UNIVERSITY OF EDUCATION, WINNEBA

THE USE OF INFORMATION AND COMMUNICATION TOOLS TO TEACH PARTICULATE NATURE OF MATTER: A STUDY OF A SCIENCE CLASS.

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OCTOBER, 2017

DECLARATION

Student's Declaration

I, FREDERICK AMEYAW, declare that this Thesis, with the exception of quotations and references contained in published works which have all been identified and acknowledged, is entirely my own original work and it has not been submitted, either in part or whole, to any institution anywhere for any academic purposes.

…… ……..

Frederick Ameyaw Date

Supervisors' Declaration

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

……. …….

Professor Mawuadem Koku Amedeker Date

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This work has been successful due to the assistance and cooperation of so many important personalities.

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DEDICATION

This work is dedicated to my mother Madam Georgina Owusuah, my brothers and sisters and all who helped in diverse ways to make this work a successful one.

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ABSTRACT

The study investigated the use of information and communication tools to teach Particulate Nature of Matter in a science class at Guakro Effah Senior High School in the Techiman north district. The research design used for the study was Action Research. The target population was all 85 form one General Agricultural and General Science study. A total sample of 35 students were selected for the study. Convenience sampling was used to select the students. The instrument used for gathering data was test and class observation. The study was piloted in Tuobodom senior High School also in the same district to determine the reliability of the test. Information and communication tools were used to teach the students during the intervention. Data collected was analysed with descriptive and inferential statistics. The findings revealed that students understand abstract concepts better when Information and communication tools were used to teach, students' performance improved and they were motivated during chemistry lesson when information and communication tools were used to teach. The study recommends the need to use Information and communication tools to teach abstract concepts in chemistry and the need to priorities in-service training, workshops and seminars for science teachers especially chemistry teachers to improve on their ICT skills in order to use Information and communication tools in delivery of their lessons.

CHAPTER ONE

1.0 Overview

This chapter provides a general introduction by articulating the background to the study and goes on to identify the problem of the study. This chapter also looked at the reasons for conducting the study and discussed what the research intends to achieve. This chapter again talked about the conditions that posed threat to the study and how these conditions were controlled. This chapter moreover experience abbreviation used in the study. This chapter ends with an outline of the structure of the thesis.

1.1 Background to the Study

Researches in science education show that students have difficulty in acquisition of abstract scientific concepts (Özcan, 2003; Çimer, 2004; Saka, 2006; Zeidan, 2010). Many Senior high school students experience difficulties with fundamental concepts in chemistry. Chemistry deals with chemicals and their reactions most of which are very dangerous to life if not handled with caution. Reactions of these chemicals in most cases are not easy to understand by students without seeing them in real term. Teachers usually explain these reactions abstractly and through molecular diagrams. Despite the importance of the foundation of chemistry, most students emerge from introductory courses with very limited understanding of the subject. Chemistry had been regarded as a difficult subject for students by many researchers, teachers and science educators because of the abstract nature of many chemical concepts, teaching styles applied in class and lack of teaching aids. Atomic structure is one of the chemistry concepts, often identified as a threshold concept fundamental for mastering further understanding (Francisco, Nakhleh, Nurrenbern, & Miller, 2002; Niaz, Aguilera, Maza, & Liendo, 2002; de Jong & Taber, 2007; Park & Light, 2009). Atomic Structure is among some chemistry topics which are taught abstractly by many senior High School Science Teachers. Park and Light (2009) have studied the concept of atomic structure and maintained that one problem with previous research has been in

focusing on students' difficulties, while not providing advice to teachers how to proceed and solve these difficulties.

Gongden, Gongden, and Lohdip (2011) carried out a study on Assessment of the difficult areas of the Senior Secondary school 2 (two) chemistry syllabus of the Nigerian Science curriculum. Agogo and Onda, (2014) also carried out a study on Identification of students' perceived difficult concepts in Senior Secondary school chemistry in Oju local government area of Benue state. They all made the recommendations that there should be more practical works, and illustrations of concepts must be done with real objects or simulation for students to understand.

Huffman, Goldberg and Michlin (2000) recognised that using ICT can involve a different teaching and learning style from that of the traditional, didactic approach. ICT has become within a short time one of the basic building blocks of a modern society. Many countries now regard understanding ICT and mastering its basic concepts as part of the core of education (UNESCO, 2002). The use of ICT tools is important in teaching and learning process as it increases learner's motivation, makes students to understand better abstract concepts, allows collaborative learning and provides the opportunity for learning through simulation. Appropriate use of ICT simulations helped significantly to improve students' understanding of science ideas compared with the use of non-ICT teaching activities. Tchombe (2008) asserted that ICT tools if used appropriately can stimulate the development of higher cognitive skills, deepen learning and contribute to the acquisition of skills needed for learning all lifelong. Using ICT tools in teaching Science lesson can also help students to understand Science concepts through a relationship with a real life situation. ICT improves educational outcomes and enhances quality of teaching and learning (Wagner, 2001).

1.2 Statement of the Problem

The Researcher's observation shows that science students in Guakro Effah Senior High School do not grasp chemistry concepts when lecture method is used in teaching. Lecture

method of teaching is not suited for teaching higher order of thinking such as application, analysis, and synthesis (Sze-yin, 2015). Students resort to memorising abstract concepts since they find it difficult understanding it meaningfully hence leading to their low performance in Chemistry (Krah, 2014). It is against this background that the Researcher wants to find out the effect of Information and Communication and Technology (ICT) tools on the learning outcomes of students.

1.3 Purpose of the Study

The purpose of the study is to find out the effect of Information and communication tools on the learning outcomes of students in chemistry.

1.4 Objectives of the Study

The objectives of the study sought to determine:

- the scientific misconceptions students have about the Particulate Nature of Matter
- the effect of ICT tools on the learning outcomes of students

1.5 Research Questions

To guide this study the following research questions will be addressed:

1. What scientific misconceptions do students have about the Particulate Nature of Matter?
2. What effect does the use of ICT tools in teaching particulate nature of matter have on the learning outcomes of students?

1.6 Significance of the Study

The outcome of this study will serve as useful guidelines to Students and Education researchers.

- To students, the use of ICT tools in teaching will facilitate their learning as they will understand abstract concepts in chemistry better and their interest aroused.
- To Education researchers, the outcome will serve as guide for further research on chemistry topics which are taught abstractly in the senior High Schools.

1.7 Limitation of the Study

According to Best and khan (2006) limitations are conditions beyond the control of the researcher that places restriction on the validity of the study.

The Researcher encountered the following limitations which affected his findings:

- Students did not have access to a computer each because of inadequate ICT tools in the school.
- Inadequate ICT tools and time did not permit the Researcher to sample larger student's population than he had done.

1.8 Delimitations of the Study

According to Simon (2013) delimitation is the characteristics that limits the scope and define the boundaries of the study.

The study was conducted on only students of Guakro Effah Senior High School hence the results of the study cannot be generalized over all the schools in Techiman North District.

1.9 Operational Definition of Term

ICT -is a term for the hardware, software, peripheral devices and digital systems that enable data and information to be managed, stored, processed and communicated.

ICT tools-are devices and objects used in information and communication technology. Examples are computer, projector, cell phones, radio, and television.

Motivation is the arousing and sustaining the interest of an individual or a person to do something.

1.10 Abbreviations

ICT	Information, Communication and Technology.
GESHS	Guakro Effah Senior High School
GoG	Government of Ghana
GES	Ghana Education Service
UNESCO	United Nations Educational, Scientific and Cultural Organisation.

1.11 Organisation of the Study

The study has been organised into five chapters. Chapter One is the introductory phase of the study. It deals with the background of the study, the statement of the problem, the purpose of the study, research questions, and significance of the study. It also covers the delimitation, limitation, definition of terms, abbreviations and organization of the study.

Chapter Two covers, the review of related literature. It deals with issues such as theoretical framework, theoretical perspectives of ICT in teaching and learning, ICT tools and the use in teaching, ICT in education policy in Ghana and the three pillars of ICT in education. Others include advantages of using ICT tools in teaching and teacher's confidence in the use of ICT tools. It concludes with empirical review.

Chapter Three focuses on the methodology of the study. It covers issues such as the research design, population, sample and sampling procedures used as well as research instrument, validity and reliability, data collection procedure and data analysis procedure have also been discussed in this chapter.

Chapter Four deals with the presentation of report of lessons, analysis and discussion of data.

The concluding chapter, Chapter Five presents the summary, conclusions and recommendations of the study. It also covers suggestions for further studies.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter reviewed literature relevant to the use of ICT tools in Teaching. This chapter begun with a discussion of the theory of learning and relate it to how ICT tools can be used to teach abstract concepts and make learning more meaningful. This chapter also looked at people's view about the need to use ICT tool to teach science and also talks about the Advantages in using ICT tools to teach science. This chapter again looked at a brief history of how ICT has metamorphosed into the Educational system in Ghana and most especially the three pillars on which ICT policy Document in Education is built around and concluded with empirical review.

2.1 Theoretical framework

The study was guided by Cognitive Theory of Multimedia Learning (Mayer, 2009). According to Mayer (2009), the cognitive process of integrating is most likely to occur when the learner has corresponding pictorial and verbal representations in working memory at the same time. According to Mayer, the computer is a system for delivering information to learners and learning involves adding information to one's memory. The instructional designer's role is to present information (e.g. pictures, word, videos) and the learner's role is to receive the information. As some students prefer visual presentations, other students may prefer verbal presentations. Therefore, multimedia presentations would be effective in delivering information effectively to both kinds of students and they could select their delivery way.

2.2 Theoretical perspective of ICT in teaching and learning

Volman and VanEck (2001) ascertain that the use of Information and Communication Technology (ICT) creates a powerful learning environment and it transforms the learning and teaching process in which students deal with knowledge in an active, self-directed and constructive way. ICT can help deepen students' content knowledge, engage them in constructing their own knowledge, and support the development of complex thinking skills (Kozma, 2005; Kulik, 2003; Webb & Cox, 2004). ICT can also be used to promote collaborative learning, including role playing, group problem solving activities and articulated projects (Forcheri & Molfino, 2000). Korte and Husing (2007) refer to computer as an instrument that motivates students to learn. In addition, students who use the computer simulations have a significant increase in conceptual understanding of chemical concepts (Kozma, Chin, Russell, & Marx, 2000). Generally, ICT promotes new approaches to working and learning, and new ways of interacting. Technology involves the generation of knowledge and processes to develop systems that solve problems and extend human capabilities. In other words, technology can change or alter how people access, gather, analyse, present, transmit, and simulate information. The impact of technology is one of the most critical issues in education (Webber, 2003). DfES (2003a) suggests that ICT can be used effectively in Science teaching to show video sequences of things that are hard to explain. For example, animated sequences could be used to show how water molecules behave as temperature changes alter the state of the water from ice, through liquid water to steam. Beetheng and Chiahua (2008) conducted a study that explored the extent of ICT adoption among secondary school teachers in Malaysia. From the study they found that most of the respondents were positive with the use of ICT in school, and they appreciated the use of ICT in enhancing teaching and learning. The teachers have positive attitude towards further integration of technology into classroom instruction. According to Kubiatko (2010), the results of students' attitudes toward ICT tools use in teaching and

learning Science subject among high school students were based on statistical evaluation. Students seemed interested in using ICT tools in the teaching of Science subjects. The same study also concluded that ICT tools used in teaching can enhance students' learning in Science from early age. Ong, Foo and Lee (2010) in their study revealed that the initiative of Malaysia Smart Schools promotes the use of ICT has created significant positive attitude towards Science among students. Anil (2009) conducted a research on teachers' use of computer technology in remedial teaching. Results concluded that computer – assisted instruction programme in remediation task was found to be successful as the students were able to overcome the difficult points in the content. Hence they were able to increase their achievement significantly. The use of computer technology in remedial instruction was found effective. Nimavathi and Gnanadevan (2008) did a research to examine the effectiveness of multimedia programme in teaching science. Results were found that multimedia programme prepared by the researcher is more effective for the achievement in science of ninth standard students. The students learning through multimedia programme are found to be better than the students learning through the conventional method of teaching. Some studies on the use of ICT tools in science simulations have focused on the most difficult aspect of science teaching, developing students' conceptual understanding of difficult science topics. McFarlane and Sakellariou (2002) argue that using ICT either as a tool or as a substitute for the laboratory-based elements of an investigation can aid theoretical conceptual understanding in some topics in the science curriculum. Some experimental studies have shown that computer simulations can be as effective as the real activity in teaching science concepts and improving scientific understanding across a variety of topics (Baxter & Preece, 2000; Huppert, Lomask, & Lazarowitz, 2002; Trindade, Fiolhais, & Almeida, 2002; Zacharia, 2005). Su (2011) as cited in Alhabi (2014) suggested

that the use of ICT tools in teaching can support students to achieve a greater understanding of a chemistry lesson and improves their attitude and approach to chemistry learning. In an experimental study related to chemistry, Shepr (2003) aimed to identify the effect of using ICT in helping students to learn chemistry. The findings indicated that the use of ICT was highly effective in helping students to learn Chemistry. In another study concerning physics, Al Sharhan (2002) explored the effect of using ICT on the achievements of first-year secondary graders enrolled in one of Riyadh schools in Kingdom of Saudi Arabia, in physics, investigating the skills of remembering, understanding, and application. The results showed that there were statistically significant differences in the understanding and application levels, in favour of the experimental group. Students in ICT-supported science classrooms also benefited from the instant feedback from experiments, as well as from the chance for more independent and self-directed learning (Baggott La Velle, McFarlane, & Brawn, 2003). Comber et al. (2002) suggested that ICT can be used effectively in the Science subject to show video sequences of things that are hard to explain.

However, ICT should not be seen as the only educational tool, but as one of a number of possible tools which could be used to teach content and skills. As John and Sutherland (2004) pointed out, ICT alone does not enhance learning; rather it is the ways in which ICT is incorporated into the various learning activities that is of fundamental importance. Barriers, associated with ICT integration that fall within the physical realm are beyond the direct control of the teacher (Loveless, 2004).The barriers are: limited number of computers and projectors in some senior high schools in Ghana. Computer software for teaching and frequent training of teachers on the use of computers are also unavailable. UNESCO (2009) as cited in Ochieng (2013) revealed that there was limited use of ICT in pedagogical support with very minimal technical support to the teachers. The study also indicated that there was inadequate ICT software for both general teaching and specific subject, hence low level of

ICT integration in teaching. Learning institutions, therefore, need to embrace the use of ICT tools in teaching to make teaching and learning of sciences more meaningful. Innovative use of ICT tools in teaching can facilitate student centred learning (Drent, 2005). Hence, every classroom teacher should use learning technologies to enhance their student learning in every subject because it can engage the thinking, decision making, problem solving and reasoning behaviours of students (Grabe & Grabe, 2001).

2.3 ICT tools and the use in teaching

There are many ICT tools that are used for teaching and learning. For the purpose of this study they have been classified as follows:

Computer

Adekomi (2001) defines computer as a combination of related devices capable of solving problems by accepting data, performing described operations on the data and supplying the results of these operations. Hence, computer can be said to be a man-made machine made up of electronic components that operates information at a very high speed to produce results that are meaningful to the user. Computer can be used to mix colours, separate colours, draw images, design various things and create charts and graphs for instructional purpose (Ajibade, 2006). Computers are also used to access information from the internet and watch youtube videos relevant to the lesson. Teachers can assess information relevant to their lesson from the internet and project it onto the screen so that the whole class can see. Students can also work in groups and use laptop computers to take notes on their group discussions and then share their findings with the whole class with the aid of a projector. Siddiqui (2009) as cited in Sisiliya (2013) points out that computers are envisioned as ways to empower teaching by telling and learning by listening, serving as means to get information from the internet into learners mind. Barad (2010) cited in Sisiliya (2013) also

ascertain that the unique combination of tutorial, interactive and visual capabilities enables computer to have a beneficial effect on learner motivation.

Projector

A projector is an optical device that projects an image or moving images onto a surface or screen. Projectors are used in conjunction with a laptop or desktop computer to project the images or videos from the computer onto a screen or wall. With projectors, teachers can use films, slides and images to teach students science concepts. Motivation and engagement are frequently identified as the major benefits of using projector to support teaching (Andrews, 2003). Talabi (2001) points out that the use of projector as instructional media ensures students attention throughout lessons. The pictures, images, videos are presented sequentially and are displayed as slides on a large-screen video monitor, or projection screen (Lever-Duffy, Mcdonald, & Mizell, 2005). Mohanty (2004) as cited in Sisiliya (2013) also points out that visual aids such as projector can be used in the classroom as teaching aids to give a common visual experience to students. This will help students to understand concepts better since they will be able to relate new concept with their already existing concepts.

Multimedia device

Multimedia device is a tool for the integration of animation, audio, graphics, text and full motion video through computer hardware and software for education, entertainment or training. The most common multimedia for recoding audio and video are tape recorder, microphone and camera. By using multimedia tools in teaching, teachers can capture attention, engage learners, explain difficult concepts, and inspire creativity. Zhang (2006) points out that multimedia device can offer rich source of authentic learning materials such

as pictures and pleasant sounds which will help arouse student's interest in learning. Ogunbote and Adesoye (2006) ascertain that multimedia technology adds new dimension to teaching experiences because concepts are easier to present and comprehend when words are complemented with images and animations. Teacher can record videos and audios and present to students as tutorial. Reid, Burn and Parker (2002) in an evaluation of a pilot study of digital video in 50 schools in the UK, reported that teachers found that filming and editing a video about forces helped pupils to assimilate scientific concepts more effectively, quickly and substantially than would have been achieved with handouts or textbooks. A study by Ubogu (2006) supports the view that multimedia resources facilitates access to all human knowledge anytime and anywhere in a friendly, multi-modal, efficient and effective way by overcoming barriers of distance, language and culture.

2.4 ICT in education policy

The current National ICT in Education Policy for Ghana was originally drafted in 2003 and saw two reviews in 2006 and 2008 (Government of Ghana [GoG], 2015). The Ministry of Education promulgated the revised policy document in 2009 for implementation.

In his foreword to the current ICT in Education Policy in January 2009, the Hon. Minister of Education noted, among other things that;

"… The deployment of ICT into Education will result in the creation of new possibilities for learners and teachers to engage in new ways of information acquisition and analysis. ICT will enhance access to education and improve the quality of education delivery on equitable basis" (Government of Ghana [GoG], 2015, p.9) and further that: "… It is the government's desire that through the deployment of ICT in Education, the culture and practice of traditional memory-based learning will be transformed to education that stimulates thinking and creativity necessary to meet the challenges of the 21st Century"(

Government of Ghana [GoG], 2015, P.9). The government of Ghana has acknowledged the need for ICT training and education in the schools, colleges and Universities and the improvement of the education system as a whole. The development of ICT into Education will result in the creation of new possibilities for learners and teachers to engage in new ways of Information Acquisition and analysis; ICT will enhance access to Education and improve the quality of education delivery on equitable basis (Government of Ghana [GoG], 2015).

The ICT in Education Policy for Ghana had a long gestation period. An attempt at policy development for the sector predates the national ICT policy. A committee set up by the Ministry of Education, Youth and Sports to outline an ICT in Education Policy Framework and produce a document that could remain untouched for a long time. Mangesi (2007) as cited in Gyamera (2012, p. 25) outlined the objectives of the policy as to: "…

1. facilitate training of teachers and students in ICT.
2. promote ICT as a learning tool in the school curriculum at all"

The Ghanaian tertiary education sector is the most advanced in the deployment and use of ICTs in the country. All the country's major universities have their own separate ICT policy, which includes an ICT levy for students. This enables students to have access to 24-hour computer laboratories with broadband connection. However, the same cannot be said about senior high schools in Ghana. Very few senior high schools are well endowed with computer laboratories with internet connections.

2.5 The three pillars of ICT in education

National ICT policies for education in Ghana can serve important functions and provide a rationale, a set of goals, and a vision for how education systems might be with the introduction of ICT, and how students, teachers, parents and the general population might benefit from its use in schools (Kozma, 2008). It is recognised that "…the policy document

on ICT in Education policy must be hinged around three pillars, each of which should receive slightly different policy intervention emphasis and strategy to assure effectiveness, namely:

a) ICT as a learning and operating tool b) ICT as integrated into the teaching and learning" (Government of Ghana [GoG], 2015, p. 18).

In all three pillars, provision shall be made for policy interventions to regulate, support or procure services from certified service providers.

The above distinctions are necessary as it makes it easy to extract the requisite policy emphasis applicable to the different nodal points on the education continuum, as further explained below:

a) ICT as learning and operating tool: This would allow for ICT (software applications as well as hardware devices) to be used as tool to help manage educational environments. The implication is that there is the need to improve ICT literacy among school leaders & administrators, teachers, learners as well as parents for them to be able to access the relevant ICT infrastructure to get their work done or understand (in the case of parents) what is happening at school is duly recognised and catered for.

b) ICT as integrated into the Teaching and Learning of Subjects: This allows for ICT to be integrated into all subjects within the national curriculum and create the opportunity for teachers and educational policy overseers to make it possible to use ICT or applicable educational technology tools in the teaching and learning of all subjects in all spheres of our educational system and by extension, our national life Similarly, policy direction shall be focused on creating the right environment for the learners (students) to be able to appreciate and adapt to the use of the ICT in the teaching of the subjects on their syllabi. Swarts (2006) cited in Owusu-Ansah (2015) noted that ICTs can be powerful, essential tools for learning: understanding, interpreting and communicating about the real world.

2.6 Advantages of using ICT tools in teaching

According to Haddad and Jurich (2002) the use of ICTs, in particular computer technologies, is correlated to positive academic outcomes, including higher test scores, better attitudes towards schools, and better understanding of abstract concepts. ICT tools also provides a richer and more exciting learning environment for teaching and learning (Jonassen, 2002).Video presentation of concepts with the aid of Projector will make teaching more lively and interesting which will intend motivate students to learn.

ICT tools have the potential to accelerate, enrich and motivates students to learn (Yusuf, 2005). Using computer generated graphics to illustrate relationships of all kinds especially dynamics processes that cannot be illustrated by individual pictures enhances teaching and learning process by helping students have a clear picture of what is been taught which will lead to better understanding of concepts. Many studies have describe the motivating effect of using ICT tools in schools and the positive effect it can have on students attention and effort in class. Trimmel and Bachman (2004) studied the impact of introducing laptops into classrooms and one of their conclusions was that ICT tools have a positive impact on school attendance and learning interest. The DfES (2003b) drew on a number of research projects to support its statement that ICT can play an important role in motivating pupils and encouraging them to engage in learning within and beyond the classroom. The use of ICT tools in teaching can also improve teaching and learning quality. As Lowther, Inan, Strahl, and Ross (2008) ascertain that there are three important characteristics that are needed to develop good quality teaching and learning with ICT: autonomy, capability, and creativity. Autonomy means that teachers take control of their teaching through the use of ICT tools by using their own images and videos that are relevant to the topic to be taught. Teachers can also assign students to complete certain tasks with peers or in groups. Through collaborative learning with ICT tools, the students have more opportunity to build the new knowledge onto their background knowledge, and become more confident to take risks and

learn from their mistakes. Further, Serhan (2009) concluded that ICT fosters autonomy by allowing educators to create their own material, thus providing more control over course content than is possible in a traditional classroom setting. With regard to capability, once teachers are more confident in the teaching processes, they can develop the capability to apply and transfer knowledge while using new technology with efficiency and effectiveness. In addition, finding good software to record their voice is another prerequisite for these learners. Therefore, the whole learning process enriches students' learning skills and broadens their knowledge beyond what they already know. By using ICT tools in teaching, teachers' delivery can be real. They may discover new multimedia tools and create materials in the styles readily available to them through games, which can also help in their teaching (Gee, 2007).With a combination of teachers' autonomy, capability, and creativity, the use of ICT can improve the quality of teaching. The use of ICT tool in teaching provides a more effective presentation of concepts (Demirel, 2005). Moreover, it makes instruction more meaningful and enjoyable.

2.7 Teachers' confidence in the use of ICT tools

Becker (2001) as cited in Gyamera (2012) noted that teachers' expertise in ICT tools was an important factor in the use of ICT tools in teaching. The ways that teachers have their students use computers are certainly affected by their own level of technical expertise. Becker (2000) as cited in Moore (2005) established that there is a clear correlation between teachers' knowledge of ICT (as well as a constructivist theory of teaching and the availability of ICT in the classroom) and the frequency and effectiveness of software use in teaching. This finding was confirmed by OFSTED (2004), which pointed out that teachers' knowledge remains the key to the most effective practice. Dillon (2004) also supports this view the representations of software of many non-specialist teachers are idiosyncratic, fragmentary and transient with imperfectly learnt links and false assumptions

and that these teachers are concerned that the skills of their students are more advanced than their own. It is hardly surprising that teachers are reluctant to experiment with ICT if they are concerned that their students' knowledge is greater than their own. Many teachers still fear some forms of technology, which prevents them making much use of them in their teaching. BECTA (2004) report says that the lack of confidence is linked to other barriers affecting the use of ICT tools in teaching. The report mentioned the fear of ICT as a factor that can compromise the level of confidence. Other factors that were mentioned included the lack of technical assistance which can lead to low confidence levels, lack of competence and the quality of training received. Balanskat, Blamire, and Kefala (2006) pointed out in the ICT impact report: A review of studies of ICT impact on schools in Europe that the limitation in the knowledge base of the teacher in the use of ICTs tools make them feel anxious about using it and thus not confidence to use it in teaching. Hennessy and Onguko (2010) emphasise that before a school can successfully make use of ICT tools in lesson delivery, it needs to ensure that teachers acquire appropriate ICT and pedagogical skills that are necessary for teaching. Such skills enable the teachers to have the self-drive and enthusiasm to use ICT tools in teaching. Omufwoko (2009) emphasise that motivation to use computers is reduced where teachers have inadequate technical skills. To investigate the factors hindering teachers' readiness and confidence in using ICTs, Tella, Toyobo, Adika, and Adeyinka (2007) found from their study on ICT impact on schools in Europe that inadequate knowledge to evaluate the role of ICT tools in teaching and learning, lack of skills in the use of ICT equipment and software had resulted in a lack of confidence in the use of ICT tools. This is consistent with Preston, Cox and Cox (2000) who found that lack of technical support was found to be the key inhibitor to the use of ICT tools in classroom.

In addition, obstacles such as access to equipment, time, lack of mentor and opportunities for apprenticeship of observation also have an impact on teachers' ability and confidence to use ICT tools in teaching (Slaouti & Barton, 2007). Furthermore, teachers' workload and time management was found to be inhibiting the implementation of computer instruction in classroom (Guha, 2000). On the other hand, Atan, Azli, Rahman, and Idrus (2002) found that teachers exhibit greater competence in computer when they made frequent use of it. Hence, it was predicted that teachers who make daily use of ICTs are more competent in ICTs compared to those with a lower rate of adoption. Teachers with higher ICT competency shown greater ICT adoption rate in their profession. According to Peralta and Costa (2007) teachers with more experience with computers have greater confidence in their ability to use them effectively. Jones (2004) reported that teachers competence relate directly to confidence. Teachers' confidence also relate to their perceptions of their ability to use computers in the classroom. According to Bingimlas (2009) teacher competence refers primarily to the ability to use ICT tools in teaching. Lack of competence is regarded as a significant teacher related barrier to the use of ICT tools in teaching. A teacher's lack of knowledge serves as a considerable challenge to the use of computers in teaching methods and practices. Tezci (2009) noted that if teachers have a high level of ICT knowledge and competence then there will be a higher level of ICT use in teaching. Teachers who lacked knowledge and skills to use computers were not enthusiastic about integrating ICT in teaching and learning (Newhouse, 2002). Lack of technological knowhow is the main obstacle to acceptance and adoption of new technology by teachers in classroom instruction (Pelgrum, 2001). Further, studies conducted in Bungoma by Wanjala, Khaemba, and Mukwa, (2011) confirmed that indeed to adopt any educational technology effectively, teachers must feel confident in its operation and their own ability to use it in classroom instruction.

2. 8 Empirical review

It has been argued by certain scholars that the use of ICT tools in the classroom is essential for providing opportunities for students to acquire knowledge and skills that will enable them to function in an information age (Bingimlas, 2009). There are several roles that ICT tools can play in the teaching and learning process.

First, ICT tools have a great potential to enhance learner achievement (Bransford, Brown & Cocking, 2000). A number of theorists and scholars assert that the use of ICT tools can make the learners to become knowledgeable, reduce the amount of direct instruction given to them and provide a learning environment where teachers can assist learners with special needs.

In addition, the use of ICT tools in teaching will motivate the learners and hence develop favourable attitude towards science subject. Agrahari and Singh (2013) found that ICT tools have a positive effect on student achievement scores in chemistry at secondary level. Similarly, Ziden, Ismail, Spian and Kumutha (2011) found that the application of ICT tools in teaching and learning increased the students' achievement in science subjects. Likewise, Safdar, Yousuf, Parveen and Behlol (2011) concluded that ICT tools have a positive effect on students' achievement scores. Similarly, Okoro and Ekpo (2016) concluded that students who were taught through ICT tools performed well as compared to those who were taught via conventional instructional strategy. Avinash and Shailja (2013) found that the ICT program is more compelling and effective than the conventional teaching approach in terms of students' achievement scores in chemistry. Jyothi (2007) designed a research method to investigate the impact of computer based learning on students of chemistry. Results revealed that the self-instructional module prepared by a teacher through power point presentation had immense positive impact on learning of chemistry. Hussain, Suleman, Din and Shafique (2017) Investigating the effects of ICT tools on students' retention in chemistry, the findings reveal that the use of ICT tools was found more effective on

students' retention as compared to traditional teaching methods. The results are consistent with the findings of Oginni and Popoola (2013) found that by using information and communication technology, students' retention scores were better when contrasted with those who were instructed via unconventional methods. Badeleh and Sheela (2011) inferred that generally to study chemistry, component based achievement, retention of learning and comprehension, ICT tools were more successful than the laboratory training model of teaching. Lim (2005) found that the use of ICT in teaching and learning allowed students to be active in finding information and build knowledge from information obtained by the chance to cross-link between knowledge of subjects without restricted by time and distance. Deaney, Ruthven and Hennessy (2003) also found that ICT has increased the interest and motivation for pupils in schools. Similar study proved that teaching and learning using ICT improved the achievement of moderate learners (Norzita, 2004). Moore (2005) summarised about the positive impact of ICT tools on pupils' learning such as increased students' motivation to stay on-task and drive them to behave better and produce high quality work. All these findings however contradict with the findings of Cener, Acun and Demirhan (2015) who concluded that ICT tools do not have an effect on students' achievement scores. Likewise, Mbaeze, Ukwandu and Anudu (2010) also found that there was no significant relationship between ICT tools and students' academic performance.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter looked at the overall strategy used to conduct the research. This chapter begun with the research design and talk about the types of research design and also explained the reason for choosing the research instruments for collecting data. This chapter also talked about the population for the study that is the number of people who took part in the research, the techniques that were used to select the sample, how data were collected from the sample and how the data were presented for analysis. This chapter also, discussed data collection instruments using, test (pre-intervention test and post-intervention test) and observation, the procedures involved, how valid and reliable the research instruments were and the means of analysing the data.

3.1 Research Design

A research design establishes how a research project is conducted (Denscombe, 2010 a). It describes components of the study including the theoretical perspective of research, details of the procedures by which the study is conducted including sampling, methods of data collection, analysis of data, and other aspects of the research plan (Blaikie, 2000). According to Kothari (2004) research design is a blue print, which facilitates the smooth sailing of the various research operations, thereby making research as efficient as possible hence yielding maximum information with minimum expenditure of effort, time and money. Research design is a master plan or blue-print that specifies how data relating to a given problem should be collected and analysed to solve research problems (Zikmund, 2003). He further explained that for every research study, the choice of a particular research design must be appropriate to the subject under investigation, and that the various designs in research have specific advantages and disadvantages. Some examples of research

designs according to Amedahe (2002) are Survey, Case Study, Quasi-experimental and Action Research.

Survey

According to Best and Khan (2003) survey basically deals with the conditions or relationships that exist such as determining the nature of prevailing conditions, practices and attitudes, opinions, processes that are going on or trends that are developed and reporting them as they are. The design is suitable when gathering data from a relatively large number of cases at a particular time.

Survey items can be closed-ended or open-ended questions. According to Creswell (2007) Closed-ended questions offer the participant a fixed range of choices, for example, yes, no, or multiple choice pre-set options. The advantage of this is that coding is quick and can be performed by computer. The responses can be compared, and even assigned numerical values for statistical analysis. However, the responses do not always reflect the true experiences of the respondents. Open-ended questions allow the participant to respond in their own language within their cultural and social experiences rather than through the researcher's experiences (Creswell, 2007). However, analysis and coding can be a more time-consuming process than the analysis of closed-ended items

Case Study

Case studies focus on one or just a few instances of a particular phenomenon with a view to providing an in-depth account of events, relationships, experiences or processes occurring in that particular instance (Denscombe, 2010 b). This involves collecting data, generally from only one or a small number of cases. It usually provides rich detail about those cases of a predominantly qualitative nature. According to Yin (2003) a case study design should be considered when: the focus of the study is to answer "how" and "why"

questions; you cannot manipulate the behaviour of those involved in the study; you want to cover contextual conditions because you believe they are relevant to the phenomenon under study; or the boundaries are not clear between the phenomenon and context. The greatest strength of case study is that it allows the researcher to concentrate on a specific instance or situation and to identify, the various interactive processes at work (Cepni, 2010). These processes may remain hidden in a large scale survey but may be crucial to the success or failure of the study. However, it does not usually claim representativeness and should be care not to over-generalise.

Quasi-experimental

Quasi-experimental research is an educational research design which test causal hypothesis in which two or more groups of the same characteristics are compared after one or more has been given a specified treatment (White & Sabarwal, 2014). In the causal comparative research, the researcher examines how the independent variables are affected by the dependent variables and involves cause and effect relationships between the variables.

Action Research

According to Leedy and Ormrod (2010) Action Research is a systematic process of collecting, analysing and interpreting data in order to increase our understanding of a phenomenon about which we are interested or concern in the classroom. Action Research is a process in which participants examine their own educational practice systematically and carefully, using the techniques of research (Ferrance, 2000). Action Research involves systematic observations and data collection which can be used by practitioner-researcher in reflection, decision making and development of more effective classroom strategies (Parson & Brown, 2002). Although there are many types of research that may be undertaken, Action Research specifically refers to a disciplined

inquiry done by a teacher with the intent that the research will inform and change his or her practices in the future. This research is carried out within the context of the teacher's environment that is, with the students and at the school in which the teacher works. Mills (2000) is of the view that the purpose for choosing Action Research is to effect positive educational change. By this, Mills (2000) implies that an Action Research is resorted to in order to solve an immediate problem in a given situation to bring about a positive change. Labaree (2011) asserts that the essentials of Action Research design follow a characteristic cycle where initially an exploratory stance is adopted. This in his view helps the researcher to learn and understand the problem under consideration so that some form of intervention strategy could be developed. The intervention according to Labaree (2011) is carried out during which pertinent observations are made in various forms to collate and examine data to improve the intervention strategy. The approach enables researchers and their participants to learn from each other through a cycle of planning, action, observation and reflection (Steepless, 2014).

In this study, Action Research design approach was adopted and this design sought to find the types of misconceptions that students have about the structure of the atom. Then the study also used intervention lessons to correct the misconceptions held by students on the structure of the atom.

3.2 Population

A population is a group of individuals or objects who have the same characteristics (Creswell, 2008). Osuala (2005) defines population as the total group of subjects to which the findings or outcome of the research are to be generalised.

3.2.1 Types of population

Target Population

The target population refers to the entire group of individuals to which researchers are interested in generalising their conclusions (Castillo, 2009). The target population contains members of a group that a researcher is interested in studying. The results of the study are generalised to this population, because they all have significant traits in common.

In this study the target population was all 85 Form one General Agriculture Science and General Science students of Guakro Effah Senior High School.

Accessible population

Accessible population is the population which the researchers can readily access, work with, and apply their conclusions (Castillo, 2009). Accessible population is the subset of the target population.

In this study, the accessible population comprised all Form one General Agricultural Science students. The choice of General Science class form one students was made because that is the class assigned to the researcher hence the researcher followed the normal time table of the school to conduct the research without disrupting classes.

3.3 Sample

A sample is a smaller group which is drawn from a larger population and studied (Robson, 2002; Punch, 2006). A sample is representative of the population to the extent that it exhibits the same distribution of characteristics as the population. The concept of sample arises from the inability of the researchers to test all the individuals in a given population. The sample must be a fair representative of the population from which it was drawn and it must have good size to warrant statistical analysis (Castillo, 2009).

In this study, the sample size was 35 students and out these, 25 of them were boys and the remaining 10 were girls.

3.4 Sampling Techniques

Probability sampling

According Trochim (2002) probability sampling is the type where every member of the population has equal opportunity to be selected into the sample.

Non-Probability sampling

Non-probability sampling is a deliberately selected sample to represent the wider population; it seeks only to present a particular group, a particular named section of a wider population, such as a class of students, a group of students who are taking a particular examination, and a group of teachers (Trochim, 2002)

In this study, the sampling technique used was convenience non-probability sampling which comprised of first year General Agricultural Science students at Guakro Effah senior high school, Brong Ahafo Region. Convenience sampling was used because all the student's in General Agricultural Science class were used to conduct the research and also the Researcher was the class teacher.

3.5 Instrumentation for Data Collection

Questionnaire

According to Jack and Norman (2003) a questionnaire is a written document that has a set of questions given to respondents or used by an interviewer to ask questions and record answers.

Interview

An interview involves posing questions to respondents for answers in a face-to-face situation or by phone (Amedahe, 2002).

Class Observations

According to Mubielwana (2012) class observation occur to document behaviour of students in the classroom and to provide insight to teachers. This involves watching students, events, situations, or phenomena and obtaining first-hand information relating to particular aspects of such students, events, situation or phenomena in the classroom (Annum, 2015). It deals with perceiving data through the senses: sight, hearing, taste, touch and smell.

In this study, class observation was used in collecting data. The choice of class observation as the research instrument was to assist the Researcher observe the behaviour, activities, movements and relationships of students during lessons. It allowed the Researcher to move beyond data based on perceptions, i.e. the sort of information gathered to access the personal knowledge of the respondents (Cohen, Manion, & Morrison, 2003).

In addition, it allowed the Researcher to better understand the mood and feelings of the respondents in the classroom when ICT tools were used in teaching. An observational checklist was used to gather information about students' attitudes to chemistry when ICT tools were used in teaching. The form was used to evaluate students' attendance and participation aspects of attitude in the classroom during the lessons. It was designed in such a way that it contains some attributes of attitude to be observed and brief remarks or notes. The Researcher also observed how students were able to effectively use ICT tools during their presentations. The Researcher wrote observational note after each lesson in order to avoid Hawthorn effect. Hawthorn effect is a form of reactivity whereby subject improves or modify an aspect of their behaviour which is being experimentally measured, in response to the fact that they know they are being studied (McCarney, Warner, Iliffe, Van, Haselen, Griffin & Fisher, 2007).

Test

According to Kazdin (2000) a test is an instrument or systematic procedure for measuring human abilities, including intelligence amplitudes, skills and achievement. In this study, the first data collection method that was employed was test (pre-intervention test and post-intervention test). A pre- intervention test was conducted to find students basic knowledge in the structure of Atom. This enabled the Researcher get to know the students prior knowledge on the structure of Atom. A post-intervention test was conducted to assess the students' newly acquired knowledge of the atom. The pre-intervention and post-intervention tests were sampled from test books and past SSCE and WASSCE questions. A 20-item knowledge, comprehension and application test made up of 8 multiple choice item, 8 true or false and 4 essay questions were used to collect data from respondents before and after intervention.

3.6 Validity

Content (face) validity was employed in the test to measure the intended content area since a test must measure what it claims to measure, in order to be considered valid (Alhoward, 2015) as cited in Ansah (2015). In doing this the test items in the instrument were compared with questions in the chemistry syllabus on the selected topics and was given to a colleague science teacher and my supervisor to be scrutinized. It was then confirmed to be within the level of the respondents and so was permitted to administer the items.

3.7 Reliability of the Instrument

Cohen, Manion and Morrison (2000) ascertained that for a research instrument to be reliable, it must demonstrate that if it were to be carried out on a similar group of respondents in a similar context, then similar results would be found. That is if the same test is repeated under the same conditions, the responses should be the same or similar

for each individual. Reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials (Mugenda & Mugenda, 2003). The test items were piloted on form one General Science students of Tuobodom Senior High School also in the same district and Alpha (Cronbach) coefficients was used to calculate for the components of each measurement scale to verify internal consistency. The pilot study obtained coefficient relations of 0.6, which made the test items to be considered reliable for Kothari (2004) who confirms that reliability of 0.6 is adequate.

3.8 Intervention Design

The intervention lasted for five weeks and was structured such that the first week was used for lesson preparation and the second and third weeks were used for lesson presentations. The last week was used to test students to determine the effect of the intervention. Students were taught the particulate nature of matter for a week using lecture method. Pre-test was given to the students under the supervision of the researcher to prevent students from copying from their colleagues. The test was marked and the results were recorded in order to ascertain their performance before the intervention. It also served as a baseline to compare the effect of the intervention on the student's performance. The intervention was used in five separate lessons. ICT tools (computer and projector) were used to teach structure of the atom. The lessons taught were planned and written out by the researcher based on the chemistry syllabus. The intervention was guided by Cognitive Theory of Multimedia Learning (Mayer, 2009). According to Mayer (2009) According to this theory, the ICT tools are medium for delivering information to learners and learning involves adding information to one's memory. The instructional designer's role is to present

information (e.g. pictures, word, videos) and the learner's role is to receive the information. The lessons were structured as follows:

Activities

The Researcher downloaded images and videos and uploaded on his computer. The Researcher projected images and scrolled through them with the students. The Researcher also projected video showing how the structure of the atom was proposed by various scientists for students to watch and also discussed the observations that were made by those scientists. This was to help students to see how the cathode ray tube is and how it works and also how alpha particles experiment was used to discover the atom. The Researcher used image and video showing the structure of atom with the aid of the projector and computer in a PowerPoint presentation and discussed with the students the structure of the atom.

Monitoring and intervening

While the students' were working on a given task, the Researcher moved round and observed each individual task. At random, the Researcher asked facilitating questions which stimulate the students' to think and which are relevant to the task given. The Researcher intervened in each individual if he/she asked for a clarification to be made while working on the task. He intervened when the need aroused.

Post-intervention

The Post –intervention test was administered. The same number of questions and similar in nature as the pre-intervention was administered with same number of students. The test was marked and the scores obtained were collated and analyzed.

3.9 Data Collection Procedure

In this study, data was collected with the aid of the research instruments Test and class observation. The data collection procedure was divided into three phases: pre-intervention, intervention and the post intervention phases. The test and observation were conducted by the researcher in the school.

Pre-intervention phase

This stage of the study lasted for a week. The Researcher informed the headmaster about the research work he wanted to carry out in the school in order to solicit his cooperation and assistance. He then liaised with the headmaster to get ICT tools (computer and projector) and a stand by generator in case of power outage. Lesson notes were prepared.

Intervention phase

This phase had to do with the implementation of the intervention. The stage lasted for two weeks. The Researcher delivered the lessons with the aid of the ICT tools (computer and projector).

The Researcher monitored students' attitude during the intervention with guidelines from the observation checklist. The Researcher wrote observational note after each lesson.

Post-intervention phase

This was the final phase which was mainly used to test students to find out if the intervention was successful. The test was marked and collated for analysis.

This stage lasted for a week.

3.10 Data Analysis procedures

Data analysis is the process of simplifying data in order to make it comprehensive (Jack & Norman, 2003). According to Bogdan and Biklen (2003) data analysis refers to the process of systematically searching and arranging the interview transcripts, field notes, and other materials that are accumulated to produce findings. Data analysis is the process of converting raw data collected into usable information.

In this study, data analysis procedure that was employed was both Qualitative and Quantitative procedures. Quantitative data that was obtained from the Pre-intervention and Post-intervention test were analysed using descriptive analysis, described by Sarantakos (2005) as a type of analysis that aims at identifying and describing the main content of data and inferential statistics. Qualitative data were presented in report on the lessons and analysed based on the progress of the students from lesson to lesson. The activities carried out, the interactions, the level of participation in the lessons and the progression of the lessons were all grounded in the report. The observations made during the lessons and findings from the lessons were analyzed. Discussions of the findings were made based on the research questions. On the basis of analysing the findings, conclusions and recommendations were made.

CHAPTER FOUR

PRESENTATION, ANALYSIS AND DISCUSSION OF DATA

4.0 Overview

This chapter dealt with the findings of the five lessons. Each lesson report was based on the teaching and learning activities that went on in the classroom. A number of Tables and Figures were constructed for easy presentation and analysis of data. The chapter ended with discussion of the findings according to the research questions

4.1 Report on Lesson one

Information and communication tools used in this lesson includes: computer and projector

Topic: Matter

Objectives: Students' should be able to:

- Describe the characteristics and nature of the states of matter
- Identify the particles that an atom is composed of

Relevant Previous Knowledge: Students' have seen tree, pen, book, and water, smoke, stone and sand.

Activity 1: Description of the characteristics and nature of matter

By way of introduction, the Researcher asked students to define matter

Students' Response:

Matter is anything that has mass and can occupy space.

The Researcher opened images showing examples of matter and asked them to group them into solid, liquid and gas. The Researcher opened the first animated image which contains pictures of a pen, table, Bicycle, hat, computer and a tree. Students were able to group them

as solids. The Researcher then opened second animated image showing pictures of rain, swimming pool, milk and a drink. Students were able to group them as liquids. The Researcher then opened the third animated image which contains pictures of fog, wind and air. Students were able to group them as gases.

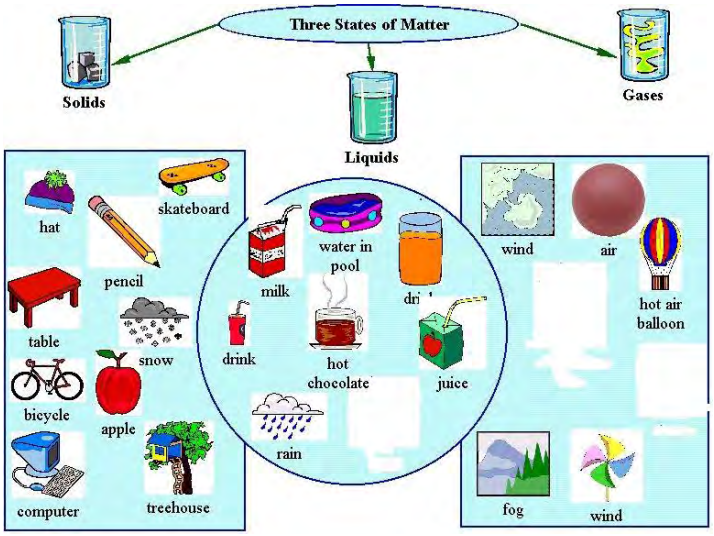

Figure 1.0: Animated image showing examples of Matter in Solid, Liquid and Gas (Sarong, 2007)

Activity 3: Particles of matter

Researcher: **What are the particles of matter?**

Students' response: Atom, Molecule and Ion

The Researcher projected a video animation showing how the particles of matter are arranged in solids, liquids and gases on their computer. The particles were arranged in a regular shape in the solid. The particles in the liquid and gas were seen moving from each other but the particles in the gases were far away from each other as compared to the liquids.

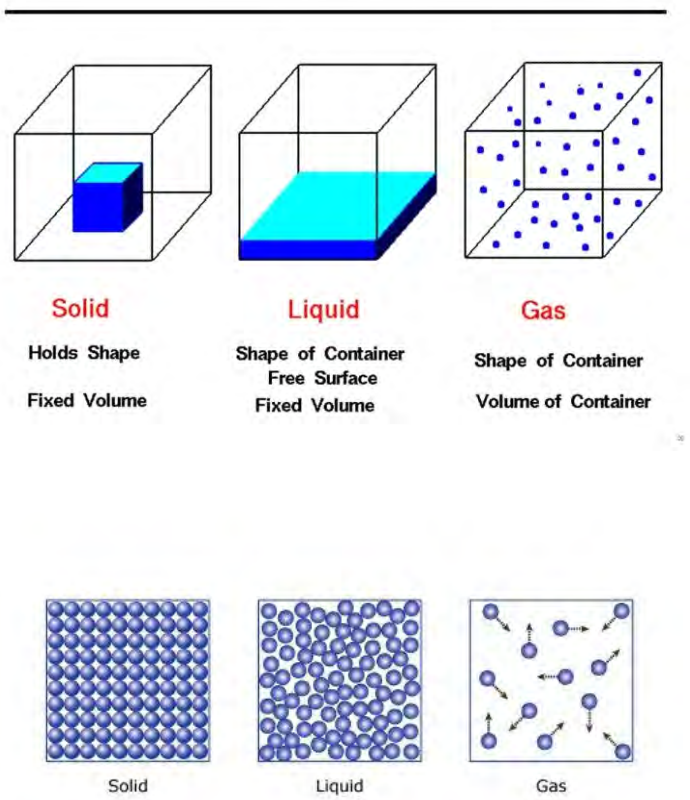

Figure 1.1: Arrangement of particles in Solid, Liquid and Gas (Sarong, 2007)

The Researcher asked students to describe how particles are arranged in solid, liquid and gas.

Students' response:

Solid

- Particles in the solid are arranged in a regular and ordered form
- They are closely packed to each other.
- Solid particles do not flow.
- Solid particles have a definite shape and size.

Liquid

- Liquid particles are loosely packed together and moderately ordered
- Liquid particles flow about

- Liquid particles have a definite volume but do not have definite shape.

Gases

- Gaseous particles move independently hence are wide apart from each other and are highly disordered.
- Gaseous particles flow.
- Gaseous particles do not have definite shape and volume.

Researcher: **What is an Atom?**

Students' response: An Atom is the smallest particle of matter that takes part in chemical reaction.

The Researcher went further to ask students about chemical reaction to test their notion about it. Most of them could not explain what chemical reaction is. A few of them however, gave an example of chemical reaction as burning of paper into ashes and rusting.

Activity 4: Identification of sub-atomic particles

The Researcher projected images of the structure of Atom with the parts labeled I, II and III.

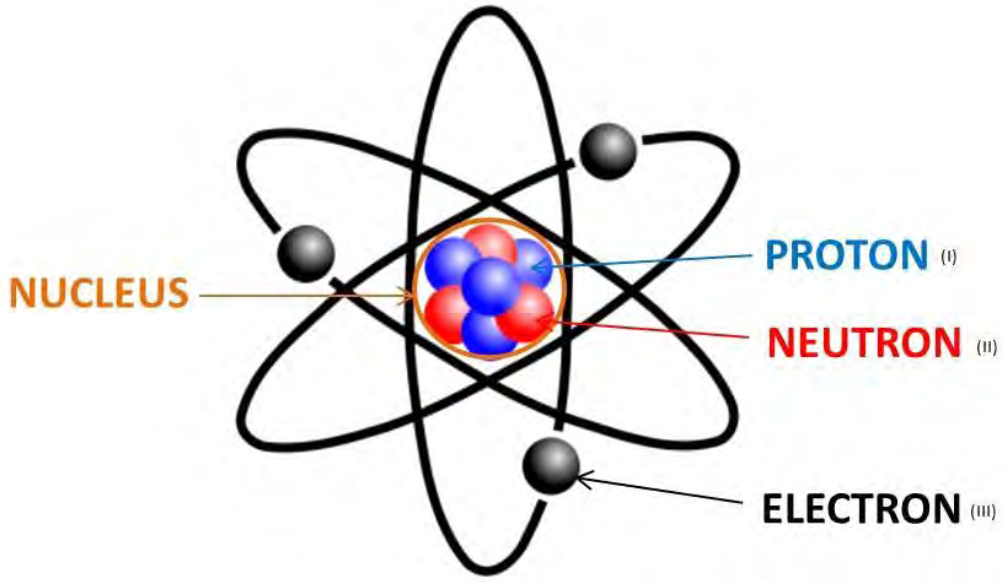

Figure 1.2: Image showing the Sub-atomic particles (Sarong, 2007)

The researcher projects the structure of the atom and assists students to name the sub-atomic particles.

Researcher: **What are the sub-atomic particles?**

Students' Response: protons, electrons and neutrons

The Researcher projected image of the structure of Atom

Researcher: **Which sub-atomic particles can be found inside the nucleus of atom?**

Students' response: protons.

The Researcher asked students to identify the sub-atomic particles found inside the nucleus of an atom. Some students mentioned protons and others did not agree and also mentioned neutrons. The Researcher opened an image showing the particles found in the nucleus of an atom

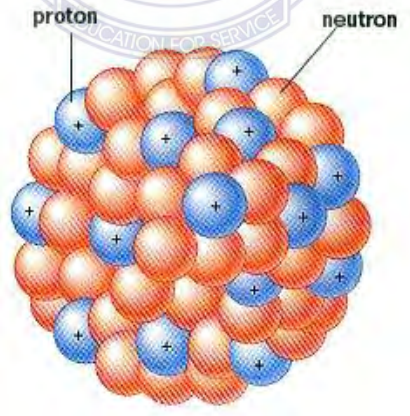

Figure 1.3: Composition of the Nucleus (Sarong, 2007)

The Researcher asked the same question again after the image was projected.

Researcher: **Which among the sub-atomic particle can be found outside the nucleus of atom?**

Students' response: Nucleus of an atom is made up of protons and neutrons.

Findings from lesson 1

Students were able to

- describe the characteristics of the states of matter as solids have a definite shape and size, liquids have definite volume but do not have fixed shape and gases do not have definite shape and volume.
- describe the nature of the states of matter as the particles in solids are arranged in a regular and ordered form, the particles in liquids are moderately ordered and gases are highly disordered.
- identify the sub-atomic particles as protons, neutrons and electrons.
- identify the position of the nucleus as the center of an atom which contains protons and neutrons whilst electrons moves around the nucleus.

4.2 Report on lesson two

Information and communication tools used in this lesson includes: computer and projector

Topic: J.J. Thomson's structure of the atom

OBJECTIVES: Students' should be able to:

- Identify the parts of the cathode ray tube
- Explain how electron was discovered by J. J. Thomson
- Draw J. J. Thomson's structure of Atom

Relevant Previous Knowledge: Students' have seen the structure of atom.

Activity 1: Identifying Parts of the Cathode ray tube

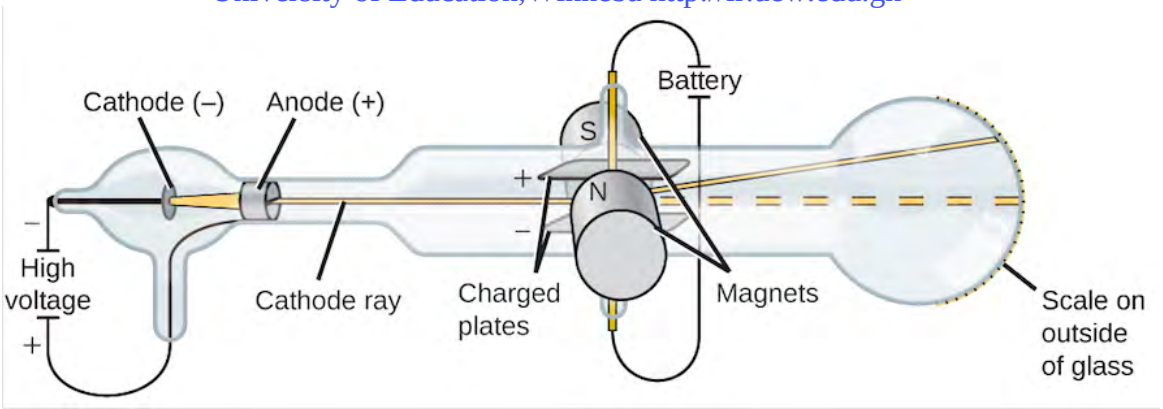

Figure 1.4: Image showing the Cathode ray tube (Petrucci, Harwood, Herring & Madera, 2007)

The Researcher installed the software on his computer and opened picture showing images of the parts of the cathode ray tube on his computer. The Researcher then projected and scroll through the images showing the various parts of the cathode ray tube on his computer.

The Researcher asked students to identify the part labeled I. Some students mentioned Battery but others did not agree with them. The Researcher pressed on the next key on his keyboard and an arrow with the name of the part labeled I popped up as High voltage.

The Researcher opened Image 2 and asked them to name the part labeled II. Two students gave an answer as Cathode and two others said Anode but the fest of the students did not answer. The Researcher then pressed on the next key and an arrow with the name of the part labeled II popped up as Cathode.

The Researcher opened Image 3 and asked them to name the part labeled III. A girl gave an answer as positive plates. The Researcher pressed the next key and an arrow with the name of the part labeled III popped up as Anode.

The Researcher pressed Image 3 and asked students to name the part labeled IV. A boy gave an answer as positive and negative charge. The Researcher then pressed the next key and an arrow with the name of the part labeled IV popped up as Electric field.

The Researcher opened Image 4 and asked them to name the part labeled V. Most of the students gave an answer as magnet. The Researcher then pressed on the next key and an arrow with the name of the part labeled V popped up as Magnetic field.

The Researcher opened Image 4 and asked them to name the part labeled VI. Some of the students gave an answer as light. The Researcher then pressed on the next key and an arrow with the name of the part labeled VI popped up as Fluorescence screen.

The Researcher asked Students to observe the cathode ray tube (image 7), draw and identify the parts in their book.

Activity 2: How electrons were discovered using cathode ray tube

The Researcher downloaded video by Wendell (2012) explaining how electrons were discovered with cathode ray tube and installed on his computer. The Researcher projected the video and played with VLC media player for students to watch. The video explains how electrons were discovered by the cathode ray tube. Cathode rays emanated from negative metal plate (Cathode) through a variety of gases at low pressure. The rays were deflected by both electric and magnetic field and gave a glow at the fluorescence screen detector. The charge/mass ratio of the particle was determined and was found out to be the same whatever gas was used. The particles were named electrons. After watching the video a student asked why cathode ray tubes have to contain a gas at low pressure. A girl explained that lowering the pressure means that there are less molecules of gas for the rays to collide with. If the electrons in the beam of rays hit the molecules, more of the rays will be deflected and may not reach the target.

The Researcher asked students to explain how electrons were discovered by J. J. Thomson.

Activity 3: Description of Thomson' structure of Atom

The Researcher opened image 8 showing Thomson's structure of atom on the projector.

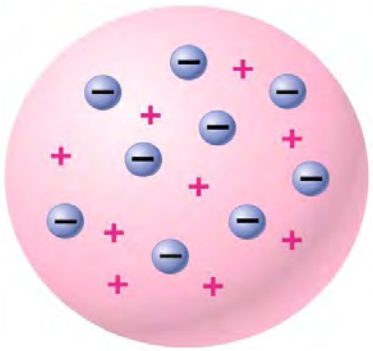

Figure 1.5: J. J. Thompson's Model of Atom (Sarong, 2007)

Researcher: **How does J. J. Thomson's structure of atom looks?**

Students' response:

1. An atom is a solid sphere of positive charge with rings of negative electrons
2. The negative and positive charges balance to make the atom electrically neutral.

The Researcher asked students to draw Thompson's structure of atom and awarded marks.

Findings from lesson 2

Students were able to

- identify parts of the cathode ray tube as High voltage equipment which has two electrodes (-) and anode (+),
- identify electric field placed in the middle of the cathode ray tube.
- identify magnetic field placed at right angle to the electric field
- identify fluorescence screen where the cathode rays were detected placed at the bottom of the cathode ray tube.

- explain how electron were discovered from the cathode ray tube.

- describe Thomson's structure of the atom as a solid sphere of positive charge with rings of negative electrons.

4.3 Report on lesson three

Information and communication tools used in this lesson includes: computer and a projector.

Topic: Rutherford structure of atom

Objectives: Students' should be able to:

- Explain Rutherford alpha scattering experiment
- Interpret the results on the three observations made
- Draw Rutherford structure of atom

Relevant Previous Knowledge: Students' have seen Thomson's structure of Atom.

Activity 1: Description of Rutherford Alpha scattering experiment of Atom

The Researcher downloaded images showing Rutherford's alpha scattering experiment on his computer. The Researcher then projected and scroll through the images showing the various parts of the alpha scattering experiment.

The Researcher opened image I on the projector and asked students to identify the part labeled I. Some students gave an answer to I as cube. The Researcher then pressed on the next key and an arrow with the name of the part labeled I popped up as Source of alpha particles. The Researcher pressed on the next key and asked students to identify II. Some of the students mentioned a circle. The Researcher pressed on the next key and arrow with an answer of the part labeled II popped up as circular fluorescence screen. The Researcher pressed on the next key and asked students to identify the part labeled III. A students gave

an answer as a yellow rectangle. The Researcher then pressed on the next key and an arrow with an answer of the part labeled III popped up as a thin gold foil.

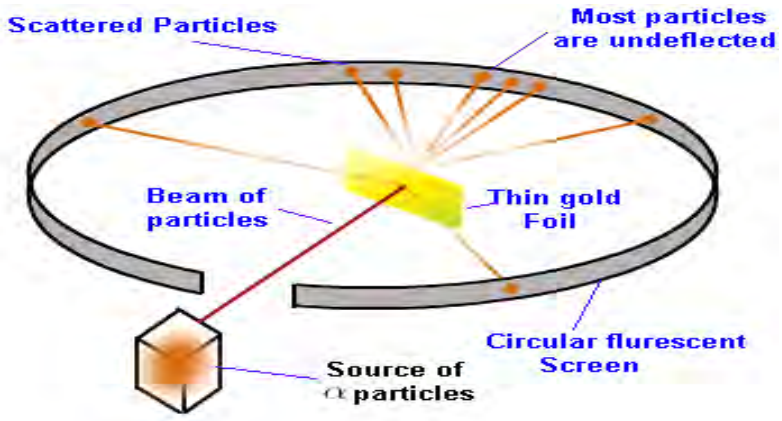

Figure 1.6: Image Rutherford's Alpha Scattering Experiment (Tyler, 2012)

The Researcher downloaded a video showing how Rutherford's alpha scattering experiment by Tyler (2012) projected the video and played with VLC media player for students to watch. The video explains how alpha particles were made to bombard the nucleus of the thin gold foil.

Most of the alpha particles passed through the nucleus of the gold without deflecting. A few of the alpha particles deflected through large angles. A small portion of the alpha particles bounced back.

Activity 2: Observations from the experiment

The Researcher opened image 9 showing how the alpha particles were been deflected on their computer.

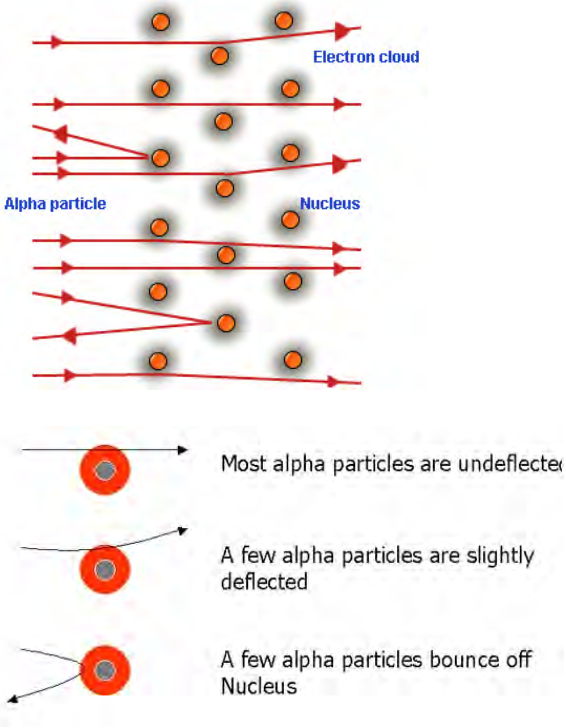

Figure 1.7: Deflection of Alpha Particles (Tyler, 2012)

Researcher: **What interpretation can be made from the observations?**

Students' responses:

- Most of the volume of the atom is empty space occupied by electrons which are light to deflect alpha particles
- Deflection through large angles were as a result of repulsion of the alpha particles which came very close to a concentrate region of positive charge.
- Alpha particles bounced back as a result of 'head on' collision with massive positively.

Activity 3: Description of Rutherford's structure of Atom

Students opened image of Rutherford's structure of atom.

Researcher: **How does Rutherford model of the atom looks like?**

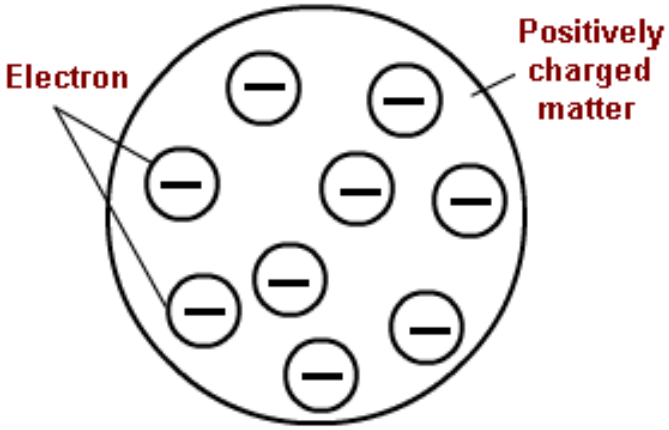

Figure 1.8: Rutherford's Model of the Atom (Tyler, 2012)

Students' response:

- The atom has a central positive nucleus composed of protons where all the mass is concentrated.
- The electrons in the atom orbit around the nucleus
- The greater portion of the atom is an empty space occupied by electrons.

The Researcher asked students to draw Rutherford structure of Atom and award marks.

Findings from lesson 3

Students were able to

- explain Rutherford's alpha scattering experiment on the atom.
- interpret the observations as most of the volume of the Atom is empty space occupied by electrons which are light to deflect alpha particles, deflection through large angles were as a result of repulsion of the alpha particles which came very close to a concentrate region of positive charge and alpha particles bounced back as a result of 'head on' collision with massive positively.
- describe Rutherford's structure of atom as an atom has a central positive nucleus composed of protons where all the mass is concentrated and electrons in the atom orbit around the nucleus.

4.4 Report on lesson four

Information and communication tools used in this lesson includes: computer and a projector

Topic: Structure of Atom

Objectives: Students' should be able to:

- Explain why atom is said to be electrically neutral
- Identify mass number and atomic number of an atom.

Relevant Previous Knowledge: Students' have seen Rutherford's structure of Atom.

Activity 1: why an atom is said to be electrically neutral

Students could not explain why an atom is said to be electrically neutral. The Researcher opened the image and asked students to count the number of protons, neutrons and electrons in the image.

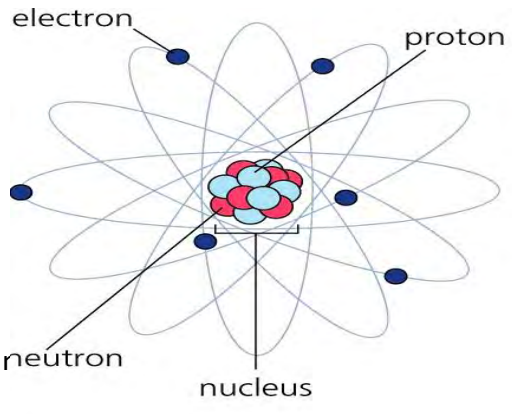

Figure 1.9: Structure of the Atom (Sarong, 2007)

Researcher: **How many protons are in the atom?**

The students gave an answer as 6.

Researcher: **How many electrons are in the atom?**

Students' response: 6

Researcher: **How many neutrons are in the atom?**

Students' response: 6

The Researcher asked students to state the charges of proton, neutron and electron

Students' response:

Proton has a charge of (+1), neutron has no charge and electron has a charge of (-1)

Researcher: **What is the net charge of the atom in Fig. 1.12 which has 6 proton, 6 neutrons and 6 electrons?**

Students' response: the net charge of the atom is 0.

Researcher: **Why is an atom said to be electrically neutral?**

Students' response: The negatively charge electrons and positively charge protons of a neutral atom are the same hence they cancel out and makes an atom electrically neutral.

Activity 2. Identifying mass number and atomic number of Atom

The Researcher opened an image showing the representation of three isotopes of hydrogen on the projector and asked students to identify the mass numbers and atomic numbers of Hydrogen.

A= Mass number **Z= Atomic number**

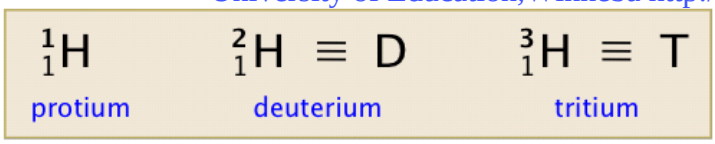

Figure 1.10: Representation of the Atom (Sarong, 2007)

Students' response: Mass number (A) is placed as a left superscript on the chemical symbol of an element and Atomic number (Z) is placed as a subscript on the chemical symbol of an element. Hence the mass number of Protium is 1 and it's atomic number is 1, the mass number of deuterium is 2 and it's atomic number is 1 and the mass number of tritium is 3 and it's atomic number is 1.

Researcher: **What is the mass number and atomic number in the atom Cl ?**

Students' response: mass number is 35 and atomic number is 17

Findings from lesson 4

Students were able to

- explain why an atom is said to be electrically neutral as a neutral atom has the same number of protons and electrons hence their net charges cancels out making an atom electrically neutral.
- identify that mass number is always written as a superscript and atomic number is also written as a subscript by the chemical symbol of every element.

4.5 Report on lesson five

Information and communication tools used in this lesson includes: computer and projector

Topic: Matter

Objectives: After studying this, students' should be able to:

- Explain how a molecules is formed from atom
- Explain how an ion is formed from an atom

Relevant Previous Knowledge: Students' can draw structure of atom.

Researcher: **what is a Molecule?**

Students' response: A molecule is composed of two or more atoms that are chemically combined.

Activity 1: Formation of a Molecule

Researcher: **How is a Molecule formed?**

Students were not able to answer the question.

The Researcher projected an image showing how two atoms of hydrogen combine to form hydrogen gas (molecule) and discussed with students how molecules are formed from atoms.

Figure 1.11: Formation of hydrogen gas (molecule) (Sarong, 2007)

The Researcher pressed on the keyboard and an image popped up showing addition of two atoms of hydrogen. The Researcher asked student to explain what will happen when on atom of hydrogen is added to another one atom of hydrogen. The students explain that

the two atoms will combine to form hydrogen molecules. The Researcher then pressed on the next key and an arrow with the image of hydrogen molecule popped up. The Researcher explained to students that when two or more atoms combines chemically a molecule is formed.

Activity 2: Formation of an Ion

Researcher: **What is an Ion?**

Students' response: An ion is an electrically charged atom.

Researcher: **How is an ion formed from an atom?**

Students were not able to answer the question.

The Researcher projected an image showing how an ion is formed from an atom and discussed with students how ions are formed from atom.

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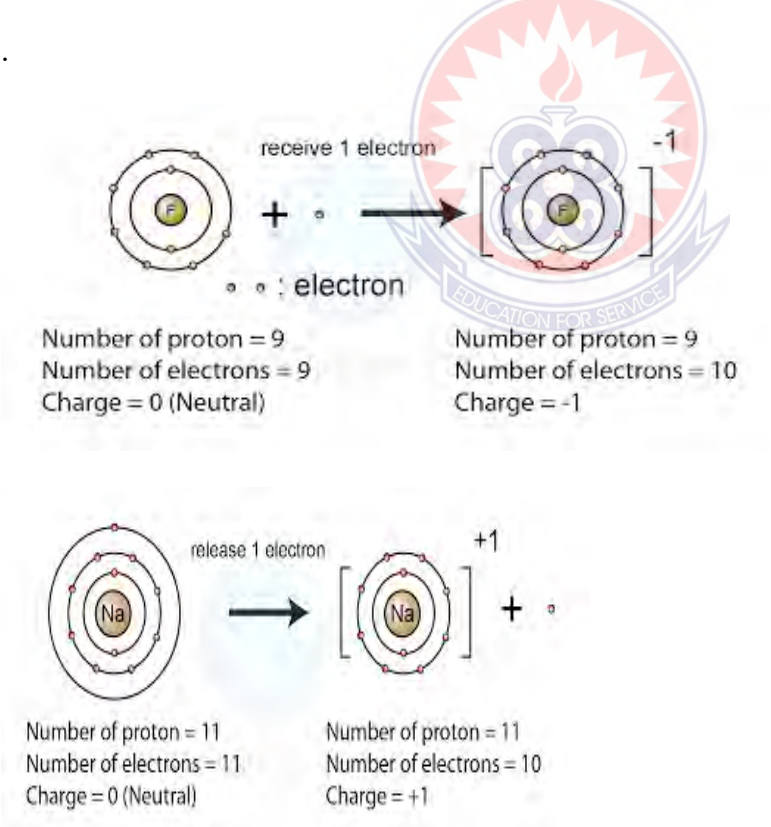

Figure 1.12: Formation of an ion (Sarong, 2007)

The Researcher asked students to describe what they see in the image.

Students' responses: The atom has a total of 9 electrons around the nucleus. Electrons in the outer shell are 7 and electrons in the inner shell are 2.

The Researcher pressed on the next key and an arrow with another image popped up. The Researcher asked students to describe the image.

Students' response: the atom has gained an electron hence it has a total of 10 electrons. The outermost shell has 8 electrons and the innermost shell has 2 electrons. It has a charge of -1.

The Researcher asked the students to explain why the atom has a charge of -1. The students explained as the addition of an extra electron made the atom electrically charged.

The Researcher pressed on the next key and asked the students to describe the image that popped up.

Students' response: The atom has a total of 11electrons with only one electron in the outermost shell. It has no charge.

The Researcher pressed on the next key and an arrow with another image popped up. The Researcher asked students to describe the image.

Students' response: the atom has lost one electron hence it has a total of 10electrons. It also has a charge of +1.

The Researcher asked the students to explain why the atom has a charge of +1. The students explained as the loss of an electron in the outermost shell made the atom electrically charged.

The Researcher then opened an image showing how chlorine atoms forms chloride ion and ask students to explain.

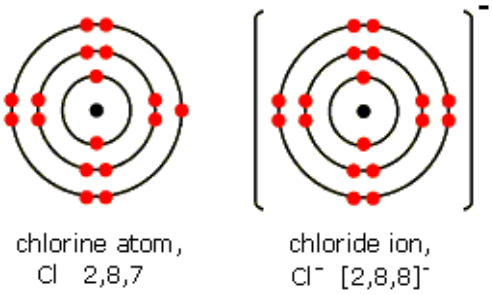

Figure 1.13: Formation of chloride ion (Sarong, 2007)

Student's response: Chlorine atom has 17 protons in the nucleus and 17electrons surrounding it. Chlorine gains one electron into the outermost shell in other to gain stability. Gain of one electron makes it chloride ion. This means there are 17 protons and 18 electrons. Chloride ion now has a net charge of -1.

Findings from lesson 5

Students were able to

- explain that molecules are formed as when two or more atoms of the same elements or different elements combine chemically
- explain that ions are also formed when an atom loose or gain electrons. An atom loses an electron to become positively charged and are called cation and gains electron to become positively charged and are called anion.

4.6 Discussion of findings

Research question 1: What scientific misconceptions do students have about particulate nature of matter?

From the observation made, the Researcher has observed that Chemistry students' in Guakro Effah Senior High School:

- appear to be unable to answer questions when it comes to structure of the atom. They have the misconception that particulate nature of matter is very difficult. The difficulty is caused by their inability to interpret concepts, been taught abstractly or verbally without visuals images. Students have been taught that matter is made up of smaller particles but they have not seen these particles to be able to visualise

- the structure and the composition of these particles. Another difficulty is caused by conceptual understanding of the models of the atoms proposed by J. J. Thompson and Lord Rutherford. This is due to the fact that students did not see images or videos on these models hence their inability to form mental picture of the models to be able to link them to their already existing mental schema in order to make understand concepts meaningfully.
- were able to define concepts but could not explain how the concept was formed. The Researcher asked students' to define an ion and most of them were able to define ion but could not explain how ions are formed from atoms. Students could not also explain how molecules are formed. The Classroom interactions that occurred between the Researcher and the student's again revealed that student did not know why an atom is said to be electrically neutral.

- Performance however improved as the use of ICT tools in teaching particulate nature of matter provided students with a more student-centered and activity based pedagogy, and enhanced conceptual understanding of structure of the atom. Using ICT tools in teaching particulate nature of matter also helped maintain the quality of teaching and learning by providing a learning environment where students were given effective opportunity to visualise, abstract concepts. The use of image representation, animation and video has proven beneficial for the students' process of understanding of concepts. From the study, students who initially had the misconception that particulate nature of matter is difficult were able to draw the structure of the atom with ease after ICT tools were used to teach and were also able to interpret observations made by Rutherford on the structure of the atom without committing them to memory. Understanding of more complex and abstract phenomena cannot be achieved without the use of a variety of representations, especially the integration between submicroscopic and symbolic level representations. Using ICT tools for teaching and learning particulate nature of matter is very necessary

because pupils better understand chemical phenomena and they can formulate appropriate mental models of concepts. Students actively participated fully in all the lessons and came together to share ideas in order to come out with solution to the various assignments given to them by the Researcher. The use of ICT tools made teaching and learning more interesting, encouraging and effective as students' were motivated to learn. This made students' punctual in class and lateness was also avoided. Based on these findings, lessons on the structure of atom should be taught using pictures and videos to enable students understand it better.

This study also sought to improve student's academic performance by addressing the second research question.

Research question 2*: *What effect does the use of ICT tools in teaching particulate nature of matter have on the learning outcomes of students?

Data was collected in the pre-intervention exercise and was compared with the data collected after the intervention was implemented and analysed.

Table 1. ***The Comparison of Students' Mean Performance in Knowledge, Comprehension and Analysis of Pre-test and Knowledge, Comprehension and Analysis of Post-test***

Test	Mean	N	Std. Deviation	t	df.	p-Value
Post-test (knowledge)	4.9143	35	1.59727	11.889	34	0.000
Pre-test (knowledge)	2.2857	35	1.54485			
Post-test (Comprehension)	5.0571	35	1.73108	11.265	34	0.000
Pre-test (Comprehension)	1.6571	35	1.0.2736			
Post-test (Analysis)	3.0857	35	.78108	9.659	34	0.000
Pre-test (Analysis)	1.1714	35	1.12422			

From Table 1, the mean knowledge in post-test is 4.9143 and the mean knowledge in pre-test is 2.2857. The p value is 0.000. Since the p value is less than 0.05 it means there is a statistical difference between the mean knowledge in pre-test and mean knowledge in post-test. Comparison of students' mean achievement showed that student's knowledge in the structure of atom during the post-test was higher than the pre-test.

More also, the mean comprehension in post-test is 5.0571 and the mean comprehension in pre-test is 1.6571. The p value is 0.000. Since the p value is less than 0.05 it means there is a statistical difference between the means comprehension in pre-test and mean comprehension in post-test. Comparison of students' mean achievement showed that student's comprehension in the structure of atom during the post-test was higher than the pre-test.

Finally, the mean analysis in post-test is 3.0857 and the mean analysis in pre-test is 1.1714. The p value is 0.000. Since the p value is less than 0.05 it means there is a statistical difference between the means Analysis in pre-test and mean Analysis in post-test. Comparison of students' mean achievement showed that student's Analysis in the structure of atom during the post-test was higher than the pre-test. This study has found out that the students' performance increased when ICT was used in teaching the structure of an Atom.

This study has found out that the students' performance increased when ICT was used in teaching in the lessons.

Table 2. ***The Comparison of Students' Mean Performance in Pre-test and Post-test***

Test	Mean	N	Std. Deviation	t	df	p-Value
Post-test	13.1429	35	3.33557			
				18.638	34	0.000
Pre-test	5.0286	35	2.66222			

From Table 2, the mean of post-test is 13.1429 and the mean of pre-test is 5.0286. The p value is 0.000. Since the p value is less than 0.05 it means there is a statistical difference between the means of post-test and pre-test. The comparison of students' mean achievement showed that the post-test was higher than the pre-test. It was concluded that there was a significant difference in achievement of students in the structure of the atom. This indicated that the performance of students in knowledge, comprehension and Analysis were all increased when teacher used ICT tools in teaching the structure of the atom.

As a result of the use of ICT tools in teaching, student's performance improved. Students were able to explain why an atom is said to be electrically neutral and they were able to interpret why most alpha particles passed through the nucleus of a thin gold without deflection, why most of the alpha particles deflected through large angles and why a few alpha particles bounced back. As far as students' performance on knowledge, comprehension and Analysis is concerned, it was inferred that the performance of students on the structure of the atom in the post-test after the intervention has improved as compared to pre-test before the intervention. Based on the findings from the pre-test and post-test when science teachers use ICT tools to teach particulate nature of matter and understand how to use these technologies into their teaching, value is added to the learning environment and students are afforded the opportunity to improve their learning outcomes. ICT tools used in teaching particulate nature of matter can assist weaker students to make

progress as the learning material can be directed at the level appropriate for each student and they will be motivated to learn. This finding is supported by Yusuf (2005) who revealed that ICT tools have the potential to accelerate, enrich and motivates students to learn. In addition, ICT tools also provide a richer and more exciting learning environment for teaching and learning (Jonassen, 2002). Video presentation of concepts with the aid of Projector will make teaching more lively and interesting which will intend motivates students to learn. According to Haddad and Jurich (2002) the use of ICT tools, in particular computer technologies, is correlated to positive academic outcomes, including higher test scores, better attitudes towards schools, and better understanding of abstract concepts. Many studies have describe the motivating effect of using ICT tools in schools and the positive effect it can have on students attention and effort in class. Trimmel and Bachman (2004) studied the impact of introducing laptops into classrooms and one of their conclusions was that ICT tools have a positive impact on school attendance and learning interest. The DfES (2003b) drew on a number of research projects to support its statement that ICT can play an important role in motivating pupils and encouraging them to engage in learning within and beyond the classroom.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter outlined summary of findings of the study, made some recommendations for teachers and Heads of institution and drew conclusion from the findings and also made suggestions for further studies

5.1 Summary of findings

The study sought to find out student's learning outcomes when ICT tools are used in teaching Particulate Nature of Matter at GESHS form one class in the Techiman North District in the Brong-Ahafo Region. The major findings in this study which spanned five lessons on the structure of atom were as follows:

- The students were able to describe the characteristics of the states of matter through the use of animated images which described solids as having a definite shape and size, liquids having definite volume but do not have fixed shape and gases do not have definite shape and volume.

- The students were able to identify the sub-atomic particles of atoms as proton, neutron and electron and were able to identify the position of the nucleus through the use of pictures which showed nucleus as the center of an atom which contains protons and neutrons whilst electrons moves around the nucleus.
- The students were able to identify parts of the cathode ray tube through animated pictures which showed the parts of the cathode ray tube as High voltage, electric field, magnetic field and fluorescence screen.

- The students were able to explain how Thompson discovered the electron from the cathode ray tube and describe Thomson's structure of Atom through the use of video which showed how the electrons were discovered.

- The students were able to explain Rutherford's alpha scattering experiment of the atom through the use of video which described Rutherford's scattering experiment and structure of Atom as having a central positive nucleus composed of protons where all the mass is concentrated and electrons in the atom orbit around the nucleus.
- The students were able to explain why an atom is said to be electrically neutral through the use of animated images which shows how protons and electrons cancels out to make an atom electrically neutral.
- The students were able to identify mass number and atomic number of an element through the use of pictures which showed mass number written as a superscript and atomic number as a subscript by the chemical symbol of every element.
- The students were able to explain that molecules and ions are formed through the use of pictures which showed how molecules and ions are formed from an atom.

5.2 Conclusion

One purpose of science education is to ensure that learner understand science concepts and be able to apply it to man's need. The study revealed that students from GESHS did not understand structure of the atom because they could not visualise it because it was taught abstractly hence leading to their poor performance.

However, the use of ICT tools in teaching particulate nature of matter illustrated how it provided a learning environment where students were given effective opportunity to visualise, abstract concepts. For instance, Images and videos that were projected helped

students to see the parts of the cathode ray tube and how cathode rays were emitted from the cathode through the anode to the fluorescent screen detector. After watching the video, students were able to explain how electrons were discovered from the cathode ray tube without committing them to memory. The use of ICT tools in teaching and learning helps students to expand knowledge, experience and increase understanding, especially in the Science subjects that require visual, audio, flow chart, video presentation and so on. The findings concluded that using ICT tools to teach Particulate Nature of matter has positive impact on student's achievements. Schools must strive to increase usage of ICT tools amongst teachers. On the other hand, teachers should put more effort to use ICT tools in their Science lesson in order to increase students' achievements. Teachers who are weak in the use of ICT tools in teaching need to participate in ICT training courses. ICT facilities provided by the government in schools must be fully utilised by the teachers.

Using ICT tools in teaching can also help students to understand concepts through a relationship with a real life situation. The use of ICT tools in teaching particulate nature of matter can improve students' achievements compared to using traditional approaches. Moreover, it can make teaching and learning process become more interesting, encouraging and effective. Using ICT tools in teaching encourages students to process information better and thus enhances the understanding and improves students' memory.

The overall conclusion from this study reveals that ICT tools has a significant and positive impact on teaching and learning specifically for Science subject. ICT tools contributes greater performance or achievement of students. Teachers should replace traditional teaching approach with attractive learning style by involving ICT tools in their lesson. Science field that needs investigation and practical works needs ICT tools to assist in teaching.

5.3 Recommendation

Based on the findings of the study, and the availability of the ICT tools in the school, the following recommendations were made to enhance the teaching and learning of the particulate nature of matter. It is recommended that:

- teachers in the school should use ITC tool to show images which describes the characteristics of the states of matter in order for students to see how particles in the solid, liquid and gases behaves.
- teachers in the school use ICT tools to show images which describes how sub-atomic particles are arranged in an atom for students to be able to identify the position of each subatomic particle.
- teachers in the school should use ICT tools to project images of the parts of the cathode ray tube for students to be able to identify the parts.
- teachers in the school need to be aware that the structure of Atom as proposed by J. J. Thomson and Lord Rutherford is not readily comprehensible to students' so it is recommended that they should use ICT tools to project images and videos showing how electrons were discovered from the cathode ray tube experiments and the structure of atom proposed by J. J. Thomson.
- teachers in the school should use ICT tools to project images and video to show how Rutherford used alpha scattering experiment to establish the structure of Atom.
- teachers in the school should moreover use ICT tools to project images to show students how the charges of proton and electrons cancels out to make an atom electrically neutral.
- teachers in the school should use ICT tools to project images to show students that mass numbers are placed as a superscript and atomic numbers are placed as

subscript by the chemical symbol of every element. This will enable them not to interchange superscript as atomic number and subscript as mass number.

- teachers in the school should use ICT tools to show images of how molecules and ions are formed from atom.
- Headmaster of the school should enforce the use of ICT tools in the teaching particulate nature of matter.
- Ministry of Education and Ghana Education Service should prioritise in-service training, workshops and seminars for science teachers especially chemistry teachers to improve on their ICT skills in order to use ICT tools in delivery of their lessons. This will build teachers confidence and will appropriately use them to achieve lesson objectives.

5.4 Suggestions for further research

Since science is tentative and society continuous to be dynamic with continuous change in social needs there is always the need for further research to be conducted into many aspects of education at all levels to meet the aspirations of the society. It is therefore recommended:

- A study of the use of ICT tools in teaching more abstract topics in chemistry such as Chemical formula and chemical equations, Hybridization and Bonding in chemistry and Radioactivity.
- A study of the use of ICT tools in teaching particulate nature of matter is conducted with a larger and more representative sample from other regional and district senior high schools in Ghana.
- Further studies may be conducted in other science subject areas such as (Biology, Physics and Integrated science).

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APPENDICE A

PRE-TEST QUESTIONS

GUAKRO EFFAH SENIOR HIGH SCHOOL

CHEMISTRY

ANSWER ALL QUESTIONS

Time: 30 minutes

Each question in section A is followed by four options lettered A to D. Choose the correct option. Section B is a True or False statement. Select the statement that is either True or False. Section C, are essay questions, do not write more than a page for a question.

SECTION A. (MULTIPLE CHOICE)

1. Which among the following did Rutherford use to bombard the nuclei of atom during his experiment to discover the structure of an atom?

A. Alpha particles B. Beta particles C. Gamma rays D. Delta

2. Which among the sub-atomic particle(s) can be found inside the nucleus of an atom?

A. Proton and Electron B. Proton and Neutron. C. Proton only D. Electron and Neutrons

3. According to Rutherford's experiment nearly all the alpha particles passed through the gold foil unimpeded because?

A. most of the volume of the atom is empty space occupied by electrons

B. there was repulsion of the alpha particles

C. there was a head on collision with massive positively charged centres

D. there were attraction from the positively charge centre

4. Which among the following scientists used cathode ray tube to discover electrons?

A. Dmitri Mendeleev B. John Dalton C. J. J. Thomson D. Lord Rutherford

5. Which among the following scientists used thin Gold foil to propose the structure of an Atom?

A. Dmitri Mendeleev B. John Dalton C. J. J. Thomson D. Lord Rutherford

6. According to Rutherford's experiment few of the alpha particle deflected through large angles because?

A. most of the volume of the atom is empty space occupied by electrons

B. there was repulsion of the alpha particles

C. there was a head on collision with massive positively charged centres

D. there were attraction from the positively charge centres

7. J. J. Thomson passed cathode rays which emanated from the negative metal plate (cathode)

through gases at a very?

A. Low pressure B. High pressure C. High temperature D. low temperature

8. Which of the following is not a sub-atomic particle?

A. electrons B. element C. neutron D. proton

SECTION B. (TRUE OR FALSE)

9. An atom is the smallest electrically neutral particle of an element that can take part in chemical change.

True or false

10. According to J. J. Thomson experiment of an atom, the rays that emanated from the cathode of the cathode ray tube were deflected by both electric and magnetic fields.

True or false

11. According to J. J Thomson an atom is a solid sphere of negative charge in which rings of positive electrons are embedded.

True or false

12. According to Rutherford's alpha scattering experiment, a small portion of alpha particles were deflected through large angles of the thin metal sheet.

True or false

13. According to Rutherford the greater portion of an atom is an empty space occupied by electrons.

True or false

14. The negative and positive charges in an atom balance to make the atom electrically charged.

True or false

15. J. J. Thomson found out that cathode rays always had the same charge/mass ratio whatever gas was used.

True /False

16. J. J. Thomson's model of the atom was rejected since it couldn't explain the behavior of the Atom.

True/ False

SECTION C (ESSAY)

17. Briefly explain how the cathode ray tube was used by J. J. Thomson to discover the structure of an Atom.

18. State three observations made by J. J. Thomson and how were they used to establish the structure of the atom.

19. Explain briefly Lord Rutherford's alpha scattering experiment of the atom.

20. How were Lord Rutherford's observations used to establish the structure of the atom.

APPENDIX B

POST TEST QUESTIONS

GUAKRO EFFAH SENIOR HIGH SCHOOL

CHEMISTRY

Time: 30 minutes

ANSWER ALL QUESTIONS

Each question in section A is followed by four options lettered A to D. Choose the correct option. Section B is a True or False statement, select the statement that is either True or False. Section **C,** are essay questions, do not write more than a page for a question.

SECTION A. (MULTIPLE CHOICE)

1. Which of the following instrument was used to discover the electron?

A. Cathode ray tube B. electron microscope C. Geiger muller counter D. mass spectrometer

2. Which among the sub-atomic particle can be found outside the nucleus of an atom

A. electrons B. neutrons. C. protons. D. ions

3. Which among the following scientists discovered the electrons

A. Dmitri Mendeleev B. John Dalton C. J. J. Thomson D. Lord Rutherford

4. The nucleus of an atom is made up of?

A. protons and electrons. B. protons and neutrons

C. electrons and neutrons D. protons and elements

5. According to Rutherford's experiment a small portion of the alpha particle bounced back because?

A. most of the volume of the atom is empty space occupied by electrons

B. there was repulsion of the alpha particles

C. there was a head on collision with massive positively charged centres

D. there were attraction from the positively charge centres

6. What did Rutherford used to bombard various nuclei of thin Gold foil?

A. alpha particle B. beta particles C. gamma rays D. cathode rays

7. Which of the following is not a sub-atomic particle?

A. electrons B. element C. neutron D. proton

8. According to John Dalton's postulate of the atomic theory, atoms of the same element have the same

A. atomic number B. atomic size C. mass D. weight

SECTION B. (TRUE OR FALSE)

9. An atom is the smallest electrically neutral particle of an element that can part in chemical change.

True or false

10. According to J. J. Thomson experiment of an atom, the rays that emanated from the cathode of the cathode ray tube were not deflected by both electric and magnetic fields.

True or false

11. According to J. J Thomson an atom is a solid sphere of positive charge in which rings of negative electrons are embedded.

True or false

12. The negative and positive charges in an atom balance to make the atom electrically neutral.

True or false

13. According to Rutherford the greater portion of an atom is an empty space occupied by protons.

True or false

14. Alpha particles bounced back as a result of repulsion of the alpha particles which came very close to concentrated region of negative charges according to Rutherford's observation of the alpha scattering experiment of the atom.

True or false

15. According to Rutherford an atom has a central positive nucleus composed of protons where all the mass is concentrated.

True or false

16. According to Rutherford alpha scattering experiment, nearly all the alpha particles were deflected through large angles of the thin metal sheet.

True or false

SECTION C (ESSAY)

17. Briefly describe Rutherford alpha particles scattering experiment and state the three observations made.

18. How were the results used to establish the structure of the atom?

19. Describe briefly the structure of the atom as proposed by Rutherford.

20. (a) Describe briefly the structure of the atom as proposed by J. J. Thomson.

(b) Why is pressure kept low in the cathode ray tube?

APPENDIX C

Student's Pre-test (Scores)				
Number	**Knowledge**	**Comprehension**	**Analysis**	**Total**
1	2	3	1	6
2	1	2	1	4
3	2	3	0	5
4	2	3	2	7
5	3	2	1	6
6	1	1	1	3
7	0	1	0	1
8	3	1	0	4
9	5	0	3	8
10	3	1	3	7
11	2	1	0	3
12	4	2	0	6
13	5	3	3	11
14	6	4	4	14
15	2	0	3	5
16	3	0	0	3
17	1	3	2	6
18	1	2	1	4
19	1	1	2	4
20	2	1	1	4
21	4	3	0	4
22	0	2	1	3
23	0	1	0	1
24	2	1	2	5
25	3	2	0	5
26	2	0	1	3
27	3	3	2	8
28	1	2	1	4
29	2	2	2	6
30	5	1	0	6
31	2	2	1	5
32	1	1	1	3
33	0	1	0	1
34	2	1	0	3
35	4	2	2	8

Appendix D

Student's Post-test (scores)				
Number	Knowledge	Comprehension	Analysis	Total
1	7	6	4	17
2	4	5	3	12
3	5	6	3	14
4	6	7	3	16
5	8	6	4	18
6	6	6	2	14
7	4	6	3	13
8	5	7	3	15
9	7	6	4	17
10	5	8	4	17
11	4	7	4	15
12	7	7	3	17
13	6	8	4	18
14	8	8	3	19
15	7	6	4	17
16	6	5	2	13
17	4	4	4	12
18	6	5	3	14
19	5	3	2	10
20	4	4	3	11
21	4	5	4	13
22	4	6	2	12
23	3	2	3	8
24	4	4	2	10
25	7	3	3	13
26	4	4	2	10
27	4	4	3	11
28	2	5	3	10
29	4	4	4	12
30	6	6	4	16
31	4	3	3	10
32	4	3	2	9
33	2	2	2	6
34	3	2	2	7
35	6	4	4	14

APPENDIX E

CLASS OBSERVATION CHECKLIST

1. How enthused are the students when ICT tools are used in teaching?
2. Do the students pay much attention when ICT tools are used in teaching?
3. What is the attitude of students when ICT tools are used in teaching?
4. Do the respondents sleep when ICT tools are used in teaching?
5. Do the students move out of the class frequently when ICT tools are used in teaching?

APPENDIX F

Marking Scheme for Pre-test

SECTION A

1. A (1mark)

2. B (1mark)

3. A (1mark)

4. C (1mark)

5. D (1mark)

6. B (1mark)

7. A (1mark)

8. B (1mark)

SECTION B

9. True (1mark)

10. True (1mark)

11. False (1mark)

12. True (1mark)

13. True (1mark)

14. False (1mark)

15. True (1mark)

16. True (1mark)

SECTION C

17. J. J. Thomson investigated the conductivity of electricity by gases at very low pressure using discharge tube. He passed cathode rays which emanated from the negative metal plate (cathode) through a variety of gases at low pressure. The rays were deflected by both

electric and magnetic fields indicating they were charged particles. He found out that cathode rays always had the same charge/mass ratio whatever gas was and named the particles electrons.

(1 mark)

18. **OBSERVATIOS MADE (1 mark)**

-The rays gave a glow at the fluorescent screen detector

-The rays were deflected by both electric and magnetic fields indicating they were charged particles.

-cathode rays always had the same charge/mass ratio whatever gas was used.

Thompson proposed the structure of Atom as a solid sphere of positive charge with rings of negative electrons the negative and positive charges balances to make the Atom electrically neutral.

19. Rutherford bombarded various nuclei of thin gold foil with alpha particles and made these observations:

-nearly all of the alpha particles passed through the thin metal sheet unimpeded

-few of the alpha particles were deflected through large angles -a small portion of the alpha particles bounced back **(1mark)**

20. **INTERPRETATION OF THE RESULTS (1mark)**

-most of the volume of the Atom is empty space occupied by electrons which are light to deflect alpha particles.

-deflection through large angles were as a result of repulsion of the alpha particles which came very close to a concentrate region of positive charge.

-alpha particles bounced back as a result of 'head on' collision with massive positively charged centers.

MODEL OF THE ATOM PROPOSED BY RUTHERFORD

-the Atom has a central positive nucleus composed of protons where all the mass is concentrated.

-the electrons in the atom orbit around the nucleus.

-the greater portion of the atom is an empty space occupied by electrons

APPENDIX G

Marking Scheme for Post-test

SECTION A

1. A (1mark)

2. A (1mark)

3. C (1mark)

4. B (1mark)

5. C (1mark)

6. A (1mark)

7. B (1mark)

8. C (1mark)

9. True (1mark)

SECTION B

10. False (1mark)

11. True (1mark)

12. True (1mark)

13. False (1mark)

14. False (1mark)

15. True (1mark)

16. False (1mark)

SECTION C

17. Rutherford bombarded various nuclei of thin gold foil with alpha particles and made these observations:

-nearly all of the alpha particles passed through the thin metal sheet unimpeded

-few of the alpha particles were deflected through large angles -a small portion of the alpha particles bounced back **(1mark)**

18. -Most of the volume of the Atom is empty space occupied by electrons which are light to deflect alpha particles.

-Deflection through large angles was as a result of repulsion of the alpha particles which came very close to a concentrate region of positive charge.

-Alpha particles bounced back as a result of 'head on' collision with massive positively charged centers.

Rutherford then proposed that Atom has a central positive nucleus composed of protons where all the mass is concentrated. The electrons in the atom orbit around the nucleus. **(1 mark)**

19. Thompson proposed the structure of Atom as a solid sphere of positive charge with rings of negative electrons the negative and positive charges balances to make the Atom electrically neutral**.** **(1mark)**

20. lowering the pressure means that there are less molecules of gas for the rays to collide with. Because if the electrons in the beam of rays hit the molecules, more of the rays will be deflected and may not reach the target. Hence pressure is kept low in the cathode ray tube to prevent the prevent rays from colliding with more molecules of gas.

(1mark)

APPENDIX H

LESSON ONE

Subject: Chemistry

Duration: 80 minutes

Topic: Matter

Objectives: By the end of this lesson, students should be able to:

- Describe the characteristics and nature of the states of matter
- Identify the particles that an atom is composed of

Relevant Previous Knowledge: Students' have seen tree, pen, book, water, smoke, stone and sand.

Introduction (5minutes)

Teacher: What is matter?

Students' expected answer: Matter is anything that has mass and occupy space

Teacher: Mention some examples of matter

Students' expected answer: Sand, Tree, Pen, Book, Water, Smoke

Teaching and Learning Activities (60 minutes)

Teachers project video animation showing how the particles of matter are arranged in solids, liquids and gases on their computer and discuss with student the nature and characteristics of the states of matter. Teacher again project images of the structure of Atom and discuss with students the position of each of the subatomic particles.

Evaluation (15 minutes)

- Define matter and give three examples of matter in the solid, liquid and gas each.
- Describe the characteristics and nature of the three states of matter.
- State the three subatomic particles and identify their location in the atom

APPENDIX **I**

LESSON TWO

Subject: Chemistry

Duration: 80 minutes

Topic: J. J. Thomson's structure of the atom

OBJECTIVES: After studying this, students' should be able to:

- Identify the parts of the cathode ray tube
- Explain how electron was discovered by J. J. Thomson
- Draw J. J. Thomson's structure of Atom

Relevant Previous Knowledge: Students' have seen the structure of atom.

Introduction (5minutes)

Teacher: Describe the structure of atom

Students' expected answer: The atom is composed of a center part called nucleus which contains protons and neutrons with electrons moving around it.

Teaching Learning Activities (60 minutes)

Teacher displays image of the cathode ray tube and assists students to identify the parts.Teacher again projects video showing how electrons were discovered by J. J. and also assist them to draw the structure of atom as proposed by Thomson.

EVALUATION (15 MINUTES)

- Draw the cathode ray tube and identify the parts
- Briefly explain how Thomson use the cathode ray tube to discover the electrons.
- Draw Thomson's structure of the atom.

APPENDIX J

LESSON THREE

Subject: Chemistry

Duration: 80 minutes

Topic: Rutherford structure of atom

Objectives: After studying this, students' should be able to:

- Explain Rutherford alpha scattering experiment
- Interpret the results on the three observations made
- Draw Rutherford structure of Atom

Relevant Previous Knowledge: Students' have seen Thomson's structure of Atom.

INTRODUCTION (5 minutes)

Teacher: Describe Thomson's structure of the Atom

Students' expected answer: An Atom is a solid sphere of positive charge with rings of negative electrons. The negative and positive charges balances to make the Atom electrically neutral.

Teacher Learner Activities (60 minutes)

Teacher projects images and video which shows how alpha particles were used to bombard several nuclei of gold and assists students to discuss the observations and interpretations that were made by Rutherford. Teacher also displays image and discus with students the structure of atom as proposed by Rutherford.

EVALUATION (15 minutes)

- Briefly describe Rutherford's alpha scattering experiment and state the observations that were made.
- State the interpretations that were made on the observations.
- Draw Rutherford's structure of atom.

APPENDIX K

LESSON FOUR

Subject: Chemistry

Duration: 80 minutes

Topic: Structure of atom

Objectives: After studying this, students' should be able to:

- Explain why atom is said to be electrically neutral.
- Identify mass number and atomic number of an atom.

Relevant Previous Knowledge: Students' have seen Rutherford's structure of Atom.

INTRODUCTION (5 minutes)

Teacher: Describe Rutherford's structure of Atom

Student's expected answer: Atom has a central positive nucleus composed of protons where all the mass is concentrated and electrons in the atom orbit around the nucleus.

Teacher Learner Activities (60 minutes)

Teacher projects images of an atom showing protons and electron and discuss with students how the net charges results to zero making an atom electrically neutral. Teacher again projects images which show how atomic number and mass number is represented on an atom and assist students to identify the mass number as the superscript and atomic number as the subscript written on the chemical symbol of an element.

EVALUATION (15 MINUTES)

- Why is an Atom said to be electrically neutral?
- Identify the mass number an atomic number of the following elements

K b. Mg c. O

APPENDIX L

LESSON FIVE

Subject: Chemistry

Duration: 80 minutes

Topic: Matter

Objectives: After studying this, students' should be able to:

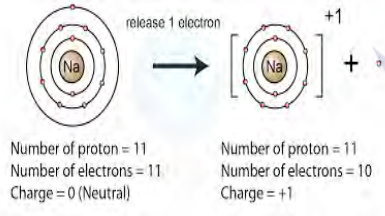
- Explain how a molecules is formed from atom
- Explain how an ion is formed from an atom

Relevant Previous Knowledge: Students' can draw structure of atom.

INTRODUCTION (5 minutes)

Teacher: Draw the structure of sodium

Student's expected answer:



Teacher Learner Activities (60 minutes)

Teacher projects images showing how two of more hydrogen atoms combine to form molecules and how sodium atom loses an electron to become positively charged and how chlorine atom gains electrons to become negatively charged.

Evaluation (15 MINUTES)

- Explain how Oxygen gas molecule and Nitrogen gas molecules are formed.
- Explain how potassium ion and Aluminium ions are formed.