =C= =D=
7. =A= =B= =C= =D=
8. =A= =B= =C= =D=
9. =A= =B= =C= =D=
10. =A= =B= =C= =D=
11. =A= =B= =C= =D=
12. =A= =B= =C= =D=
13. =A= =B= =C= =D=
14. =A= =B= =C= =D=
15. =A= =B= =C= =D=
16. =A= =B= =C= =D=
17. =A= =B= =C= =D=
18. =A= =B= =C= =D=
19. =A= =B= =C= =D=
20. =A= =B= =C= =D=
21. =A= =B= =C= =D=
22. =A= =B= =C= =D=
23. =A= =B= =C= =D=
24. =A= =B= =C= =D=
25. =A= =B= =C= =D=
26. =A= =B= =C= =D=
27. =A= =B= =C= =D=
28. =A= =B= =C= =D=
29. =A= =B= =C= =D=
30. =A= =B= =C= =D=
31. =A= =B= =C= =D=
32. =A= =B= =C= =D=
33. =A= =B= =C= =D=
34. =A= =B= =C= =D=
35. =A= =B= =C= =D=
36. =A= =B= =C= =D=
37. =A= =B= =C= =D=
38. =A= =B= =C= =D=
39. =A= =B= =C= =D=
40. =A= =B= =C= =D=
41. =A= =B= =C= =D=
42. =A= =B= =C= =D=
43. =A= =B= =C= =D=
44. =A= =B= =C= =D=
45. =A= =B= =C= =D=
46. =A= =B= =C= =D=
47. =A= =B= =C= =D=
48. =A= =B= =C= =D=
49. =A= =B= =C= =D=
50. =A= =B= =C= =D

APPENDIX D

Students Attitude towards Electrolysis concepts Questionnaire (SATEQ)

Dear respondent

This questionnaire is designed by a postgraduate student to obtain information from you about students' attitude towards electrolysis concepts. You are please requested to rate the items based on your opinion in the order of priority from strongly agreed (SA) Agreed (A) Undecided (U) Disagreed (D) to Strongly Disagreed (SD). Be informed that this research is for academic purpose and therefore your responses used for academic purpose only and will be kept confidential.

SECTION A: PERSONAL DATA

School ………………………………………….

Class…………………………………………………….

Age………………………………………………………….

Sex………………………………………………………….

SECTION B: ELECTROLYSIS CONCEPT ATTITUDE QUESTIONNAIRE ITEMS

SERIAL NO	ITEMS	SA	A	U	D	SA
1	Electrolysis concepts is difficult to learn					
2	I get confused when electrolysis concepts is taught in the class					
3	I admire chemistry teacher teaching electrolysis concepts					
4	I enjoy lessons containing electrolysis concept					
5	Electrolysis concepts is useful to me in learning chemistry					

6	Calculations involving electrolysis concepts is boring to me					
7	Electrolysis concepts should be made an area of speciality					
8	Electrolysis concepts is easy to understand					
9	Equations involving electrolysis concepts are not easy to understand					
10	Textbooks containing electrolysis are self explanatory and easy to comprehend					
11	Cathode and anode differences in electrolysis concepts are confusing					
12	I enjoy doing calculation work involving electrolysis concept					
13	I like electrolysis concept because faradays Laws of electrolysis conform with reality					
14	I don't like Oxidation and reduction reaction in electrolysis concepts because they are confusing					
15	I have the benefit of electrolysis concept because we learn how to generate electricity using chemicals					
16	I hate calculation work involving electrolysis concept					
17	Balancing chemical Equation in electrolysis concepts are desirable					
18	Electrolysis concept can exposed students to criminal act of making explosives					
19	I am learning electrolysis concepts out of will					
20	I like chemistry period because of my interest to learn electrolysis concept					

APPENDIX E

ITEM DIFFICULTY INDEX AND DISCRIMINATION INDEX FOR

ELECTROLYSIS CONCEPTS ACHIEVEMENT TEST

ITEM NO	$p = \frac{R}{T} \times 100$	$D = \frac{RU - RL}{N}$
1	54%	0.51
2	51%	0.52
3	52%	0.46
4	57%	0.47
5	45%	0.45
6	41%	0.43
7	49%	0.55
8	19%	0.20
9	55%	0.42
10	46%	0.50
11	52%	0.54
12	49%	0.50
13	50%	0.48
14	50%	0.49
15	48%	0.54
16	46%	0.57
17	53%	0.51
18	56%	0.46
19	49%	0.58
20	54%	0.54
21	51%	0.55
22	44%	0.49
23	45%	0.58
24	54%	0.56
25	49%	0.50
26	49%	0.51
27	58%	0.55
28	51%	0.60
29	56%	0.44
30	48%	0.50
31	45%	0.49
32	49%	0.49
33	46%	0.50
34	44%	0.50
35	49%	0.56
36	47%	0.49
37	56%	0.55
38	50%	0.58
39	42%	0.49
40	44%	0.45
41	52%	0.49
42	56%	0.54
43	48%	0.50
44	46%	0.47
45	49%	0.50
46	49%	0.48
47	54%	0.47
48	63%	0.51
49	52%	0.54
50	57%	0.49

APPENDIX F

LESSON PLAN FOR EXPERIMENTAL GROUP

Subject	Chemistry
Topic:	Introduction to Electrolysis
Class: SS II	
Average Age:	16 Years
Mode of Teaching:	Computer-Assisted Instruction
Duration: 40 Minutes	
Instructional Material:	Computer, and screen projector
Behavioural Objectives:	At the end of the lesson students should be able to:

i. Understand what is electrolysis
ii. Understand what is Electrolyte and electrode
iii. Identify and differentiate between Anode and Cathode

Previous Knowledge; The students have learnt about electron transfer in a Redox reaction

Step 1

System set up Phase: In this step the teacher provide the instruments needed for Computer- Assisted Instruction which include the system (computer or laptop) the electrolysis concept software package, the projector and power supply, the teacher installed the software into the system, connect the projector and ensure students' proper sitting arrangement enables projection view clearly.

Step 2

Introduction Phase: The teacher introduces the lesson by stating clearly the main objectives of the lesson and ask students questions base on their previous knowledge of electron transfer in a chemical concept

Step 3

Content Delivery Phase: The teacher presents the lesson using the computer Assisted Instruction software package installed into the system through power point/slide projection, the teacher define electrolysis, electrolyte, and electrode.

– Electrolysis this is the chemical decomposition of a compound by direct current passing through either a solution of the compound or their molten state.

– Electrolyte; as compound which conduct electricity and decomposed in the process while

– Electrodes are conductors in the form of of wires, rod or plate through which an electric current enters the electrolyte or by which electrons leaves electrolyte

– Anode This is positive eletrode by which the conventional current currents enters the electrolyte or by which electrons leaves an electrolyte. Its the electrode which is joined to the positive terminal of electric supply.

– Cathode – this is the negative electrode by which the conventional current leaves the electrolytes or by which the electrons enters the electrolyte. It is the electrode is joined to the negative terminal of the electric supply.

the teacher guide and explained the main point of the lesson step by step while the students partook actively in visualising, observing and learning some of the abstract contents of the lesson projected on the screen. Chalk and board were also used to write and give examples where necessary

Step 4

Summary Phase: The teacher revise the lesson and summarises the main point of the lesson, the subjects were referred to relevant chemistry text books for more information.

Step 5

Evaluation Phase: The teacher evaluates the lesson by asking students the following questions

1. What is electrolysis
2. Differentiate between electrodes and electrolytes
3. What is the difference between anode and cathode

Conclusion; The teacher conclude the lesson by asking students to read about ionic theory

Assignment; The teacher gives the students the following assignments

1. Give two examples of strong and weak electrolytes
2. What is an electrolytic cell?

LESSON PLAN 2

Subject	Chemistry
Topic:	Mechanism of Electrolysis
Class:	SS II
Average Age:	16 Years
Mode of Teaching:	Computer-Assisted Instruction
Duration:	40 Minutes
Instructional Material:	computer and screen projector
Behavioural Objectives:	At the end of the lesson students should be able to:
	1. Explain the movement of electrons towards positive and negative terminals (Anode and Cathode) electrodes
Previous knowledge:	The students have learnt about electrolysis electrode, electrolyte, anode and cathode

Step 1.

System set up Phase: the teacher provide the instruments needed for Computer- Assisted Instruction which include the system (computer or laptop) the electrolysis concept software package, the projector and power supply, the teacher installed the software into the system, connect the projector and ensure students' proper sitting arrangement enables projection view clearly.

Step 2

Introduction Phase: The teacher introduces the lesson by stating clearly the main objectives of the lesson and ask students questions base on their previous knowledge to define electrolysis, differentiate electrode and electrolyte, cathode and anode

Step 3

Content Delivery Phase: The teacher presents the lesson using the computer Assisted Instruction software package installed into the system through power point/slide projection, The teacher project on the screen the mechanism of electrolysis and begins to explain the mechanism of electrolysis using computer Assisted instructional package to display the concept

- Electrolysis is the chemical change brought about by the passage of direct current through an electrolyte via electrodes.

Before the passage of currents, the ions moves about randomly in the electrolyte. When electrolysis begins the battery or generator of electric current pumps electrons from its negative terminal (anode) to the catode of electrolytic cell. The negatively charged cathode then attracts the cations in the electrolyte it self. The cations accept electron to become electrically neutral and are eventually discharged. The positive terminal (cathode) of the battery draws electron from the anode of electrolytic cell. Anions in the electrolyte are then attracted to the positively charged anode, where they give up their electrons to become electrically neutral and are also finaly discharged. Hence the electric currents passes through the complete circuit.

the teacher guide and explained the main point of the lesson step by step while the students partook actively in visualising, observing and learning some of the abstract contents of the lesson projected on the screen. Chalk and board were also used to write and give examples where necessary

Step 4

Summary Phase: The teacher revise the lesson and summarises the main point of the lesson, the subjects were referred to relevant chemistry text books for more information.

Step 5

Evaluation Phase: The teacher evaluates the lesson by asking students the following questions

- explain how ions moves in an electrolyte
- explain how ions how ions are being discharged in elecrolysis
- Assignment: The teacher give students assignment to draw the diagrammed of electrolysis set up and label it

LESSON PLAN 3

Subject	Chemistry
Topic:	Electrolytic reaction
Class:	SS II
Average Age:	16 Years
Mode of Teaching:	Computer-Assisted Instruction
Duration:	40 Minutes
Instructional Material:	Computer, and screen projector
Behavioural Objectives:	At the end of the lesson students should be able to:

1. Understand what is electrolytic reaction
2. State the conditions governing the discharge of ions

Step 1.

System set up Phase: the teacher provide the instruments needed for Computer- Assisted Instruction which include the system (computer or laptop) the electrolysis concept software package, the projector and power supply, the teacher installed the software into the system, connect the projector and ensure students' proper sitting arrangement enables projection view clearly.

Step 2

Introduction Phase: The teacher introduces the lesson by stating clearly the main objectives of the lesson and ask students questions base on their previous knowledge to explain the movement of ions in an electrolytes

Step 3

Content Delivery Phase: The teacher presents the lesson using the computer Assisted Instruction software package installed into the system through power point/slide projection, The teacher begins to explain electrolytic reaction through computer Assisted instructional package projected on the screen

- Electrolytic reaction are redox reaction since they involve transfer of electrons. Oxidation occurs at the anode where the anions lose electronss this reaction at the anode is known as anodic half reaction. The cathodic half reaction which take place simultaneously at the cathode is a reduction reaction since the cations gains an electrons here. The overrall reaction is obtained by algebraic addition of the two reactions.

Example

Cathodic half reaction $2Cu_2^{+} \longrightarrow (aq) + 4e^{-} \longrightarrow 2Cu\ (s)$

Anodic half reaction $4OH^{-}\ (aq) \longrightarrow 2H_2O(l) + O_2\ (g)$

Overall reaction $2Cu_2^{+}\ (aq) + 4OH^{-}\ (aq) \longrightarrow 2Cu\ (s) + O_2\ (g) + 2H_2O(l)$

the teacher Begins to expain the condition governing the position of the ion in the electrochemical series

- The concentration of the ion in the electrolyte
- The nature of the electrode

the teacher guide and explained the main point of the lesson step by step while the students partook actively in visualising, observing and learning some of the abstract contents of the lesson projected on the screen. Chalk and board were also used to write and give examples where necessary

Step 4

Summary Phase: The teacher revise the lesson and summarises the main point of the lesson, the subjects were referred to relevant chemistry text books for more information.

Step 5

Evaluation Phase: The teacher evaluates the lesson by asking students the following questions

- What is an electrolytic reaction
- What are the condition governing discharged of ions

Conclusion: the teacher conclude his lesson by askin students to read about electolysis of water with dillute hydrogen tetraoxosulphate (iv) acid

Assignment: The teacher gives students assignment to write and show the relative position of the ion in the electrochemical series.

LESSON PLAN 4

Subject Chemistry

Topic:	Faradays Laws of electrolysis
Class:	SS II
Average Age:	16 Years
Mode of Teaching:	Computer-Assisted Instruction
Duration:	40 Minutes
Instructional Material:	Computer and screen projector
Behavioural Objectives:	At the end of the lesson students should be able to:

1) Understand Faradays first Laws of electrolysis
2) Understand and State Faradays second Laws of electrolysis
3) Calculate the mass of silver deposited when a current is passed through its solution.

Step 1.

System set up Phase: the teacher provide the instruments needed for Computer- Assisted Instruction which include the system (computer or laptop) the electrolysis concept software package, the projector and power supply, the teacher installed the software into the system, connect the projector and ensure students' proper sitting arrangement enables projection view clearly.

Step 2

Introduction Phase: The teacher introduce the lesson by stating clearly the main objectives of the lesson and ask students questions base on their previous knowledge to explain what is an electrolytic reaction

Step 3

Content Delivery Phase: The teacher presents the lesson using the computer Assisted Instruction software package installed into the system through power point/slide projection, the teacher begins to explain Faradays Laws of electrolysis

The quantity of product liberated at the electrode during electrolysis is dependent on

i. The magnitude of the steady current passed
ii. The time flow of the steady current
iii. The ionic charge of the liberated element

These quantitative aspects of electrolysis were investigated by faraday that put forward two laws in 1883 to describe these relationships.

- Faradays first Laws of electrolysis stated tha the mass of an element discharged during an electrolysis is directly proportiional to the quantity of electricity passing through it

- Faradays second Laws of electrolysis state that when the same quantity of electricity is passed through different eletrolytes the relative number of moles of the element discharged are inversely proportional to the charges on the ions of the elements.

work example

Calculate the mass of silver deposited when a current of 2.6A is passed through a solution a silver salt ($Agcl_2$) for 70 minutes (Ag = 108, 1 Faraday = 96500C)

Quantity of electricity used = It = (2.6 x 70 x 60) C

$Ag^+ (aq) + e^- \longrightarrow Ag (s)$

108g if 108g

96500C liberated 108g of Ag

(2.6 x 70 x 60) C will liberate $\frac{2.6 \times 70 \times 108}{96500}$ = 12.22g

Therefore mass of silver deposited is 12.22g

the teacher guide and explained the main point of the lesson step by step while the students partook actively in visualising, observing and learning some of the abstract contents of the lesson projected on the screen. Chalk and board were also used to write and give examples where necessary

Step 4

Summary Phase: The teacher revise the lesson and summarise the main point of the lesson, the subjects were referred to relevant chemistry text books for more information.

Step 5

Evaluation Phase: The teacher evaluates the lesson by asking students the following questions

1 .Define faradays first law of electrolysis

2. Define faradays second law of electrolysis

Conclusion: The teacher conclude his lesson by askin students to read about electroplating and electrode potential.

Assignment: The teacher gives students assignment to Calculate the mass of silver deposited when a current of 5.3A is passed through a solution a silver salt ($Agcl_2$) for 90 minutes (Ag = 108, 1 Faraday = 96500C)

LESSON PLAN 5

Subject	Chemistry
Topic:	Electrochemical cells
Class:	SS II

Average Age: 16 Years

Mode of Teaching: Computer-Assisted Instruction

Duration: 40 Minutes

Instructional Material: Computer and screen projector

Behavioural Objectives: At the end of the lesson students should be able to:

1. Identify salt bridge in an electrochemical cell
2. Understand Daniel cell
3. Understand Leclanche cell
4. Understand Lead accumulator

Step 1

System set up Phase: the teacher provide the instruments needed for Computer- Assisted Instruction which include the system (computer or laptop) the electrolysis concept software package, the projector and power supply, the teacher installed the software into the system, connect the projector and ensure students' proper sitting arrangement enables projection view clearly.

Step 2

Introduction Phase: The teacher introduces the lesson by stating clearly the main objectives of the lesson and ask students questions base on their previous knowledge to state the laws of electrolysis

Step 2

Content Delivery Phase: The teacher presents the lesson using the computer Assisted Instruction software package installed into the system through power point/slide projection, the teacher explain the flow of electron (i.e an electric current) can be set up between two electrodes which have different electrode potentials, the readiness and speed of this electron flow are determine by the magnitude of the difference between the two electrode potentials.

The device in which chemical energy is converted to electrical energy, is called an electrochemical cell, voltaic cell or galvanic cell it consist of two have cell

- An oxidation half-cell reaction occurs at the electrode in one half-cell and

- A complementary reduction half-cell reaction occur at the electrode in the other half-cell
- Electrochemical cells are widely employ to generate small currents of electricity for everyday purposes and industrial operations

Daniel cell

A simple electrochemical cell with practical use is Daniel cell. It consist of a copper vessel filled with a saturated solution of copper (ii) tetraoxosulphate (vi) and a porous pot filled with zinc tetraoxosulphate (vi) solution, immersed in the zinc tetraoxosulphate solution is a zinc rod. The initial e.m.f produce by the Daniel cell is about 1.1 volts. This cell has to be replaced once the chemical in it are deflected.

Lead accumulator

The lead accumulator is commonly used as a car battery. It is secondary or storage cell as it must be charged by passing a direct current through it

The charged cell can then produce an electric current when required. The cathode of fully-charged cell can then produce an electric current when required

Teacher explain the Leclanche cell through computer Assisted instructional package projected on the screen

the teacher guide and explained the main point of the lesson step by step while the students partook actively in visualising, observing and learning some of the abstract contents of the lesson projected on the screen. Chalk and board were also used to write and give examples where necessary

Step 4

Summary Phase: The teacher revise the lesson and summarise the main point of the lesson, the subjects were referred to relevant chemistry text books for more information.

Step 5

Evaluation Phase: The teacher evaluates the lesson by asking students the following questions

- Explain what they understand by lead accumulator
- Explain what they understand about chemical cell

Conclusion: The teacher conclude his lesson by asking students to read about electrical charges and electrical conductivity, electroplating and electrode potential.

Assignment: Draw and explain Daniel cell

LESSON PLAN 6

Subject	Chemistry
Topic:	Electrical charges and current
Class:	SS II

Average Age: 16 Years

Mode of Teaching: Computer-Assisted Instruction

Duration: 40 Minutes

Instructional Material: Computer and screen projector

Behavioural Objectives: At the end of the lesson students should be able to:

- ✓ To know how electrical charges and currents flow
- ✓ Understand what is an open circuit and a close circuit
- ✓ Understand the source of electricity
- ✓ Understand what are conductors and insulators

Step 1

System set up Phase: the teacher provide the instruments needed for Computer- Assisted Instruction which include the system (computer or laptop) the electrolysis concept software package, the projector and power supply, the teacher installed the software into the system, connect the projector and ensure students' proper sitting arrangement enables projection view clearly.

Step 2

Introduction Phase: The teacher introduces the lesson by stating clearly the main objectives of the lesson and ask students questions base on their previous knowledge to explain what they understand about Daniel cell, Leclanche cell, and lead accumulators

Step 3

Content Delivery Phase: The teacher presents the lesson using the computer Assisted Instruction software package installed into the system through power point/slide projection, The teacher begins to explain electrical charges through computer Assisted instructional package projected on the screen

Matter is made up of atom. An atom consists of positively-charged protons, neutrons and negatively charged the electrical property of matter is due to the charges on these atomic sub particle

An atom is neutral. i.e it has an equal number of protons and electrons. When two material are rubbed together, however, electrons from the atom of one material can be transferred onto the material, the material that loses electron becomes positively charged, while the one that gains the electron becomes negatively charged

When object made of certain material gain or lose electrons, they become charged. Such object exhibit static electricity. The charges on them remain stationary i.e there is no electron flow. Charged object attract uncharged object. Object will like charges repel one another and those with unlike charge attract one another.

The teacher explains electric current through computer Assisted instructional package projected on the screen

An electric current is a flow of electrons. The complete continues path taken by these electrons is called an electric circuit. Some important effects are associated with such a flow of electron (current) around an electric circuit. They are heating lighting, magnetic and chemical effects

The teacher explain open circuit and a closed circuit

A simple electric circuit may consist of a source of electric energy (e.g dry cell or lead accumulator) connected by wires to a load (e.g an electric bulb and a switch. If the wires are not disconnected at any point along an electric circuit, we say that that the circuit has a complete conducting path such circuit is called a closed circuit.

- An open circuit is one which has one or more gaps along its conducting path

the teacher guide and explained the main point of the lesson step by step while the students partook actively in visualising, observing and learning some of the abstract contents of the lesson projected on the screen. Chalk and board were also used to write and give examples where necessary

Step 4

Summary Phase: The teacher revise the lesson and summarise the main point of the lesson, the subjects were referred to relevant chemistry text books for more information.

Step 5

Evaluation Phase: The teacher evaluates the lesson by asking students the following questions

- Expain what is an open circuit
- Explain what is a close circuit

Conclusion: the teacher conclude his lesson by askin students to read about sources of electricity

Assignment: The teacher gives students assignment to explain how electric current a flowing using electrolysis concept.

APPENDIX G

LESSON PLAN FOR CONTROL GROUP

Subject	Chemistry
Topic:	Introduction to Electrolysis
Class:	SS II

Average Age:	16 Years
Mode of Teaching:	Lecture Method
Duration:	40 Minutes
	Instructional Material: Chalk and board
Behavioural Objectives:	At the end of the lesson students should be able to:

iv. Understand what is electrolysis
v. Understand what is Electrolyte and electrode
vi. Identify and differentiate between Anode and Cathode

Previous Knowledge; The students have learnt about electron transfer in Redox reaction

Presentation;

Step1. The teacher begins his lesson asking student some questions based on their previous knowledge of electron transfer in a chemical reaction concepts

Step ii. The teacher introduces by defining electrolysis, electrolyte, and electrode. – Electrolysis this is the chemical decomposition of a compound by direct current passing through either a solution of the compound or the molten compound

Step iii. The teacher define electrolyte; as compound which conduct electricity and decomposed in the process while Electrodes- these are conductors in the form of of wires, rod or plate through which an electric current enters the electrolyte or by which electrons leaves electrolyte

Step iv. The teacher defines Anode and cathode and explain their differences

Anode This is positive eletrode by which the conventional current currents enters the electrolyte or by which electrons leaves an electrolyte. Its the electrode which is joined to the positive terminal of electric supply.

Cathode – this is the negative electode by which the conventional current leaves the electrolytes or by which the electrons enters the electrolyte. It is the elecrode is joined to the negative terminal of the electric supply.

Summary;	the teacher summarises the lesson by briefly going through the main points of the lesson
Evaluation;	The teacher evaluate the lesson by asking students the following questions i. What is electrolysis ii. Differentiate between electrodes and electrolytes iii. What is the difference between anode and cathode
Conclusion;	The teacher conclude the lesson by asking students to read about ionic theory
Assignment;	The teacher gives the students the following assignments i. Give two examples of strong and weak electrolytes ii. What is an electrolytic cell?

LESSON PLAN 2

Subject	Chemistry
Topic:	Mechanism of Electrolysis
Class:	SS II
Average Age:	16 Years

Mode of Teaching: Lecture Method

Duration: 40 Minutes

Instructional Material: Chalk and board

Behavioural Objectives: At the end of the lesson students should be able to:

a. Understand the movement of electrons towards positive and negative terminals (Anode and Cathode)

Previous knowledge: The students have learnt about electrolysis electrode, electrolyte, anode and cathode

Presentation

Step i The teacher begins the lesson by asking students questions based on their previous knowledge to define electrolysis, differentiate electrode and electrolyte, cathode and anode

Step ii the teacher begins to explain the mechanism of electrolysis

- Electrolysis is the chemical change brought about by the passage of direct current through an electrolyte via electrodes. Before the passage of currents, the ions moves about randomly in the electrolyte. When electrolysis begins the battery or generator of electric current pumps electrons from its negative terminal (anode) to the catode of electrolytic cell. The negatively charged cathode then attracts the cations in the electrolyte it self. The cations accept electron to become electrically neutral and are eventually discharged. The positive terminal (cathode) of the battery draws electron from the anode of electrolytic cell. Anions in the electrolyte are then attracted to the positively charged anode, where they give up their electrons to become electrically neutral and are also finaly discharged. Hence the electric currents passes through the complete circuit.

Step iii **Summary** the teacher summarised the lesson by briefly going through the main point of the lesson

Conclusion:	The teacher evaluate the lesson by asking students to explain how ions in an electrolyte and how ions are being discharged
Assignment:	The teacher gives students assignment to draw the diagrammed of electrolysis set up and label it

LESSON PLAN 3

Subject	Chemistry
Topic:	Electrolytic reaction
Class:	SS II
Average Age:	16 Years

Mode of Teaching: Lecture Method

Duration: 40 Minutes

Instructional Material: Chalk and board

Behavioural Objectives: At the end of the lesson students should be able to:

a. Understand what is electrolytic reaction

b. State the conditions governing the discharge of ions

Presentation

Step i. The teacher introduce his lesson by asking students question based on their previous knowledge to explain the movement of ions in an electrolytes

Step ii. The teacher begins to explain what electrolytic reaction is

- Electrolytic reaction are redox reaction since they involve transfer of electrons. Oxidation occurs at the anode where the anions lose electronss this reaction at the anode is known as anodic half reaction. The cathodic half reaction which take place simultaneously at the cathode is a reduction reaction since the cations gains an electrons here. The overall reaction is obtained by algebraic addition of the two reactions.

Example

Cathodic half reaction $2Cu_2+ (aq) + 4e^- \longrightarrow 2Cu (s)$

Anodic half reaction $4OH^- (aq) \longrightarrow 2H_2O(l) + O_2 (g)$

Overall reaction $2Cu_2+ (aq) + 4OH^- (aq) \longrightarrow 2Cu (s) + O_2 (g) + 2H_2O(l)$

Step iii the teacher Begins to expain the condition governing the discharge of ions namely

i. The position of the ion in the electrochemical series

ii. The concentration of the ion in the electrolyte

iii. The nature of the electrode

Summary

The teacher summarised the lesson by breifly going through the main points of the lesson

Evaluation : The teacher evaluate the lesson by asking students the following questions

- What is an electrolytic reaction
- What are the condition governing discharged of ions

Conclusion: the teacher conclude his lesson by askin students to read about electolysis of water with dillute hydrogen tetraoxosulphate (iv) acid

Assignment: The teacher gives students assignment to write and show the relative position of the ion in the electrochemical series.

LESSON PLAN 4

Subject	Chemistry
Topic:	Faradays Laws of electrolysis
Class:	SS II
Average Age:	16 Years
Mode of Teaching:	Lecture Method
Duration:	40 Minutes

Instructional Material:	Chalk and board
Behavioural Objectives:	At the end of the lesson students should be able to:

4) Understand and State Faradays first Laws of electrolysis
5) Understand and State Faradays second Laws of electrolysis
6) Calculate the mass of silver deposited when a current is passed through its solution.

Presentation

Step i. The teacher introduce his lesson by asking students question based on their previous knowledge to explain what is an electrolytic reaction

Step ii. The teacher begins to explain Faradays Laws of electrolysis

The quantity of product liberated at the electrode during electrolysis is dependent on

a. The magnitude of the steady current passed
b. The time flow of the steady current
c. The ionic charge of the liberated element

These quantitative aspects of electrolysis were investigated by faraday that put forward two laws in 1883 to describe these relationships.

Step iii. The teacher state the first and second law of electrolysis

- Faradays first Laws of electrolysis stated tha the mass of an element discharged during an electrolysis is directly proportiional to the quantity of electricity passing through it

- Faradays second Laws of electrolysis state that when the same quantity of electricity is passed through different eletrolytes the relative number of moles of the element discharged are inversely proportional to the charges on the ions of the elements.

Step iv. The teacher gives work examples

Calculate the mass of silver deposited when a current of 2.6A is passed through a solution a silver salt ($Agcl_2$) for 70 minutes (Ag = 108, 1 Faraday = 96500C)

Quantity of electricity used = It = (2.6 x 70 x 60) C

$Ag^+ (aq) + e^- \longrightarrow Ag (s)$

108g if 108g

96500C liberated 108g of Ag

(2.6 x 70 x 60) C will liberate $\frac{2.6 \times 70 \times 108}{96500} = 12.22g$

Therefore mass of silver deposited is 12.22g

Summary : the teacher summarised the lesson by breifly going through the main points of the lesson

Evaluation : the teacher evaluate the lesson by asking students the following questions

- Define faradays first law of electrolysis
- Define faradays second law of electrolysis

Conclusion: the teacher conclude his lesson by askin students to read about electroplating and electrode potential.

Assignment: The teacher gives students assignment to Calculate the mass of silver deposited when a current of 5.3A is passed through a solution a silver salt ($Agcl_2$) for 90 minutes (Ag = 108, 1 Faraday = 96500C)

LESSON PLAN 5

Subject	Chemistry
Topic:	Electrochemical cells
Class:	SS II
Average Age:	16 Years
Mode of Teaching:	Lecture Method
Duration:	40 Minutes
Instructional Material:	Chalk and board

Behavioural Objectives: At the end of the lesson students should be able to:

- ✓ Identify salt bridge in an electrochemical cell
- ✓ Understand Daniel cell
- ✓ Understand Leclanche cell
- ✓ Understand Leclanche cell
- ✓ Understand Lead accumulator

Presentation

Step i. The teacher introduce his lesson by asking students question based on their previous knowledge to state the laws of electrolysis

Step ii. The teacher begins to explain the concepts of electrochemical cells

A flow of electron (i.e an electric current) can be set up between two electrodes which have different electrode potentials, the readiness and speed of this electron flow are determine by the magnitude of the difference between the two electrode potentials.

The device in which chemical energy is converted to electrical energy, is called an electrochemical cell, voltaic cell or galvanic cell it consist of two half cell

- An oxidation half-cell reaction occurs at the electrode in one half-cell and
- A complementary reduction half-cell reaction occur at the electrode in the other half-cell
- Electrochemical cells are widely employ to generate small currents of electricity for everyday purposes and industrial operations

Step iii: The teacher explain Daniel cell

A simple electrochemical cell with practical use is Daniel cell. It consist of a copper vessel filled with a saturated solution of copper (ii) tetraoxosulphate (vi) and a porous pot filled with zinc tetraoxosulphate (vi) solution, immersed in the zinc tetraoxosulphate solution is a zinc rod. The initial e.m.f produce by the Daniel cell is about 1.1 volts. This cell has to be replaced once the chemical in it are depleted.

Step iv; The teacher explain lead accumulator to the students

The lead accumulator is commonly used as a car battery. It is secondary or storage cell as it must be charged by passing a direct current through it

The charged cell can then produce an electric current when required. The cathode of fully-charged cell can then produce an electric current when required

Step v. The teacher explain Leclanche cell

Summary : The teacher summarised the lesson by breifly going through the main points of the lesson

Evaluation : The teacher evaluate the lesson by asking students the following questions

- Explain what they understand by lead accumulator
- Explain what they understand about chemical cell

Conclusion: The teacher conclude his lesson by askin students to read about electrical charges and electrical conductivity, electroplating and electrode potential.

Assignment: Draw and explain Daniel cell

LESSON PLAN 6

Subject	Chemistry
Topic:	Electrical charges and current
Class:	SS II
Average Age:	16 Years
Mode of Teaching:	Lecture Method
Duration:	40 Minutes
Instructional Material:	Chalk and board
Behavioural Objectives:	At the end of the lesson students should be able to:

- ✓ To know how electrical charges and currents flow
- ✓ Understand what is an open circuit and a close circuit
- ✓ Understand the source of electricity
- ✓ Understand what are conductors and insulators

Presentation

Step i. The teacher introduce his lesson by asking students questions based on their previous knowledge to explain what they understand about Daniel cell, Leclanche cell, lead accumulators

Step ii. The teacher begins to explain electrical charges. Matter is made up of atom. An atom consists of positively-charged protons, neutrons and negatively charged the electrical property of matter is due to the charges on these atomic sub particle

An atom is neutral. i.e it has an equal number of protons and electrons. When two material are rubbed together, however, electrons from the atom of one material can be transferred onto the material, the material that loses electron becomes positively charged, while the one that gains the electron becomes negatively charged

When object made of certain material gain or lose electrons, they become charged. Such object exhibit static electricity. The charges on them remain stationary i.e there is no electron flow. Charged object attract uncharged object. Object will like charges repel one another and those with unlike charge attract one another.

Step iii: The teacher explain what is electric current

An electric current is a flow of electrons. The complete continues path taken by these electrons is called an electric circuit. Some important effects are associated with such a flow of electron (current) around an electric circuit. They are heating lighting, magnetic and chemical effects

Step iv.	The teacher explain open circuit and a closed circuit
	A simple electric circuit may consist of a source of electric energy (e.g dry cell or lead accumulator) connected by wires to a load (e.g an electric bulb and a switch. If the wires are not disconnected at any point along an electric circuit, we say that that the circuit has a complete conducting path such circuit is called a closed circuit.
	An open circuit is one which has one or more gaps along its conducting path
Summary :	The teacher summarised the lesson by breifly going through the main points of the lesson
Evaluation :	The teacher evaluate the lesson by asking students the following questions
	➢ Expain what is an open circuit
	➢ Explain what is a close circuit
Conclusion:	The teacher conclude his lesson by askin students to read about sources of electricity
Assignment:	The teacher gives students assignment to explain how electric current a flowing using electrolysis concept

APPENDIX H

PILOT TEST RESULT AND GENERAL RESULT PRINT-OUT

```
PILOT TEST PRINT-OUT

GET
  FILE='C:\project\AAACOMPLETE THESIS\gachijamilu spss.sav'.
DATASET NAME DataSet0 WINDOW=FRONT.
CORRELATIONS
  /VARIABLES=TEST1 RETEST
  /PRINT=TWOTAIL NOSIG

  /MISSING=PAIRWISE.

NONPAR CORR
  /VARIABLES=SPLITHALF1 SPLITHALF2
  /PRINT=SPEARMAN TWOTAIL NOSIG
```

Nonparametric Correlations

Notes

Output	

Comments		
Input	Data	C:\Users\User\Documents\split half new.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	25
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each pair of variables are based on all the cases with valid data for that pair.
Syntax		NONPAR CORR /VARIABLES=SPLITHALF1 SPLITHALF2 /PRINT=SPEARMAN TWOTAIL NOSIG /MISSING=PAIRWISE.
Resources	Processor Time	00:00:00.016
	Elapsed Time	00:00:00.017
	Number of Cases Allowed	174762 cases[a]

a. Based on availability of workspace memory

```
CORRELATIONS
NONPAR CORR
  /VARIABLES=SPLITHALF1 SPLITHALF2
  /PRINT=SPEARMAN TWOTAIL NOSIG

  /MISSING=PAIRWISE.
[DataSet1] C:\Users\User\Documents\split half new.sav
```

Correlations

			SPLITHALF1	SPLITHALF2
Spearman's rho	SPLITHALF1	Correlation Coefficient	1.000	.704*
		Sig. (2-tailed)	.	.011
		N	13	12
	SPLITHALF2	Correlation Coefficient	.704*	1.000
		Sig. (2-tailed)	.011	.
		N	12	12

Correlations

			SPLITHALF1	SPLITHALF2
Spearman's rho	SPLITHALF1	Correlation Coefficient	1.000	.704*
		Sig. (2-tailed)	.	.011
		N	13	12
	SPLITHALF2	Correlation Coefficient	.704*	1.000
		Sig. (2-tailed)	.011	.
		N	12	12

*. Correlation is significant at the 0.05 level (2-tailed).

Notes

Output		
Comments		
Input	Data	C:\Users\User\Documents\split half new.sav
	Active Dataset	DataSet1

	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	25
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each pair of variables are based on all the cases with valid data for that pair.
Syntax		CORRELATIONS /VARIABLES=TEST1 RETEST /PRINT=TWOTAIL NOSIG /MISSING=PAIRWISE.
Resources	Processor Time	00:00:00.078
	Elapsed Time	00:00:00.046

```
CORRELATIONS
  /VARIABLES=TEST1 RETEST
  /PRINT=TWOTAIL NOSIG

  /MISSING=PAIRWISE.
```

Correlations

```
[DataSet1] C:\Users\User\Documents\split half new.sav
```

Correlations

		TEST1	RETEST
TEST1	Pearson Correlation	1	.972**
	Sig. (2-tailed)		.000
	N	25	25
RETEST	Pearson Correlation	.972**	1
	Sig. (2-tailed)	.000	
	N	25	25

**. Correlation is significant at the 0.05 level (2-tailed).

```
GENERAL RESULT PRINT-OUT

GET
  FILE='C:\project\AAACOMPLETE THESIS\gachijamilu spss.sav'.
DATASET NAME DataSet0 WINDOW=FRONT.
T-TEST GROUPS=score(2 3)
  /MISSING=ANALYSIS
  /VARIABLES=test

  /CRITERIA=CI(.9500).

NEW FILE.
DATASET NAME DataSet2 WINDOW=FRONT.
T-TEST GROUPS=score(3 4)
```

```
  /MISSING=ANALYSIS
  /VARIABLES=test

  /CRITERIA=CI(.9500).

T-TEST GROUPS=SCORE2(5 6)
  /MISSING=ANALYSIS
  /VARIABLES=TEST2

  /CRITERIA=CI(.9500).

T-TEST GROUPS=SCORE3(7 8)
  /MISSING=ANALYSIS
  /VARIABLES=TEST3

  /CRITERIA=CI(.9500).

NPAR TESTS
  /M-W= TEST4 BY SCORE4(9 10)

  /MISSING ANALYSIS.

NPAR TESTS
  /M-W= TEST5 BY SCORE5(12 13)

  /MISSING ANALYSIS.

SAVE OUTFILE='C:\Users\User\Documents\jamilu gachi NEW SPSSSSS.sav'
  /COMPRESSED.
DATASET ACTIVATE DataSet1.
NEW FILE.

DATASET NAME DataSet3 WINDOW=FRONT.
```

NPar Tests

Notes

Output Created		
Comments		
Input	Active Dataset	DataSet2
	Filter	<none>
	Weight	<none>

	Split File	<none>
	N of Rows in Working Data File	129
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
Syntax		NPAR TESTS /M-W= TEST5 BY SCORE5(12 13) /MISSING ANALYSIS.
Resources	Processor Time	00:00:00.063
	Elapsed Time	00:00:00.094
	Number of Cases Allowed[a]	112347

a. Based on availability of workspace memory.

```
[DataSet2]
```

Mann-Whitney Test

Ranks

	SCORE 5	N	Mean Rank	Sum of Ranks
POST-TEST5	12	59	80.64	4757.50
	13	64	44.82	2868.50
	Total	123		

Test Statistics[a]

	TEST5
Mann-Whitney U	788.500
Wilcoxon W	2.868E3
Z	-5.572
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: SCORE5

T-Test

Notes

Output Created		
Comments		
Input	Active Dataset	DataSet2
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	129

Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=SCORE3(7 8) /MISSING=ANALYSIS /VARIABLES=TEST3 /CRITERIA=CI(.9500).
Resources	Processor Time	00:00:00.000
	Elapsed Time	00:00:00.000

[DataSet2]

Group Statistics

	SCORE 3	N	Mean	Std. Deviation	Std. Error Mean
Post-Posttest3	7	59	27.5085	8.56692	1.11532
	8	64	20.6562	6.55676	.81959

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
PostPosttest3	Equal variances assumed	4.532	.035	5.004	121	.000	6.85222	1.36934	4.14126	9.56319
	Equal variances not assumed			4.951	108.442	.000	6.85222	1.38408	4.10887	9.59558

T-Test

Notes

Output Created		
Comments		
Input	Active Dataset	DataSet2
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	129

Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=SCORE2(5 6) /MISSING=ANALYSIS /VARIABLES=TEST2 /CRITERIA=CI(.9500).
Resources	Processor Time	00:00:00.000
	Elapsed Time	00:00:00.000

[DataSet2]

Group Statistics

	SCORE 2	N	Mean	Std. Deviation	Std. Error Mean
Post-TEST2	5	59	31.5593	6.91144	.89979
	6	64	21.8750	7.84877	.98110

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Post-TEST2	Equal variances assumed	1.170	.282	7.237	121	.000	9.68432	1.33815	7.03510	12.33354
	Equal variances not assumed			7.275	120.755	.000	9.68432	1.33123	7.04875	12.31990

T-Test

Notes

Output Created		
Comments		
Input	Data	C:\Users\User\Documents\KHADIJAT NEW SPSSSSS.sav
	Active Dataset	DataSet2
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	129

Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=SCORE6(14 15) /MISSING=ANALYSIS /VARIABLES=TEST6 /CRITERIA=CI(.9500).
Resources	Processor Time	00:00:00.016
	Elapsed Time	00:00:00.017

```
[DataSet2] C:\Users\User\Documents\jamilu gachi NEW SPSSSSS.sav
```

Group Statistics

	SCORE 6	N	Mean	Std. Deviation	Std. Error Mean
GENDER TEST6	14	37	32.5676	6.38375	1.04948
	15	22	32.1364	7.04608	1.50223

Independent Samples Test

	Levene's Test for Equality of Variances	t-test for Equality of Means

		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
GENDER TEST6	Equal variances assumed	1.170	.284	.241	57	.810	.43120	1.78643	-3.14605	4.00846
	Equal variances not assumed			.235	40.828	.815	.43120	1.83251	-3.27010	4.13251

T-Test

Notes

Output Created		
Comments		
Input	Active Dataset	DataSet2
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	129
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.

	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=score(3 4) /MISSING=ANALYSIS /VARIABLES=test /CRITERIA=CI(.9500).
Resources	Processor Time	00:00:00.000
	Elapsed Time	00:00:00.000

[DataSet2]

Group Statistics

	score	N	Mean	Std. Deviation	Std. Error Mean
Pre-TEST1	3	59	16.2712	4.41717	.57507
	4	64	15.2188	4.24065	.53008

Independent Samples Test

	Levene's Test for Equality of Variances	t-test for Equality of Means

		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Pre-TEST1	Equal variances assumed	.031	.859	1.348	121	.180	1.05244	.78080	-.49336	2.59823
	Equal variances not assumed			1.346	119.205	.181	1.05244	.78210	-.49618	2.60105

NPar Tests

Notes

Output Created		
Comments		
Input	Data	C:\Users\User\Documents\witney 1.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	124
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.

	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
Syntax		NPAR TESTS /M-W= VAR00018 BY VAR00019(9 10) /MISSING ANALYSIS.
Resources	Processor Time[a]	00:00:00.015
	Elapsed Time	00:00:00.015
	Number of Cases Allowed	112347

a. Based on availability of workspace memory.

```
[DataSet1] C:\Users\User\Documents\witney 1.sav
```

Mann-Whitney Test

Ranks

	SCORE 4	N	Mean Rank	Sum of Ranks
PRE-TEST4	9	59	44.11	3192.50
	10	64	49.27	4433.50
	Total	123		

Test Statistics[a]

	TEST4
Mann-Whitney U	1.422E3

Wilcoxon W	3.192E3
Z	-2.360
Asymp. Sig. (2-tailed)	.018

a. Grouping Variable: SCORE4

APPENDIX I

Screenshoots of Computer-Assisted instruction (CAI) Software package on Electrolysis Concept

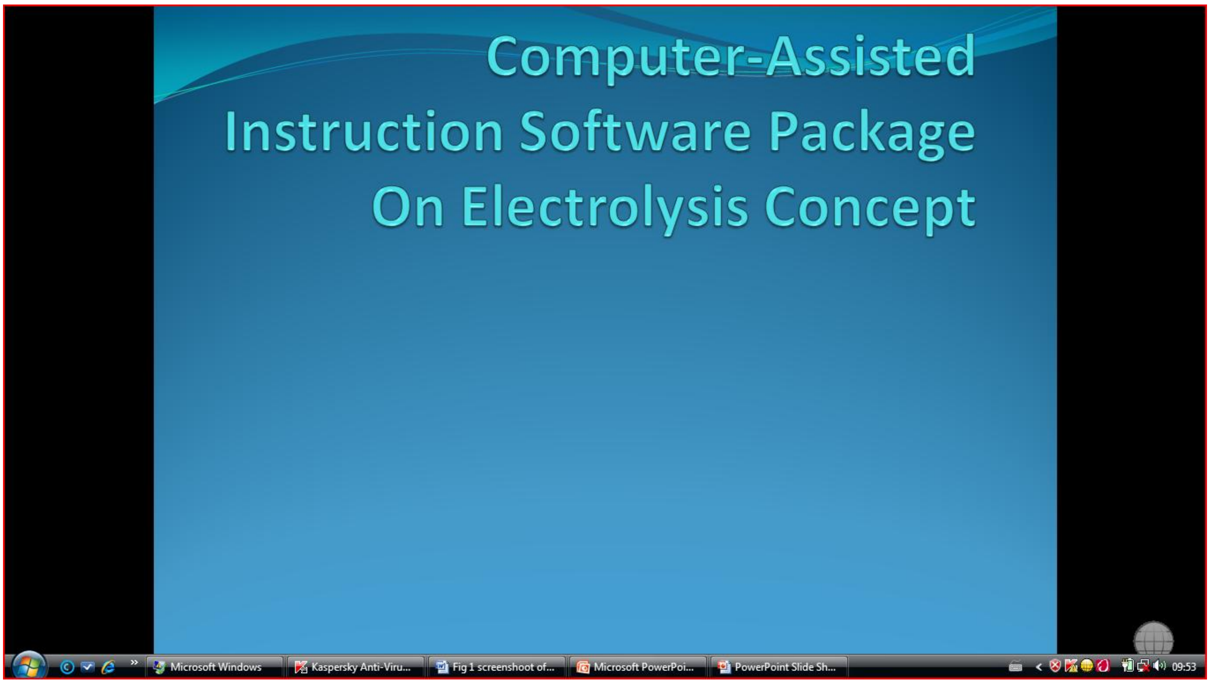

Fig 1: Screenshoot for the Title Page

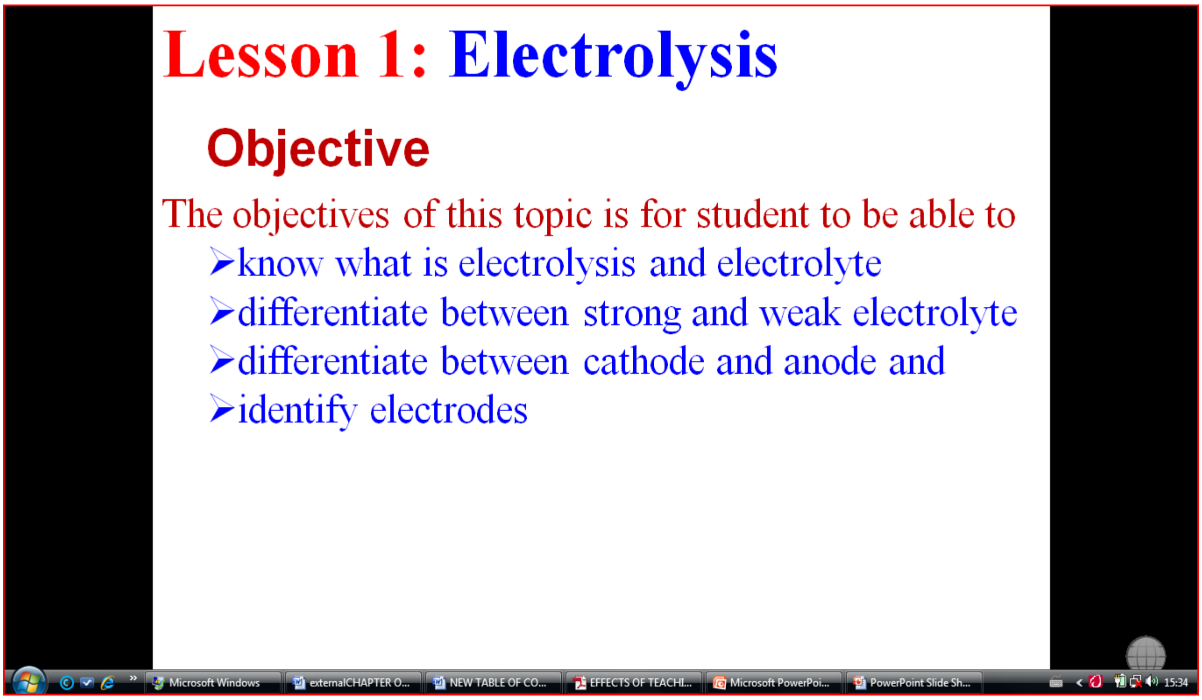

Fig 2: Screenshoot for lesson 1 objectives

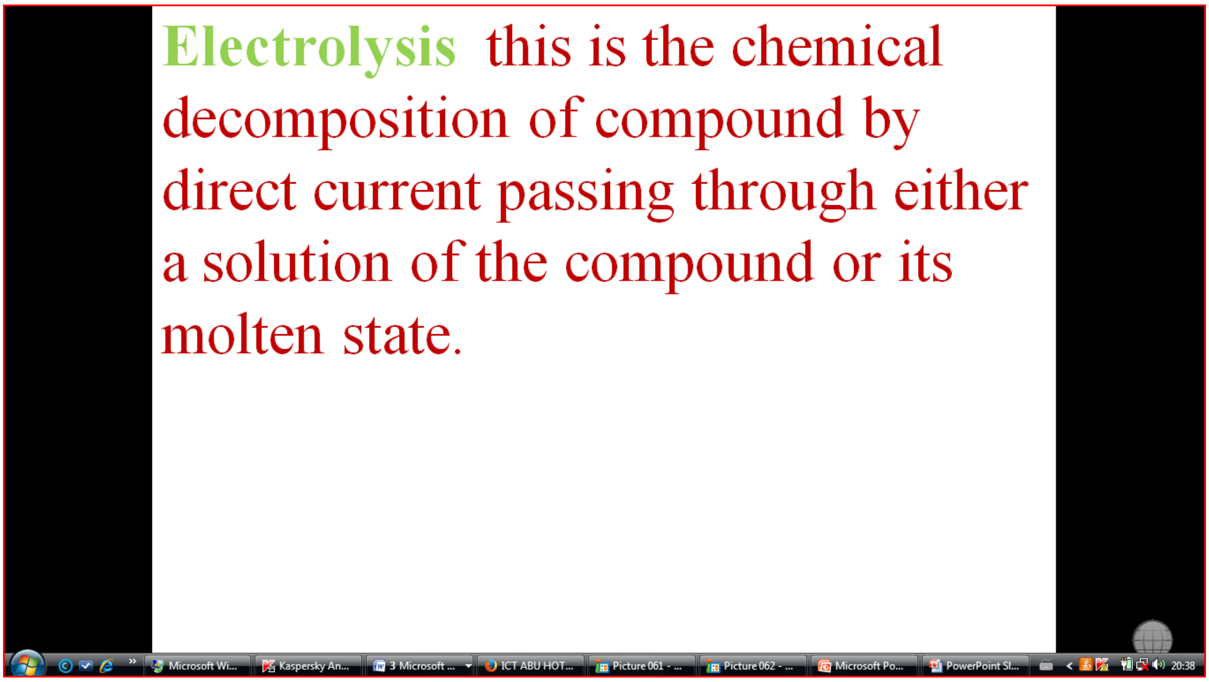

Fig 3: Screenshoot for defination of electrolysis

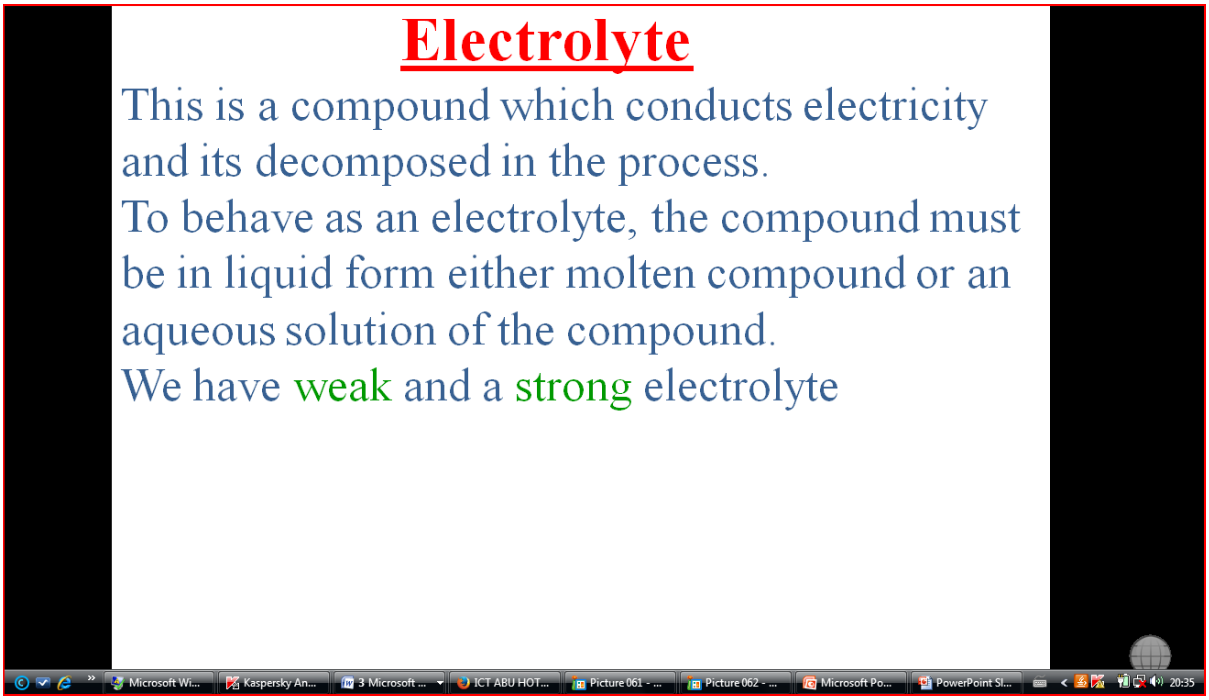

Fig 4: Screenshoot for defination of electrolyte

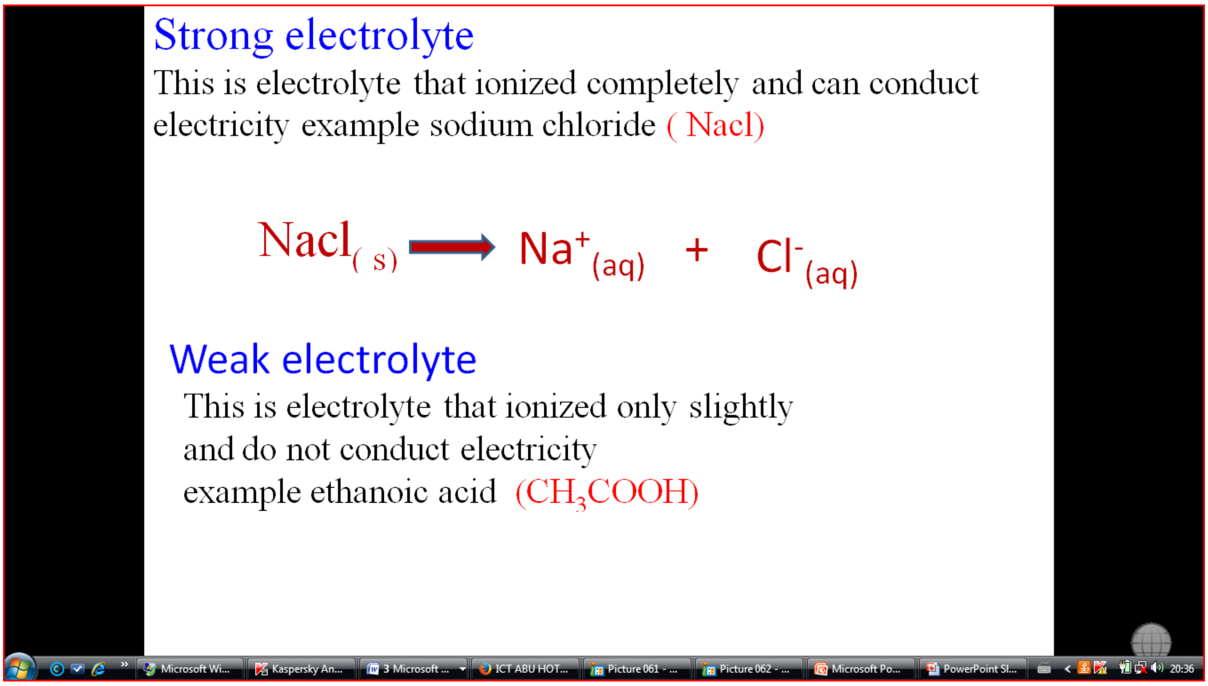

Fig 5: Screenshoot diffrenciating strong and weak electrolyte

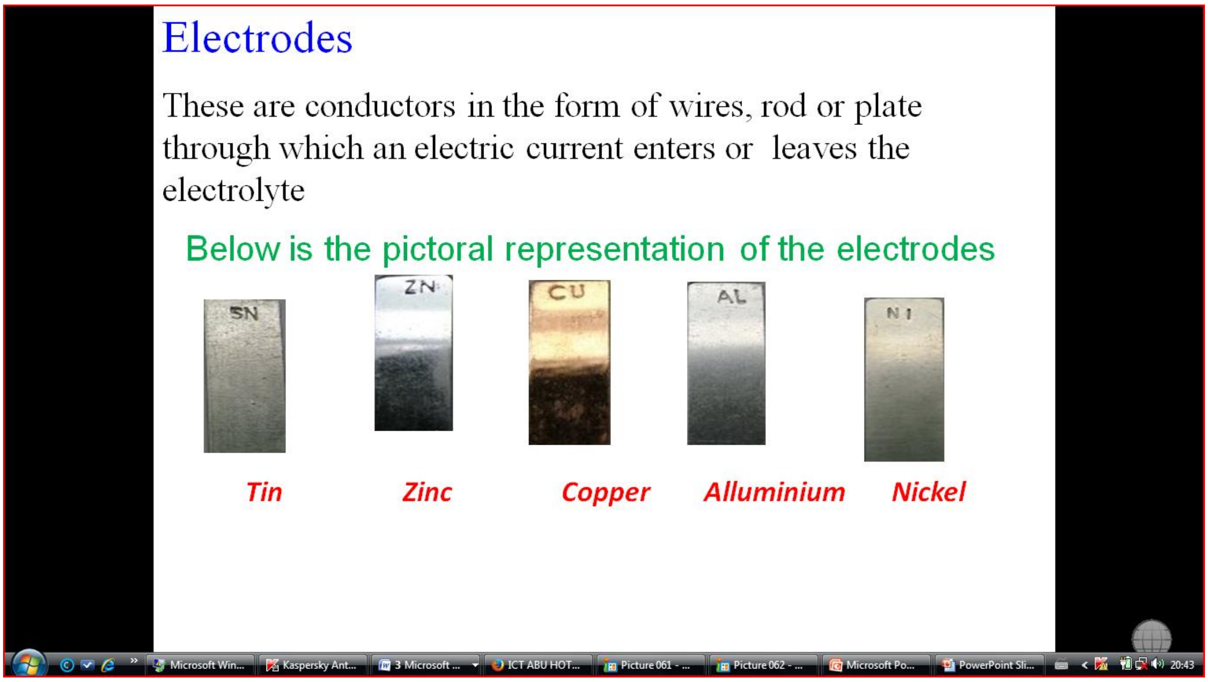

Fig 6: Screenshoot for definition of electrodes and simluation showing pictoral representation of electrodes

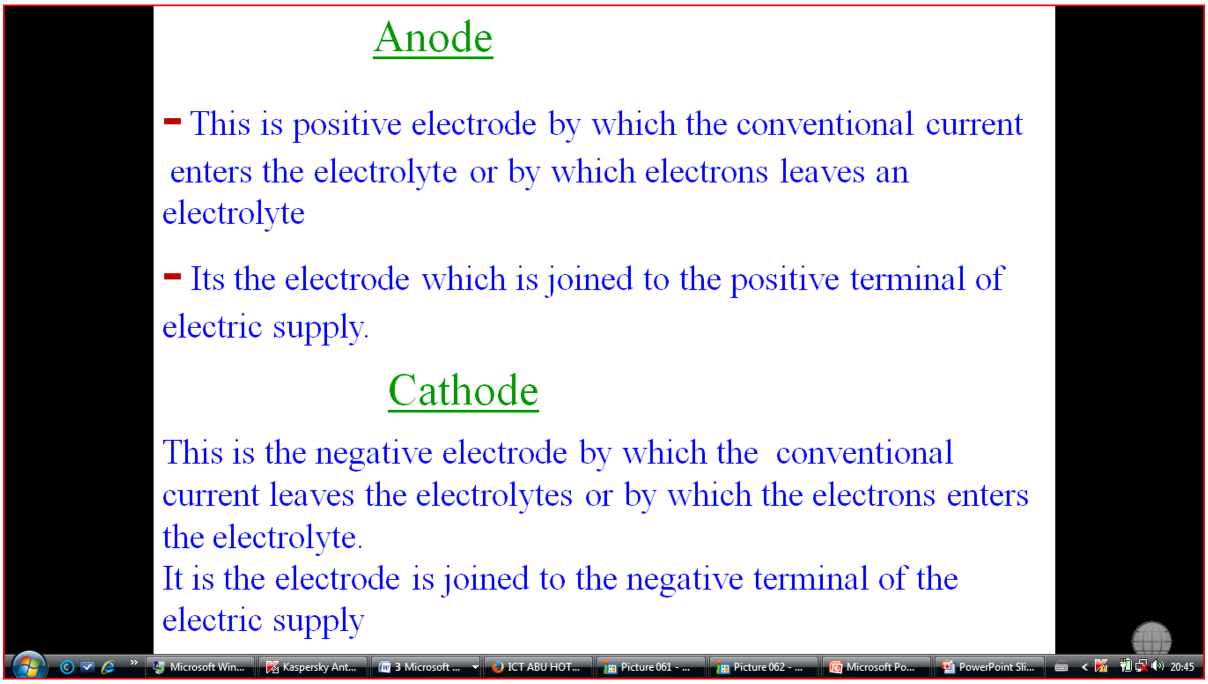

Fig 7: Screenshoot for Cathode and Anode diffrences

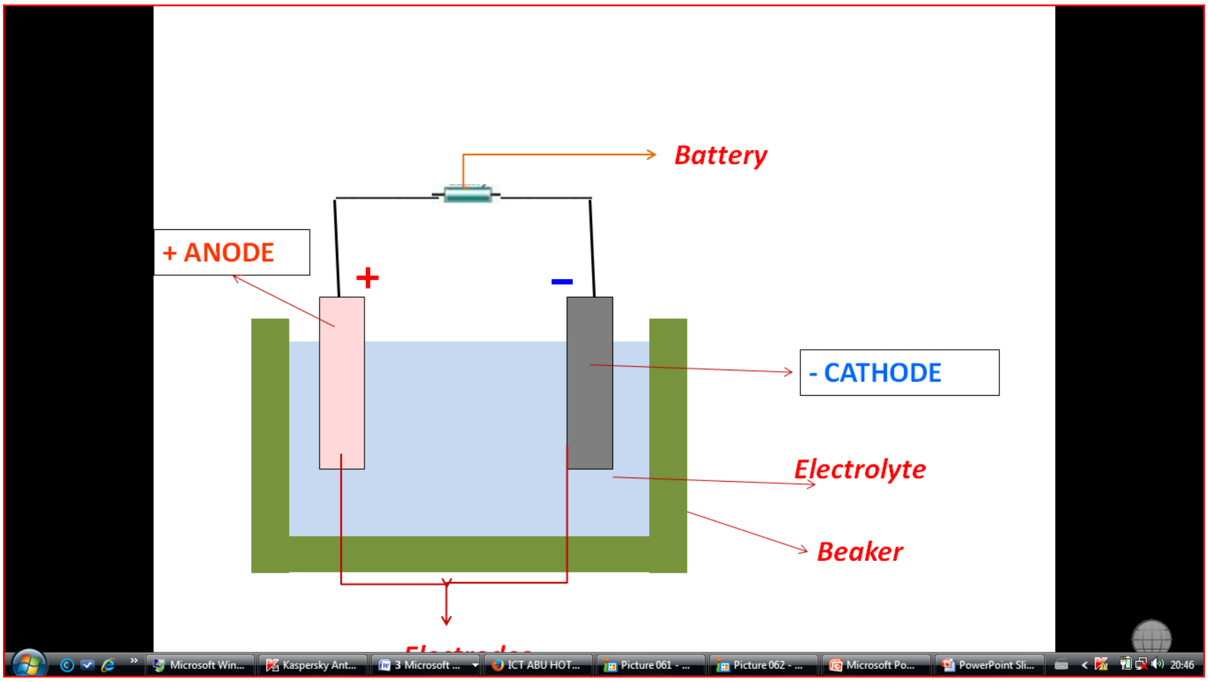

Fig 8: Screenshoot simulation to show electrodes , electrolyte, cathode and anode

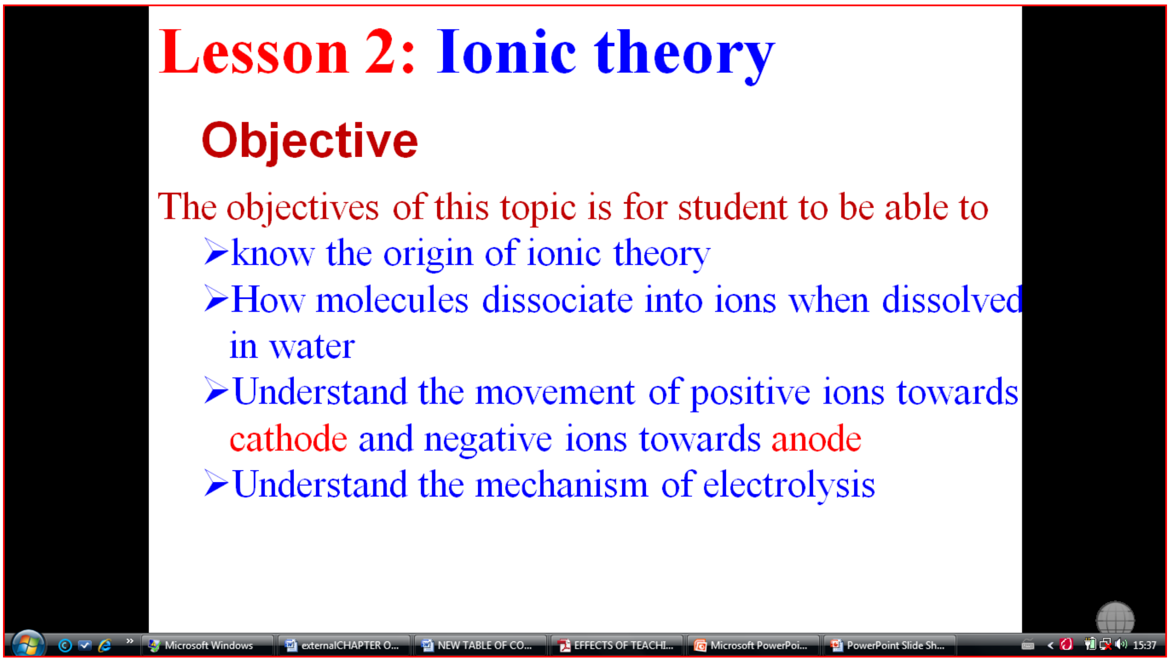

Fig 9: Screenshoot for lesson 2 objectives

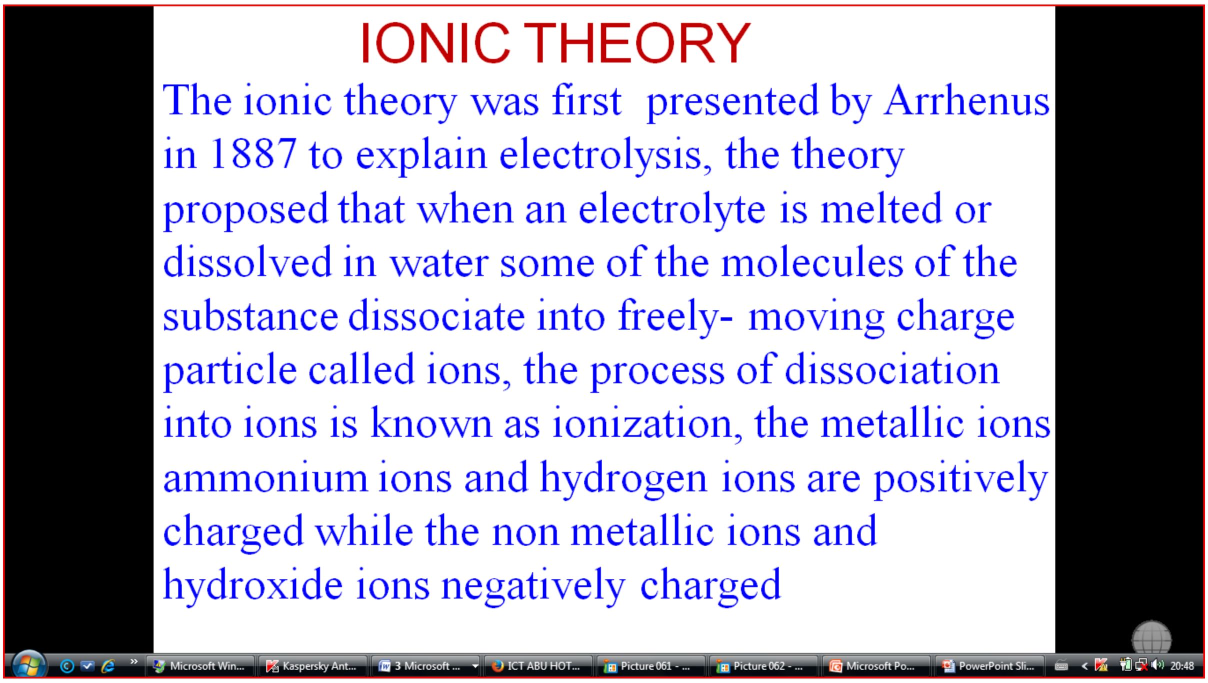

Fig 10: Screenshoot for origin of ionic theory

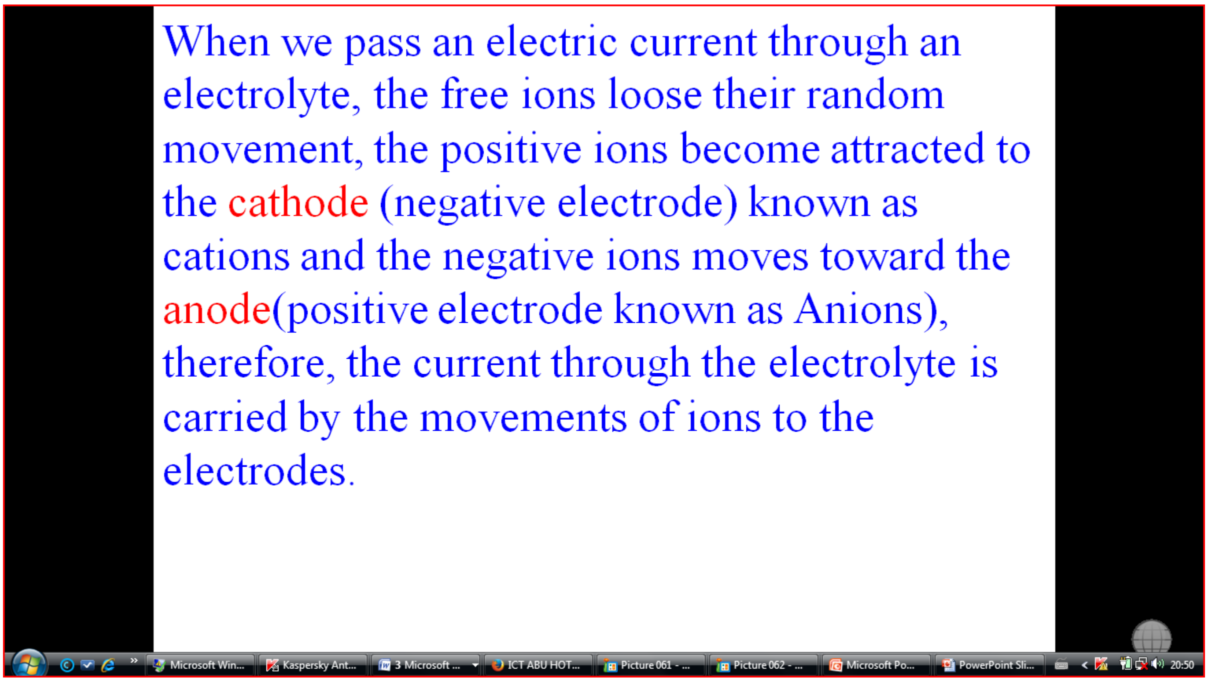

Fig 11: Screenshoot for movement of ions to the electrodes

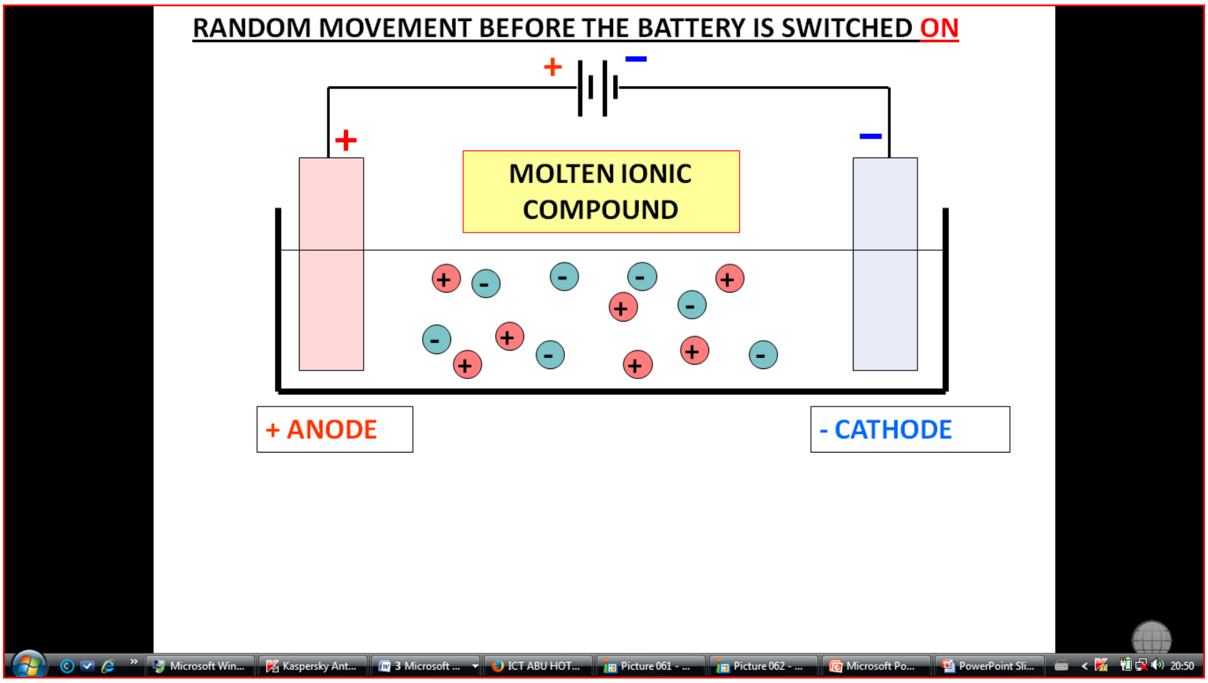

Fig 12: Screenshoot for simulation to show the random movements of ions in electrolysis set-up before the battery is switch on

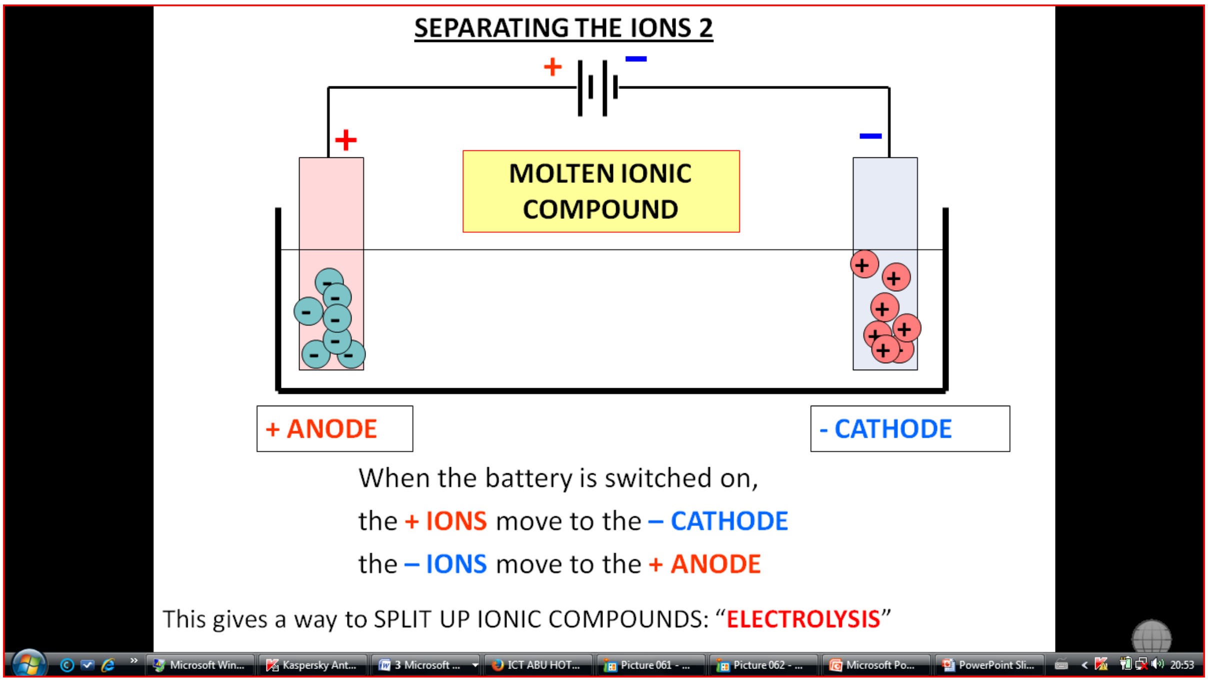

Fig 13: Screenshoot for simulation to show separation of the ions toward cathodes and anode when the battery is switch on

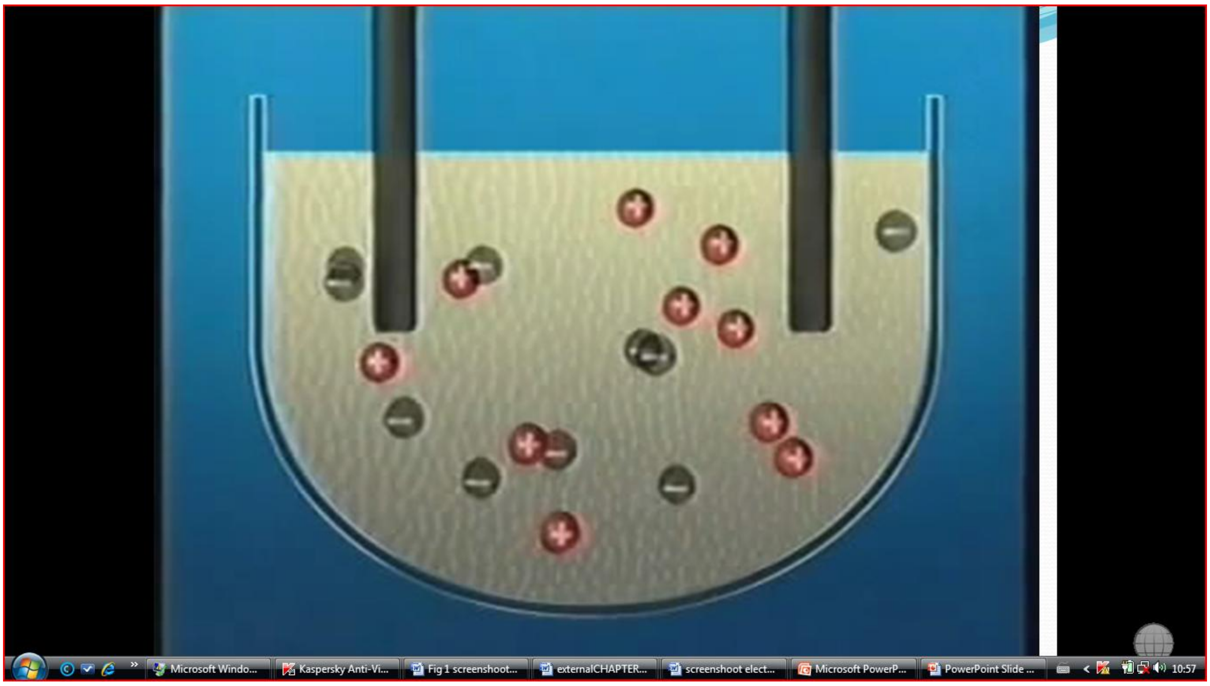

Fig 14: Screenshoot for simulation to show movement of ions toward cathodes and anode

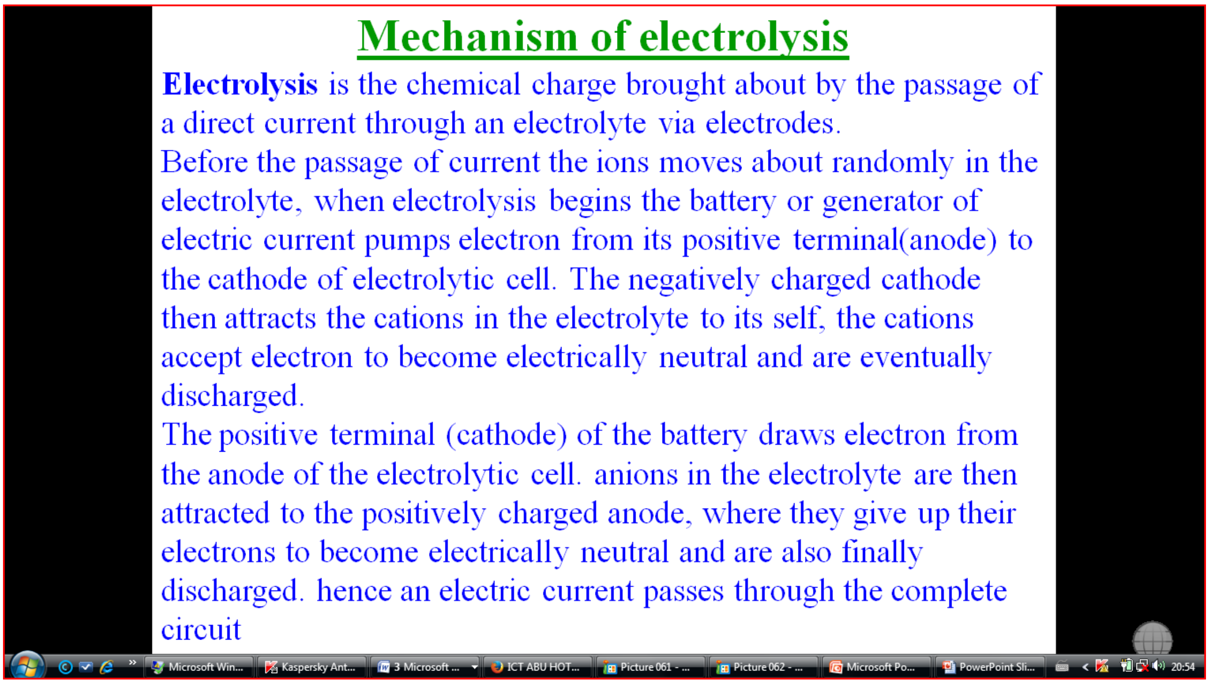

Fig 15: Screenshoot for mechanism of electrolysis

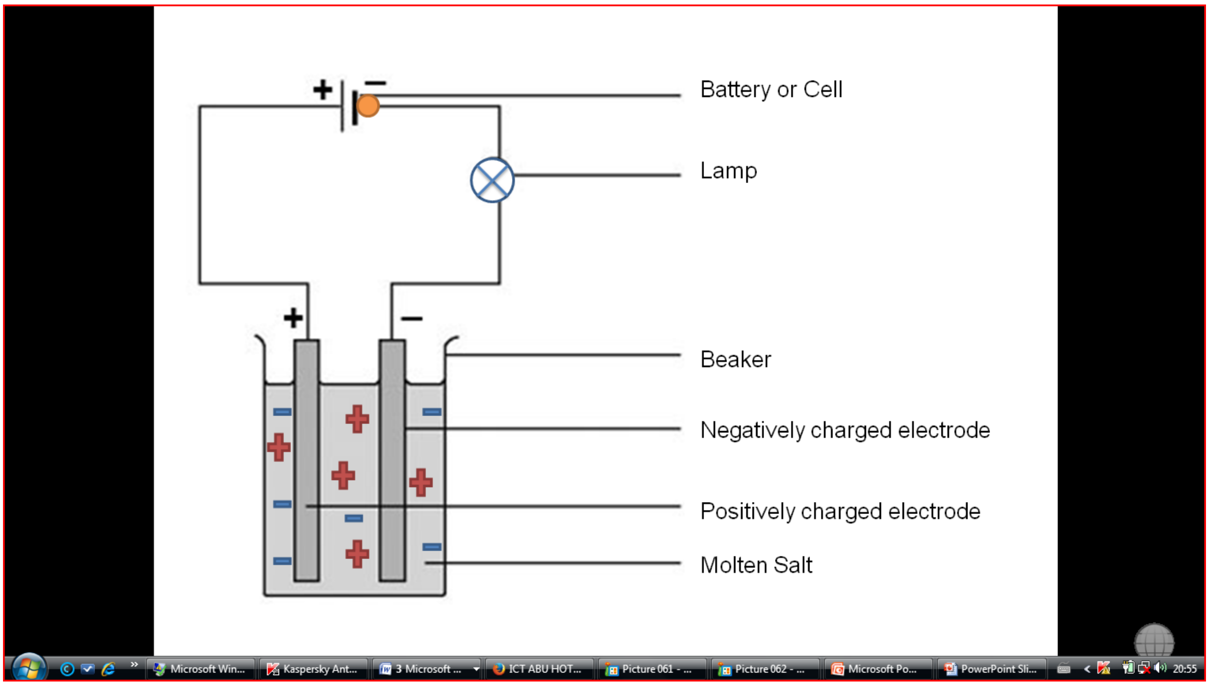

Fig 16: Screenshoot for simulation to show the attraction of cations and anions in the electrolytes

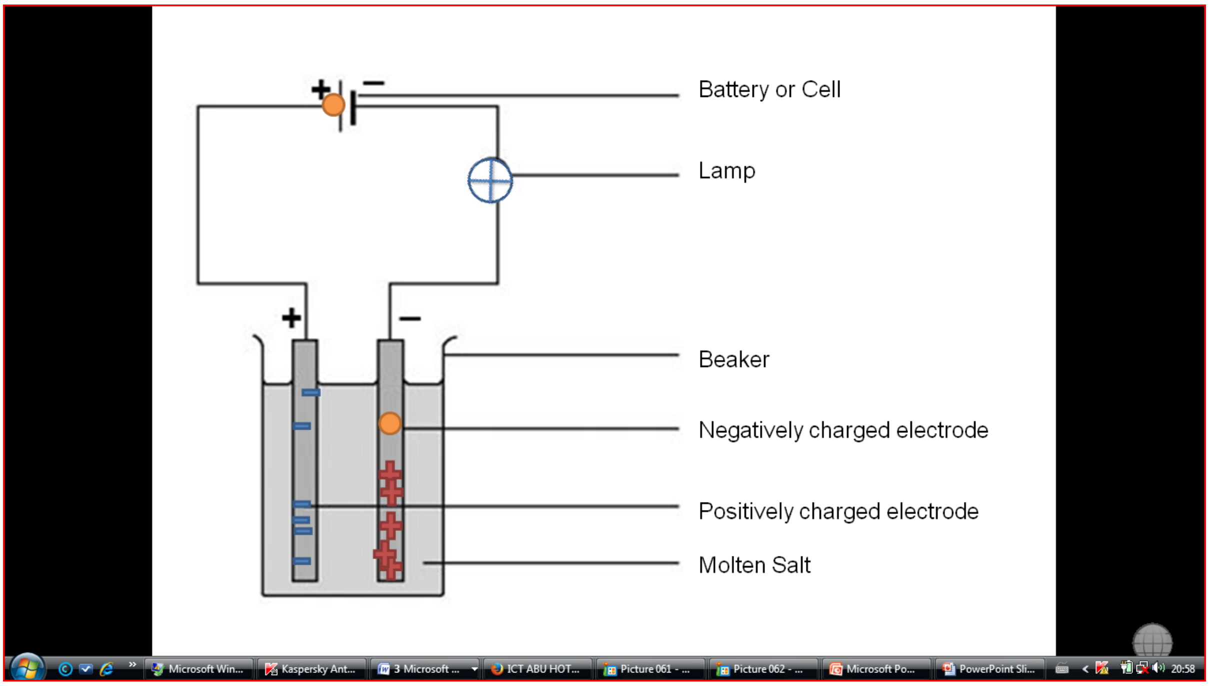

Fig 17: Screenshoot for simulation to show how electrons are being discharge

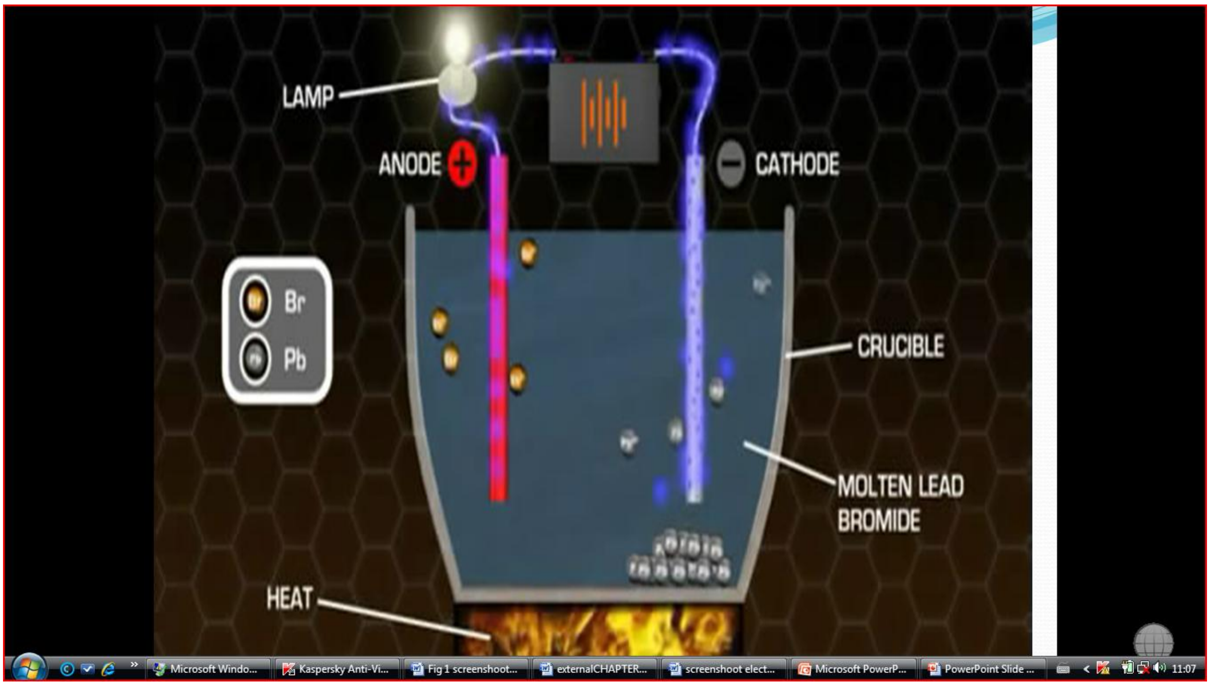

Fig 18: Screenshoot for simulation to show how electric current pass through a complete cycle

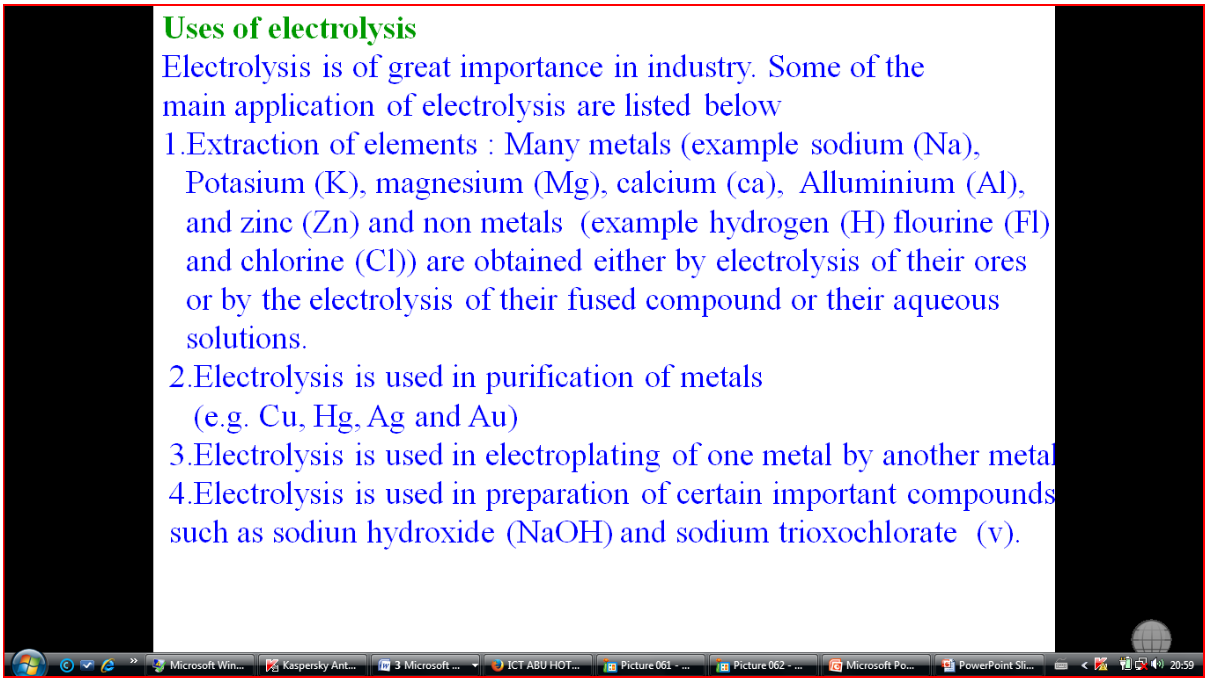

Fig 19: Screenshoot for uses of electrolysis

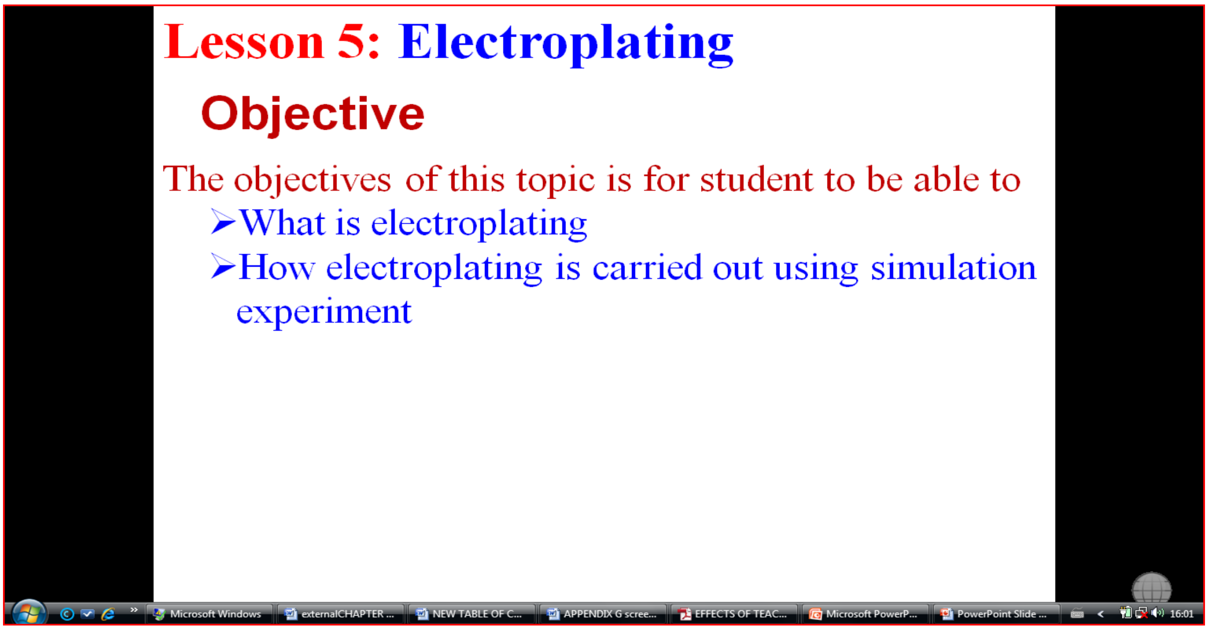

Fig 20: Screenshoot for Electroplating lesson objectives

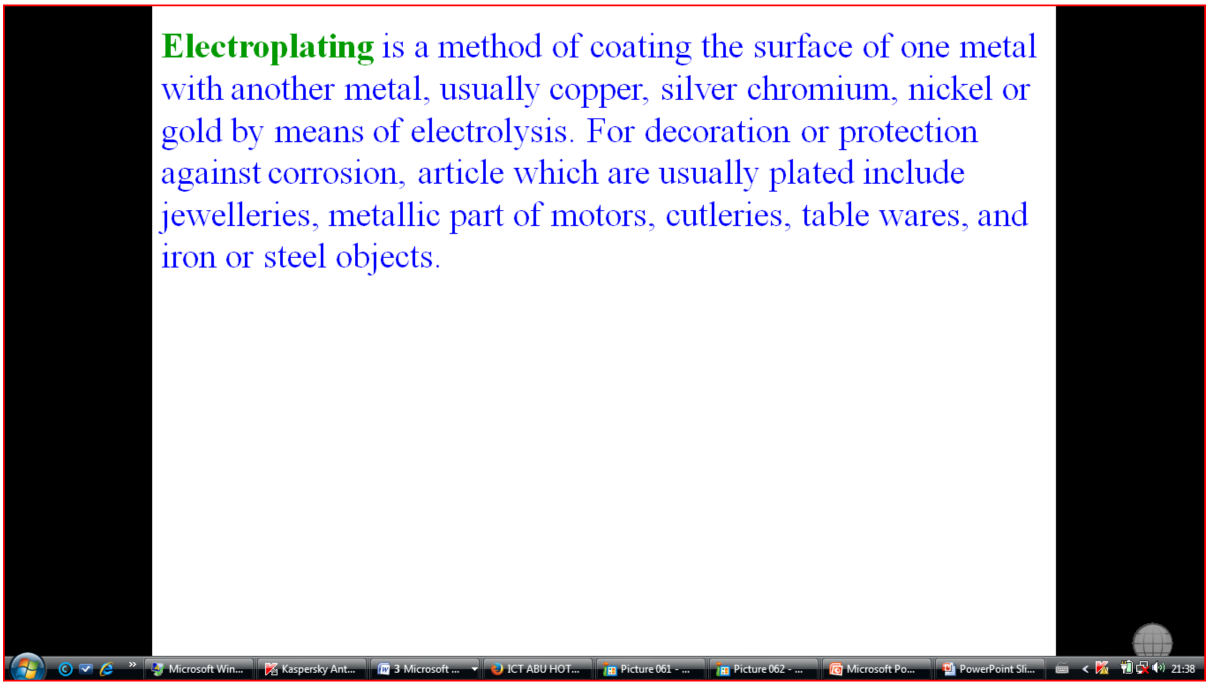

Fig 21: Screenshoot for defination of electroplating

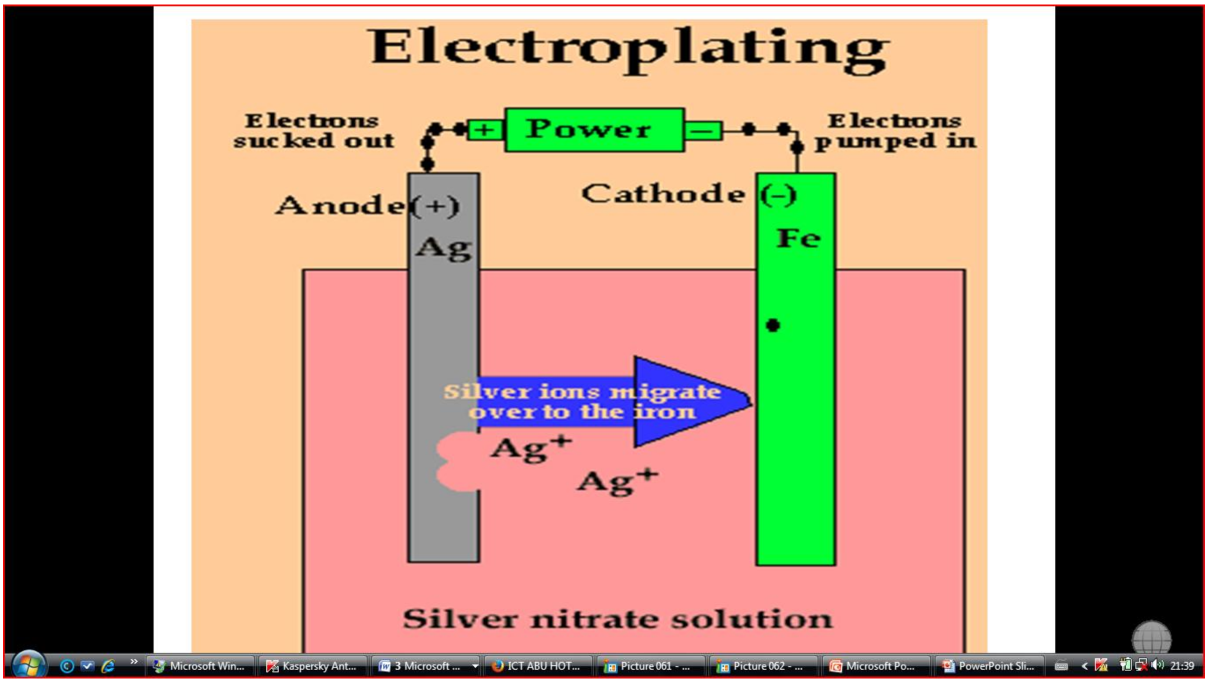

Fig 22: Screenshoot simulation to show how silver ions are migrating towards iron

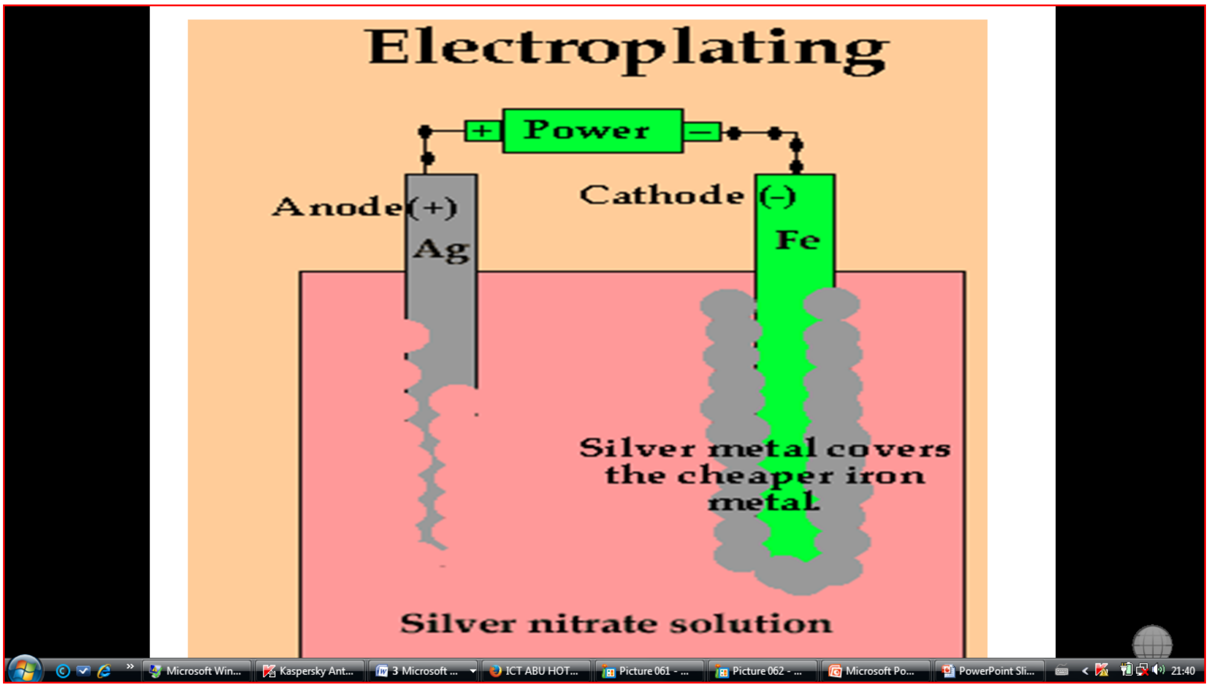

Fig 23: Screenshoot simulation to show electroplating of iron with silver

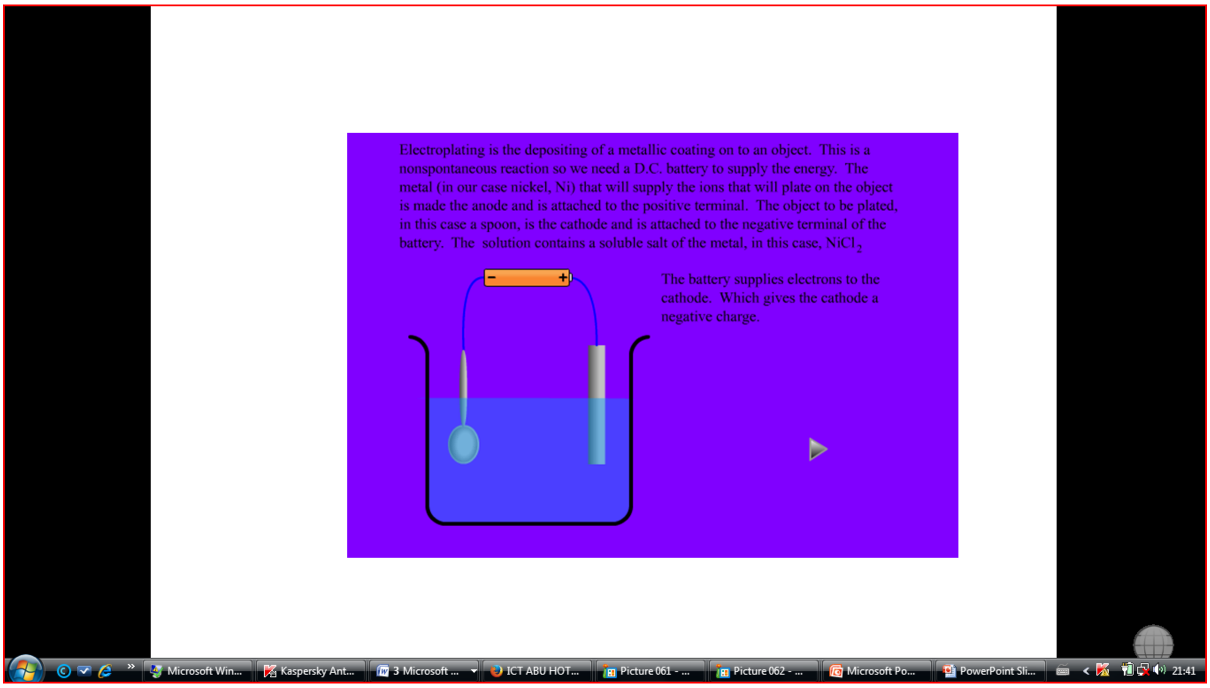

Fig 24: Screenshoot simulation to show electroplating

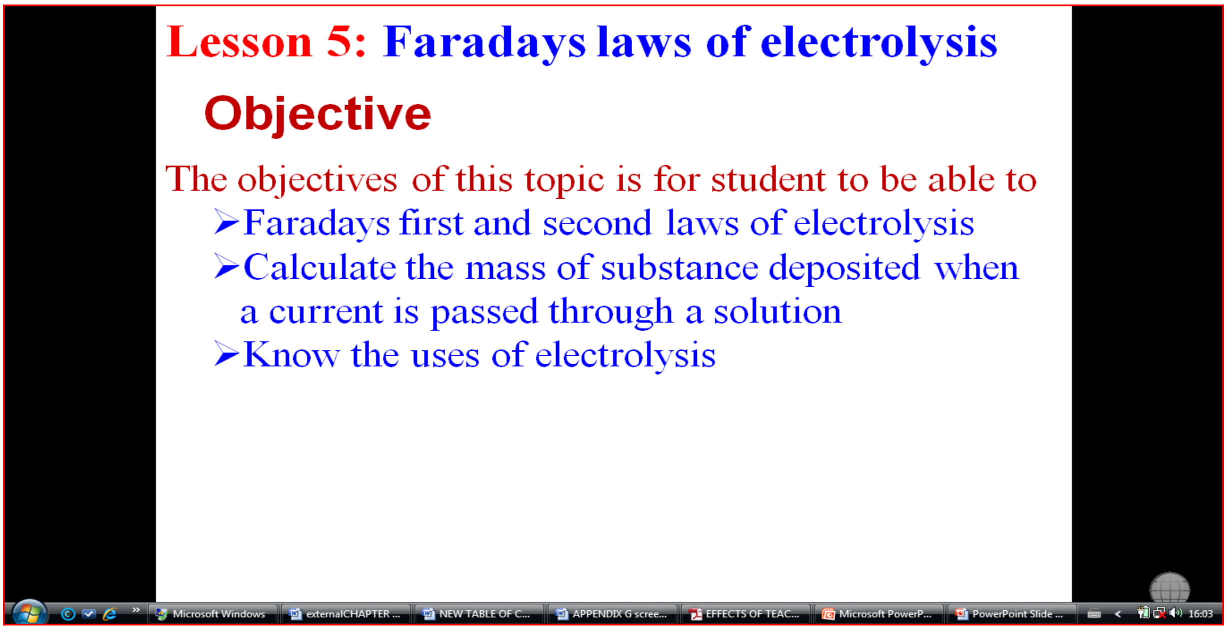

Fig 25: Screenshoot for lesson 5 objectives

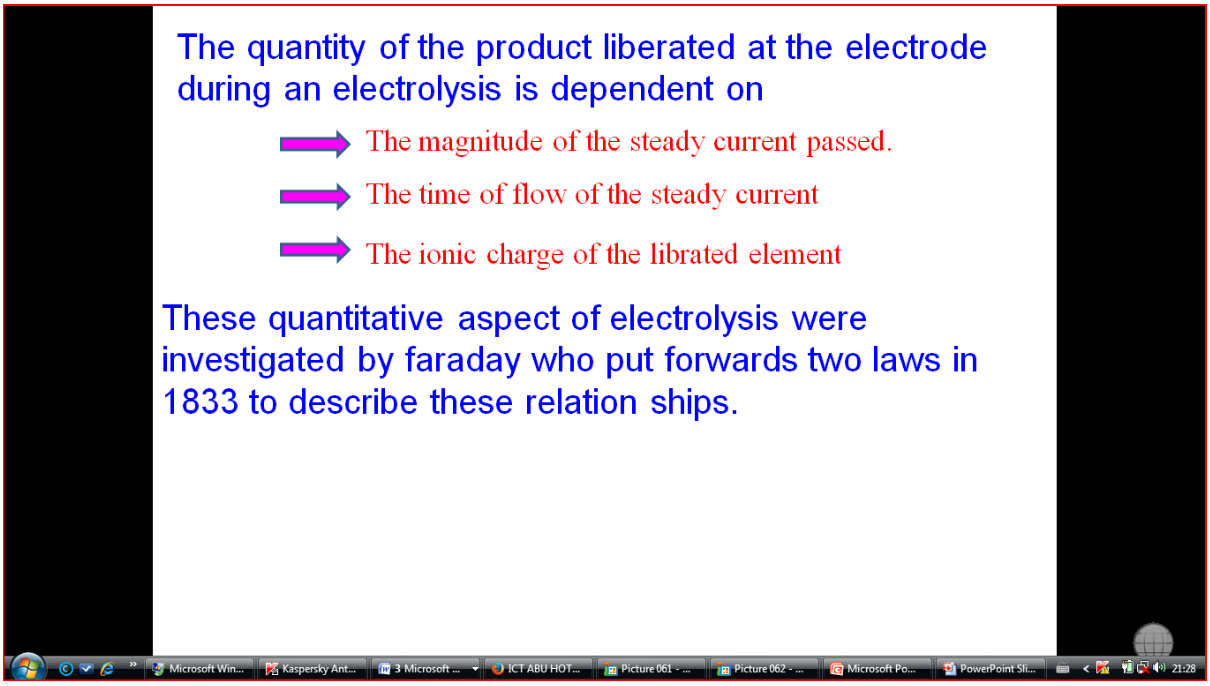

Fig 26: Screenshoot for condion governing the quantity of product liberated during electrolysis

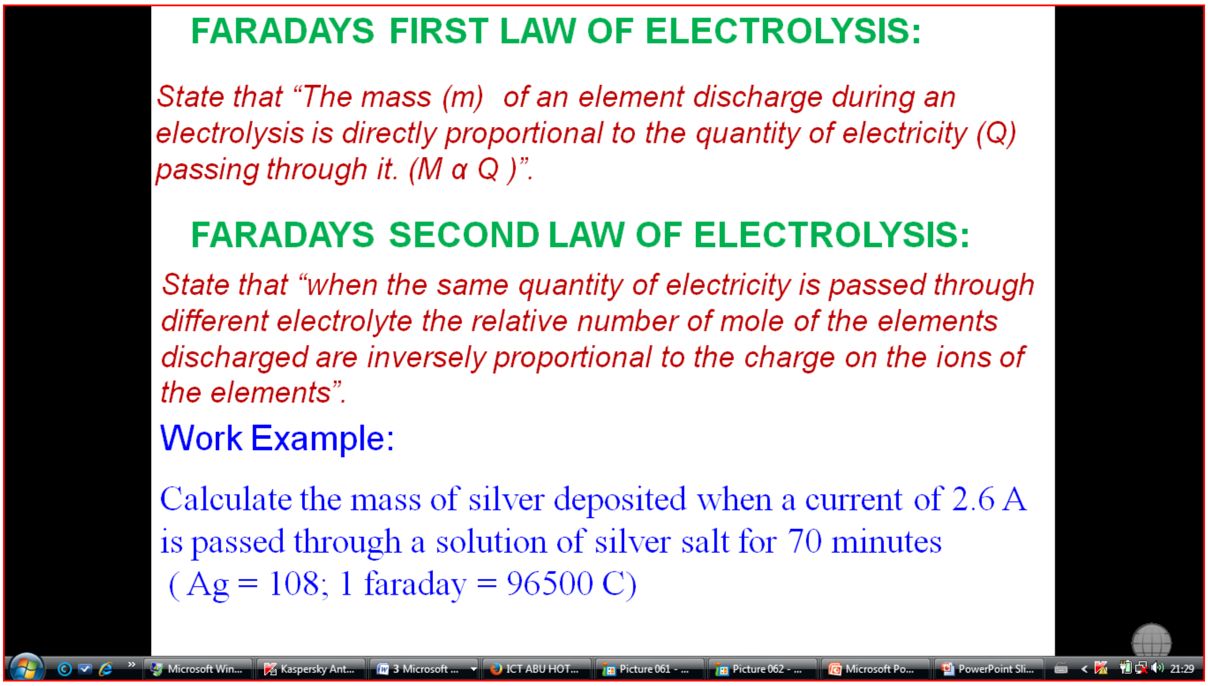

Fig 27: Screenshoot for faradays first and second law with work example

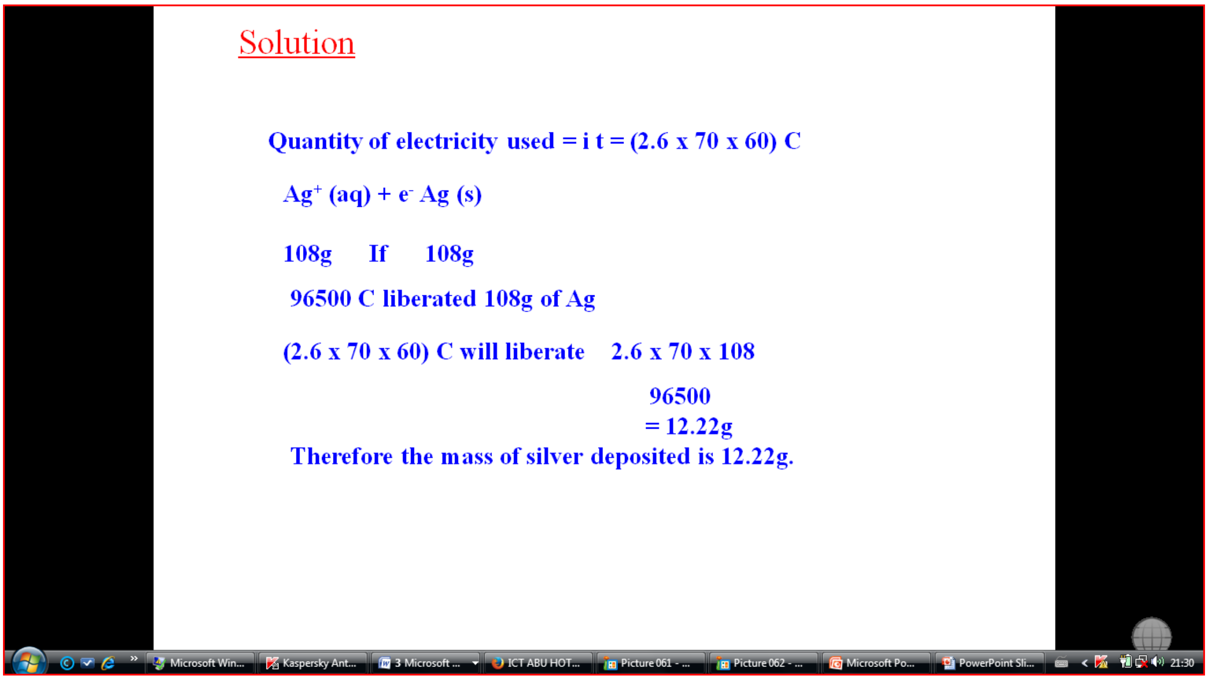

Fig 28: Screenshoot for solution for the work example

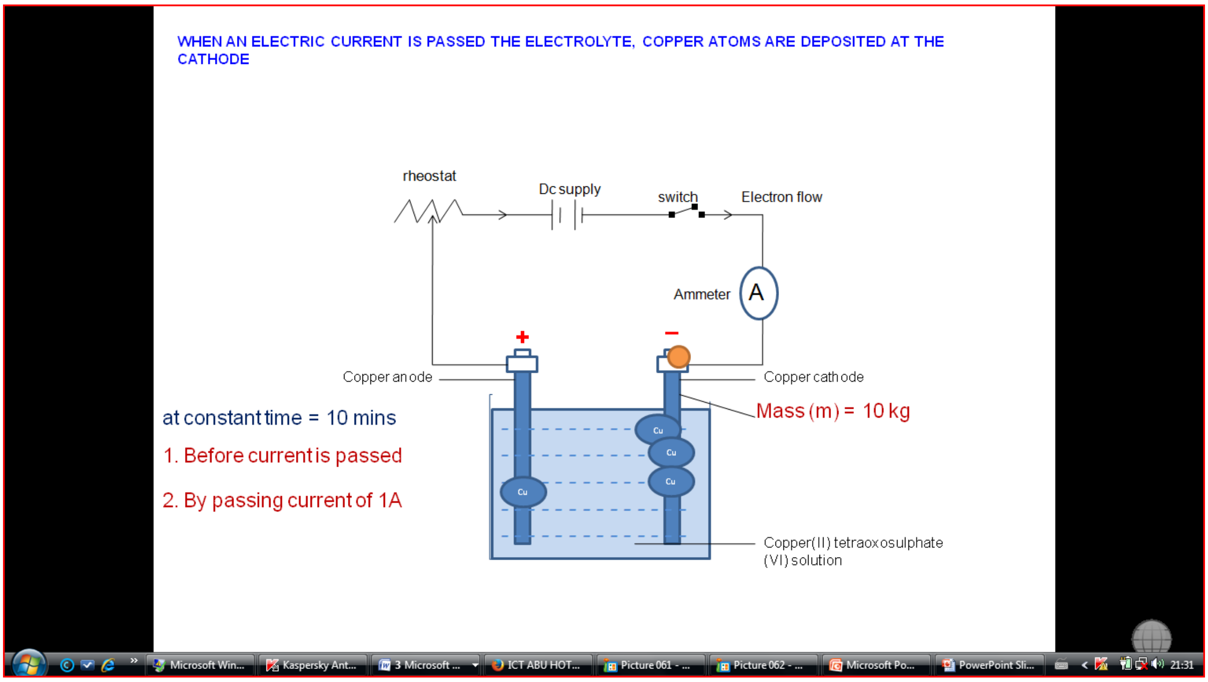

Fig 29: Screenshoot simulation to justify faradays first law of electrolysis

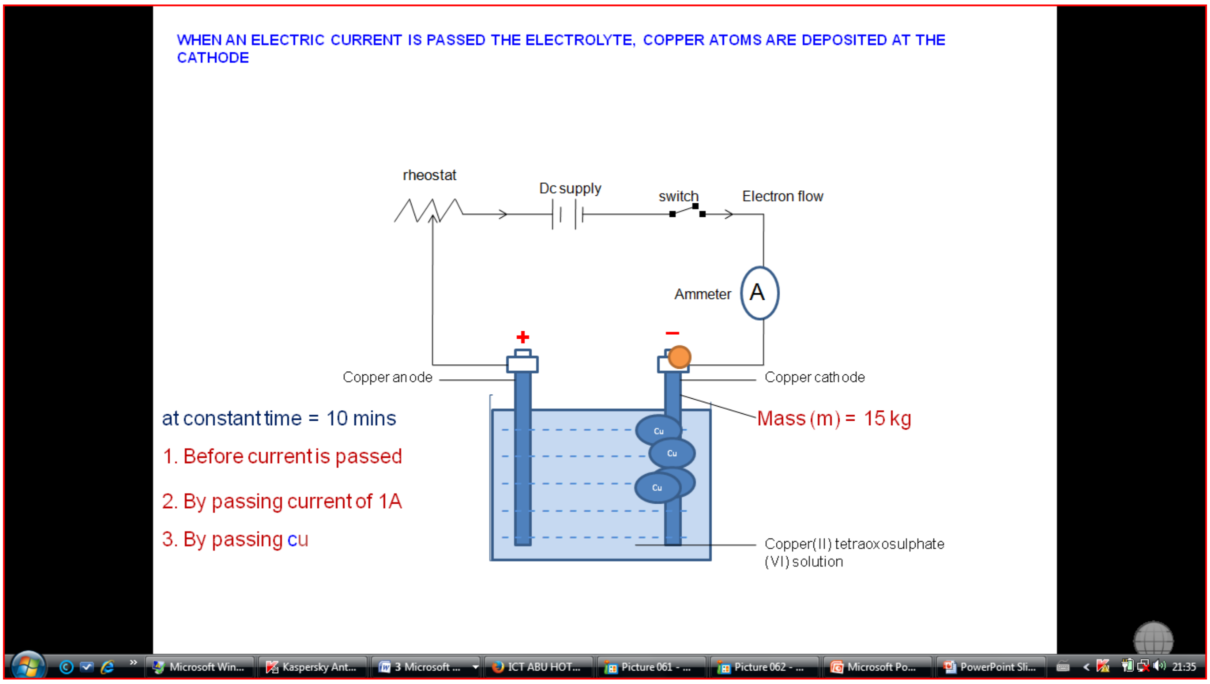

Fig 30: Screenshoot simulation to justify faradays first law

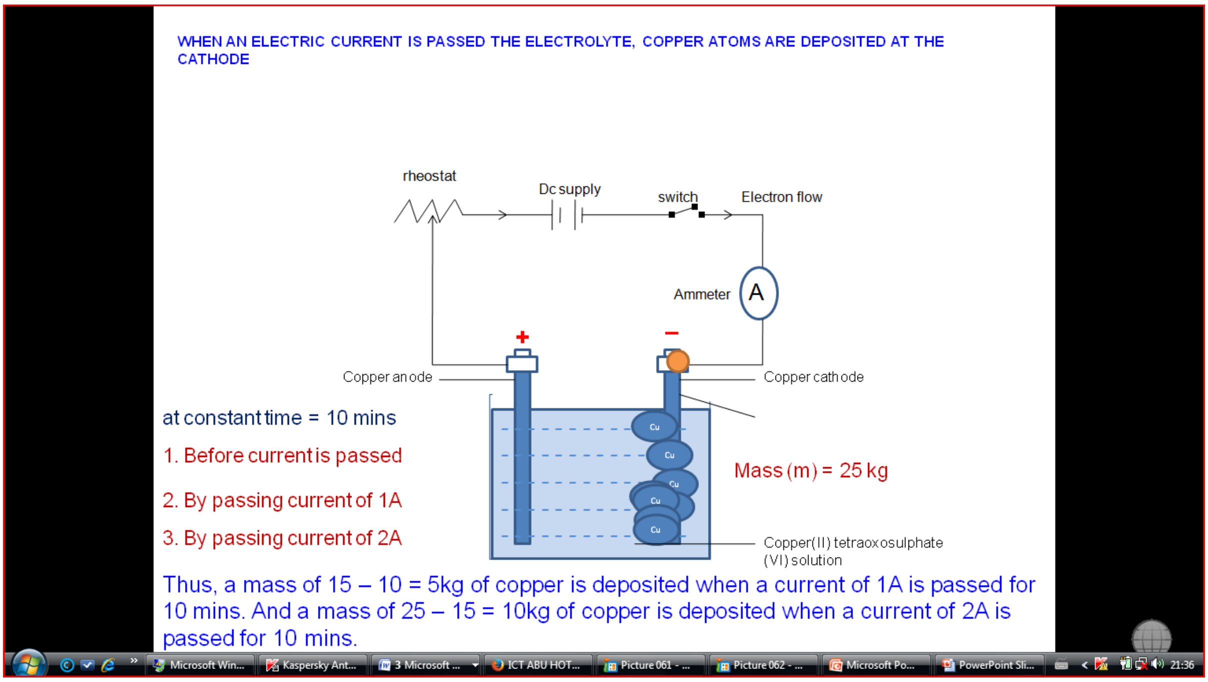

Fig 31: Screenshoot simulation to justify faradays first law