EFFECTS OF FIREPLACE ADVANCE ORGANIZER TEACHING STRATEGY ON SECONDARY SCHOOL STUDENTS' MOTIVATION AND ACHIEVEMENT IN CHEMISTRY IN BARINGO COUNTY, KENYA

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A Thesis Submitted to Graduate School in Partial Fulfillment of the Requirements for the Award of the Degree of Master of Education (Science) of Egerton University

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been submitted before for any award of a degree in this or any other university.

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Recommendation

This thesis has been submitted for examination with our approval as University supervisors.

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DEDICATION

This work is dedicated to my wife Caren and our children Manu, Mitchelle and Liana for their patience, encouragement and forbearance. To my parents Chebet and Kimoi for their great sacrifice and teaching me to dedicate myself towards any worthwhile endeavour.

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ABSTRACT

Chemistry is a fundamental science and is responsible for many of the materials used in modern society as well as developments and tests carried out in the field of medicine. However, Kenya's secondary school students' performance in chemistry has been poor. This poor performance has been attributed partially to teaching methods used in the classroom.Thus, there is need to seek teaching strategies that can improve students' performance in chemistry and motivate them. The use of Advance Organizer Teaching Strategy may stimulate active thinking and facilitate the integration of new information into established schemas. However, it is not clear how a Fireplace Advance Organizer Teaching Strategy would affect students motivation and achievement in Baringo County. This study sought to address this issue. The study used Solomon Four Non- Equivalent Control Group Design. Simple random sampling was used to obtain 8 sample schools from the 19 County single sex secondary schools in Baringo County. The 8 sample schools were assigned to the experimental and control groups. Each sample school provided a Form Three class with 45 students; hence 360 subjects were involved. Experimental groups were taught using a Fireplace Advance Organizer Teaching Strategy (FAOTS) while control groups were taught using the conventional methods. Prior to the study, teachers and students from experimental group were trained on the use of FAOTS. Experimental group (E_1) and control group (C_1) were pretested using Students' Motivation Questionnaire (SMQ) and Chemistry Achievement Test (CAT) and all groups post-tested at the end of three weeks. The two instruments were pilot tested determine their reliability while their validity was ascertained by experts from the Deparment of Curriculum Instruction and Educational Management of Egerton University. The reliability coefficient for SMQ was 0.73 while that of the CAT was 0.98. Statistical Package for Social science (SPSS) was used for data analysis. Data was analyzed using descriptive statistics and inferential statistics, at α=0.05. The results of the study showed that students' achievement and motivation are higher when FAOTS is used than when reqular methods are used. When FAOTS is used, boys' in boys schools achieve higher motivation and achievement than girls' in girls schools. Based on the findings, the study recommended chemistry teachers' to revisit their teaching strategies and the teacher education programs to incorporate FAOTS in order to improve the learners' performance.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANCOVA	-	Analysis of Covariance
ANOVA	-	Analysis of Variance
ASC	-	African Science Centre
CAT	-	Chemistry Assessment Test
D.E.O	-	District Education Officer
FAOTS	-	Fireplace Advance Organizer Teaching Strategy
JICA	-	Japan International Cooperation Agency
KCPE	-	Kenya Certificate of Primary Education
KCSE	-	Kenya Certificate of Secondary Education
K.I.E	-	Kenya Institute of Education
KLB	-	Kenya Literature Bureau
KNEC	-	Kenya National Examination Council
NCST	-	National Council for Science and Technology
RANDFORUM	-	Research and Development Forum for Science
SMASSE	-	Strengthening of Mathematics and Science in Secondary Education
SMQ	-	Students Motivation Questionnaire
SPSS	-	Statistical Package for Social Sciences
SR	-	Stimulus Response
SRT	-	Science Reasoning Tasks
SSP	-	School Science Project
UNESCO	-	United Nations Educational, Scientific and Cultural Organization
www	-	world wide web

CHAPTER ONE

INTRODUCTION

1.1. Background Information

Chemistry is a branch of natural science that deals principally with the properties of substances,the changes they undergo, and the natural laws that describe these changes. Chemistry is a science, which means its procedures are systematic and reproducible and its hypotheses are tested using the scientific method. It serves as an interface to practically all of the other sciences, as well as to many other areas of human endeavor. The history of Chemistry shows that the natural philosophy of atomism developed in ancient traditions. The atomists theorisized that the natural world consists of two parts: indivisible atoms and empty void (Hudson, 1992). Dalton found an atomic theory of matter could elegantly explain this common patterns in chemistry. Since then, there has been rapid development of Chemistry (Wachanga, 2005). Through laboratory experiments, new materials and chemical processes have been discovered which have made our homes more comfortable today by the use of variety of materials that were unknown when our great grandparents were young (Ngaruiya, Kimani & Mburu, 2003). Chemistry provides explanation for everyday things, like why laundry detergent works better in hot water or how baking powder works or why not all pain relievers work equally well on a headache. The fire fighters and those who make fireworks also make use of chemistry. In addition,chemistry enables learners acquire knowledge and skills needed to further their education and training (K.I.E 2006). Physicist, chemists, biologists, engineers, doctors, nurses, pharmacists, veterinarians among others study chemistry in their courses. The teaching they encounter in colleges shapes their understanding, their ability to use it to solve problems and their confidence in and disposition towards chemistry.

In Kenya, students' performance in chemistry continues to be poor despite public complaints every year that the results are below average. The Kenya National Examination Council (KNEC) reports of 2005, 2006 and 2008 reveal that the national performance in chemistry has been below 26 percent. Table 1 shows a summary of students' performance from 2003 to2007.

Table 1

Average Performance in KCSE Chemistry from 2003 to 2007

Year	Candidature	% Mean Score
2003	198,016	19.69
2004	214,520	20.85
2005	253,508	20.02
2006	236,831	24.90
2007	267,831	25.39

Souce: KNEC 2005 and 2008 reports.

The performance in KCSE chemistry examinations indicate that although the general performance by students' in chemistry is rising, the mean score is still very low compared to the maximum mean.This poor performance by secondary school students in chemistry may be attributed to conventional teaching methods used by the teachers. The 2009 KCSE results show that candidates performed poorly in chemistry, with 328,922 candidates scoring an average mark below 19.13% (Otieno, 2010). In addition' KNEC reports of 2006 and 2007 indicated that boys had performed better than girls. Otieno (2010) noted that there was a remarkable drop in chemistry performance in 2008. The boys had recorded a percentage mark of 31.8 % and girls had recorded a percentage mark below 20%. This gender disparity has been attributed the materials selected by teachers that reflect sexual bias in their content. Hohn (1995) encourages teachers to provide equal opportunities for both sexes in all class activities based interests and skill.

Lahey (2007) encourages teachers to win the trust of students in order to influence their academic performance and character development. Winning students trust is the easiest way to ensuring that learners achieve their full potential in all aspects of education and motivation.Pintrich and Schunk (1996) posit that motivation is the heart of learning process and there is a relationship between how a motivated person is and how much such a person can achieve. In learning, an individual who is motivated will try to complete a task and work hard to achieve success. A person who is not motivated will not try, will not work hard or will bring in some other behavior that sabotages the outcome of the situation. Entwistle (1981) argues that students should be motivated for them to learn more effectively and that motivation is the starting point in secondary schools. Kochar (1992) concur that once motivation has been created, it must be maintained. When motivation is created, success increases self esteem which is a powerful motivator and it is the engine that drives learning. Santrock (2001) calls upon teachers to facilitate motivation by strategies that improve students' effort and commitment to learning and to achieving high standards of comprehension and understanding. In their study, Twoli, Maundu, Kiio and Kithinji (2007) estimated that, intelligence accounts for 45% of the variance related to performance while motivation accounts for 35%. Motivation, therefore, has a significant contribution to learning and should be accorded reasonable attention in the learning related activities, especially in this study.

While chemistry is very important subject, teaching and learning in secondary schools is beset by many problems (Miruka,1999). One of these is the feeling by most teachers that students do not find some topics in the syllabus relevant. This,certainly, is an indication that the teaching of chemistry is faced with a problem thus warrants new strategies. The chemistry syllabus encourages small group teaching through experiments, projects, discussions, field trips and lecturing which are mainly expository (Kiboss, 1997). These expository teaching methods makes students lack interest in the area difficult to teach or involves the use of dangerous and poisonous chemicals. The use of these methods fail to enable the learner appreciate chemistry. Kisaka (2006) explains that such dominant practices are in effective since students display poor mastery of content, lack basic practical skills hence performing poorly in chemistry.

The teaching strategies that have been used in chemistry instruction remain a big issue to be considered (K.I.E, 2002). Several studies have shown that instructional teaching strategies used by the teachers in teaching chemistry is a strong factor to consider (Wachanga, 2002). Mugenda (2006) asserts that a good teacher should have sufficient knowledge of the subject matter, skills in varied methodologies and language of instruction. The improvement of chemistry learning for students requires effective teaching strategies in the classroom. As students learn by connecting new ideas to prior knowledge, it is essential that teachers establish what the students already know. Thus teachers should ask questions and plan lessons that reveal students prior knowledge. This can enable them design experiences and lessons that respond to and build on that knowledge (Kiprop, 2002). It is clear that chemistry has not been well performed and thus the need to study other ways apart from the regular teaching methods that may improve the subject, like the use of a Fireplace Advance Organizer Strategy. An effective teaching strategy should enhance learners' motivation and actively involve them in learning process (Lahey, 2007). Nasibi (2003) reinforces that a teacher can motivate learners by using interesting teaching strategies that pay more attention on heuristic as opposed to expository strategies of learning.

An advance organizer is a device that a teacher uses to help students make connections between what they know and what is to be learnt. Ausubel (1960, 1968) had worked consistently to prove that advance organizers facilitate learning and much of his research has influenced others since 1960s. According to Mayer (2003), advance organizers work best when there is no prior knowledge involved, because the advance organizer becomes the students' prior knowledge before learning the new material. Gutkin and Reynolds (1990) argue that, for integrated learning to take place, the learner has to relate new information actively to existing knowledge, building the external and internal connections. Advance organizers promote transfer of creative problem solving tasks which leads to learning of more specific and subordinate concepts and rules. They also improve understanding of new concepts by comparing them with already learned concepts (Mayer, 1979; Hohn, 1995; Santrock, (2004). All these arguments point to the important role advance organizers may play in motivating and determining the achievement of students. There is need, therefore, for continuous search for effective use of advance organizers as a teaching strategy in chemistry.

In this study, a Fireplace Advance Organizer Teaching Strategy (FAOTS) was developed by the researcher. It was then used to determine its effectiveness in teaching of secondary school students' motivation and achievement. The strategy was used to teach Form Three chemistry students Diffusion and Grahams Law in the experimental group E_1 and E_2. This topic is normally viewed by the students as abstract and therefore lack interest and find it difficult to understand the content during the lesson. This has been attributed to difficult terms used like ions, molecules, diffusion, rate of diffusion, kinetic theory and the calculations involved. Chemicals used in this topic to perform experiments are dangerous and poisonous hence most teachers don't perform them at all. The Fireplace Advance organizer Teaching Strategy was therefore used to find out if it may help students appreciate the subject and also improve students' performance in chemistry. Figure 3 is the diagram of Fireplace Advance Organizer Teaching Strategy containing burning firewood. The firewood burn to produce hot yellow flame. The smoke then moves up the chimney with the help of air at a particular speed depending on the type, the density and the mass of the smoke. When the fire was lit, the time taken for the smoke to reach the end of the chimney was measured, and the height of the chimney was also measured. This was the Fireplace advance Organizer teaching strategy used to provide the students with new knowledge that would orient them to the upcoming lesson on Diffusion and Graham's law (Santrock, 2004).

This advance organizer is suitable because what goes on in a fireplace can be compared to diffusion in solids, liquids and gases. The strategy compared: burning firewood to diffusion of potassium manganate VII in water; movement of smoke particles to diffusion of bromine in air;

smoke moving up the chimney to the rate of diffusion of gases at particular points (KLB, 2005). According to Eggen, Kauchak and Harder (1979) advance organizers reinforces and directs students' thinking during learning thus may enhance students' motivation to learn chemistry. In this study, FAOTS was developed and used to determine its effectiveness on secondary school students' motivation and achievement in chemistry in Baringo County.

1.2 Statement of the Problem

Kenyan secondary school students' performance in KCSE chemistry examinations has been below average. This poor performance could probably be attributed to inappropriate teaching methods used by teachers which do not a llow learners to be actively involved so as to gain higher motivation and meaningful learning. A strategy that may help improve students' motivation and achievement is the use of advance organizers. Such a strategy is the use of Fireplace Advance Organizer in teaching. However, it is not clear how this strategy would affect students' motivation and achievement in chemistry in Baringo County. This study was therefore intended to provide this vital information.

1.3 Purpose of the Study

The purpose of this study was to investigate the effects of a Fireplace Advance Organizer Teaching Strategy on secondary school students' motivation and achievement in chemistry in Baringo County, Kenya.

1.4 Objectives of the Study

The following objectives guided the study:

(i). To determine the effects of using a Fireplace Advance Organizer Teaching Strategy on secondary school students'achievement in chemistry in Baringo County.

(ii). To determine the effects of using a Fireplace Advance Organizer Teaching Strategy on secondary school students' motivation in chemistry in Baringo County.

(iii). To find out whether gender affects achievement when Fireplace Advance Organizer Teaching Strategy is used.

(iv). To find out whether gender affects motivation when Fireplace Advance Organizer Teaching Strategy is used.

1.5 Hypotheses of the Study

H_{O1}: There is no statistically significant difference between the chemistry achievement scores of students who are taught using a Fireplace Advance Organizer Teaching Strategy and those taught using conventional teaching methods.

H_{O2}: There is no statistically significant difference in students' motivation to learn chemistry between students who are exposed to a fireplace advance organizer and those who are exposed to conventional teaching methods.

H_{O3}: There is no statistically significant gender difference in students' achievement scores between girls and boys exposed to Fireplace Advance organizer Teaching Strategy.

H_{O4}: There is no statistically significant gender difference in students' motivation between girls and boys exposed to Fireplace Advance Organizer Teaching strategy.

1.6 Significance of the Study

The findings of the study was expected to help teachers reconsider their teaching methods and update them to meet the technological advancement and be compliant to the current era. It is also expected to help the chemistry teachers arrest the problem of poor performance. In addition, it is also expected that chemistry curriculum developers may include advance organizers in secondary school chemistry syllabus. The other departments like languages and humanities may also use the same teaching strategy during curriculum instruction. It is also believed that the strategy would challenge the universities and teacher training colleges to incorporate the use of advance organizers in training their subject areas to improve learning. The findings also added knowledge and the data can be used as baseline for researchers. Through the use of Fireplace Advance Organizer Teaching Strategy, the students are also expected to perform better in chemistry. Higher achievement in chemistry was found to motivate the learners hence better their careers at the university and tertiary colleges.

1.7 The Scope of the Study

This study was conducted in eight County public secondary schools, in which four boys' schools and four girls' schools were selected randomly from the list of 19 single sex secondary schools of Baringo County which teach Chemistry. Diffusion topic was chosen because it is taught in form three. A Fireplace Advance Organizer Teaching Strategy was used because what goes on in a fireplace is similar to diffusion of gases, solids, and liquids. The burning of firewood in a fireplace to produce heat and smoke which moves up the chimney is comparable to diffusion of solids in liquids and gases in air (Kenya Literature Bureau, 2004).

1.8 Limitations of the Study

The study was limited to provincial public single sex secondary schools within Baringo County. It's findings were generalized with caution to secondary schools within Baringo county. In addition, the study was also limited to the teaching of the topic on diffusion and Graham's law.

1.9 Assumptions of the Study

This study was carried out with the following assumptions:

(i) The data collected from students was a true reflection and honest response of their motivation towards the use of advance organizers in chemistry education.

(ii) Form three learners were of similar age.

1.10 Definition of Terms

The following are the operational terms were used in this study.

Advance organizer: Is a material introduced before a lesson in order to stimulate active thinking so that learners think for themselves and make a link between what they know and what is to be learnt. In this study, it refers to the teaching strategy that was used in teaching diffusion and Grahams law. It involved a fireplace attached to a chimney.

Chemistry: Is a science subject taught in secondary schools and it involves the study of matter,its properties and reactions that matter undergoes when subjected to different conditions.

Diffusion: Movement of smoke particles through the air from the fireplace to the upper part of the chimney which is fitted to the kitchen wall.

Extrinsic motivation: Motivation by which participants in an activity participate in it for tangible reasons. This may make the participants to engage more in chemistry activities for external reasons.

Fireplace: An open recess connected to a chimney where fire is made. It is a place in a dining hall kitchen where food is cooked using firewood. It is used in this study to refer to a strategy used by teachers to help students make connections between what goes on in a fireplace and diffusion in solids, liquids and gases.

Gender: Personal and psychological characteristics that one is a male or a female andthat these characteristics contribute to performance either positively or negatively.

Intrinsic motivation: Motivation by which people participate in an activity for their own enjoyment, rather than get a reward. This motivation makes one engage in chemistry activities for its own sake.

Students' achievement: Students performance in chemistry test items, the pre-test and post-test scores.

Students' motivation: Ability to incite and sustain action in a participant. It involves students feeling towards chemistry activities when an advance organizer is used. In this study, it refers to the motivation scores obtaiened by students on the students' Motivation Questionnaire.

Regular teaching method: Conventional teaching methods which are commonly used in classroom instruction by the chemistry teachers apart from the use of FAOTS.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section deals with the changes in chemistry curriculum that have taken place and the instructional approaches that have been used in the chemistry teaching. It also discusses the types of advance organizers, and how it is used as a teaching strategy. The section also highlights researches that have been done on contemporary teaching chemistry teaching methods and how students' have performed in chemistry examinations in Secondary Schools. In addition, the researcher considers learning and motivational theories. Review of the related literature on categories and uses of advance organizers are also considered. Ausubel's theory of meaningful learning is also discussed. The conceptual framework which guides the study is finally discussed.

2.2 Secondary School Chemistry Curriculum

According to scholars, secondary school curriculum has not been static in Kenya. Asiachi, Shiundu and Omulando (1992), explain how the curriculum has been changing since independence. In 1963, the first chemistry curriculum was formulated by the African Science Centre (ASC) which is presently known as Kenya Institute of Education (Taba, 1962). This was followed by UNESCO pilot project in 1967, which emphasized teacher demonstration experiments approach, a teacher centered curriculum (Sifuna 1990). It was until 1968, when the Nuffield Science Project chemistry was developed in Britain to encourage learning through discovery and doing though it heavily relied on imported materials which were not appropriate. The School Science Project (SSP) of 1970 was developed in Kenya. It encouraged investigatory approach in teaching and learning using locally available materials. The SSP was mainly used in well established schools (Lawton, 1973). It was then followed by Traditional chemistry syllabus of 1973 since not all schools could afford SSP syllabus due to its heavy reliance on well equipped laboratories. There were three types of chemistry traditional syll abus; Pure Chemistry syllabus 542, Physical Chemistry Syllabus 548, and General Science.

In 1981, another syllabus called new Kenya National Examination Council chemistry was developed to replace the three syllabuses above. In 1985, Secondary Education physical science chemistry syllabus was also developed, it emphasized learning through discovery and practical work in chemistry teaching and learning (Sifuna 1990). In 1992, the chemistry syllabus was further developed to 8.4.4 pure syllabus and physical chemistry syllabus. In the year 2002, 8.4.4.Secondary new syllabus which emphasized project work and rearrangement of content was used and found to be more of application than the previous curriculum. Currently the revised syllabus of 2005 is used (K.I.E, 2006).

Wachanga (2002), emphasized that Chemistry should be included in the school curriculum because it occupies a central position among the traditional science subjects like Physics and Biology. The challenge in Chemistry curriculum is that, while centralized national curricula has provided the teacher with valuable resource material, the enormous diversity of environments of school facilities and pupils interests and aptitudes makes it difficult to adopt such a national curricula as a whole, though teachers are advised to use science reasoning tasks (SRT). SRT looks at difficulties with the existing curricula and research into possible relationships between aspects of culture, language and cognitive development on the other (Shayer & Adey, 1981).

2.3 Instructional Approaches used in Chemistry Teaching

Fasokun, Katahoire and Oduaran (2005) point out that, psychologists help learners as they construe ideas and events about learning and build frameworks of meanings. The teaching method advocated by teachers involves the spectrum of resources available to provide the condition which will help the learners attain their objectives like the artist groups organize their pupils in many kinds of groups to achieve specific learning goals (Nsubuga, 2000). Dahama and Bhatnagar (1992) encourage teachers to create situations that they may help in bringing desired changes in the behavior of learners by selecting teaching methods which maximize the responsibility of the learners for maximum learning. This calls for teachers to be sensitive to the methods of instruction and understand the curriculum and its purposes particularly when programmes and paradigms are introduced instead of depending on the regular teaching methods discussed below (Mills, 2000).

2.3.1 Demonstration Teaching Method

This method requires a teacher to illustrate an idea or skill and guide learners through an activity step by step (Das, 1992). Teacher demonstrations are quite common in the sciences and these are usually held in laboratory (Ayot & Patel, 1987). Demonstration is done by a teacher to a large group especially when there is shortage of apparatus, safety is a priority, and when particular attention is needed in a certain parts of the experiment which might be over looked when the pupils do it alone. Wachanga (2005) adds that, many schools have a shortage of equipments and chemicals hence teaching have mainly been based on demonstrations and not on class experiments. This method is commonly used though the learners may become dishonest when the teacher has to play the main role in the discussion and demonstration of the topic. The teachers may be tempted to lecture rather than teach. Lack of materials to be used for demonstration may impede its application.

2.3.2 Lecture Method

According to Ayot & Patel (1987), lecture method is expository in nature and as such carries most characteristics of this approach of the dominant presenter and passive receiver. The teacher is the only active participant and the pupils are passive listeners. According to Wachanga (2005), the method can help the teacher deliver a lot of information to the pupils in a short time. Research shows that, the longer the lecture, the more the mental fatigue leading to loss of information. This method is appropriate when starting a new topic, when explaining certain difficult and theoretical points which cannot be shown practically, when summarizing and recapitulating certain generalizations and principles at the end of the lesson and when explaining some relevant background material of a topic (Ayot & Patel, 1987). The only challenge is the passiveness of the learners since they write down information from a lecture. The learners are busy transcribing hence have little time to reflect on the material and could miss little facts or explanation.

2.3.3 Questioning Method

This is used when the teacher aims at developing pupil's concepts and to ensure active participation (Das, 1985). It is a teaching method that can be used on its own or as part of another. Wachanga says that the method should accompany the lecture method which will result to class experiment. The questions are aimed atgetting feedback for the teacher as well as pupils, understanding the level of pupils, that is their present level of learning.

2.3.4 Discussion Method

Class discussion involves pooling ideas and experiences from a group. It is an effective method especially after presentation, film or experience that needs to be analyzed (Twoli et al, 2007). This method allows everyone to participate in an active process, but it is not practical with more than twenty students. This is because few people can dominate the discussion and others may not participate. It is also a time consuming method and students can even get off track (Too & Mukwa, 2002).

2.3.5 Project Method

Nsubuga (2000) argues that project teaching method makes learning real by presenting a real task for the pupils to tackle. It puts responsibility on the pupils and gives scope for their initiative (Das, 1985). It consists of building up of comprehensive unit of connected facts around a central theme which may be scientific principle, or a theory. Das emphasizes that through this method, students learn through association, activity, and cooperation. Proje cts also widens students horizon, though it has not been used in secondary schools widely because it requires a of lot time yet the syllabus is very broad. Too and Mukwa (2002) explain that most projects offer excellent learning experiences but can be time consuming for both the learner and the teacher since most of the progammes are packed and any activity seems to consume more time than expected. It is also considered expensive on resources especially when the project involves chemistry.

2.3.6 Excursion Method

This method involves learners visiting a place of educational value such as a factory, a museum, a research center or a dam for learning purposes (Too & Mukwa, 2002). It is regarded as a useful method since they get firsthand experience by observing and using other senses to feel this experience. Although this is a highly recommended mode of instruction, many institutions are beginning to find it difficult to arrange for trips. This is because they have become expensive, time consuming and there can be accidents on the way and this can hurt one's health and therefore add to expenses (Twoli et al, 2007). These teaching methods fails to enable the learners appreciate chemistry because of the limitations discussed above. These methods also make learners lack interest in the area difficult to teach or dangerous to teach. In the present study, a fireplace advance Organizer teaching strategy was developed and its effectiveness in secondary schools was determined.

The chemistry syllabus encourages small group teaching, teaching through experiments, projects, discussions, field trips and lecture methods which are mainly expository (Kiboss, 1997). These expository methods makes students lack interest in the area difficult or dangerous to teach. The use of these methods fails to enable the child appreciate chemistry. Kisaka (2006) explain that such dominant classroom practices are in effective since students display poor mastery of content, lack basic practical skills hence they end up performing poorly in chemistry. Twoli et al (2007) agree that expository methods emphasizes the transfer of basic information for the learner to memorise and reproduce leading to shallow learning because it neglects the students abilities, interests and potential.The chemistry curriculum developers intented chemistry to be taught through learner –centered approach, but teaching chemistry in secondary schools has remained largely expository (Nasibi, 2003). Expository teaching encourages competition among students but students who compete and fail or who do not even try to compete resent those who succeed (Dembo, 1994). Keraro and Shihusa (2009) posit that teachers should use approaches that would enhance learners positive attitudes towards science and hence motivation to learn. According to Osborne (1997), teachers should change from closely directed learning of facts to conceptual understanding, application of acquired knowledge and skills to solve emerging problems. Expository methods cannot stand up to challenges of the new demands and objectives of chemistry education hence the need to explore new teaching strategies (UNESCO, 1986).

An effective strategy utilizes a wide variety ot teaching strategies to enhance learners motivation and achievement and actively involve them in learning process (Nelson, 2000). Effective teacher should therefore generate the greatest opportunity for students to learn by using teaching strategies that allow the students to bridge the gap between what the learner knows and what the learner needs to learn before hand. According to Malone theory of motivation, intrinsically motivating environment positively affect learning (Malone, 1981). Malone proposes that advance organizers should be designed to bring the mind prior knowledge that is relevant to the lessons and are often presented at high level of obstraction.

2.4 Advance Organizers

Hohn (1995) defines advance organizers as statements that are more abstract and inclusive than the material that is to follow and serving as a vehicle for subsuming or assimilating the new material into memory. According to Hohn (1995), Ausubel believes that meaningful learning occurs only when new information is related to concepts already in existence. Travers (1982) research cues and prompts that facilitate the organization of information in short term memory will facilitate the transfer of information to long term memory in a retrievable form. He argues that Cues and prompts should be supplied by the teacher or by teaching materials to the learner. The program of Ausubel (1960) proposed that the central cue or prompt should be an advance organizer. In addition, Singh (2005) encourages teachers to start lesson by proposing a specific problems to illustrate fundamental principle and then solicit suggestions from the students on the methods of attack.

Good and Brophy (1995), adds that advance organizers are super ordinate concepts within which learners can subsume the new material and relate it to what they already know. Advance organizers are not convectional previews or summaries that state the main points of the main text in briefer form, but characterize the general nature of the text and provide super ordinate concepts within which it can be subsumed.

2.4.1 Types of Advance Organizers

Advance organizers can be grouped into two major categories, namely;

(a) Expository Advance Organizers

Hohn (1995) point out that, this kind of advance organizer presents information that is more abstract than the subsequent content. Santrock (2004) agrees with Hohn that, expository advance organizers provide students with new knowledge that will orient them to the upcoming lesson. Hohn also points out that, Kloster and Winnie (1983), gave an example of advance organizer, on prevention of crime. This advance organizer on new invention gives rise to new crimes, which in turn result in new methods for controlling these abuses. Good and Brophy (1995), points out that Ausubel stressed organizing content in logical ways and helping learners to recognize this organization by presenting outlines, noting transitions between parts and including summaries at the end. Good and Brophy adds that, these are advance organizers that present key terms or principles rather than characterizing the material to be learned with reference to previous knowledge.

(b) Comparative Advance Organizers

Hohn (1995) sees comparative advance organizers as ideas on related topics that are similar in level of abstraction to the new information to be learnt. This type is used when the material to be learnt is not entirely novel, because they are intended to point out ways in which the new material resembles and differs from that which is already known. This type of advance organizer is used to improve understanding of new concepts by comparing them with already learned concepts (Santrock, 2004). Good and Brophy (1985), shows that Ausubel advocated that advance organizers are not conventional previews or summaries that state the main points of the main text in briefer form but characterize the general nature of the text and provide super ordinate concepts within it can be subsumed.

According to Githua & Nyabwa (2008), advance organizers which are commonly used come in many formats namely;

(i) **Expository**; describes new content to which students are exposed to.

(ii) **Narrative**; information is presented to students in a story format.

(iii) **An analogy**; adopted to fit the background of a particular student population and it helps to link the new material to the familiar concepts.

(iv) **Skimming**; used to look over the new material and gain a basic overview.

(v) **Graphic**: is a non linguistic and visually represent what students will learn.

(vi) **Concept mapping:** diagram that shows relationship between concepts.

2.4.2 Use of Advance Organizers as a Teaching Strategy

Ausubel (1960, 1968), the first to study the effects of the use of advance organizers, described an advance organizer as providing "ideational scaffolding for the best stable incorporation and retention of more detailed and differentiated material that follows". The studies testing effectiveness of advance organizer yielded mixed results (Barnes & Clawton, 1975). Their results were not striking as expected. It was found that, it was only effective for low achievers which surprised people because such learners are characterized by inability to organize new information (Travers, 1973). According to Travers, research on advance organizers leaves a lot to be discovered though the difficulty of understanding such is that the children given advance organizers devote more time to learning unless the control groups are given more additional time. It was not until later investigations taking into account the mediating cognitive process and outcomes that the phenomenon of advance organizers was better understood (Gutkin & Reynolds, 1990).

Gutkin& Reynolds (1990) argues that advance organizers were the earliest instructional manipulations, designed to facilitate learning by activating the prior knowledge. According to Ausubel (2010), advance organizers represent one strategy to address subsumption theory which suggests that learning is based upon the kinds of super ordinate, representational and combinatorial process that occur during the reception of information. Ausubel (2010) adds that, when new knowledge is created that is substantive and non-verbatim, and is related to existing knowledge, retention and are primed. Mayer (2003) adds that research has been able to prove that these work best where there is no prior knowledge involved, because an advance organizer becomes the students' prior knowledge before learning the new material. The advance organizer is meant to provide a cognitive structure to which learning is anchored. Bromley, Irwin and Modlo (1995) posit that when prior knowledge is retrieved, the schema provides a framework on which to attach new knowledge if no new knowledge is available, advance organizers are used to give knowledge to students in order for this framework to be followed and new information retained for recall.

In addition, Hohn (1995) adds that advance organizers are designed to facilitate the integration of new information into established schemas. They also serve as a scaffold for what is to follow, enforcing the activation and integrating of existing schemas. Hohn also points out that, advance organizers facilitate the transfer of new information to other learning tasks. They work best when organized from unitary, hierarchically organized topics. This results to learning of more specific and subordinate concepts and rules.

The use of advance organizer also leads to meaningful learning. Mayer (1979) argues that advance organizers promote learning and transfer only under certain conditions. Mayer through his studies demonstrated that advance organizers increased learning significantly for students who lacked the background knowledge as assessed by a pre-test on prior knowledge but not for students who scored high on the background test (Gutkin & Reynolds, 1990).

In addition, advance organizers enhance students understanding of difficult topics. Mayer (2003) asserts that they are useful since they improve levels of understanding and recall. Gutkin and Reynolds (1990) also point out that advance organizers are mostly effective when they provide the pre-requisite knowledge to understand abstract material. Ausubel (1967) adds that, advance organizers provide learners with a framework to link previous knowledge to the new material that is learned. This enhances understanding of the material taught.

Ausubel singles out the principle function of advance organizers as to bridge the gap between what the learner knows and what he needs to know before he can learn the task at hand successfully. Travers (1982) also sees the advance organizers as bridging the gap between what the learner knows and what he needs to know. He adds that, present research papers asserts that the function of advance organizers as orientating or alerting one. Advance organizers would function by tagging the information to be learned on information to be assimilated and stored under a particularly category of memory. Francks (2003), adds that, Hume who was an empiricist, building on Locke observed that, thoughts do not simply wonder through our minds randomly, but follows one another in sequences and that ideas are linked together in our minds by chains of association.

A study by Keraro and Shihuna (2008) investigated the effects of using advance organizers on students' motivation in learning biology. In this study, a film and a chart were used as expository advance organizers. The findings of this study revealed that, the use of advance organizer results in higher students' motivation in biology. Eggen, Kauchak and Harder (1979) agree that advance organizer is an efficient teaching strategy since the learner is able to know beforehand what is going to be learned. Eggen et al (1979) further assert that advance organizers reinforce and direct students thinking hence improving motivation of the students to learn. According to Gutkin and Reynolds (1990) and Mayer (1973), advance organizers promote transfer of knowledge on creative problem-solving tasks. Mayer (2003) argues that effects of advance organizers should be most visible for tests that involve creative problem solving because advance organizers allows learners to organize the material into familiar structures. Good and Brophy (1995) posit that advance organizers have positive influence on learning outcomes. A study by Githua and Nyabwa (2008) investigated the effects of advance organizer on students' mathematics achievement. The study used analogies which involved real life situations of business transactions that were obtained in Nakuru district. The findings showed that the use of advance organizers in teaching results in better students' performance in mathematics. Moreover, it was found that students' gender does not affect their mathematics achievement.

The research by Kigo (2005), found that, advance organizers enhances students' physics conceptualization as well as proving conceptual framework for integrating new information. They also become conceptual 'bridges' from prior knowledge to the information to be learned.

Entwistle (1981), advises teachers to use advance organizer in order to arouse the interest of learners by presenting a stimulating problem. Advance organizers stimulate active thinking so that they think for themselves. Teachers should also create situations which are directly relevant to experiments to be done and show how knowledge relate to the real world and how it can be applied in day to day life. According to Mayer (1979), production of advance organizers is not easy due to: lack of expertise, a lot of planning is required, lack of relevance advance organizers and inadequacy of resources. The producers of advance organizers should ask themselves the following questions:

(i) Does the advance organizer produced allow one to generate all or some of the logical relationship in the material to the learner?

(ii) Does the advance organizer provide the learner with a method of relating unfamiliar material?

(iii) Does the advance organizer allow the learner to use the content?

(iv) Is it likely that the student will normally fail to use his organizational capabilities in the case of material to be learned in the fourth coming lesson?

Rao and Reddy (2004), warns that, this method requires careful planning and skillful guidance to attain desired objectives. Teachers are therefore encouraged to deal with real situations so that motivation is provided by sense of accomplishment when a student reaches a conclusion. Good and Brophy (1995), advocates that learning should be organized and when teachers are using advance organizers, they are advised to:-present new materials in small steps organized and sequenced logically and follow up the lesson with questions or assignments that require student to encode materials in their own words or apply or extend it to new contexts. This prepares learners to gain more because learning is organized.

Despite the above available literature on effectiveness of advance organizers, the extent to which they can motivate learners in Chemistry need to be established. In addition, this study tried to find out if the use of fire place advances organizer could improve the students' Chemistry achievement in Baringo District Secondary Schools.

The research study therefore was intended to fill this gap in the body of knowledge.

2.5 Research on Contemporary Chemistry Teaching Methods

Teaching methods are the features of education that has altered most during the present century. Research in science and industry has produced better and quicker methods of doing things. Arthur (1986) argues that there is constant endeavour of the professionals to devise courses, examinations of new teaching methods and accommodate new technologies while adjusting the changing patterns of schooling and society. Arthur points out that convergent thinking and memorization has been encouraged.

According to Jarvis (2001), the changes in educational scene are that; from childhood and adult to life long education; from teacher centered to student - centered education. In support of student centered approach, Jarvis points out that progressive ideas of the American philosopher John Dewey, emphasized child's experience and was encouraged in School education. As modernity era drew close, speed of change of knowledge was such that it became much more difficult to equate knowledge to truth. Relatively of all knowledge began to emerge and educators could no longer specify correct ''knowledge and truth'' so they placed greater emphasis on the learners own beliefs about content of learning. The learner centered became popular up to today.Herbert Spencer a great, a distinguished philosopher looked upon modern science and scientific methods of teaching with great hope. He argued that good life is the product of knowledge which is needed to give direction to action secured by scientific enquiry. This aroused interests in educators in the needs of the learners and hence the need for modern good teaching methods (Singh, 2005).

Britto,Brooks and Griffins (2006) indicated that there was success in teaching using local materials to solve societal problems. They found that underground water in Argentina, Gambia, Ghana,Peru and South Africa contained arsenic substances which were poisonous. They solved the problem using simple system specifically developed for households (family filter). The filter didn't require any chemical and operated under gravity. The filter was a cheap absorbent because the procedure of producing iron oxide coated the filter material was successful (Britto et al, 2006). As a result of this success, UNESCO has been encouraging teaching of chemistry using local materials which are easily found in the environment.

2.6 Students' KCSE Performance in Chemistry Examinations

During the last five years, students achievement in chemistry at the Kenya certificate of secondary education (KCSE) has been and continues to be low (KNEC,2005,2007,2008). Amada, Omonso and Ngetich (2006) observed that many schools were well equipped, but failed to produce good results. Otieno (2010) argues that though majority of the science subjects are popular with students, performance in each of them is below average and chemistry had the least mean score after mathematics. According to Aduda (2004), chemistry was the worst preformed subject with a mean mark of 20.85 %. Table 2 shows a summary of this performance from 2003 to 2007.

Table 2

KCSE Performance in Chemistry from 2003 to 2007

Year	Candidature	Maximum mark	%Mean Score
2003	198,016	190	19.69
2004	214,520	190	20.85
2005	253,508	190	20.02
2006	236,831	200	24.90
2007	267,719	200	25.39

Source: KNEC reports (2006, 2007 and 2008).

In addition, the performance in Baringo Couny has also been poor. Table 3 shows how chemistry has been performed in the county from 2003 to 2007.

Table 3

KCSE chemistry performance in Baringo County from 2003 to 2007

Year	Candidature	% Mean score
2003	1788	31
2004	2085	33
2005	2158	33
2006	2109	30
2007	2233	29

Source: Baringo County KNEC reports (2008)

Despite the government introducing SMASSE through the government of Japan (JICA), students' performance is still low (Changeiywo, 2000). Table 1 and Table 3 shows that chemistry has not been well performed and thus the need to study other ways apart from the regular teaching methods that may improve the chemistry performance like the use of a FAOTS.

2.7 Theories of Motivation

A theory is a set of interconnected statements that integrate information within a field of inquiry and suggests new relationships among the phenomena under study (Brodzinsky, Gromly and Ambron, 1986). Ayot and Patel (1987) discussed two types of motivation, intrinsic and extrinsic. Ayot and Patel argue that extrinsic motivation links students' knowledge and skills with their present and future life outside the school. Lepper and Henderlong (2000) found motivational benefits as having both intrinsic and extrinsic motivation for activity. Educators should pursue the internalization of students extrinsic and intrinsic motivation for free tasks and should make the value of activity explicit and clear (Harter,1981). This research was guided by the following theories.

2.7.1 Attribution Theory

According to Santrock (2001), attribution theory states that in their effort to make sense of their own behaviour or performance, individuals are motivated to discover its underlying causes. Attribution theorists view students as intuitive scientists seeking to explain the cause behind what happens. Harter (1981) argues that an important motivational dimension critical to educators is whether children are intrinsically or extrinsically motivated in classroom. Weiner (1992) and Harter (1981) identify three dimensions of causal attributions which include;

(i) Locus. Locus of control refers to the degree to which results are due to factors inside and outside an individual. Harter (1981) focuses on whether the students are intrinsically motivated by curiosity and the love of learning or are they merely extrinsically motivated to do the schoolwork assigned. Santrock (2001) posits that students who perceive their success as being due to internal reasons such as effort are more likely to have higher self-esteem following success, than students who believe that their success was due to external reasons such as luck.

Pintrich and Schunk (1996) indicated that causation for events may be placed in a continuum ranging from conditions completely within to those completely outside individuals influence.

(ii) Stability. According to Weiner (1992), stability refers to the extent to which the cause remains the same or changes. Pintrich and Schunk (1996) refers stability to unchanging cause and successful performance as a result of chance. Weiner adds that stability of cause influences students' expectations of success. When students ascribe a positive outcome to a stable cause, such as aptitude, future success will be achieved, but if negative outcome is ascribed to a stable cause, they expect future failure.

(iii) Controllability. Controllability refers to the extent to which the individual can control the cause (Santrock, 2001). Pintrich and Schunk (1996) also defines controllability to those factors that can be controlled to influence results. Skills and confidence are classified as controllable, while luck and mood are classified as uncontrollable. Weiner (1992) adds that when students' perceive that they are prevented from succeeding because of external factors that other people could have controlled such as noise, they often become angry. When they perceive that they have not done well because of internally controllable cause such as not enough effort or negligence, they often feel guilty.

Santock (2001) recommends that teachers should provide students' with experiences in achievement contexts in which modeling, information about strategies and practice are used to help them: concentrate on the task at hand rather than worrying about failings, cope with failures by retracing their steps to discover their mistakes and attribute their problems to lack of effort rather than lack of ability (Good & Brophy, 1995).

2.7.2 Malone's Theory

Malone (1981) argued that, intrinsically motivating activities are those in which people engage for their own sake and not to receive some external rewards. Malone assumed that intrinsically motivating environments positively affect learning. Lahey (2007) add that intrinsic motivation can be facilitated on tasks that are comparable to real word situations and meet needs of choice and control. Lahey (2007) argues that, when people have options, they will choose activities, that they are intrinsically motivated to perform, and performing them will further their intrinsic motivation. Malone's theory puts it that, if students are intrinsically motivated to learn something, they may spend more time and effort in learning. This makes them learn better in the sense that more fundamental cognitive structures are modified, including development of such skills as learning how to learn.

Through his empirical studies, Malone attempted to identify the precise features of those environments by using a computer to create a motivating environment. Three features of intrinsically motivating emerged;

(i) **Challenge**; for environment to be challenging, it should provide minimally a set of goals and uncertain outcome and self-esteem play an important role.

(ii) **Fantasy**; is defined as mental images of things not present to the senses or within the actual experience of the person involved. In addition, it defines three dimensions along which fantasies in intrinsically motivating learning environments can be discussed;intrinsic versus extrinsic, where extrinsic means that fantasy depends on the use of the skill. The intrinsic means that the fantasy not only depends on the skill, but the skill also depends on the fantasy; their cognitive aspect, the extent to which they employ metaphors and analogies involving old knowledge to help the students acquire new knowledge; their emotional aspects, the extent to which they fulfill the emotional needs of students.

(iii) **Curiosity**; In order to evoke curiosity, a learning environment should be neither complicated nor too simple with respect to the learners existing knowledge. It should be well and surprising, but not completely incomprehensible.However, Santrock (2001) posits that curiosity, flexibility and insightful thinking and creativity are major indicators of the learners' intrinsic motivation to learn. Santrock (2006) add that students' internal motivation and intrinsic interest in school tasks increase when students have some choice and some opportunities to take personal responsibilities for their learning.

Malone distinguishes between two types of curiosity; sensory curiosity which involves attention and cognitive curiosity which is a desire to bring better to ones knowledge structures, where the desired form is one in which knowledge is complete, consistent and parsimonious. According to Malone (1981), the way to engage learner's cognitive curiosity is to provide them with enough information to make their existing knowledge seem incomplete, inconsistent or unparsimonious. Cauley and Pannazzo (2008) emphasized that interested students challenge their existing knowledge and are more likely to develop conceptual frameworks that integrate prior knowledge and new information into understanding. Nasibi (2003) perceives advance organizers as the most effective because they provide the prerequisite knowledge to understand abstract material. This study used a fireplace advance organizer to establish these claims.

2.7.3 Students Achievement Motivation

According to Aggarwal (2008), a person who has high need for achievement considers problems and obstacles as challenges to be met. Parke and Locke (1999) add that it is a personal tendency to strive for successful performance. Variations in achievement motivation and performance are often related to child's' emotions and opinions. Baron and Karlsher (1998) define achievement motivation as the desire to accomplish difficult tasks and meet standards of excellence. Findings suggest that achievement motivation in combination with several other factors may affect success in a school.

Lahey (2007) enumerates sources of achievement motivation as mastery of goals, performance approach goals and performance avoidance goals. Lahey further points out those students with higher performance approach goals make better grades and those who make lower grades have low performance approach and high avoidance goals. Papalia, Gross & Feldman (2003) argue that students who are high in self-efficacy believe that they can master school work and regulate their own learning. Papalia et al (2003) add that such students are more likely to succeed than students who do not believe in their own abilities because they try hard, persist in the face of difficulties and seek help when necessary.

Motivation is the heart of learning processes.The teacher should evolve new patterns in his teaching to motivate, to learn with zeal and eagerness, making use of incentives, for example, providing opportunity to do independent work, giving responsibility and leadership, in Chemistry activities (Das (1985). Petty (1998) adds that, when the learner realizes that unemployment in a place is low, it de-motivates the learner but when they work for qualifications which they believe they will use, they will be motivated. Rao and Reddy (2004), advocates for student participation in learning process because they get motivated. Stimulating and arousing students' enthusiasm is important from the teacher. By using advance organizers, Rao & Reddy (2004) and Chambers et al (2002) argue that it stimulates discussion with considerable test and enthusiasm for finding a solution and also serve to develop sound and logical thinking since the students rather than teachers ideas are considered.

2.8 Theories of Learning

A theory provides detailed systematic information of an area of knowledge. It serves as a guideline to conduct further research. It provides new facts or supplements the previous facts (Aggarwal, 2008). Learning theories may be broadly divided into two categories;

2.8.1 Stimulus Response (SR) Theories

According to the principle of reinforcement, children learning become effective when they are rewarded immediately after they perform well. Aggarwal (2008) explained learning in terms of physiological changing by adopting an objective method of study. Conditioning was accepted as a theoretical framework and practical technique of solving variety of problems.

According to Rao and Reddy (2004), learning depends on motivation. In learning theory, we find that there has been a great deal of research in this area and theories have been formulated which are more easily put into practice than social theories (Marshall, 1992). Educational Psychologists agree that teaching is physically and emotionally demanding but psychological theory makes one less tiring, get better results, and derive greater enjoyment from your job.

Dahama and Bhatangar (1992) discusses learning laws according to Thorndike that there are four laws of learning, namely; the law of readiness, the law of belonging, the law of exercise and the law of effect. Teachers are advised to see to it that the effect of learning experience is desirable to the student and they must help the learners to fix the goals in advance and keep those goals in focus throughout the learning process (Lahey & Harries, 1997). Dahama and Bhatangar add that learning is facilitated when the situations are real and life like. These can be provided by a means of an advance organizer or bringing a specimen to a laboratory. Marshall (1992) points out that, Stimulus Response (SR) theories are concerned with learning by connecting what the learner knows and what the learner needs to know. The known SR theories that deals with learning include, Pavlov's SR theories, Watson SR theories, Thorndike, Hull and Skinner. SR theories regard learning as the acquisition of habits.Thorndike and skinner SR - theories say that, of the responses the children make to stimuli, they learn those that are rewarded or reinforced (Frandsen, 1967). Aggarwal (2008) argues that classical conditioning can be used for developing favourable attitudes to subject teachers and above all the school. In addition, when stimulus and response occur at the same time in contiguity, the connection between (SR) is strengthened and this depends upon the frequency of SR repetitions.Aggarwal adds that children read printed words as symbols while looking them they also say. When the child sees such symbols in future, the child tends to say them correctly because of stimulus SR connections.

Aseey and Ayot (2009) add that the classical conditioning paradigm originated with Pavlov's famous experiments on conditioning of dogs to salivate. Behaviourists' principles on classical conditions are relevant to persuasion process. These principles are recency and frequency. Thorndike was the chief proponent of the theory of connectionism. The basis of learning accepted by Thorndike is an association between sense impressions and impulse to action. This association was later called "bond" or connection. According to Aggarwal (2008) teachers should prepare minds of students to be ready to accept knowledge, skills and aptitude through the use of advance organizers. The teacher should provide opportunities for those experiences in which students can spontaneously participate and arouse the capacity to link the experience with their everyday life

2.8.2 Ausubel Theory of Meaningful Learning

Ausubel's theory is concerned with how individuals learn large material from verbal or textual presentation in a school setting (in contrast to theories developed in the context of laboratory experiments). According to Ausubel, learning is based upon the kinds of super ordinate, representational and combinatorial process that occur during the reception of information (Ausubel, 1963). A primary process in learning is subsumption in which new material is related to relevant idea, in the existing cognitive structure on a substantive, non –verbative basis. Indeed, Ausubel posit that cognitive structures represent the residue of learning experiences.

Ausubel (1978), insists that,

i) Material is easily learned if it is arranged in logical sequence and must be meaningful to the learner. The teacher must first study, analyze and take note of concepts, terminologies, arrange them in order of priority and present the subject matter from what the learner know to what they don't know.

ii) The learners must be ready for those ideas to be presented to them, and they should subsume ideas, meaning material must be relatable to some hypothetical cognitive structures or framework models. Ausubel adds that the learning of material cannot be meaningful unless it is related to individuals past or immediate experiences.

Persuh (1999), argues according to Woolfolk that, rote learning or memorization is not considered meaningful learning, since the material learnt is not connected with existing knowledge, though it can be used in situations where the material to be learnt lacks logical meaningfulness and where pupils lack relevant ideas and meaningful learning set.

Ausubel (1977), points out the importance of meaningful learning that it enables the learner to relate the new concept of knowledge acquired previously. Ausubel therefore advises teachers to use advance organizers which are designed to bring the mind prior knowledge that is relevant to the lesson and are often presented at a higher levels of abstraction.

2.8.3 Bridging Analogies

Advance organizers have been described as bridges from students' previous knowledge to whatever to be learnt. Ausubel (1960) says that the value of advance organizer depends on the familiarity of the analogy to the students and the degree of overlap between the ideas to be taught and analogy used. Kogo (2005) did point out that research has been conducted on the effectiveness of advance organizers on students' retention of the material learnt, and himself looked at the effects of advance organizer on the physics students' conceptualization. This study tried to find out the effects of using fireplace advance organizer on students' motivation and achievement in Chemistry.

2.9. Theoretical Framework

The use of advance organizers is tied to Ausubel's theory of meaningful learning. This theory is concerned with how individuals learn large material from verbal or textual presentation in a school setting (Ausubel, 1963). According to this theory, new ideas and concepts can be learnt and retained in episodic memory, provided that relevant and inclusive concepts are clear and available in the learners' cognitive structures and act as support for new concepts (Ausubel, 1960). Ausubel (1977) emphasized that meaningful learning enables learners to relate the new concept of knowledge acquired previously. Learning of the new material cannot be meaningful unless it is related to individuals past or immediate experiences. Advance organizers are lauded for facilitating the incorporation into a working memory of new unfamiliar concepts. They act as a subsuming bridge between new learning material and existing related ideas. This study is tied to Malone's theory of motivation. According to this theory, intrinsically motivatingactivities are those in which students engage for their own sake and not receiving external awards (Malone, 1981). The way to engage learner's cognitive structure is to provide them with enough information to make theirexisting knowledge seem incomplete and inconsistent. Nasibi (2003) argue that advance organizers provide pre requisite knowledge to understand abstract material. Cauley and Pannazzo (1981) also stress that curiosity makes students challenge their existing knowledge and are more likely to develop conceptual frameworks that integrate prior knowledge and new information into understanding.

2.9.1 Conceptual Framework

The conceptual framework that was used in this study was based on systems theory approach improved by Ayot& Patel (1987). Ayot& Patel (1987) improved the model of a system approach to include elements such as specification of desired output, checking the desired output against expected output. Aseey&Ayot (2009) asserts that in general system theory all the system parts are dependent on another in performance of organizational activities. Twoli et al (2007) adds that in the simplest technological model consists of three basic elements; input, process and output. The learners are processed at different levels of education and finally come out as educated individuals or output. Any change in or influence on one component inevitably affects other system components. Maslow's theory of motivation indicates that humans are motivated to engage in behaviour to meet their needs. Abraham Maslow proposed a hierarchy of needs that directs behaviour beginning with physiological to self-actualization needs. Teachers should use effective teaching strategies to enhance positive emotions and intrinsic motivation to learn, and methods that increase learner's perceptions that a task is interesting and personally relevant (Santrock, 2001). The best outputs may be achieved when advance organizers are used in teaching learning system. This may result to motivation of learners hence improve their performance in chemistry.

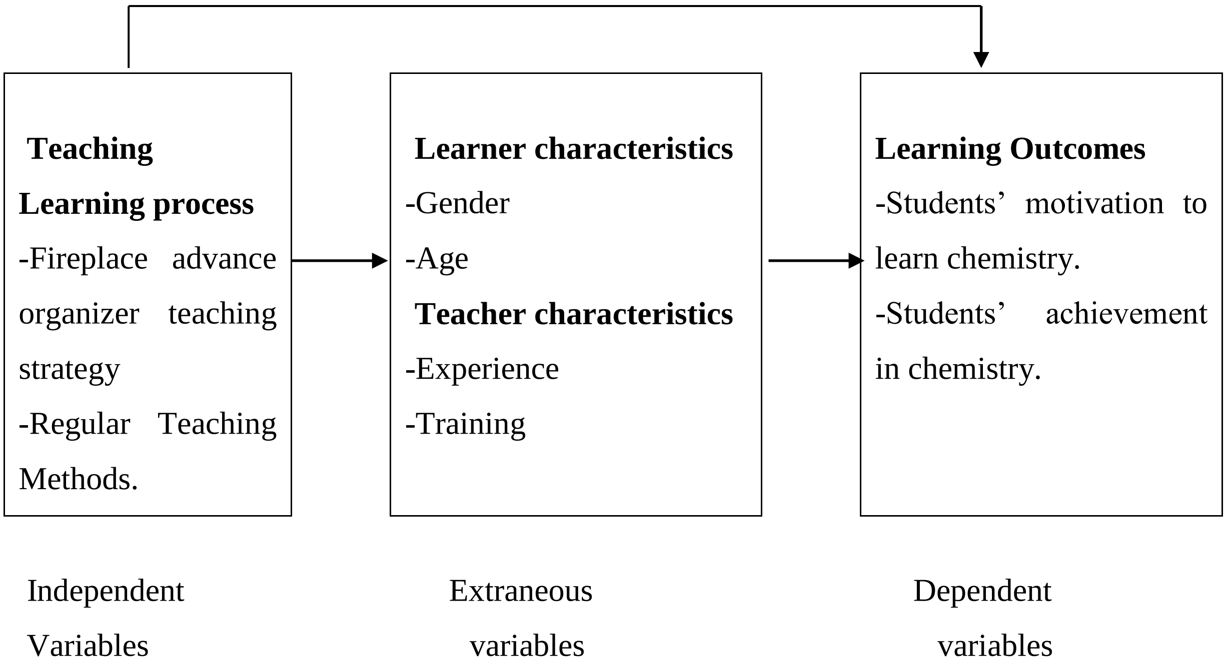

Figure 1: Relationship between Variables of the Study.

In this study, the dependent variables were students' motivation and students' achievement in chemistry. The independent variables were the use a fireplace advance organizer as a teaching strategy and the regular teaching methods. The regular teaching method in this study refer to all teaching methods of teaching chemistry as opposed to the use of advance organizers for all chemistry lessons in this study. The outcomes of this study may be influenced by learners characteristics and teachers characteristics; hence the researcher introduced four extraneous variables in the study. The age of the learners was controlled by involving Form Three students who were assumed to be the same age. Gender differential was determined to see if the performance and the motivation of learners was different. The other extraneous variables were teacher's training and teacher's experience. They were accounted for in this study by involving teachers who had a minimum qualification of a diploma and teachers who had taught form three classes for a minimum of two years respectively. These extraneous variables were interrelated and was thought to influence teaching learning process thus influenced performance.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter focuses on the methodology that was used in this study. It presents the research design which was used, the location of the study and the population that was studied. Sampling procedures together with the sample size are also highlighted. The section finally mentions the instruments which were used, the data collection procedures and the ways the data was analyzed.

3.2 Research Design

Bernard and Whiteney (2002) describe experimental research design as the most powerful quantitative research method for establishing cause and effect relationship between variables. This study used Solomon Four Non-equivalent Control Group Design under quasi-experimental research which is a strong quasi experimental procedure because it takes care of effect of treatment, the effect of pre-test and assess the interaction between pre-test and treatment (Cosby, 2001;Mugenda & Mugenda, 2003). The Solomon Four Non-equivalent Control Group Design was used because secondary school classes once constituted as intact groups, school authorities cannot allow them to be broken up or re-constituted for research purposes (Kathuri & Pals, 1993). This design minimizes variations that might arise due to difference of experiences that may contaminate the internal validity of the study (Shaughnessy,Zechmeister & Zechmeister, 2006). Figure 2 illustrates Solomon Four Non-equivalent Control Group Design.

Group	Pre-test	Treatment	Post-test
E_1	O_1	X	O_2
C_1	0_3		O_4
E_2		X	O_5
C_2			O_6

Figure 2: Solomon Four Non-equivalent Control Group Design.

Key

E_1 represents experimental group one. Group E_1 received the pre-test 0_1, the treatment X and the post test 0_2

E_2 represents experimental group two. The group E_2 received treatment and post test only.

C_1 represents control group one. The group C_1 received pretest followed by control condition and a posttest

C_2 represents control group two. It received posttest only.

__ represents no treatment.

O_1 and O_4 represents pretest.

O_2, O_3, O_5, and O_6 represents posttest.

X represents treatment

----represents non-equivalent of the groups.

3.3 Population of Study

The population was 19 County single sex secondary schools in Baringo County. Eight sample County single sex secondary schools were randomly chosen from the population. The study targeted form three chemistry secondary schools students in the County single sex schools within Baringo County because the topic Diffusion and Grahams law is taught at this level (KLB, 2005). The County was chosen by the researcher because it has been recording low achievement in chemistry at the Kenya Certificate of Secondary Education (KCSE) as shown in Table 3.

3.4 Sampling Procedure and Sample Size

Simple random sampling method was employed to select eight single sex secondary schools out of the possible 19 County single sex secondary schools in Baringo County, in which there are 9 boys' and 10 girls' secondary schools. Kathuri and Pals (1993) assert that simple random sampling yields data that can be generalised within margins of error that can be determined statistically. The eight schools were chosen because the Solomon Four Non- equivalent control group design requires four groups and the eight sample schools represents 42% of the total number of the single sex County secondary schools. Kothari (2004) acknowledges that the larger the sample the more representative it is likely to be. Due to the small number of sample schools, balloting method was employed to pick the sample schools. This involved assigning a numerical number to each of the 19 schools, placing the papers in a container and then picking a number at random. The school corresponding to the numbers picked was included in the study sample. The sample schools was then assigned to either control groups or experimental groups such that each group had a girl's school and a boy's school. Each group provided 45 form three students for study, making the actual sample size to be 360 students. Fraenkel and Wallen (2000) recommends this number because most of the secondary schools have about 45 students per class.

3.5 Instrumentation

Students' Motivation Questionnaire (SMQ) was used since it has the ability to collect a large amount of information in a reasonably quick space and time. The Chemistry Achievement Test (CAT) was used to collect the required data since they are the most valid, reliable and useful measures available to the educational researcher.

3.5.1 Students Motivation Questionnaire

This study adapted the Students Motivation Questionnaire (SMQ) developed by Wachanga (2002). It was revised so that it could fit this study. The questionnaire had a total of five items constructed on a five point likert scale. The five items was based on the topic Graham's law and diffusion which was the focus of the study. It contained thirty eight five-point likert scale items, which was aimed at assessing the students' level of motivation when fireplace advance organizer teaching strategy and the conventional teaching methods were used to teach chemistry in secondary schools.

3.5.2 Chemistry Achievement Test (CAT)

The chemistry achievement test (CAT) was developed and used in this study. It contained nineteen short answer items on Graham's law and diffusion. The nineteen items instrument tested students' knowledge, comprehension, application and analysis of chemistry topic on Grahams' law and diffusion. The CAT had a maximum of twenty six marks.

3.5.3 Validity and Reliability of the Research Instruments

The SMQ and CAT was systematically evaluated to ensure their validity and reliability. Validity refers to how well an instrument measures what is intended to measure (Best & Kahn, 2006). On the other hand, reliability refers to how consistent an instrument produces similar respondents on different occasions (Bernard & Whiteney, 2002). The SMQ and CAT was given to six experts from the Department of Curriculum, Instruction and Education Management of Egerton University to check the validity of the instruments. Their comments were used to improve the questionnaire and the chemistry achievement test. The two instruments were then pilot-tested using one girl's school and one boy's schools in Nakuru County which neighbours Baringo County. This ascertained the tests suitability, content validity and reliability. The reliability of the

SMQ was estimated using cronbach's Alpha method. The method was appropriate because the instrument was administered once and had a likert type items.It yielded a reliability coefficient of 0.73. In addition, the reliability of the CAT was calculated using the Kuder Richardson method, specifically formula KR-21. According to Fraenkel and Wallen (2000), KR-21 was appropriate because the tool generated continuous data and does not require the assumption that all items are of equal difficulty. Cronbach's coefficient alpha computed was 0.98, which meant that items correlated among themselves (Mugenda & Mugenda, 2003). These values of were accepted because most classroom tests have reported reliability coefficient of 0.70 and higher when KR-21 is used, which agrees with the rule of thumb that reliability should be at least 0.70 or higher.

3.6 Fireplace Advance Organizer Teaching Strategy

The strategy used the fireplace in the school kitchen as the Fireplace Advance Organizer Teaching Strategy. It involved the learners in the experimental groups burning the firewood in the fireplace prior to classroom instruction. The learners were expected to observe what was going on and compare it to diffusion. A chart of FAOTS was then drawn by the students so that it could be used in the classroom. During the instruction, learners were given time to explain their understanding of the term diffusion. The teacher actively engaged the learners in the comparison between the strategy and diffusion of solids, liquids and gases.

During the classroom instruction, a chart comparing burning of firewood was compared to diffusion of potassium manganate VII in water; movement of smoke particles up the chimney was compared to diffusion of bromine liquid in air; the chimney whose length was measured was compared to a long glass tube hence the rate of diffusion between ammonia and hydrogen chloride gas was calculated. The learners were then asked to state Graham's law of diffusion. The learners were expected to link the message presented by the chart to the content learnt. The learners were actively involved in the discussion as they made effort to compare Diffusion and Graham's law and what goes on in a fireplace.

3.7 Data Collection Procedure

An introductory letter was requested from Graduate School by the researcher. The letter was used to ask for permission from the National Council for Science and Technology (NCST) to undertake a research. Appointments with the administrators and heads of chemistry departments of relevant sample schools was made through direct visits and telephones. The heads of the chemistry departments then introduced the chemistry teachers of the sample schools to the researcher who assured the teachers the purpose of the research was for research only. All the chemistry teachers in the two experimental schools were trained using the teachers guide for two days on the use of the fireplace advance organizer. This advance organizer was discussed in details with the teachers before using it. The other teachers in the control groups were not trained, but expected to use the regular teaching methods. Prior to the commencement of the course, the instrument CAT was administered to two groups E_1 and C_1 to ascertain their entry level. E_1 and E_2 were exposed to three weeks chemistry lessons using a Fireplace Advance Organizer Teaching Strategy while C_1 and C_2were exposed to the same lessons using the regular teaching methods on the same content. Upon completion of the lessons, the CAT and the SMQ were administered to all the groups at the end of the lessons. The researcher then scored and coded the collected data for analysis.

3.8 Methods of Data Analysis

Descriptive statistics (mean, standard deviation, percentages) and inferential statistics (ANCOVA, ANOVA and t-test) was used for data analysis. Analysis of covariance (ANCOVA) was used to determine if the four groups differed significantly among themselves on the experimental variables (Spatz & Kardas, 2008).The ANOVA was used to establish whether there was statistically significant difference in mean scores among the four groups(Kothari, 2004). Kothari further argues that ANOVA enables a researcher to perform simultaneous tests and as such is considered important tool of analysis in the hands of a researcher. Spatz and Kardas (2008) agrees that ANOVA is the most commonly used inferential statistics for examining null hypothesis when comparing more than two means.Inaddition, t-test was used to test the differences between the pre-test mean scores of the SMQ and CAT. The computer program called SPSS was employed in data analysis. The four hypotheses H_{01}, H_{02}, H_{03} and $H_{04}$was then subjected to the statistical tests of significant difference at $\alpha = 0.05$ (Kathuri & Pals, 1993). The table below summarizes how the data was analyzed.

Table 4

Summary of methods of Data Analysis

HYPOTHESIS	INDEPENDENT VARIABLE	DEPENDET VARIABLE	METHODS OF ANALYSIS
$H0_1$:There is no statistically significant difference between the chemistry achievement scores of students who are taught using a fireplace advance organizer and those taught using conventional teaching methods.	Exposure to FAOTS	Post-test scores on CAT	ANOVA ANCOVA
$H0_2$:There is no statistically significant difference in students' motivation to learn chemistry between students who are exposed to a fireplace advance organizer and those who are exposed to conventional teaching methods.	Exposure to FAOTS	Score on SMQ	ANOVA ANCOVA
HO_3:There is no statistically significant gender difference in students' achievement scores between girls and boys exposed to Fireplace Advance organizer Teaching Strategy.	Gender	Students' scores on CAT	t-test
HO_4:There is no statistically significant difference in motivation of students exposed to Fireplace Advance Organizer Teaching strategy between boys and girls.	Gender	Students' score on SMQ	t-test

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents results from the research carried out. The first section presents
Pre-tests analysis to ascertain whetherthe selected samples had groups of the same ability. The sections 4.3 and 4.4 presentsthe analysis of the post-tests scores on students' achievement scores and students'motivation scores respectively.Sections 4.5 and 4.6 analyses the effects of FAOTS on students' achievement and motivation respectively by school type. Lastly the chapter discusses the results obtained in detail.

4.2 Pre-test Analysis

A pre-test was administeredto one experimental group (E_1) and one control group (C_1) using CAT and SMQ. The pre-test was aimed at establishing the entry level of thegroups. The data obtained from the experimental group (E_1) and control group (C_1) on CAT and SMQ are summarized in table 5.

Table 5

Table of Means and Standard Deviations of the Dependent variables

Scale		N	Mean	Maximum score	SD
CAT	C1	84	27.63	100	11.14
	E1	84	29.11	100	11.00
SMQ	C1	96	3.67	5	0.36
	E1	96	3.59	5	0.44

The pre-test mean scores in Table 5 reveal that the experimental group has a higher (M = 20.11, SD = 11.00) mean score than their counterparts in the control groups (M = 27.63, SD = 11.14). However in motivation the control group had a higher (M = 3.67, SD = 0.36) means than the experimental group (M = 3.59, SD = 0.44). However the results do not reveal whether the difference by learning strategy between the groups on the two dependent variables arestatistically significant at 0.05 level. In order to establish this, a t-test was conducted. The results are given in Table 6.

Table 6

Comparison by Learning Strategy of Students Mean Scores on CAT and SMQ.

Scale	df	t-value	p-value
CAT	178	0.897	0.371
SMQ	178	1.290	0.199

The pre-test results in Table 6 indicates that the pre-test means on both the CAT and SMQ were not statistically significant at t(178) =0.897, p=0.371 and t(178)=1.290, p=0.199 respectively. These results seem to suggest that the students were equivalent when they started the programme.

4.2.1 Pre-test Analysis by Gender

Another purpose of this pre-test was to assess any possible differential effects of Fireplace Advance organizer teaching Strategy that may exist in relation to gender in terms of students' achievement and motivation prior to the start of the programme. The results are shown in Table 7.

Table 7

Students' Pre-test Mean Scores and Standard deviations on CAT and SMQ by Gender

Scale	School Type	N	Mean	maximum score	SD
CAT	Boys' only	87	31.05	100	11.58
	Girls' only	93	25.97	100	10.00
SMQ	Boys' only	87	3.75	5	0.50
	Girls' only	94	3.51	5	0.24

The results in Table 7 reveal that the performance of boys in boys' only schools in both CAT and SMQ was higher than that of girls in girls' only schools. This necessitated the use of independent samples t-test to determine whether these differences were statistically significant and the results are indicated in Table 8.

Table 8

Comparison of Students' Pre-test Mean Scores on CAT and SMQ by Gender

Scale	df	t-value	p-value
CAT	178	3.15	0.002
SMQ	179	4.17	0.000

The results in Table 8 indicates that there is statistically significant diffence between the boys in boys' only schools and girls in girls' only schools on both the CAT and SMQ. This indicates that both the boys' only and girls' only schools were not similar at the beginning of the course.This necessitated the use of ANCOVA on post test analysis to adjust the means. The results of an ANCOVA test performed using Kenya Certificate of Primary Education (KCPE) as covariates showed that students were from equivalent group before the start of the programme

4.3. Effect of Fireplace Advance Organizer Teaching Strategy on Students' Chemistry Achievement

Chemistry Achievement Test (CAT) was used to collect data for use in determining whether or not there would be any significant difference between the achievement of the students exposed to FAOTS and those not exposed to it. The results in Table 9 show that there is difference in pre-test and post-test scores in both the experimental and control groups.

Table 9

A Comparison of Students' Means Scores with their Mean Gain in the CAT

Scale			C1	E1
CAT	pre-test	mean	27.63	29.11
		SD	11.14	11.00
CAT	post-test	mean	43.06	58.08
		SD	12.00	14.37
	Mean Gain		15.43	28.97

It is clear from the Table 9 that the experimental group whose pre-test mean 29.11 and post test mean 58.08 had a higher mean gain of 28.97 compared to their counterparts in control group with pre-test mean score of 27.63 and post test mean score of 43.06 which had a lower mean gain of 15.43. In order to ascertain whether the difference in mean gains between the two groups was statistically significant, a t-test was done and the results are shown in table 10.

Table 10

Independent Samples t-test Mean Gain on the CAT

Scale	df	t-value	p-value
CAT Mean Gain	178	7.104	0.000

The difference in mean gain of control group (C_I) and experimental group (E_I) are significantly different at 0.05 level in favour of the experimental group. This significance could be attributed to the use of FAOTS by the experimental group. Also analysis of the CAT post test mean scores and standard deviations of the four groups was done and the results are shown in Table 11.

Table 11

Results of Students' Achievement Post-test Mean and Standard Deviations of Groups by Learning Strategy

Group	N	Mean	SD
C_1	84	43.06	12.00
C_2	84	42.90	12.00
E_1	96	58.08	14.37
E_2	96	56.12	13.27

The resultsof the four groups indicate that the experimental groups E_1 and E_2 posted higher mean scores of 58.08 and 56.12 respectively. The control groups C_1 and C_2 posted lower means scores of 43.06 and 42.90 respectvely. However, the results do not reveal whether the difference in mean scores are statistically significant at 0.05 level or not.There was need to conduct an ANOVA test to establish whether there was a significant difference.The results obtained are shown in Table 12.

Table 12

Results of One-Way ANOVA on Students' Post-test CAT Means Scores on Achievement

Scale	sum of squares	df	mean squares	F-value	p-value
Between groups	18069.384	3	6023.128	35.586	0.000
Within groups	60254.571	356	169.254		
Total	78323.956	359			

One-Way ANOVA results, yielded F ratios of $F(3,356) = 35.586$, $p<0.05$ on the post-test scores. This reveals that there is a statistically significant difference between the performance of experimental groups and that of control groups. These results suggests that the students exposed to Fireplace Advance organizer Teaching Strategy performed well compared to their counterparts in control groups. However this test was not enough to determine which of the experimental group was significant. This necessitated the need for post-hoc test to determine where the significance lies. Scheffe's post-hoc test was used because the number of subjects were not similar in groups.The results of post-hoc test on CAT students' post-test scores using Scheffe's multiple comparisons are shown in Table 13.

Table 13

Scheffe's Multiple Comparisons of Students' Post-test Means Score on CAT

Groups	Mean Difference	P-value
C_1vs C_2	0.17	1.000
C_1vs E_1	-15.02	0.000
C_1vs E_2	-13.07	0.000
C_2vs E_1	- 15.19	0.000
C_2vs E_2	- 13.23	0.000
E_1 vs E_2	1.958	0.780

The mean CAT difference between control group C_I and C_2 (M = 0.17) and between the experimental groups E_I and E_2 (M = 13.53) were not significantly different. However, the post-hoc pair-wise comparisons show significant differences between the control group C_I and E_I (-15.02), C_I and E_2 (-13.07), C_2 and E_1(-15.19) were significantly different at $\alpha = 0.05$. This could be attributed to the treatment given to the experimental groups.Though the results are statistically significant, we cannot fully attribute this significance to the treatment given. This is because the groups (E_1 and C_1) were pre-tested and post-tested while the other two groups (E_2 and C_2) received only the post-test. Initially the students'seemed to be different in their performance prior to the commencement of the programme, and since ANOVA does nothave features that can deal with differences at the entry point, it became necessary to carry out an ANCOVA test on the post-test results. The ANCOVA is able to deal with entry behavior differences when covariates are used to adjust the means.In this study, the students' Kenya Certificate of Secondary Education (KCPE) results were used as covariate. The adjusted mean results are shown in Table 14.

Table 14

Adjusted CAT Post-test Mean Scores for ANCOVA with KCPE Marks as Covariate

Teaching Strategy	N	Mean	Std Error
C_1	84	42.960	1.403
C_2	84	42.924	1.402
E_1	96	58.302	1.313
E_2	96	56.226	1.341

The results in Ttable 14 show the adjusted means as follows: C_1 42.960 from 43.06, C_2 42.924 from 42.90, E_1 58.302 from 58.08 and E_2 56.226 from 56.12. The results indicate that the experimental groups scored higher than the control groups. A univariate analysis of covariate was conducted to adjust for the preexisting differences between the groups. The results are shown in Table 15.

Table 15

ANCOVA of the post-test Scores on the CAT with KCPE Marks as Covariate

	Sum of squares	df	Mean square	F	Significance
Contrast	18446.504	3	6149.501	37.230	0.000
Error	57976.783	351	165.176		

The ANCOVA results reveal an F-ratio of $F(3,351) = 37.230$, $p<0.05$. These results predict that the use of FAOTS was effective in enhancing students' achievement. A pair wise comparison was also conducted to find out where the significance was in the groups. The results are shown in Table 16.

Table16

Pairwise Comparisons of Dependent Variables on Achievement Post-test Mean Scores

(I)Teaching Strategy	(J) Teaching Method	Mean Difference(I-J)	Std Error	Significance
C_1	C_2	.036	1.983	.985
	E_1	-15.341*	1.922	.000
	E_2	-13.265*	1.940	.000
C_2	C_1	-.036	1.983	.985
	E_1	-15.378*	1.921	.000
	E_2	-13.302*	1.940	.000
E_1	C_1	15.341*	1.922	.000
	C_2	15.378*	1.921	.000
	E_2	2.076	1.878	.270
E_2	C_1	13.265*	1.940	.000
	C_2	13.302*	1.940	.000
	E_1	-2.076	1.878	.270

*denotes that the mean difference are significant at 0.05 confidence level

Table 16 shows that the experimental groups performed better than the control groups. This is because the mean difference of experimental group is statistically significantly at 0.05 level, thus H_{01} was rejected.

4.4 Effects of Fireplace Advance Organizer Teaching Strategy on Students' Motivation

The effect of Fireplace Advance Organizer Teaching Strategy on students' motivation was determined by comparing the students' mean scores on the pre-test and post test on the Students' Motivation Questionnaire (SMQ). The ANOVA and ANCOVA tests were also used.

Table17

Gain Analysis on Students'Motivation.

Scale		C1	E1
SMQ pre-test	Mean	3.67	3.59
	SD	0.36	0.44
SMQ post-test	Mean	3.87	4.09
	SD	0.38	0.25
Overall mean gain		0.21	0.5

Table 17 shows that the pre-test mean scores obtained by students in both experimental and control groups were almost similar.These findings imply that the groups had almost the same motivation towards learning chemistry before the beginning of the programme. The post test results reveal that after they were exposed to FAOTS, there was a slight difference between the mean scores of the two groups in favour of the experimental group. The mean gain between the students' SMQ Pre- test scores and Post-test scores for the experimental group (E_I) was higher than the control groups (C_I).To ascertain whether there was a significant difference, a t-test was performed and the results obtained are as shown in Table 18.

Table 18

Results of t-test Performed on Students' Motivation Mean gain

Scale	df	t-value	P-value
SMQ	158	8.396	0.000

Table 18 shows that the difference in mean gains is statistically significant at 0.05 level. This significance could be attributed to the use of FAOTS on the experimental group. In addition, analysis of posttest mean scores and standard deviation of the four groups was done and the results are shown in Table 19.

Table 19

Comparisons of SMQ Post-test Means and Standard Deviations Analysis.

Group	N	Mean	SD
C_1	84	3.87	0.38
C_2	84	3.89	0.40
E_1	96	4.09	0.25
E_2	96	4.29	0.37

Table 19 reveal that the experimental groups $E_1$and E_2 posted slightly higher mean scores of 4.09 and 4.29 respectively than the control groups C_1 and C_2 with 3.87 and 3.89 respectively. However this observation is not sufficient to show whether the difference in mean scores are statistically significant at 0,05 level. Therefore, there was need to carry out One-Way ANOVA to establish whether the mean scores obtained by the students in the experimental and control groups were statistically significantly different at 0.05 level.

Table 20

One-Way ANOVA Analysis of Students' Post test Mean Scores on SMQ

Scale	sum of squares	df	mean square	F-value	p-value
Between groups	10.288	3	3.429	30.990	0.000
Within groups	39.394	356	0.111		
Total	49.682	359			

The difference is statistically significant in favour of the experimental group. This suggests that the FAOTS increased students' motivation. However, the results do not reveal where the significance are. This necessitated the performance of the post-hoc multiple comparison.Scheffe's post-hoc test was used since the number of subjects were not similar in the groups. Results of students post-test scores on SMQ using Scheffe's Multiple Comparisons are shown in table 21.

Table 21

Scheffe's Multiple Comparisons of Students' Post-test Mean Scores on SMQ

Group	Mean Difference	P-value
C_1vs C_2	-0.02	0.991
C_1vs E_1	0.22	0.000
C_1vs E_2	0.41	0.000
C_2vs E_1	0.20	0.001
C_2vs E_2	0.40	0.000
E_1vs E_2	0.20	0.196

The post-hoc pairwise comparisons based on ANOVA show significant difference between groups C_1 and E_1, C_1 and E_2, C_2 and E_1, C_2 and E_2, andE_1 and E_2. Differences between groups C_1 and C_2were not significant. The mean difference of groups C_1 and E_1, and C_2 and E_2 were almost similar but higher than for the groups C_1 and E_2. Therefore, the higher performance of experimental groups could be as a result of treatment given, but we cannot fully attribute this significance to the treatment since only two groups E_1 and C_1 were pre-tested and post-tested while C_2 and E_2 were only post-tested. Since ANOVA does not take care of the differences at the entry point, it was necessary to carry out an ANCOVA test. This test is able to deal with entry behavior differences by adjusting the posttest means. The students' KCPE results were used as the covariate. The adjusted means are shown in Table 22.

Table 22

Results of ANCOVA Analysis on the Students' Motivation Post test Scores

Teaching Strategy	Mean	Std Error
C_1	3.875[a]	0.036
C_2	3.891[a]	0.036
E_1	4.089[a]	0.034
E_2	4.297[a]	0.035

The results in Table 22 show the adjusted means as follows: C_1 3.875 from 3.87, C_2 3.891 from 3.89, E_1 4.089 from 4.09 and E_2 4.297 from 4.29. These results shows that experimental groups scored slightly higher than their counterparts in control groups. A univariate analysis of covariance was carried out to adjust the preexisting differences between the groups and the results are shown in Table 23.

Table 23

ANCOVA of Post-test Scores on SMQ using KCPE marks as the Covariates.

	Sum of Squares	df	Mean Square	F	Sig.
Contrast	10.438	3	3.479	31.420	0.000
Error	38.867	351	.111		

The ANCOVA results reveal an F-ratio of $F(3,351) = 31.420$, $p<0.05$. This points out that the use of Fireplace Advance Organizer Teaching Strategy was effective since it enhanced students' motivation towards learning chemistry. A pair wise comparison was then carried out to confirm where the significance was in the groups. This is shown in Table 24.

Table 24

Pairwise Comparisons of Dependent Variables on SMQ Posttest Mean Scores

(I)Teaching Strategy	(J) Teaching Method	Mean Difference(I-J)	Std Error	Sig.
C_1	C_2	-.016	.051	.763
	E_1	-.214*	.050	.000
	E_2	-.422*	.050	.000
C_2	C_1	.016	.051	.763
	E_1	-.199*	.050	.000
	E_2	-.406*	.050	.000
E_1	C_1	.214*	.050	.000
	C_2	.199*	.050	.000
	E_2	-.016	.051	.763
E_2	C_1	.422*	.050	.000
	C_2	.406*	.050	.000
	E_1	.016	.051	.763

*denotes that the mean differences are significant at 0.05 confidence level

Table 24 clearly shows that the experimental groups performed better than the control groups. This is because the mean differences of the experimental groups are significant at 0.05 level. This significance affirms that the use of fireplace Advance Organizer Teaching Strategy enhanced students' motivation to learn chemistry.Therefore H_{02} was rejected.

4.5 Effect of FAOTS on Students' Achievement by Gender

The other objective that the study sought was to examine whether gender affected students achievement in single sex schools. It was deemed necessary to determine whether the effect observed was related to the gender difference. The analysis of the results are in Table 26.

Table 25

Comparisons of Students' Post-test Mean Scores and Standard Deviations on CAT by Gender

School Type	N	Mean	SD
Boys'Only	97	59.86	13.86
Girls' Only	95	54.40	13.33

From Table 25 above, the boys in boys' school posted a higher mean score of 59.86 than the girls in girls' schools with 54.40 on the CAT. This shows that the post test mean scores of boys in boys' only schools are higher than those of girls in girls' schools on CAT. To determine whether these differences are statistically significant or not, a t-test was undertaken and results are shown in Table 26.

Table 26

Comparisons of t-test Results Performed on Students' Posttest Mean Scores Gender.

Scale	df	t-value	p-value
CAT	190	2.783	0.006

The analysis in Table 26 indicate that the posttest differences on the CAT are statistically significant at 0.05 level. The boys mean score in boys' schools was significantly higher than that of the girls in girls' schools. This implies that gender significantly affects achievement when FAOTS is used with boys in boys' only schools attaining higher score . Thus, H_{03} was rejected.

4.6. Effect of FAOTS on Students' Motivation by Gender

The last objective was to examine the effect of FAOTS on students' motivation by school type. It sought to determine whether school type significantly affected boys or girls motivation in boys' only and girls' only schools respectively. The results are shown in the Table 27.

Table 27
Comparisons of Students' Posttest Mean Scores and Standard Deviations on SMQ by Gender

Scale	School Tpye	N	Mean	SD
SMQ	Boys' only	95	4.23	0.032
	Girls' only	97	4.15	0.026

A comparison of the mean scores of the two types of schools show that the boys in boys' only schools posted slightly higher mean scores of 4.23 than the girls in girls only schools with 4.15. However this observation is not sufficient to show whether the differences in mean scores between the two types of schools are statistically significant at 0.05 level. Thus a t-test was necessary to determine this significance. The results are shown in Table 28.

Table 28

Comparisons of t-test Results on Students' Posttest Mean Scores on SMQ by Gender

Scale	df	t-value	p-value
SMQ	190	2.105	0.037

The results show that the differences in means between boys in boys' only schools and girls in girls'only schools are statistically significantly different at 0.05 level. This indicates that boys in boys' only schools had higher motivation to learn chemistry compared to their girls counterparts in girls'onlyschools.Therefore the type of school affected students' motivation in favour of boys' schools. Therefore, H_{04} was rejected.

4.7 Discussion of the Results

4.7.1 Pre-test Analysis

The pre-test results showed that the students' pre-test meanscores in the experimental class was not significantly different from that of students in the control group (Table 5 and 6). This was done in order to assess the homogeneity of the groups before application of the treatment. A pre-test was administered to the two groups E_1 and C_1. The pre-test used was the Chemistry Achievement Test (CAT) and the Students Motivation Questionnaire (SMQ).

Table 5 shows that the CAT means for the experimental group (E_1) was 29.11 while that of control group was 27.63. The SMQ mean was 3.67 for the experimental group and that of control group was 3.59. Since these means were different, t-test was conducted to test if the means were significantly different. The t-test results in Table 6 revealed that the CAT means for the two groups were not significantly different, t (176) =0.371, $p<0.05$. In addition, Table 6 also show that the SMQ means scores for the experimental group (E_1) and control group (C_1) were not significantly different, t(176)=1.29, $p<0.05$.This implied that the groups had comparable characteristics and as a result were suitable for the study (Table 5 and 6).

The pre-test by gender showed that the CAT means for boys in boys' only schools was 31.05 and girls in girls' only schools was 25.97. The SMQ mean score was 3.75 and 3.51 for boys and girls respectively. Table 8 analysis show that these means were significantly different and this necessitated performance of ANCOVA on posttest results.

4.7.2 Effect of Fireplace Advance Organizer Teaching Strategy on Students' Achievement

One way ANOVA was used on students' Post-test CAT scores to estimate the effect of FAOTS on students' chemistry achievement (Table 9 to 11). A comparison of students mean scores with their mean gain in the CAT showed that the experimental group (E_1) had higher mean gain of 28.97 than the control group (C_1) which had a mean gain of 15.43. The t-test shows that these means scores are significantly different at 0.05 level. Table 11 show that the mean score of experimental groups E_1 and E_2 had means of 58.08 and 56.16 respectively while the control groups C_1 and C_2 had 43.06 and 42.90 means respectively.

One way ANOVA was carried out to find out whether these means were significantly different. The results shown in Table 12 indicate that the difference in mean scores between the four groups were significant $F(3, 356) =35.586$, $P< 0.05$. This means that there was a significant difference between the students taught Diffusion and Graham's Law using FAOTS and conventional teaching methods. Further tests were needed to show where the difference was. This was done using Post-hoc multiple comparisons and the results are presented in Table 14. The results indicate that the difference in groups E_1 and C_1, groups E_1 and C_2, groups E_2 and C_1 and groups E_2 and C_2 were statistically significant at 0.05 margins of error. But this significance cannot be fully attributed to the treatment because not all groups were pre-tested and post tested hence ANCOVA was carried out to deal with the differences at the entry point. The results on Table 15,16 and 17 indicate that FAOTS enhanced students' achievement in favour of experimental groups.Differences between groups C_1 and C_2 and groups E_1 and E_2 were not significant.

The results of this study showed that the Fireplace Advance Organizer Teaching Strategy enhanced students' achievement in chemistry. The posttest means score of the students in the experimental groups was found to be significantly different from that of their colleagues in the control groups. The finding has revealed the efficacy of the use of advance organizers in enhancing students' achievement in chemistry. This finding corroborates the studies of Githua & Nyabwa (2008) and Keraro & Shihusa (2009) which showed that advance organizers with analogies and behavioural objectives were more effective in teaching mathematics and biology respectively. Thus it is an effective strategy for teaching and learning. This finding do not agree with the outcome of a similar study conducted by Barnes & Clauton (1975) whose results were not striking as expected because advance organizers were found to be only effective for low achievers which surprised people because such learners are characterized by inability to organize information. Studies carried out later by Mayer (1977;1979;2003) revealed that advance organizers promote transfer of knowledge on creative problem solving tasks hence have positive influence on learning outcomes. This implied that students in experimental groups were able to link previous knowledge to the new material that is learned and this enhances the material taught.

4.7.3 Effect of Fireplace Advance Organizer Teaching Strategy on Students' Motivation

The students' Motivation Questionnaire (SMQ) mean scores from the four groups were compared using one way ANOVA. The results are shown in Table 14. The Post-test mean scores for the four groups were different. The experimental groups $E_1$and E_2 had a means of 4.09 and 4.29 respectively while the control groups $C_1$and C_2 had means of 3.87 and 3.89 respectively. One way ANOVA was performed to ascertain whether these means were significantly different. The results in Table 15 show that the mean scores for the experimental groups E_1 and E_2 and control groups C_1 and C_2 were significant $F(3,356)=30.99$, $p<0.05$.

Since there was a significant difference between the experimental and the control groups, it was necessary to carry out further tests to confirm where the difference occurred. This was done using post-hoc tests of multiple comparisons and the results presented in Table 16. The results in Table 16 indicate that the difference in mean scores of groups C_1 and E_1, C_2 and E_1, $C_1$and E_2,C_2 and E_2 and E_1 and E_2 were statistically significant different at 0.05 margins of error. The groups C_1 and C_2 were not statistically significant different. This suggests that the Fireplace Advance Organizer Teaching Strategy improved the motivation of students who were in the experimental group compared to those in the control group.The investigation revealed that advance organizers enhanced students motivation to learn chemistry. Since there was significant difference between the students who were exposed to Fireplace Advance Organizer Teaching Strategy and those exposed to conventional methods, it suggests that the FAOTS improved the motivation of students to learn chemistry in the experimental groups than those in control groups.

A study by Keraro & Shihuna (2008) on motivation showed that advance organizers enable the learner to know before hand what is going to be learned. In this study, a film and a chart were used as expository advance organizers and they captured the learners' interest hence motivated them to learn biology. This agrees with a study by Solomon (1986) which indicated that active involvement of learners' enhances their understanding of new situations. In this study, a film on pollution was used as an advance organizer and as a result, the learner's interest to learn biology was enhanced. Singh (2005) argues that modern science and scientific methods of teaching should be improved since life is the product of knowledge which is needed to give direction to action secured by scientific inquiry. Malone (1981) raised an important point that the way to engage learners cognitive curiosity is to provide them with enough information to make their existing knowledge seem incomplete, Inconsistent or unparsimonious. Malone perceives advance organizers as the most effective motivating activities which positively affect learning because they challenge students by creating fantasy and curiosity. Such stimulating and motivating strategies like the use of FAOTS influence change in the students' motivation towards science. The use of FAOTS in this study must have provided interesting and stimulating strategy to the students.

4.7.4 Effect of Fireplace Advance organizer teaching Strategy on Students' Achievement by Gender

The post-test mean scores of the CAT was analyzed in order to establish whether gender affected students' achievement when boys in boys' only schools and girls in girls' only schools are exposed to FAOTS. Table 25 shows the students post-test mean scores of boys in boys' only and girls in girls ' only schools in the experimental groups. The results in Table 25 show that the boys in boys' only schools had higher mean (M=58.86,SD=13.86) scores than girls in girls' only schools with (M=54.40,SD=13.32) mean scores. The results in Table 26 indicates that the difference in CAT mean scores between boys in boys' only and girls in girls' schools were significant, $t(188)=2.783$, $p<0.05$, implying that when exposed to FAOTS, boys in boys' only schools performed better than girls in girls' only secondary schools and thus gender significantly affect students' achievement. Therefore, the boys in boys' only schools exposed to FAOTS in the experimental group significantly achieved better than the girls in girls' only schools.

Even though there was a significant difference in achievement between boys in boys' only and girls in girls' only schools exposed to FAOTS, both performed significantly better than those taught through the conventional methods (Table 11). Therefore, gender had a significant difference on achievement in favour of boys in boys' only schools. The findings concur with the Forum for African Women Educationalists (FAWE) 1999 that science achievement for girls in Kenya was lower than for boys partly due to their poor attitudes towards science and discouragement by their teachers. They made remarks that indicated their biased beliefs or feelings that girls were unintellectual and lazy using positive reinforcement more on boys than on girls (Hohn, 1995;Petty, 1998; FAWE, 1999). The findings of this study differ with the results of Githua & Nyabwa (2007) which revealed that gender did not affect achievement. In addition, Lahey (2007) pointed out that men and women are similar in terms of cognitive ability and academic achievement than they are different. As a result, there are no gender difference in overall achievement in most school subjects, but agrees that there are areas in which females excel and some in which males excel. Lahey argues that, on average females perform better than males in a range of language skills, verbal memory, perceptual speed and fine motor skills whereas males perform better than females in mathematics, science and social attitudes. The results in Table 27 indicates that the difference in CAT mean scores between the boys in boys' only schools and girls in girls' only schools were statistically significant $t(190) = 2.783$, $p<0.05$. On using this strategy, gender significantly affected their achievement but boys in boys' only schools attained higher achievement than the girls in girls' only schools.

4.7.5 Effects of Fireplace Advance Organizer Teaching Strategy on Students' Motivation by Gender

There were 95 boys in boys' only and 97 girls in girls' only schools exposed to FAOTS (Table 28). The-post-test scores of SMQ were analyzed to establish whether gender affect students' motivation in chemistry when exposed to FAOTS. The boys mean score in boys' only schools was higher than girls mean score in girls' only schools. The boys mean score was 4.23 while the girls had the mean scores of 4.15. Table 29 shows the t-test results, which indicate that the differences in SMQ mean scores between the boys in boys' only and the girls in girls' only schools were statistically significant $t(190) = 2.105$, $p<0.05$.Thus the boys in boys' only schools who had a mean score of 4.23 were more motivated to learn chemistry than the girls in girls' only schools who had a mean of 4.15. The results established that there was a significant difference in motivation to learn chemistry in favour of boys in boys' only schools (Table 29). The study is an addition to empirical studies by Keraro & Shihusa (2004) on the effectiveness of the use of advance organizers in biology instruction in classroom.The results of the study showed that there was a significant gender difference in motivation to learn biology in favour of male students. One likely explanation for this outcome is that teachers treat boys and girls differently and in ways that often are not beneficial to girls motivation (wachanga 2000). This seems to contradict studies by Kogo (2005); Githua & Nyabwa (2007) which revealed that there was no gender difference in motivation when advance organizer strategies were used to teach physics and biology respectively. Despite the gender differential in motivation in this study, Fireplace Advance Organizer Teaching Strategy was beneficial to both boys in boys' only and girls in girls' only schools but boys' motivation was higher than girls' motivation.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the major findings of this study. The conclusions and implications are also discussed in this chapter. The recommendations are also made based on this study and finally areas warranting further research are also enumerated.

5.2 Summary

Based on the results of this study, the following were the major findings;

(i) The pre-test analysis results indicate that the control group C1 was similar to the experimental goup E1 on the CAT and SMQ before the implementation of the programme as seen by the ANCOVA test performed using the KCPE results to determine the entry behavior.

(ii) At the beginning of the study, the girls were not similar to boys on both the SMQ and CAT hence ANCOVA posttest analysis was done to adjust the means using KCPE results as the covariates.

(iii) Students exposed to Fireplace Advance Organizer Teaching Strategy had a significant learning gains than those exposed to regular teaching methods because the students in the experimental groups had a higher mean score in the CAT.

(iv) Fireplace Advance Organizer Teaching Strategy was interesting to the students in the experimental groups since they had a higher mean score than their counterparts who were taught using the regular teaching methods. FAOTS therefore boosted students motivation to learn chemistry during classroom instruction.

(v) The Fireplace Advance Organizer Teaching Strategy provides a dramatic shift from the dominant classroom practices where teacher's talk usually dominates, to a student centered learning environment where student -teacher interactions are paramount.

(vi) The use of Fireplace Advance Organizers as a teaching strategy enables both the boys and girls to improve their performance and get more motivated to learn chemistry, however, boys attain higher scores and get more motivated than the girls.

5.3 Conclusions

The study investigated the effect of FAOTS on secondary school students' motivation and achievement in chemistry in Baringo County. It was intended to find out the effect of Fireplace Advance Organizer Teaching Strategy on students' motivation and achievement in chemistry among form three students in Baringo County secondary schools when teaching Diffusion and Graham's Law.This was in relation to the students' poor performance in chemistry. The study specifically sought to determine the effects of using FAOTS on secondary school students' motivation and achievement in chemistry in Baringo County. In addition, the study sought to find out if there was any significant difference between boys in boys' only and girls in girls' only schools students taught using FAOTS in terms of achievement and motivation. The study established that;

(i) The use of Fireplace Advance Organizer Teaching Strategy enhanced students' achievement in chemistry more than the conventional teaching methods.
(ii) Students exposed to Fireplace Advance Organizer Teaching Strategy found it fun to learn chemistry because they were more motivated compared to their counterparts exposed to conventional teaching methods.
(iii) The use of Fireplace Advance Organizer Teaching Strategy demonstrated that gender had a significant influence on the students' achievement, in favour of boys in boys' only schools.
(iv) There was a significant gender difference in motivation to learn chemistry for students exposed to Fireplace Advance Organizer Teaching Strategy, in favour of boys in boys' only schools

5.4 Implications of the Study

The findings of this study have indicated that the students taught through Fireplace Advance organizer Teaching Strategy performed better than those taught through the conventional methods. In addition, it was also found that Fireplace Advance organizer Teaching Strategy enhanced students' motivation to learn chemistry though there was a significant difference in achievement and motivation in favour of boys in relation to school type. This meant that the strategy should be in cooperated into teaching of chemistry at secondary school level because it will improve the poor performance in chemistry hence better students' careers. Teacher training institutions should also make use of advance organizers part of their chemistry teacher education curriculum since the strategy enhances learning. The Quality Assurance and Standards Officers should encourage teacher to use FAOT Strategy in teaching because the strategy does not require buying of chemicals or apparatus hence it can reduce expenditure in schools. Curriculum developers in their efforts to improve the effectiveness of chemistry teaching, teachers should be encouraged to use advance organizers since it enhances students' motivation. The study also confirms the benefits of learner participation in learning, since the strategy enhanced higher motivation for both boys and girls. The findings support theoretical framework that new ideas and concepts can be learnt and retained in episodic memory provided that relevant and inclusive concepts are clear and available to learners' cognitive structures and act as support for new concepts. As found out in this study, FAOTS had a significant difference on students' achievement and motivation by school type, teachers should select the advance organizers which promote gender equality.

5.5 Recommendation

Based on the findings of this study, it is hereby recommended that;

(i) FAOTS should be used by teachers of chemistry in instructing the students in secondary schools.

(ii) The content of advance organizers should form part of the chemistry teacher education curriculum.

(iii) In service courses should be organized for practicing chemistry teachers in order to appraise them on the effectiveness of using advance organizers in teaching

(iv) The chemistry syllabus subject panels and Quality Assurance and Standards Officers need to be appraised on the use of advance organizers in chemistry teaching.

(v) Since boys in boys' only schools performed better than girls in girls' only schools, co-educational schools should be encouraged to assist girls in these subjects. Schools in the study area should organize remedials to assist students who are weak in these subjects.

(vi) There's need to identify and recognize successful professional women within the County who can act as role models to girls especially in Baringo County for this may encourage girls hence lower or eliminate gender disparity among the schools.

5.5.1 Recommendation for Further Research

The following are the areas that warrant further investigations:

(i) An inquiry to determine the effectiveness of using advance organizers on students' creativity in chemistry.

(ii) An investigation to gain further insight on the effect of fireplace advance organizers on students' conceptualization.

(iii) Study to find out the effects of evaluative feedback on performance and retention of secondary school students in chemistry.

(iv) Further studies to investigate the effectiveness of using advance organizers in relation to type of school in terms of co-educational school.

(v) An investigation to determine why boys perform better in chemistry when they are exposed to advance organizers than girls.

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APPENDICES

APPENDIX A

TEACHERS GUIDE ON DIFFUSION AND GRAHAM'S LAW.

Topic: Gas laws.

Sub-topic: Diffusion and Graham's Law.

OBJECTIVES

By the end of the topic, the learner should be able to:

- Define diffusion.
- State Graham's law of diffusion
- Explain diffusion in liquids and gases in terms of kinetic theory.
- Relate the rate of diffusion to the relative molecular mass of a gas.
- Carry out calculations involving diffusion of gases.

In teaching this topic, the experimental groups will be taken to a kitchen which is fitted with a fireplace advance organizer. The teacher in charge will then introduce the fireplace as the FAOTS and explain step by step how the FAOTS is comparable to diffusion. The teacher will then divide the students into five groups. Each group will be required to draw the diagram of a FAOTS on a manila paper which will be used during lesson time.

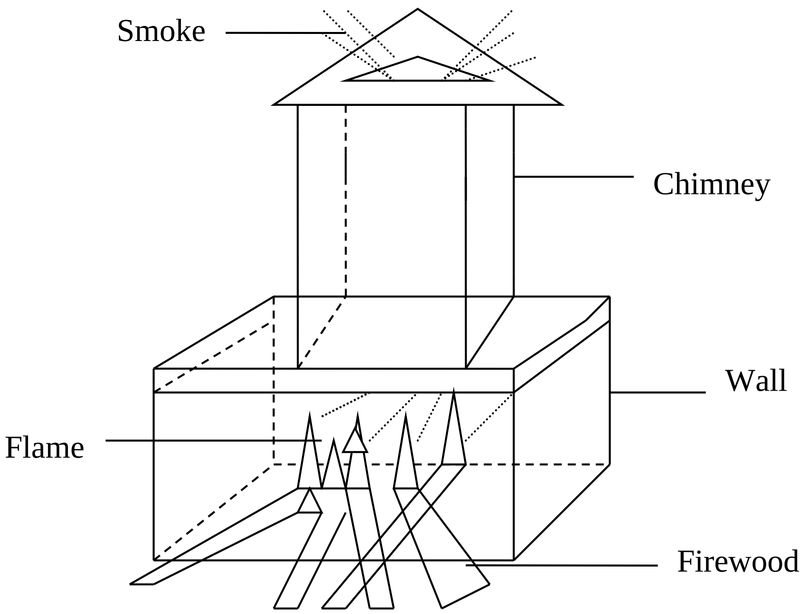


Figure 3: A Fireplace Advance Organizer.

WEEK 1

Lesson No : 1 & 2 (80min)

Lesson topic : Diffusion in Liquids

Advance Organizer

A fireplace advance organizer shall be used. In a FAOTS, firewood is a very important material. When it is burnt, it produces a hot yellow flame which is hot. The flame then changes to smoke and goes up the chimney with the help of air at a particular speed depending on the type of smoke. At the top of the chimney, smoke is normally observed. This advance organizer can be used to teach diffusion and Grahams Law in form three classes. Figure 3 above illustrates a fireplace advance organizer.

EXPERIMENT 1

Aim: To investigate what happens when a crystal of Potassium Manganate (VII) is placed in water.

Apparatus and chemicals

- A beaker, Water,PotassiumManganate (VII), Straw, Spatula,

Procedure

1. Fill a beaker with water to three quarter way.
2. Carefully place or drop a small crystal of Potassium Manganate (VII) through the straw using a spatula through a straw to the bottom of the beaker as shown in figure 3.

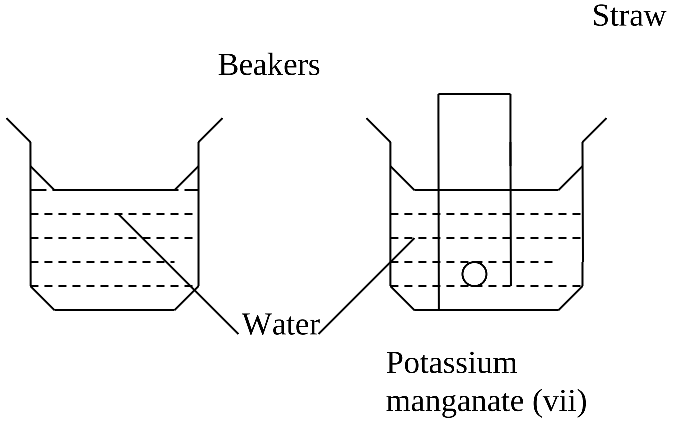


Figure 4: Diffusion of potassium manganate(VII) in water

3. Let it stand for 40 minutes

4. Make careful observations after 5 minutes and 40 minutes respectively and answer the questions that follow.

Table 4.

Results of Diffusion of Potassium Manganate (VII)

Observations after 5 minutes	
Observations after 40 minutes	

Questions

1. What observations do you make after 5 minutes?.

………………………………………………………………………………………………………

2. What observation do you make after 40 minutes.

………………………………………………………………………………………………………

3. Draw the sketches of your observations:

(i) At the start of the experiment.

(ii) After 5 minutes

(iii) At the end of experiment.

4. Explain your observation if warm water was used in this experiment instead of cold water.

……

………………………………………………………………………………………………

Conclusion.

The spreading out of the purple colour of potassium manganate (VII) in water as shown in figure 2 above is an evidence for the movement of solid particles. The movement of potassium manganate (VII) particles in water is due to the collision between manganate (VII) particles and the water molecules. This is because they have kinetic energy.

WEEK 1

Lesson No; 3&4 (80 min).

Lesson Topic: Diffusion of gases in air.

Advance organizer

Movement of smoke up the chimney

The advance organizer in this part will be the movement of the smoke particles through the chimney. The chimney contains air and thus the smoke diffuses through this air as the way bromine diffuses through the air.

The smoke moves along the chimney. This is evident when the smoke is seen on the top of the chimney. This advance organizer is likened to the bromine vapour in the inverted gas jar.

EXPERIMENT 2

Aim: To investigate what happens when bromine liquid diffuses in air.

Caution: Bromine should be handled in a fume chamber because bromine is very corrosive

Apparatus and chemicals

- Bromine liquid, 2 gas jars, 1 long dropper, Vaseline, Gas jar cover.

Procedure

1. Smear the mouths of the two gas jars with Vaseline
2. Put two drops of bromine in one of the gas jars and then cover it using a gas jar cover
3. Place the second gas jar upside down on top of the gas jar as shown in figure 4

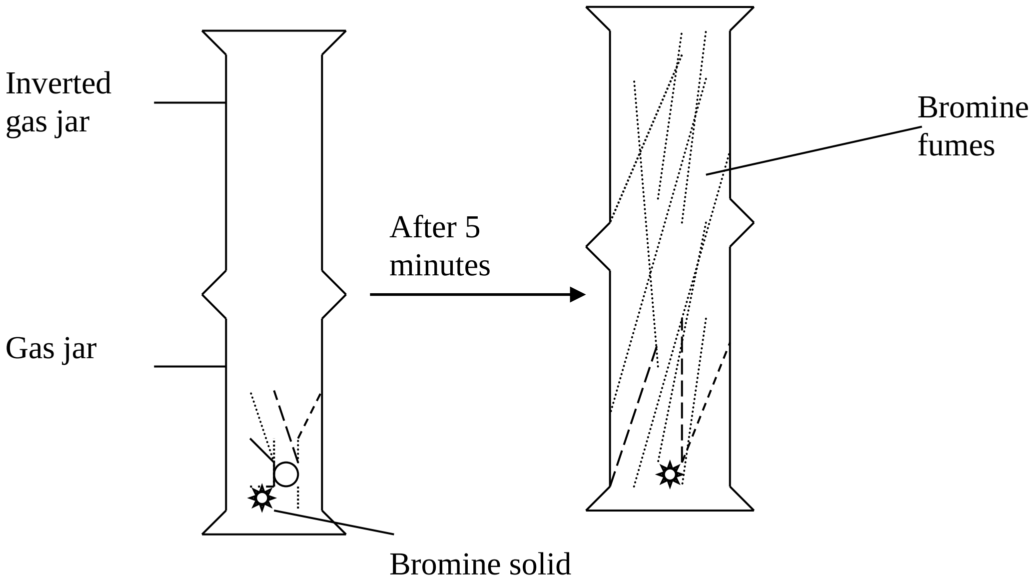


Figure 5: Diffusion of bromine gas

4. Remove the gas jar cover and leave the set up for 30 minutes.
5. Record all the results in table 5

Table 5

Diffusion of Bromine

Duration	Observation
After 30 minutes	

Questions

1. Why are the mouths of the gas jars smeared with Vaseline?

………………………………………………………………………………………………………

2. Bromine vapour is denser than air. Why does it rise into the upper gas jar?

………………………………………………………………………………………………………

3. Draw the level of bromine fumes at the end of the experiment.

4. Suggest two reasons why bromine liquid is appropriate for this experiment?

………………………………………………………………………………………………………

……………………………………………………………………………………………………

Conclusion

When bromine liquid is placed in a gas jar and another gas jar inverted over it, red brown fumes of bromine are observed in the inverted gas jar after a few minutes Ngaruiya,Kimaru and mburu, 2004). This is because bromine molecules from the lower gas jar diffuse into the inverted gas jar, due to the random movement of bromine molecules in gases

The spreading of gas particles in air takes short time. This is because gas particles are far apart and have more kinetic energy than in liquids (KLB, 2004).

WEEK 2

Lesson No; 1 & 2 (80 MIN)

Lesson topic: Rate of diffusion of gases.

Advance Organizer.

For this lesson, the teacher will use the chimney of the fire place to teach the rate of diffusion of gases. The chimney which is circular is linked to the long glass tube,

The smoke moving up the chimney is also similar to the gases diffusing between two definite points. The time taken for the smoke on the chimney is taken and the length of the chimney is measured. This will help in calculating the speed of the smoke up the chimney, which represents the rate of diffusion of a gas through a certain distance. This can be illustrated by the figure 6.

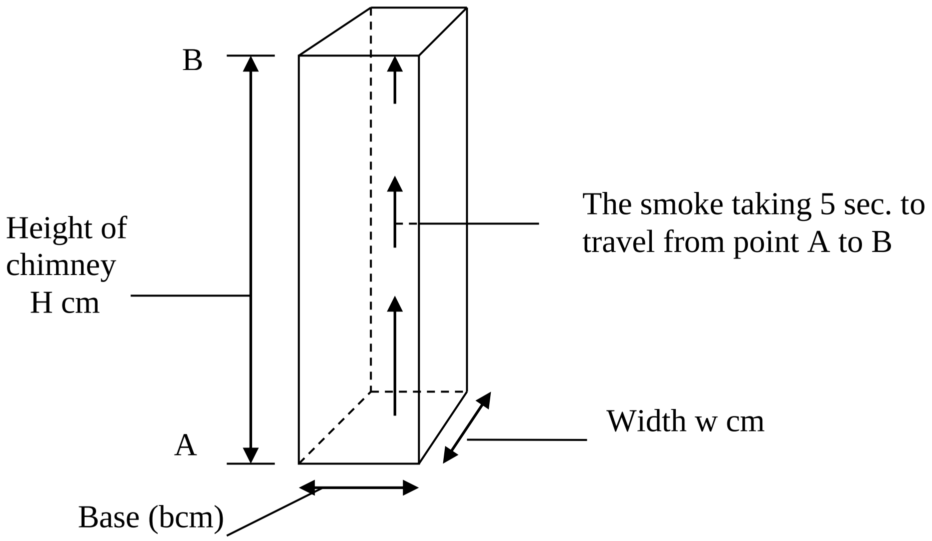


Figure 6: Rate of diffusion of gases at particular points

The volume of the smoke up the chimney can be calculated by multiplying

base x Width x height. = b x w x H $cm^{3.}$

Since the rate of smoke is the quantity of the gas that passes through a point, B, after a particular time,t,5 seconds, then

$$\text{Rate of smoke} = \frac{b \times w x H \; cm^3.}{5 \text{ minutes}} \quad = \quad {}_{1/5}bwH \; cm^3 sec\text{-}1$$

The learners should realize that the rate of smoke is the same as the diffusion of gas in air. This advance organizer should enable the learner to calculate the rate of diffusion. The white smoke seen at the top part of the chimney is likened to the white solid observed in the combustion tube

EXPERIMENT 3

Aim: To investigate whether molecules of different gases diffuse at the same rate.

Apparatus and chemicals

- Clamp, Long glass tube, Cotton wool, A meter rule, Corks, Stop watch, Felt pen.

Procedure

1. Clamp a glass tube horizontally as shown below.
2. Soak one piece of cotton wool in concentrated ammonia and another piece in concentrated hydrochloric acid.
3. Quickly insert them simultaneously at opposite ends of the glass tube and stopper on both ends
4. Immediately start the stop-watch and record the time taken for change to occur in the glass tube,
as shown in figure 7.

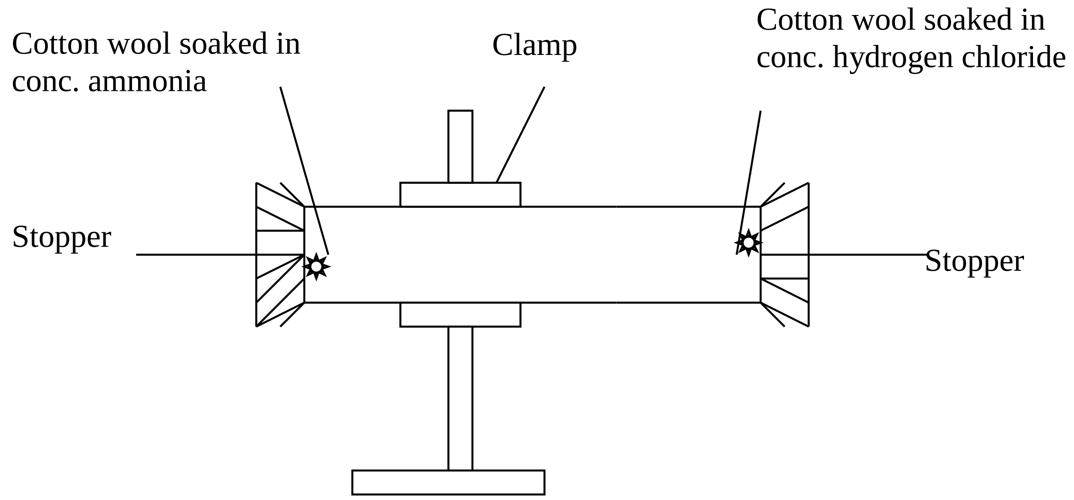


Figure 7: Rate of diffusion between ammonia and hydrogen chloride gases

5. Using a felt pen, mark on the tube where the change occurs. Measure the distance covered each gas and record the distances in table 6.

Table 6

The rate of diffusion between ammonia and hydrogen chloride gas.

Time taken for the change to occur	………………….. minutes
Distance covered by ammonia	…………………… cm
Distance covered by hydrogen chloride	…………………….. cm

Questions.

1. What observations are made in the glass tube and after how long?.

…………………………………………………………………………………………

2. Which gas covered a longer distance? …………………………………………………….
3. Explain the observation made in the glass tube…………………………………………

4. Determine the molecular masses of ammonia and hydrogen chloride. (N=14; H=1; Cl =35.5).

……………………………………………………………………………………………………

……………………………………………………………………………………………………

………………………………………………………………………………………

5. Calculate the rate of diffusion of ammonia and hydrogen chloride.

……………………………………………………………………………………………………

…………………………………………………………………………………………………

6. What is the relative rate of diffusion of ammonia to hydrogen chloride gas?

……………………………………………………………………………………………………

…………………………………………………………………………………………………

Conclusion:

The rate of diffusion is a measure of the quantity of the gas that passes through a space after a particular period of time. Molecules of different gases diffuse at different rates. This can be summarized by Graham's law which states that: Under the same conditions temperature and pressure, the rate of diffusion of a gas is inversely proportional to the square root of its density. Thus,

$$\text{Rate} \propto \frac{1}{\text{Density}} \quad ; \quad \text{Rate} \propto \frac{1}{\sqrt{\text{molecular mass}}} \quad ; \quad \text{Rate} \propto \frac{1}{\text{Time}}$$

When two gases of equal volumes A and B are compared, we have

$$\frac{\text{Rate A}}{\text{Rate B}} = \frac{\text{Time B}}{\text{time A}} = \sqrt{\frac{\text{density}}{\text{density of A}}} = \sqrt{\frac{\text{molecular mass of gas B}}{\text{molecular mass of gas A}}}$$

APPENDIX B

STUDENTS' MOTIVATION QUESTIONNAIRE (SMQ)

I am David K. Kibet a master's student EgertonUniversity undertaking a research on the effects of advance organizer on students' motivation and achievement in chemistry. Your participation will be highly appreciated.

Any information given will be treated with the confidentiality it deserves.

SCHOOL:...

CLASS: ....

GENDER:...

DATE OF BIRTH:..

STUDENTS ADMISSION NUMBER:..

The purpose of this questionnaire is to find out what you think about chemistry course.

INSTRUCTIONS

- Read the items carefully and try to understand before choosing what you accept to be true.
- Circle around the letter that corresponds with how you really feel towards the chemistry course. Circle only one of the choices.
- The choices and: SA = strongly Agree: A = Agree: D = Disagree: SD = strongly Disagree; U = Undecided.
- If you change your mind about an answer, you may cross it neatly and circle another.

ITEMS

1. Learning the chemistry course with the teacher performing the experiments was

1. Fun	SD	D	U	A	SA
2. Satisfying	SD	D	U	A	SA
3. Informative	SD	D	U	A	SA
4. Useful	SD	D	U	A	SA
5. Boring	SD	D	U	A	SA
6. Frustrating	SD	D	U	A	SA
7. Hard	SD	D	U	A	SA
8. Challenging	SD	D	U	A	SA

2. Learning Diffusion and Grahams' Law was

1. Stimulating	SD	D	U	A	SA
2. Rewarding	SD	D	U	A	SA
3. Time wasting	SD	D	U	A	SA
4. Boring	SD	D	U	A	SA
5. Useful	SD	D	U	A	SA
6. Interesting	SD	D	U	A	SA
7. Well organized	SD	D	U	A	SA

3. Learning chemistry by visiting the kitchen where the FAOTS was made me.

1. Feel confident about the chemistry course	SD	D	U	A	SA
2. Feel eager to learn the chemistry course	SD	D	U	A	SA
3. Doubt my ability to learn chemistry	SD	D	U	A	SA
4. Want to apply my knowledge to solve practical problems	SD	D	U	A	SA
5. Happy	SD	D	U	A	SA
6. Excited	SD	D	U	A	SA
7. Feel as if I was wasting my time	SD	D	U	A	SA
8. Frustrated	SD	D	U	A	SA
9. Unhappy	SD	D	U	A	SA

4. The firewood, fire smoke and the chimney used as the Advance organizers made me

1. Appreciate chemistry	SD	D	U	A	SA
2. Dislike chemistry	SD	D	U	A	SA
3. Interested in chemistry	SD	D	U	A	SA
4. Scared of chemistry	SD	D	U	A	SA
5. Like chemistry	SD	D	U	A	SA

5. Learning chemistry through the experiments performed by the teacher made m

1. Feel confident about chemistry course	SD	D	U	A	SA
2. Feel eager to learn chemistry course	SD	D	U	A	SA
3. Doubt my ability to learn chemistry	SD	D	U	A	SA
4. Want to apply my knowledge to solve Practical problems	SD	D	U	A	SA
5. Happy	SD	D	U	A	SA
6. Excited	SD	D	U	A	SA
7. Feel as if I was wasting time	SD	D	U	A	SA
8. Frustrated	SD	D	U	A	SA
9. Unhappy	SD	D	U	A	SA

APPENDIX C

CHEMISTRY ACHIEVEMENT TEST (CAT)

SCHOOL:..

ADM/NO:..

CLASS:...

AGE:...

GENDER:...

INSTRUCTIONS

- Please answer all the questions.
- Read the questionnaire carefully to ensure that you understand it before writing your answer.
- Fill the answer in the spaces provided.

1. Complete the following table.

Gas	Molecular Mass
Hydrogen	1 mk
Carbon (IV) Oxide	1mk
Sulphur (IV) Oxide	1mk

2. State Graham's Law.

....

....1mk

3. Give the colour of bromine liquid in water...1mk

4. Give two factors that affect the rate of diffusion of a gas

(i) 1mk

(ii) 1mk

5. Write the word equation for the reaction between ammonia and hydrogen chloride gases.

....

6. The density of a gas P is 1.4290 x 10^{-3}gcm^{-3} and the density of gas q is 1.2506 x 10^{-1} gcm^{-3}. Which gas will diffuse faster than the other?

....

....1mk

7. A student dropped a piece of potassium manganate (VII) through a straw into a beaker containing water. Give the colour of the solution formed.

....

....1mk

8. Give a reason why bromine should be handled with care

....1mk

9. Differentiate between diffusion and rate of diffusion.

....

....1mk

10. Give an example of a gas that will diffuse faster than ammonia gas.

....

....1mk

11. Complete the table below.

Experiment	Observation
i) Using a dropper, a student put two drops of bromine into a gas jar and then covered using another gas jar, and left for thirty minutes.	1mk
ii) Another student dropped a small crystal of potassium manganate (VII) through a straw into the bottom of a beaker with water about ¾ way and left for forty minutes	1mk

12. Explain what would happen when a crystal of copper (II) sulphate is put into a conical flask containing distilled water.

....

....1mk

13. Calculate the time taken for a given volume of methane gas to diffuse through a small hole, if the same volume of sulphur (IV) oxide under the same conditions takes 100 seconds.
(C = 12, O = 16.0, H = 1.0, S = 32.2)

....

....1mk

14. Study the following table showing the relative molecular masses of different gases and answer the questions that follow.

Gas	M	N	O	P
Relative molecular masses	28	71	2	32

a) Which gas takes a long time to diffuse through an orifice which is 30 centimetres?

....1mk

b) Which gas takes short time to diffuse through the same orifice in (a) above?

....1mk

15. Carbon (IV) oxide diffuse through a porous plug at the rate of $20cm^3s^{-1}$ and a gas Ƶ diffused at the rate of $10cm^3s^{-1}$ through the same plug. Calculate the molar mass of gas Ƶ

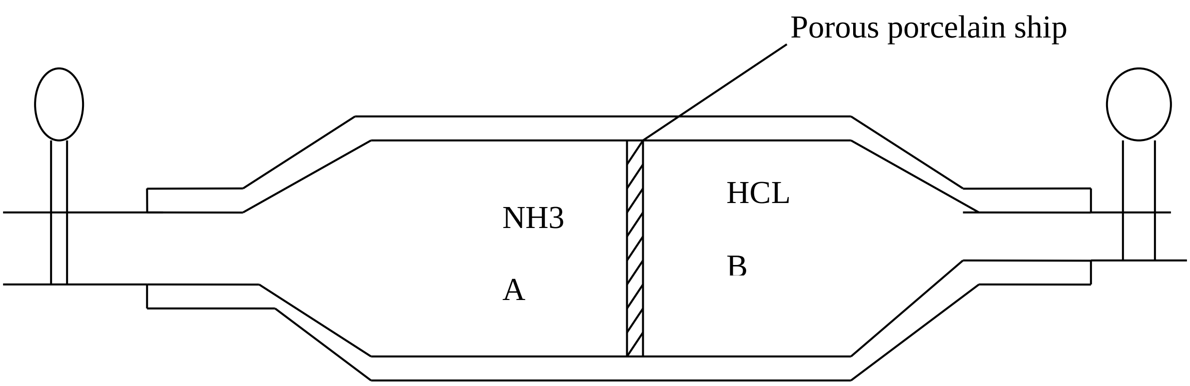
(C = 12.0, O = 16.0)

....

....

....1mk

16. Study the figure below answers the questions that follow.



i) In which chamber A or B will reaction appear to take place first? (H = 1, N = 14, Cl = 35.5)

....1mk

ii) Write the chemical equation for the reaction that will take place in (i) above.

....

....1mk

iii) Explain the reason for your answer in (i) above

....

....1mk

17. A sample of hydrogen gas of density 1.0 diffused in 82 seconds. The same volume of air diffused in 310 seconds. How many times is air denser than hydrogen.

....

....1mk

18. Describe how you would chemically test that a given gas Y is ammonia gas in the laboratory.

....

....1mk

19. Describe why a male moth is able to trace a female moth which is 8 metres away.

....

....1mk

END