EFFECTS OF CONSTRUCTIVIST TEACHING STRATEGY ON STUDENTS' ACHIEVEMENT AND MOTIVATION TO LEARN CHEMISTRY IN SECONDARY SCHOOLS IN NANDI NORTH DISTRICT, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

This research study is my original work and has not been presented for an award of Degree or Diploma in this university or any other university.

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Recommendation

This thesis has been submitted with our approval as university supervisors.

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DEDICATION

This thesis is dedicated to my dear husband Leonard, my daughters Philipa and Michelle and my son Edgar. They were patient and encouraged me throughout the study. This also extends to my parents brothers and sisters.

ABSTRACT

Chemistry is a major career subject in secondary education that is done by most of the secondary school students in Nandi North District. However, the subject has been underperformed in the past years. This could be attributed to inappropriate teaching methods employed in teaching and learning. Constructivist teaching strategy may help in improving teaching and learning of scientific concepts, but this had not been established in the District. The aim of the study was to determine the effects of using constructivist teaching strategy on students' achievement and motivation to learn Chemistry. Solomon-Four Group Non-Equivalent Control Group Design was used. Four co-educational schools were chosen using simple random sampling out of the thirty two schools in the district. One hundred and twenty students and four teachers were involved in the study. Two instruments that were used are Chemistry Achievement Test (CAT) and Students' Motivation Questionnaire (SMQ). A teaching module was developed for teaching the topic: 'Effects of Electric Current on substances' in Form Two for eleven lessons in a period of two weeks. Piloting was done in a different school within Nandi North District to ascertain the reliability and validity of the instruments. Validation of the instruments was ascertained by three experts from department of Curriculum Instruction and Educational Management (CIEM). The Cronbach's co-efficient alpha and Kuder-Richardson formula 21 (KR-21) were used for establishing reliability of SMQ and CAT respectively. Reliability was 0.72 for SMQ and 0.74 for CAT. Data were analyzed using ANOVA, ANCOVA, t-test and descriptive statistics. Hypotheses were tested at co-efficient alpha (α) = 0.05 level of significance. Results of the study indicates that constructivist teaching strategy enhances students' chemistry achievement but had no effect on students motivation. Also the results showed that there was no difference in motivation and achievement in chemistry of boys and girls taught using constructivist strategy. The results of this study are may help in enhancing teaching and learning of chemistry. This method is recommended for teachers of chemistry as a complement for the conventional teaching methods. Teacher trainers can train teachers on constructivist teaching strategy. KEMI can organize seminars workshops and refresher courses for chemistry teachers.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANCOVA - Analysis of co-variance

ANOVA - Analysis of variance

CAT – Chemistry achievement Test

CTS - constructivist Teaching strategy

KCPE - Kenya Certificate of Primary Education

KCSE – Kenya Certificate of Secondary Education

KEMI – Kenya Educational management institute

KIE - Kenya institute of Education

KNEC – Kenya National Examination Council

KR-21 -Kuder Richardson -21

NACOSTI - National commission for science and technology innovation

SMASSE – Strengthening of Mathematics and Science in Secondary Education.

SMQ – Students' Motivation Questionnaire

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Chemistry is an important subject in secondary school curriculum. It allows students entry into careers like pharmacy, medicine, biochemistry and others. It also prepares learners for other scientific vocations and assists in learning of other science subjects like Physics and Biology through lateral transfer of knowledge. In addition, it is involved in production of foods, drugs, plastics and others (KLB 2010). Therefore it should be taught using constructivist strategy since it helps students to actively engage in personal constructed theory building (Driver & Oldham 1986).

In Kenya, chemistry foundation is the science subject that is examined in KCPE (Kenya certificate of primary Education), while in secondary schools, it is an independent subject which is examined in KCSE (Kenya Certificate of Secondary Education). In 1963 when secondary chemistry curriculum was formulated and developed by the K.I.E (Kenya Institute of Education), the emphasized syllabus at that time resulted in teacher and book approach. Since then, chemistry syllabus has undergone several changes aimed at finding the best approach for teaching and learning of the subject. The search for a better teaching method has been going on for years (Okere, 1986).

In the current 8-4-4 system, during KCSE (Kenya Certificate of secondary Education) chemistry examination, students are examined on three Chemistry papers, paper 233/1-theory for two hours, paper 233/2 - theory for two hours and paper 233/3 – practical for two and a quarter hours. A student’s score is determined by converting the three papers into percentage and determine the average mark.

Chaille and Britain (1997) have argued that most children come to school ready and willing to learn. The challenge therefore the teachers’ face is to foster and strengthen this disposition and ensure the children leave school with motivation and capacity to continue learning throughout life. Sexton, Wagner and Genlovich (1998) confirm that learners' attitude s carry a state of readiness and willingness to learn. They direct learners when they enter into new experiences and hence influence how they would respond to situations or events. Therefore, it is important for teachers to use approaches that enhance learners' positive attitude towards science and hence motivation to learn.

Table 1 shows the National K.C.S.E performance in chemistry for the past seven years.

Table 1
Candidates National Overall Performance in Chemistry from the Year 2000-2007 in Kenya

Year	Number of Candidates	Maximum score	Mean Score	Improvement index (%)	Standard deviation
2000	115968	190	41.84		21.38
2001	181,238	190	30.72	-11.12	18.00
2002	187,261	190	34.27	+3.55	21.29
2003	198,016	190	37.42	+3.15	22.86
2004	214,520	200	39.62	+2.2	20.00
2005	253,508	200	38.05	-1.57	23.00
2006	237,831	200	49.82	+11.77	32.00
2007	241,368	200	50.76	+0.94	31.00

Source: Kenya National Examination Council (KNEC, 2009)

Where: -

Maximum score is the total possible scores from the three chemistry examination papers.

A mean score is the percentage average mark for a given number of candidates of that year.

Standard deviation is the difference between the score and the mean. Improvement Index in percentage is derived from the differences in mean scores of the subsequent years.

Research in teaching behavior indicates that there are some teaching methods that influence students' achievement than others (Wenglinsky, 2000). The dismal improvement index on the subject in National examination from Table 1, may be attributed by poor methods, over enrolment or lack of resources for teaching and learning of the subject.

A steady decline in academic achievement of high school in sciences as well as low enrolment in science courses has caused a deep concern in many countries (Ogunninyi ,1996) In Kenya for instance the KNEC report (KNEC , 2007) indicates the overall achievement of students in KCSE Chemistry has been a downward trend although in the year 2002 there was a slight improvement. This underachievement could be associated with low student motivation.

In Nandi North district chemistry is done by all the students. Table 2 shows overall chemistry performance in Nandi North district for the past six years.

Table 2:
Nandi North District overall performance in KCSE Chemistry year 2003-2010

Year	Number of Candidates	Maximum Score	Mean (%)	Improvement index
2003	1603	190	35.5	
2004	2045	200	36.2	+0.7
2005	1961	200	40.1	+3.9
2006	2062	200	39.92	-0.18
2007	2382	200	49.7	+9.78
2008	3160	200	50.1	+0.4
2009	4200	200	35.83	-14.27
2010	4360	200	37.5	+1.67

Source: SMASSE Report 2011 Nandi North.

From Table 2, there is a slight positive improvement except for the year 2006 and year 2009 when there was a drop. The number of registered candidates also increases yearly. An improvement observed in year 2007 could be due to a slight change in the syllabus. A slight improvement was seen in the year 2005.

Cheek (1992) described constructivist strategy as a state when learners, actively take knowledge, connect it with previously assimilated knowledge and make it their own by constructing their own interpretations. In chemistry education, children attempt to make sense of information they receive and construct individual ideas into conceptual framework. According to Driver (1983), this conceptual framework and the ideas which they contain are often not congruent with scientific understanding. In constructivist approach, the role of the teacher is to assist students to replace pre-existing ideas. The goal of the learner is to reflect on the accepted explanations or methodology expostulated by the teacher (Caprio, 1991). Unlike traditional teaching dealing with transmission of static knowledge, constructivist teaching requires that teachers extend freedom of choice to students and create the climate where students may feel free to raise their own questions and spur their own development. In Driver (1989) words 'the principles of constructivist pedagogy- encouraging collaboration, prompting activity and exploration, respecting multiple points of view, emphasizing authentic' problem solving which facilitate a more creative synthetic motivation towards learning. Nevertheless, present studies indicate that encouragement of collaborative interaction in classroom learning is likely to cause learners to interact vicariously and thereby develop positive learning experiences (Johnson and Johnson, 1992, Kiboss, 1998). In Science education, instruction involves a conceptual change rather than infusion into a vacuum (Brunner 1971).

From 2006 K.C.S.E. report that chemistry performance had risen slightly in the previous year after steady drop in the District. Among the poorly done paper two questions was Electrochemistry one, which is Form Four work. The basis of the topic is mainly on 'Effects of Electric Current on Substances' which is mainly Form two work. The topic is also linked to 'Structure and Bonding' form two work which is also under performed. Therefore, constructivist strategy can be employed in teaching prior topic for a better understanding of the current under achieved related topic.

Motivation has been defined as an "internal state that activates, guides, and maintains behaviour" (Green, 2002, p. 989). From an educational point of view, the term "motivation" can therefore apply to any process that activates and maintains learning behaviour. If the learning behaviour is developed by students always constructing meaning from what they already know, what is expected is better understanding since the process is learner-centered which is expected to eventually improve chemistry achievement. Earlier studies show that motivation is a crucial factor in the construction of knowledge.

1.2 Statement of the Problem

Chemistry has a direct impact on individual's life and technological advancement of a society. Inspite of these contributions, the performance of students in KCSE is dismal. This is likely to have been brought about by inappropriate teaching methods employed by teachers in the country, Nandi North district included. It was not clear how the use of Constructivist Teaching Strategy in teaching would affect student achievement and motivation to learn chemistry. Therefore this study was designed to fill the gap by seeking to determine effects of constructivist teaching strategy on secondary school chemistry achievement and motivation to learn chemistry.

1.3 Purpose of the Study

The purpose of this study was to determine the effects of using constructivist teaching strategy on secondary school students' achievement and motivation to learn chemistry in Nandi North District, Kenya. .

1.4 The Objectives of the Study

The objectives of the study include:-

(i) To find out the effects of using constructivist teaching strategy on students' chemistry achievement among secondary schools in Nandi North District.

(ii) To establish the effects of constructivist teaching strategy on students' motivation to learn Chemistry among secondary schools in Nandi North District.

(iii) To compare the achievement scores in chemistry of boys and girls taught using constructivist strategy.

(iv) To compare motivation level of boys and girls who were taught using constructivist strategy to learn chemistry.

1.5 Research Hypotheses

The research hypotheses of this study include:-

H_O1: There is no statistically significant difference between chemistry achievement scores of students' who are taught using constructivist teaching strategy and those who are taught using conventional methods.

H_O2: There is no statistically significant difference between motivation in chemistry of students who are taught using constructivist teaching strategy and those who are taught using conventional methods.

H_O3: There is no statistically significant difference between achievement scores of boys and girls taught using constructivist teaching strategy.

H_O4 : There is no statistically significant difference between motivation of boys and girls taught using constructivist strategy.

1.6 Significance of the Study

The findings may be used by curriculum developers to make appropriate amendments on the selection of content, objectives and evaluation of their teaching strategies . The study is expected to investigate students' conception on 'Effects of electric current on substances'. It also developed a constructivist teaching module and investigates its effectiveness on student achievement and motivation to learn the chemistry. The findings of this study are likely to assist teachers and their teaching methods in relation to students' understanding. It is expected to enable students pursue science related courses in universities and colleges.
The findings are also hoped to stimulate further research on chemistry education methodology.

1.7 Scope of Study

The study was conducted in four public co-educational schools taking 8-4-4 syllabus. The study employed the use of constructivist teaching strategy to teach form two students chemistry for three weeks in Nandi North district, Kenya.
The topic to be covered is 'Effects of Electric Current on substances' which is introduced at this level. It involves a sample of about one –sixty students and four teachers.

1.8 Assumptions of the Study

The following was assumed in the study:

1 Data that was collected from students was a true reflection of their understanding of the topic ‘Effect of Electric current on Substances’ and their motivation towards teaching and learning of Chemistry.

2 Teacher variation in teaching chemistry in the same class does not affect teaching and learning.

1.9. Limitations of the Study

The study was only limited to Form Two students mainly in Nandi North; hence the findings of this study may not be generalized to other classes or other different districts. The study is only limited to Form two chemistry topic ‘Effects of Electric Current on substances’, therefore the findings might not be generalized to other topics. Admission of students to schools of district category is based on cut-off marks and so provincial schools were not sampled.

1.10 Definition of Operational Terms

Achievement – Refers to scores obtained by students on Chemistry achievement test after completing teaching the topic 'Effects of Electric current on Substances'. The scores are the percentage mark and their respective grades.

Attitude: Liking or disliking which can be reflected in the behavior of the learners during the teaching and learning of Chemistry.

Collaborative learning: It is a learning method that requires learners to develop teamwork and see individual earning as essential related to the success of group learning (process of peer interaction)

Constructivist teaching strategy: An active learning process that involves learners coming up with their own idea from the existing. It involves processing the input through existing cognitive structures then clarified by teacher through negotiation and then retaining it in long-term memory.

Conventional methods: classroom instructional methods that are teacher and book dominated in the teaching and learning of Chemistry currently used in Nandi North District. These involve demonstration, class experiments discussions, and project and talk-chalk method.

District public co-educational secondary schools: Free local Public secondary schools with both male and female students which are subsidized by government in the district.

Effect: How the teaching and learning approach influences student achievement in the CAT and motivation to learn chemistry.

Form two: second level of secondary education based on 8-4-4 Kenyan education systems.

Gender: refers to socially constructed roles, behavior, attributes that a particular society considers appropriate for male and female.

Learning: Is an active process in which learners construct new chemistry ideas or concepts based on that current or past knowledge.

Module: Comprises of eleven successive lessons for teaching the topic 'Effects of Electric current on substances' used by the teacher to direct the teaching and learning process using constructivist strategy.

Motivation -A psychological process that determines intensity, direction and persistence of behavior related to learning chemistry

Performance: Student's chemistry achievement score

CHAPTER TWO

LITERATURE REVIEW

2. 1 Introduction

In this chapter, a summary of related concepts and theories to constructivism have been presented. These concepts are:- Chemistry learning, chemistry achievement and teaching, student motivation in chemistry, gender differences and chemistry achievement, constructivist teaching strategy, Constructivist teacher methodology in creating a constructivist classroom and conventional methods currently used by teachers in teaching chemistry. Also theoretical and conceptual frameworks are also presented.

2.2 Chemistry Learning

Chemistry teaching stresses the importance of careful planning. Emphasis is placed on adequate experimental design and acquisition of correct laboratory techniques (Everret & Jerkins 1980). They stress the characteristics of good science laboratory as well as being sensitive to students' abilities and needs. The pupils should be helped to make sense of their world by encouraging creative abilities. In this case starting from familiar to unfamiliar since a child is not a vase to be filled but a fire to be lit (Kiboss 2000).

This quotation sums up the view of how learning should be structured for children so that we can help them to learn and become independent learners. The teaching method has to build a foundation of knowledge on already existing one by:-

- Encouraging pupils to learn science concepts (chemistry) by doing.
- Ensure learning grows out of useful experiments and experimentation.
- Using teaching aids effectively.
- Create in a classroom a learning environment
- Stimulate appreciation as well as cognitive environment.
- Vary grouping of pupils to get most efficient teaming unit for each type of lesson.

Okere (1996), suggested that teaching should be judged by results that last longer and that a learner can and does actually use in life. In results that last longer, if a student is taught *characteristics of sub-atomic particles* in form one, should apply in *structure and bonding* in form two, and *Radioactivity* in form four. In the second point, 'the results that learner can use in life' means applying what one has learnt in chemistry *like ways of removing hardness of water and* use it in daily life.

However, according to Brunner (1971) students focus their attention on portion of the stimuli that is most important or interesting. Therefore, science teachers should always make content they are supposed to impart interesting by using relevant examples which are applicable. Osborne and Wittrock (1983) concurs with him by saying that the learners' memory store information and the processing strategies interact with sensory input (stimuli of sense) by actively selecting and ignoring others. The input is selected and attended to by the learners. The selected in this case is most interesting bit.

In addition, the teacher's words are not transferred to the learner simply by hearing. The learner generates between that input and those parts of his memory store considered relevant. The learner then retrieves from the memory and uses the information to construct meaning from sensory input. A test of constructed meaning against constructed meaning, memory and sensed experience can be done .The learner subsumes constructions into memory and sometimes new ideas can be accommodated alongside ideas already stored.

In this study the learning of chemistry is determined by how motivated the learners are. The achievement scores in chemistry showed how effective the learning process that took place was.

2.3 Chemistry Achievement and Teaching

Chemistry is one of the practical subjects and there seems to be a unanimous agreement that laboratory work is an essential component of modern secondary school chemistry teaching (Nakhleh, Polles & Malina 2002). Lab-work has repeatedly been characterized as having great potential for students to acquire chemistry content. It is also seen essential in allowing students to understand the scientific method (Blosser 1983). Better understanding of chemistry body of knowledge and content directly affects achievement.

The approach encouraged has emphasized the need for chemistry teachers to consider constructivist views of learning as having significant potential for improved science and so the understanding of science and technology education. In recent years science educators have used constructivist approach to enhance student learning (Trowbridge, Bybee & Powell 2004). A change does not involve improving the chemistry content knowledge of teachers. Rather we must assist teachers to become reflective practitioners. As far as becoming reflective practitioner in classroom, there is need for deep and complex nature in an individual. Therefore, performance is reflective of clarification of ideas or beliefs during science learning and teaching (Bidduph & Osborne 1984). This study determined the effect of teaching method employed by the teacher on chemistry achievement and motivation that is determined by the way the students' learn chemistry.

2.4 Student Motivation in Chemistry.

During teaching, teachers should encourage learners to recognize themselves as teachers who are learners. Brookfield (l990) says conceptual change should occur in teachers to encourage students to identify understanding at commencement of the course like drawing of concept maps in order to assess their own learning. Motivation is necessary at this level. As Kochhar (1992) states that without it there can be no learning and with it, learners cannot be prevented from learning. Nelson (2000) concurs with this idea when he posits that there is a relationship between motivation, cognitive engagement and conceptual change. An effective teaching approach should therefore utilize a wide variety of teaching methods to enhance learners' motivation and actively involve them in the learning process. This is the activation or energisation of a goal oriented behaviour .

Keraro,Wachanga and Orora (2007) conducted a study to investigate effects of cooperative concept mapping teaching approach on students' motivation to learn biology. Their findings indicate that CCM teaching approach significantly enhanced student motivation as students are actively engaged during the instructional process. Therefore active learning enhances motivation. Slavin (1997) asserts that motivation is an internal process that activates, guides and maintains learners' behaviour over time and will also propel and direct them to engage in learning activities Motivation can be intrinsic or extrinsic usually associated with high educational achievement and enjoyment of the student. The teacher should try to avoid situations where students might feel compelled to demonstrate their science ignorance or feel threatened. Also by allowing students to have a significant control over the direction and pace of own learning. The best approach is to build from what learners know and believe about teaching and learning (Tobin 1988).

It is seen that many students come to class lacking confidence with a range of concerns about their competence. Hence a teachers teaching science should encourage interactive approach of teaching science. A teacher should be a motivator, guider, innovator, experimenter and researcher (Osborne & Fry berg 1985), a facilitator of learning, resource person, naive fellow investigator and challenger of ideas (Bidduph & Osborne 1984).
Motivation involves forces that arouse, select, direct and sustain a behaviour (D'Amico & Schmid,1997). Hamachek (1995) wrote that although motivation cannot be observed directly, it can be inferred from behaviour called ability. Ability refers to what an individual is able to do, while motivation refers to what a person wants to do. Ability will involve in this study getting high scores in chemistry exams. Academic motivation may be seen as psychological process that determines intensity, direction and persistence of behaviour related to learning, in this context chemistry learning. *S*
If motivation is a prerequisite and co-requisite for the construction of knowledge,
then teachers should try to promote as many positive motivational beliefs as possible,
and to do this they should ideally utilize the full range of motivation strategies
that are available. The following is a summarizing list of the strategies that have been
advocated by the motivation constructs .
In order to enhance student motivation, teachers should:

1. Challenge students by setting chemistry tasks at a moderate level of difficulty so they can regularly experience success;
2. Use novel or discrepant experiences to arouse curiosity;
3. Use fantasy;
4. Increase the meaningfulness of chemistry content and tasks by relating them to the Students' lives;
5. Use a variety of different types of activities and tasks;
6. Allow students to be active participants in chemistry lessons
7. Allow students a realistic level of choice in work partners, activities and task formats especially in class experiments and projects.
8. Allow students to work individually or collaboratively in situations that do not encourage competition;

9. Provide assessment feedback, and use praise that rewards effort and improvement (These should be given privately, to avoid social comparison);

10. Model enthusiasm, thinking, dealing with errors, and dealing with challenge

11. Be supportive, reassuring, and attentive to the students.

Of course, some students may still be motivated even if teachers do not utilize these strategies. Such students may already have high individual interest or well developed learning goals. In this study the researcher tries to find out if motivation of students' to learn chemistry affects their chemistry achievement. Also, the differences exist in motivation of boys and girls when learning chemistry.

2.5 Gender Differences and Chemistry Achievement.

Certain subjects are viewed as gender related. Chemistry for example is often viewed as 'male' subject. Stereotypically male attributes are viewed as necessary for successful performance in science classes. Stereotypical gender role development may lead to low achievement in science. Dweck and Rapucci (1973) found out that boys attributed failure to school motivation, whereas girls attributed failure to lack of ability. Wachanga (2004) found out that differences existed between males and females in the domain of intellectual abilities and cognitive styles. Boys have been found to be better in the performance of science and mathematics while girls in the other hand have superior performance in languages (Keeves, 1985).

Though there are many studies, Keeves (1985) also noted that some intelligence tests seem to be favoring boys over girls. It would be interesting to find out whether the examination given by KNEC is void of such favoritism. Eshiwani (1985) in his studies confirmed that though boys performed better than girls in sciences the reason for this is because girls lacked the interest in sciences, lacked confidence in handling equipment tools and material. In the same study Eshiwani (1985) showed that women in Kenya were under-represented .These results have far reaching implications on employment on science related technical fields. He also found out that girls had an accelerated physical development which could be paralleled mentally. He further found out that adolescence occurred earlier in girls' than boys explained in hormonal and brain laterization. Brain laterization and organization explain sex difference in interllectual abilities by celebral dorminance. This study will compare the difference in chemistry achievement scores of boys and girls taught using constructivist strategy. It will also find out the difference in motivation of boys and girls to learn chemistry taught using constructivist strategy.

2.6 Constructivist Teaching - Learning Strategy

Constructivism is a theory of knowledge and knowing. (Bodner, 1986 Von Glasersfeld 1995). Its roots can be traced on the writings of Dewey, Piaget, Brunner Vygotsky. The verb ‘construct’ comes from Latin word *constru ere* which means to arrange or give structure. Ongoing structuring processes are the conceptual heart of constructivism. Kant (1940) emphasized the power of patterns of our thinking and regarded ideas as regulative principles in our experiences. The principles guiding the constructivism are:

1) Chemistry learning should start with issues that students are actively involved in trying to construct meaning.
2) Meaning requires understanding of chemistry concepts as wholes as well as parts that must be understood in the context of wholes.
3) The mental model that students perceive the world and assumptions used to support them should be understood,
4) The purpose of learning is for individuals to construct their own meaning, not just memory of the right answer or someone else meaning.

There are two major approaches applied in educational studies which are radical constructivism and social constructivism. (Steffe & Gale 1995). As radical constructivism focuses on individual meaning making process of knowledge construction, social constructivism places emphasis on shared cultural meaning-making process in social interaction of knowledge construction (Fosnot 1996). However to enhance knowledge construction, it is necessary to infuse the two in teaching practices (Black & Amnon 1992). To construct a constructivists' pedagogy, teachers must posses a sense of urgency and must be able to recognize that meaning and reality are socially constructed and capable of transformation.

Consequently, teachers are able to do so as Driver (1989) suggested, develop a pedagogy that is inclusive of both student voices and experiences and aimed at exposing, examining and reducing the constraints of traditional transmission model of pedagogy. In other words the teacher becomes a coach, analyzer and facilitator of the strategies used in the process of teaching and learning that would lead to empowering students in knowledge construction.

Therefore in construction, teachers think of not only means to know the subject matter but also how to foster the sort of understanding in students. In order to change their ‘culturally constructed ideological systems’ and become productive constructivist teachers, they need to examine their belief about knowing, teaching and learning and to reflect on their teaching practices. Fosnot, 1996) also makes claims as follows; if understanding the teaching learning process from constructivist view is itself constructed, and if teachers tend to teach as they were taught to teach, then teacher education needs to begin with traditional belief. In addition, he said that most participants need experiences as learners to confront traditional views of teaching and learning in order to enable them to construct a pedagogy that stands in contrast to older, more traditionally held views.

2.6.1 Brunner’s Constructivist Theory

Brunner(1966) states that a theory of instruction should address four major aspects. These are: predisposition toward learning, way in which a body of knowledge can be structured so that it can be readily grasped by the learner and the most effective sequence of presenting the material. In his theory, he based his study on cognition that he illustrated in the context of mathematical and social programs of young children focusing on educational constructivism, meaning he is intimately connected with experiences. Students come into classroom with their own experience; therefore the learner will reformulate his or her existing structures only if information are connected to knowledge already in the memory. The learner must actively construct new information onto existing mental framework for a meaningful learning to occur.

2.6.2 Social Constructivism

It was developed by Soviet psychologist Vygotsky and emphasized collaborative nature of learning as opposed to radical constructivism that emphasizes unshared meaning making procedures (Brunner 1971). Vygotsky argued that cognitive function is a product of social interaction and that learning is not simply assimilation and accommodation of new knowledge by learners, but also a process which learners are integrated into acknowledgeable community. Vygotsky accepts Piaget's claim that in learning learners not only respond to external stimuli but also to interpretations of those stimuli. An individual has actual development where one can solve problems independently. Potential development is where the learners are able to understand through the guidance of teachers and collaboration with peers. Social constructivist has both intrinsic and extrinsic phenomena. In the instruction process, individual learning is essential as it is related to group learning.

2. 7 Constructivist Teacher Methodologies of Creating a Constructivist Chemistry Classroom.

Becoming a constructivist teacher from a traditional manner requires a paradigm shift and willing abandonment of familiar perspectives and practices and adoption of new ones (Brooks and Brooks, 1993). According to him, the following are the characteristics of a constructivist teacher:-

1. Become one of the many resources that a chemistry student may learn from and not the primary source of in formation
2. Engage chemistry students in experiences that challenge previous conception of their existing knowledge mainly on previously covered chemistry topics.
3. Allow students responses to drive chemistry lessons and seek elaboration of student initial responses.
4. Encourage the spirit of questioning on chemistry topics by asking thoughtful open-ended questions.
5. Use cognitive terminology such as ‘classify’ ‘analyze’ and create which is framing task. These are science process skills applied in chemistry.
6. Encourage and accept student autonomy and initiative. Be willing to let go of chemistry classroom control.
7. Use raw data (observations made in chemistry experiments) and primary source along with manipulative interactive physical material.

Don't separate knowing from the process of finding out. This is because any chemistry content taught has its basis on experimental work.

2.8 Constructivist Teaching-Learning Model.

The model proposed by Driver and Oldman (1986) is shown in fig.1 below. This model illustrates the five phases; orientation, elicitation, restructuring, application and review. The phases overlap to some extent.

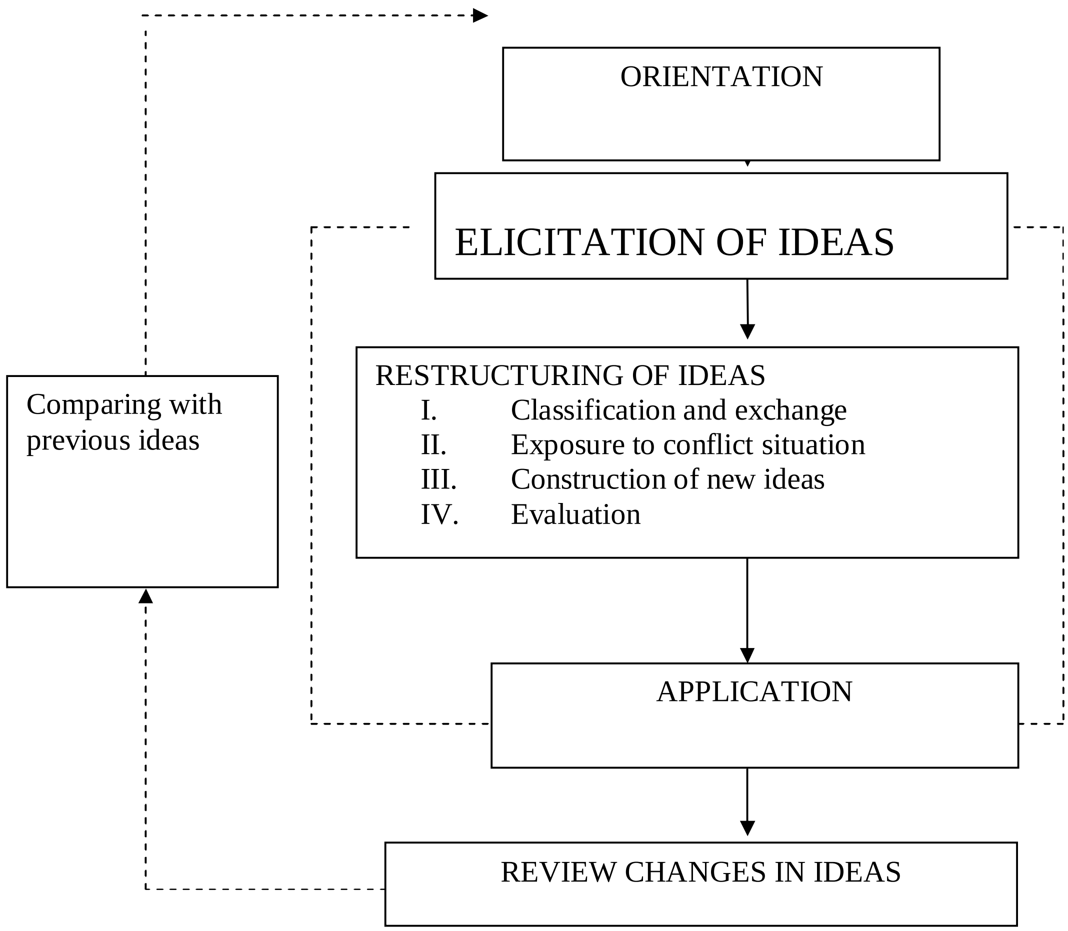

Fig.1: A Constructivist Teaching Sequence (Driver & Oldman,1986:119).

This study will be based on constructivist theory which shows five phases; Orientation, Elicitation, Restructuring, Application and Review.

Orientation phase gives learners a chance to develop a sense of purpose and motivation for learning the topic. This is an introductory phase where relevant and appropriate set of ideas are presented.

In the elicitation phase, learners express their ideas explicitly and develop awareness, which can be achieved by variety of activities like group discussion or poster making. It may also involve presence of concept to focus thinking. In this phase, the teacher probes learners' preconceived ideas about the topic to be learnt by use of open ended questions. The teacher accepts the learners' ideas for they form a basis for further discussion and activities aimed at the construction of meaning. This increases motivation. In other words provide learners with situations which challenge their existing thinking.

The restructuring phase, the teacher presents activities that will construct meaning on the topic of discussion. It is done through an experiment or models. Students' activities are conducted through discussions in collaborative groups then presented by one group to the rest of the class. The teacher acts as a facilitator in exchange of views. The phase has different aspects since learners' ideas are already out in open in the elicitation phase, clarification and exchange of ideas occurs through the discussion. In this way learners' constructed meanings and language may be reconstructed due to their exposure to conflicting situations. In this stage, students compare their ideas into the alternative and possibly conflicting news of out; exchange of views may lead to disagreement among learners. The teacher by may do an alternative method explicitly creating or promoting 'conceptual conflict through use of non-confusing demonstrations'. The conflict is also referred to as 'discrepant event' (Driver & Oldman, 1986). In this phase the learner may develop an appreciation that there can be a range of different notions to explain or describe the same concept. This is motivating mainly to the active ones. The alternative ideas and possibly scientific ones are evaluated. This may result in dissatisfaction among learners with existing conception and hence openness to change (Resnick 1988,Lord 1994).

In the application phase learners use their restructured ideas in different situations by applying the constructed knowledge in new context. The teacher can explain new ideas using relevant examples. Hence, the new conceptions are integrated and reinforced by extending the context within which they are used.

In the review phase learners are encouraged to look back to their own ideas developed by making comparisons between thinking now and at the start of the lesson. Learners in small groups will negotiate meaning on particular concepts effectively.

In the current study the researcher will find out the effects of constructivist teaching strategy on chemistry achievement and motivation of boys and girls.

2. 9 Research on Conventional Teaching Methods Currently used in Chemistry Classrooms.

Conventional teaching methods view a teacher as a sole information giver. They are the most frequently used methods though they appear outdated. This method helps the learners feel less isolated and nervous through the knowledge that other learners have the same worries as themselves which help to develop group reliance (Okere,1996). On a study in a large lecture hall setting, it was found that only twenty percent of the students retained what the instructor discussed after the lecture. Furthermore, there was an emphasis on learning of answers more than exploration questions, memory at the expense of critical thought, bits and pieces of information instead of understanding in context, recitation over argument and reading over lieu of doing. The conventional methods are like lecture, talk-chalk, discussion and question-answer. Out of these methods, the learners cannot apply what they learn in school into various and unpredictable situations that they may encounter over the course of their work lives. However these methods have failed to produce a change in classroom from teacher-dominated to student-centered. An alternative is the use of constructivist approach.

The need for research in this area was realized. Bruner (1983) state that the school classroom is the prime place to teach students to be competitive and that classrooms share two common aspects; the teaching method used encourages competition among students, and the ultimate goal is to win the attention of the teacher. When students are taught through the traditional competitive methods, they learn three things:

1. That the teacher is expert in the classroom.
2. That there is only one correct answer to the teacher's question.

3. That rewards come from pleasing the teacher.

The commonly used conventional methods include:-

2.9.1. Demonstration Method

This is a common method in teaching Chemistry amongst secondary schools in Nandi North, Its popularity is due to the fact that the students are able to observe experiments as they are performed by the teacher or another student. It allows the teacher to do what he or she is best at. Focus in this method is teacher preparedness to accomplish teaching task but not the learners accomplishing the learning content. The major problem associated with demonstration is tendency of students becoming passive and the possibility of learners missing out the chance to practice manipulative skills.

2.9.2 Class Experiment

This involves the students performing laboratory experiments on what has been learnt. As the learners perform the experiments they acquire science process skills hence promoting positive attitude and motivation due to activity of pupils towards Chemistry (Okere 1996). The only limitation is the availability of apparatus for all the students and lack of proper planning can lead to unworkable experiments that can demoralize the learners. Even though students sit for practical chemistry exams, research shows that there is no substantive relationship between practical skills and written science examination (Al Busaidi,1992).

2.9.3. Project Work-

This method came up from the need to understand the environment. The objective is only achieved by having pupils work on real life problem and they work in groups. Due to heavy teaching load, lack of time inadequate resource and large class sizes it becomes difficult for teachers to initiate project work. Research shows that it takes fifty percent of the study time and can allow investigation of more complex and extensive problems (Mbuthia 1996)

2.9.4. Discussion Method

This is a non-directive teaching that removes the teacher from his usual role as information disperses information provides a limit setter. Students are more likely to reflect and on their responses if they share in small groups or with dialogue (Appleman, 1991). Teacher-led discussion tends to make more one tolerant, broad-minded and encourages good listening. The teacher presents objective, explains the learning activity, demonstrates it and invite questions from the students before concluding the teaching activity (Mukwo & Jowi 1986). Despite the fact that discussions provide verbal interchange between students and the teacher, a great deal of participation on the part of the student is passive (Ayot &Patel,1987; Mbuthia , 1996).

2.9.5 Lecture Method

It is an oral presentation of organized thoughts and ideas by a speaker. The teacher manages to cover a wide content within a short time and present information in a logical order among other merits (Okere , 1996). According to Ayot & Patel (1987) it is the most dominant and is liked by majority of the teachers. The focus is the teacher presenting as much content as possible in an orderly way. However lecture method has several limitations which include inability of some students to listen for along time and poor comprehension. In addition, the material to be covered in a lecture may be given in form of handouts. According to Twoli, (2006) lecture method is not appropriate for most secondary school students. Another limitation is that teachers using the method are often not aware of the amount of information that can be absorbed in a given period of time. Therefore, students often get bored of listening to and watching the same person (Mbuthia,1996) . Definitely, the crucial elements of students' active involvement in learning are absent and hence there is a likelihood of most students becoming inattentive (Ayot & Patel,1987)

2.9.6. Discovery Learning Approach

This is an old time method that was used by a Greek philosopher Socrates who taught by questioning the environment. He refused to give answers to the questions which made the learners seek answers through discoveries. In discovery learning the teacher gives specific examples and the students work on them until they discover interrelationships and thus the subject structure. According to Brunner in Anderson and Ausubel (1996) discovery learning is based on four major principles namely: motivation, structure, sequence and reinforcement. The limitations of this method include assigning minimum role to the teacher that may be abused by inexperienced and lazy teachers.

The other limitation currently is the question that most students ask about why discover and the information is in the textbooks as well as whatever it is examined.

The more advanced method of this type has been discovered which called guided discovery approach.

2.9.7 Co-operative Learning

In this method, students' work in groups of four to six and receives reward based on group rather than individual performance. In competitive classrooms students engage in a win-lose struggle in an effort to determine who is the best (Johnson & Johnson, 1991).It is mainly applied in class-experiments and may not work well in topics which have abstract concepts (Wachanga 2004). The current study aims at addressing the above challenges.

In this study the researcher will use the conventional methods as control condition to teach Group II and Group IV.

2.10 Topic 'Effects of Electric Current on Substances'

Topic 'Effects of electric current on substances' is a form two fifth topic which does not have much content. It forms the basis of the topic 'Electrochemistry' in form four. The two topics are extremely unpopular to students as pointed out in the item of KCSE 2006 (KNEC 2007).It is usually abstract especially the quantitative part and teachers usually find it demanding to set experiments and therefore end up teaching the abstract content theoretically. This may lead to low motivation hence poor achievement. A better understanding of this topic will also help in understanding of other related topics like Electrochemistry, Structure and bonding and chemical families. In this study, the topic 'Effects of Electric current on Substances' has been chosen to be taught during the treatment period, using constructivist strategy for the experimental groups and conventional methods for the control groups.

2. 11 Theoretical Framework

The current study is designed to focus on constructivist theory which is based on constructivist view of learning where learners try to use what they already know to construct meaning of new experiences (Driver 1989).

Constructivist teaching strategy according to Driver (1986) shows that learning process takes place in a sequential manner. It has many models on the approach, theories (Psychological) teacher's role and the feedback among others . The present study is designed to focus on the model by Driver and Oldham (1986) highlighting the role of the teacher and the learners in the learning process and assesses its impact on students' chemistry achievement and motivation after teaching using the method .The students are placed in small interactive groups that negotiate meanings of concepts captured in the topic 'Effects of Electric current on Substances'. This is captured in the teaching sequence seen in the constructivist model as seen earlier.

2.12 Conceptual Framework.

The conceptual framework to be used to guide this study is based on constructivist theory. This study is based on Driver and Oldham model (1989) highlighting the role of the teacher in teaching and learning process as a facilitator and feedback which is seen in chemistry achievement motivation. The construction of new knowledge which teaching and learning is done in an interactive environment. The interactions will depend mainly on prior learning of the subject and readiness of the learner. The system also borrows the systems s theory presented by Joyce and Weil (1980). It holds that teaching –learning is a dynamic process that inputs and outputs. The inputs involve the teaching process and the output is the feedback in form of achievement and motivation.

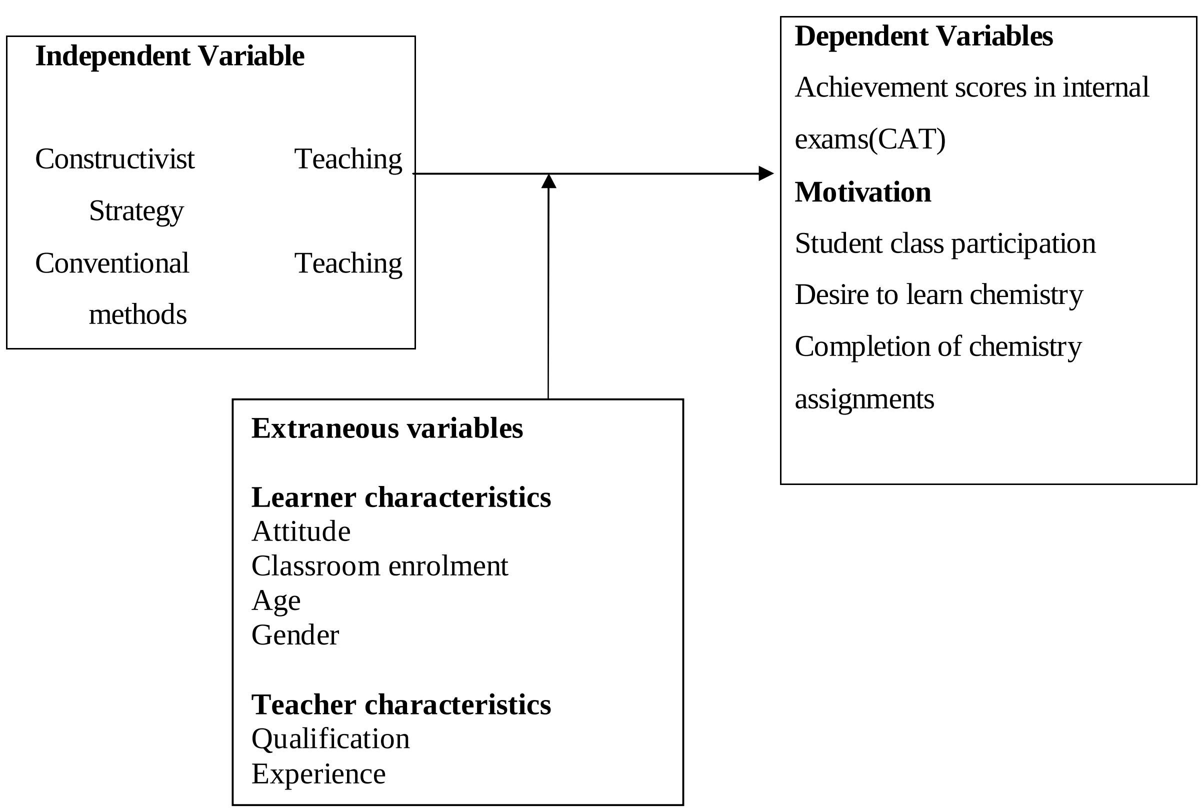

Figure 2: Conceptual Framework for determining the effect of

constructivist teaching strategy according to , Joyce and Weil (1980), Wachanga (2004)

***Source*:** Adopted from Wachanga (2004).

The dependent variables are pupils' achievement and motivation in chemistry. The independent Variables are constructivist teaching strategy and conventional teaching methods. The intervening variables are controlled by having degree or diploma teachers who have taught for at least three years. The schools are mixed so as to ensure that both boys and girls students are involved control gender variation. The age of the student is controlled by taking Form Two students who are assumed to be of the same age. The gender of the teacher is controlled by ensuring the teachers involved are all male and female using purposive sampling.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction.

This chapter contains the design and methodology to be used for the study. The research design, target population, sampling procedures and technique, research instruments, data collection procedures, validity and reliability of the research instruments. It ends with summary of statistical procedures.

3. 2 Research Design

This was a quantitative study involving Quasi-experimental research design where Solomon Four Non-equivalent Control Group design was adopted. This is a form of pre-test –post-test non-random control group design (Changeiywo & Wambugu, 2008). The design eliminated variations that may arise due to different experiments that contaminate internal validity of the study (Ogunninyi, 1992, Kiboss 2000). Furthermore, it is appropriate because the study was conducted in District co-educational schools in which classes are already established and was be possible to reorganize in order to employ randomization procedures (Koul l993, Borg 1987). In this study, instrumentation and selection as threats of internal validity will be controlled by ensuring the conditions under which instruments are administered are similar. The schools were randomly assigned to control and treatment groups to control selection, and maturation interaction (Aryl, Jacobs & Razavich ,1992).

It involves four groups of Form Two classes illustrated as follows:-

Group I(E1)	O_1	x	O_2
Group II(C1)	O_3	–	O_4
Group III(E2)		x	O_5
Group IV(C2)		–	O_6

Source: Fraenkel and Wallen (2000 p.291) , Changeiywo and Wambugu (2008).

Figure 3: Solomon Four Non-equivalent Control Group Research Design.

Where O_1 and O_3 are pre-tests, O_2, O_4, O_5 and O_6 are post-tests; X is the treatment where students' will be taught using constructivist strategy.

Group I (E1) is an experimental group which received pre-test, treatment X and post-test.

Group II (C1) administers a pre-test control conditions and then the post-test.

Group III (E2) did not administer a pre-test, but got treatment and post-test.

Group IV (C2) only administered a post-test. Group1 and III was taught using constructivist strategy while Group II and IV will be taught using conventional methods.

3.3 Study Location

The proposed study was carried out in four district co-educational schools in Nandi North District. It is one of the seventeen districts in the Rift Valley province and shares borders with four other districts, Nandi South to the East, Vihiga to the South, Lugari to the West and Uasin-Gishu to the North. The District has got a variety of schools of district status, provincial public and private with no national school.

3.4 Population of the Study.

The target population consisted of all Form Two students in Nandi North District while the accessible population consists of all Form Two students in the district co-educational public secondary schools. This quasi- experimental study was adopted on secondary schools in public category. A total of thirty two secondary schools are there in the district with fourteen of provincial category, eighteen of district category but no national school. The research also included chemistry teachers from the schools chosen. Chemistry achievement in the district has been generally low hence few students enroll for science related courses in higher institutions.

3.5 Sampling Procedures and Sample Size

The sampling frame composed of one-twenty Form Two students and four teachers from public co-educational schools in Nandi North District. Purposive sampling was used to identify schools based on availability of learning resources. List of identified schools were obtained from Kapsabet District Education office. Numerals were assigned to the district co-educational schools then picked randomly from a container in order to assign the control and experimental groups to the identified groups. In case of multiple form two classes from a single school, simple random sampling was used to identify the class to participate.

3.6 Instrumentation

The study made use of two instruments namely; chemistry achievement test (CAT)-Appendix and Student motivation questionnaire (SMQ) Appendix 11. CAT was constructed by the researcher from sources like KIE 1992, KLB 1987, KLB 2009 Wamae and Njeru 1989 then moderated by the chemistry teachers then validated by the experts in science education. The SMQ was adopted from various sources like Githua 2000 and Wachanga, 2004 then modified by the researcher.

3.6.1 Student Motivation Questionnaire (SMQ)

The students' Motivation Questionnaire (SMQ) was used to collect data. The questionnaire has a total of twenty six items constructed on five point likert scale. The items were based on the topic 'Effects of Electric current on Substances'. The items aim at assessing the students' level of motivation to learn chemistry using constructivist teaching strategy and conventional teaching methods.

The (SMQ) instrument was pilot tested in a secondary school in Nandi North district but not included in the study though having similar structures as the sampled schools. Validation was done by at least three university science educators from the department Curriculum Instruction and Educational Management and two experienced teachers.

3.6.2 Reliability of the Instruments

The chemistry achievement test (CAT) were pilot tested on independent group of form two students in Nandi North district to ascertain its reliability. The reliability co-efficient is calculated using Kuder-Richardson formula 21 (KR-21) (Gronlund ,1988). This is because the items were scored zero(0) for any wrong responses and one(1) for correct responses. This formula determined the reliability of the instrument in a single administration as 0.7396. The Cronbach's co-efficient alpha was used to estimate reliability co-efficient of SMQ which was found as 0.7162. This is because motivation is measured using Likert scale which gives a range of marks. A reliability co-efficient of 0.70 and above is recommended for consistency levels. The reliability co-efficient should be more than 0.70 which acceptable value for any study (Fraenkel & Warren 2000).

3.6.3 The Construction and Use of Instructional Materials.

The researcher developed lesson plans for teaching twelve lessons for teachers of the experimental groups. The teachers were inducted on the use of constructivist teaching strategy before the intervention period. A pre-test was administered to groups E1 and C1. This was followed by intervention period for three weeks. At the end of the intervention period, a post-test was administered to all the four groups.

3.7 Data Collection Procedures

The researcher got an introductory letter for research from Egerton University and took to NACOSTI and henceforth seek permission from the ministry of education and district education office Nandi North to carry out the research. Consequently, the researcher got in touch with the school administrators who will introduce her to the chemistry teachers. In this study SMQ was used to collect data. The researcher administered the instrument with the assistance of chemistry teachers in the respective schools. Groups E1 and C1 were given the pre-test before the start of the treatment. The treatment took three weeks. After the treatment, the researcher with the assistance of chemistry teachers from the sampled groups administered post–test to all groups. The content to be used in this research was based on the revised chemistry syllabus (KIE, 2005). A guiding manual based on this syllabus was constructed for teachers from the experimental groups E1 and E2. These teachers were trained by the researcher on how to use the manual. These teachers taught using the approach on a different topic other than ‘Effects of electric current on substances’, like ‘Salts’ to enable them master the skill. In this study CAT was used collect data on student achievement in chemistry while SMQ collected data on students’ motivation.

3.8 Data Analysis

Data was analyzed using descriptive and inferential statistics. Descriptive statistics includes the mean, frequencies, percentages and standard deviations used to describe the summarized raw data. The four hypotheses were analyzed using one-way, ANOVA, ANCOVA and t-test. ANOVA was used to determine if the four groups differed significantly among themselves on experimental variables at alpha level of 0.05. ANCOVA was used to cater for initial differences among groups by using the KCPE mark as a covariate. A t-test was used to test differences between the pre-test mean scores because of its superior quality in detecting differences between two groups (Gall, Borg & Gall, 1996).

Table 3

Summary of Data Analysis

Hypothesis	**Independent variables**	**Dependent variables**	**Statistical tools**
H_O1: There is no statistically significant difference between achievement scores of students who are taught using constructivist approach and those who are not taught through it.	Constructivist strategy Conventional methods	CAT scores students achievement	ANOVA and ANCOVA Descriptive statistics
H_O2: There is no statistically significant difference between motivation of students taught using constructivist strategy and those not taught through it.	Conventional methods, constructivist strategy	SMQ Students' motivation to learn chemistry	ANOVA ANCOVA Descriptive statistics
H_O3: There is no statistically significant difference between achievement scores of boys and girls taught using constructivist teaching strategy.	Gender	CAT score students' achievement	T-Test ANCOVA Descriptive statistics
H_O4:There is no statistically significant difference between Motivation of boys and girls taught using constructivist.	Gender	SMQ students' motivation	T-Test ANCOVA Descriptive statistics

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, the research data obtained is presented using both descriptive and inferential statistics. Results of every hypotheses tested has been presented and discussed elaborately. In addition, the contents of the findings are presented in the form of tables and their implications discussed afterwards.

4.2 Characteristics of the Sample

The population of the study is all form two students the district and the sample size of the study was four co-educational schools. The accessible population is form two students and four chemistry teachers. The average age of students is 15 years of age which is a true reflection of form two Kenyan secondary school.

Table 4

Distribution of students sample by learning method.

Group	**number**	**percentage%**
C1	48	36.9
E1	47	36.15
C2	19	14.61
E2	16	12.31

From Table 4 the average size of the groups is about thirty two hence a true reflection of the population.C2 and E2 had smaller samples based on the catchment area coupled by absenteeism due fee payments and school activities like games.

The following hypotheses were tested in this study:-

H_O1: There is no statistically significant difference between achievement scores of students who are taught using constructivist strategy and those taught using conventional methods

H_O2: There is no statistically significant difference between motivation in chemistry of students who are taught using constructivist teaching strategy and those taught using conventional methods.

H_O3: There is no statistically significant difference between achievement scores of boys and girls taught using constructivist teaching strategy

H_O4 : There is no statistically significant difference between motivation scores of boys and girls taught using constructivist teaching strategy.

The Solomon four-group design used in this study enabled the researcher have two Groups sit for pre-tests as recommended by Borg and Gall (1989). This enabled the researcher to assess the effect of pre-test relative to no pre-test and assess if there was an interaction between the pre-test and the treatment conditions. The findings starts with pre-test analysis by learning method followed by pre-test analysis by gender.

4.3. The Pre-test Analysis

The main reason for conducting a pre-test is to check whether the groups were similar before exposing them to the treatment.

Pre-test analysis was done by using the learning method and by use of gender. Table 5 shows the pre-test analysis of CAT and SMQ by learning method of groups C1 and E1.

Table 5.
Comparison of pre-test mean scores of C1 and E1 groups on CAT and SMQ by learning method.

Test	group	N	mean	SD	df	t-value	p-value
CAT	C1	48	60.00	9.84	92	9.023	0.000*
	E1	46	41.09	10.48			
SMQ	C1	44	3.56	0.58	81	0.902	0.370
	E1	39	3.45	0.50			

Table 5 shows the results of pre-test scores on CAT $t(92)=9.02$ $p<0.05$ hence for groups E1 and

C1 showed a statistically significant difference with p-value =0.000 hence < 0.05. This indicated that the groups used in the study did not exhibit comparable characteristics. The differences in CAT could be due to variation in teaching resources among schools. Measures were put in place to make the groups suitable for study when comparing the effect of constructivist teaching strategy with the use of conventional methods on achievement in chemistry.

Pre-test analysis on SMQ by learning method showed that t(81) =0.02, p>0.05. The differences were not significant at p-value =0.370 hence greater than 0.05. This indicated that the differences between C1 and E1 groups were not significant in terms of motivation .

The pre-test analysis on CAT and SMQ by learning method was done using t-test.

Table 6 shows pre-test analysis by gender.

Table 6

Pre-test analysis of CAT and SMQ by gender

Test	Gender	N	x	SD	df	t-value	p-value
CAT	Male	66	50.98	13.19	92	0.256	0.798
	Female	28	50.18	15.60			
SMQ	Male	55	3.49	0.54	80	0.021	0.983
	Female	27	3.39	0.61			

The results t(92) =0.256 p>0.05 of pre-test scores on CAT by gender for male and female showed there is no statistically significant difference. Also the pre-test scores results t(80) =0.021 p>0.05 on SMQ by gender for male and female is not significant. Their differences were not significant and exhibited comparable characteristics suitable for the study.

4.4. Effects of Constructivist Teaching Strategy on Students' Chemistry Achievement - CAT

Effect of treatment on CAT has been determined using mean gain analysis and post-test analysis. Table 7 shows the mean gain analysis.

Table 7

Mean gain analysis.

Learning method	N	post-test X	pre-test X	mean gain	df	t-value	p-value
C1	48	76.77	60.00	16.77	92	2.789	0.006*
E1	47	65.21	41.09	24.35			

*t(92) = 2.789 $p<0.05$

The results $t(92)=2.789$ $p<0.05$ showed that there was a significant mean gain in favour of E1 group. The higher pre-test mean seen in the C1 could be associated to differences in school's learning resources, teachers' number and varied schools' reading culture. .However this does not show whether the differences among other groups were significant hence there is need for post-test analysis.

4.4.1: Post-test Analysis of CAT

The post-test analysis was done through ANCOVA and ANOVA.

Table 8 shows the post-test mean score for CAT at a maximum of 100 marks obtained by students in the four groups

Table 8

Descriptive of CAT mean scores and standard deviation by Learning method

Group	N	Mean	SD
C1	48	76.77	9.97
E1	47	65.21	2.31
C2	19	54.21	11.34
E2	16	62.19	15.19

The data in table 8 shows that C1 had the highest mean (M=76.77,SD=9.97)scores followed by E1 (M=65.21, SD=2.31). This shows that control groups had better results than experimental groups. To check whether there are differences among the groups, ANOVA test was done. Table 9 shows comparison of post-test scores among groups by use of ANOVA.

Table 9

Analysis of Variance(ANOVA) on Post-test CAT Mean scores

Scale	SS	df	Ms	F-ratio	p-value
Between Groups .	8178.553	3	2726 .184	15.519	0.000*
Among Groups	22133.947	126	175.666		
Total	30312.500	129			

*($p <0.05$, df =3, F = 15.519)

Table 9 shows the results of ANOVA post-test scores on CAT. The table shows that there was a statistically significant difference between groups $F(3,126)=15.519$, $p<0.05$. This means that F factor is significant at $p<0.005$ and between squares is statistically significantly greater than within means square. This shows that there is a highly significant overall treatment effect. This means that, the null hypothesis will be rejected which states that there is no statistically significant difference between achievement scores of students who are taught using constructivist strategy and those taught using conventional methods. It can also concluded that there is probably at least one significant difference among possible comparisons of two means in the four groups. There was therefore need to find out where this experimental effect was located This made it necessary to carry out scheffe's (multiple comparison) test of significance for a difference between two means to reveal where the difference is.

Table 10

Post-hoc : Scheffe's Multiple comparison of the CAT post-test means.

	I Group	J Group	Mean difference(I-J)	P-Value
Scheffe's	E1	C1	-11.56	0.001*
		E2	3.03	0.891
		C2	11.00	0.029*
	C1	E2	14.56	0.003*
		C2	22.56	0.000*
	E2	C2	7.98	0.374

*p<0.05 represent a statistical significant difference.

Table 10 shows the results of scheffe's test of significance for a difference between any two means. The results show that pairs of CAT means of groups E1 and C1, groups E1 and C2, groups C1 and E2, groups C1 and C2 showed statistically significant difference. While groups E1 and E2 and groups E2 and C2 were not statistically significant difference at the 0.05 α-level. C1 and C2 showed significant difference associated with teaching resources like the CDF funded schools have more apparatus or teacher characteristics. C2 and E2 did not show any significant difference which could be associated with the CTS implementation time having taken 11 lessons, three weeks which is a shorter time. The effectiveness of the training of teachers on the new strategy whereby some teachers might not have internalised the process properly. This study involved non-equivalent control group design and there was therefore need to confirm the results by performing analysis of covariance (ANCOVA) using the students' Kenya Certificate of Primary Education (KCPE) scores as covariate.

Table 11

Descriptives after adjustment with the KCPE covariate

Group	mean
C1	69.39
E1	71.39
C2	54.85
E2	65.44

ANOVA did not have features to adjust initial differences at the entry point .Therefore ANCOVA of CAT post-test by learning method was done.

Table 12

Analysis of co-variance (ANCOVA) of post-test scores with KCPE as a covariate

	Ss	df	ms	f-ratio	p-value
Contrast	3384.494	3	1328.165	8.998	0.000*
Error	18451.497	125	147.612		

*(F=8.998, df=3, p<0.05**)**

Table 12 shows that there is statistically significant difference in the CAT scores of the four groups F (3,125) = 8.998 , p<0.05). This confirms that the differences between the means are statistically significant at 0.05 α-level. And therefore the differences were as a result of treatment effect since all conditions were the same except the learning method.

However, the results do not reveal where the differences are. Therefore it is necessary to use multiple comparisons (scheffe's). Table 13 shows ANCOVA post-hoc.

Table 13

ANCOVA post-hoc

Group	Mean difference	p-value
E1-C1	1.999	0.5789
E1-E2	5.947	0.098
E1-C2	-16.535	0.00*
C1-E2	3.951	0.337
C1-C2	14.539	0.00*
E2-C2	10.588	0.012*

*p< 0.05 represent statistical significant difference

Results from the Table 13 showed that groups E1 and C1, E1 and E2 and groups C1and E2 did not show any significant difference. However groups E2 and C2,E1 and C2 and groups C1and C2 showed a significant difference.

4.5. Effect of Constructivist Teaching Strategy on Students' Motivation Towards Learning Chemistry.

The effect constructivist teaching strategy on students motivation towards chemistry was ascertained through mean gain analysis and post-test analysis was done using ANOVA . The results are presented using both descriptive and inferential statistics .

Data on motivation was collected by use of SMQ.

Table 14
Mean gain analysis.

Learning method	N	post-test x□	pre-test x□	mean gain	df	t-value	p-value
Control 1	44	3.65	3.56	0.09	81	1.081	0.286
Experimental 1	39	3.74	3.45	0.29			

*t(81) = 1.081,p>0.05

The perusal of the results presented in Table 14 indicates that the mean scores obtained by students in the experimental and control groups on SMQ were almost identical. But after the exposure to constructivist teaching strategy, there is a remarkable mean gain of 0.29 made by experimental group which is higher than that of control group of 0.09.The results in Table15 show that the difference in mean scores of E1 and C1 was not significant (df=81,t-value=1.081 and p-value=0.286) at 0.05 level. This means the two groups were similar at the start of the programme. However comparing these results as it may not be sufficient to tell whether the subject mean differences are not statistically significant at α=0.05 level. Table 15 results show s the mean and standard deviation of SMQ post-test.

Table 15
Means and Standard Deviation of SMQ Post-Test

Group	N	mean	Standard deviation
E1	39	3.74	0.58
C1	44	3.65	0.79
E2	17	4.09	0.39
C2	16	3.93	0.49

From Table 15, E2 had the highest mean followed by E1, C2 and C1 respectively. The results in Table 15 did not reveal whether the differences were significant. It was then necessary to carry out ANOVA test.

Table 16
SMQ post-test analysis using ANOVA

Scale	ss	df	ms	F	p-value
Between group	2.809	3	0.936	2.33	0.078
Among groups	44.939	112	0.401		
Total	47.747	115			

*F(3,112)=2.33, p>0.05

The results in Table 16 show that the differences were not significant at the 0.05 level. However, the results do not reveal where the differences could be. It was necessary to carry out the multiple comparison analysis.

Table 17
Multiple comparison of SMQ post-test means by learning approach (ANOVA post-hoc)

Group	mean difference	p-value
E1-C1	0.094	0.928
E1-E2	-0.345	0.323
E1-C2	-0.11	0.793
C1-E2	-0.439	0.122
C1-C2	-0.285	0.499
E2-C2	0.154	0.921

*p<0.05 represents statistical significant difference

The results from Table 17 show that there was no statistically significant difference between the groups.

ANOVA test from the results from Table 16 reveals that the F (3,115=2.33 >P>0.05 is not statistically significant in favour of experimental group. This therefore suggests that the mean gain differences are not statistically significant. This is a clear indication that the use of constructivist teaching strategy did not influence the subject's motivation positively. Therefore the hypothesis suggesting that there is no statistically significant difference between motivation of students taught using constructivist teaching strategy and those not taught using the method has therefore been accepted. However the results were not conclusive as the entry behaviour of E2 was not determined as it was not pre-tested. This necessitated reanalysing the post-test mean scores using the ANCOVA with KCPE scores as a covariate. The adjusted mean scores are shown in Table 18 .

Table 18

Adjusted SMQ post-test mean scores

Group	mean	Std Error
E1	3.645	0.120
C1	3.760	0.121
E2	4.023	0.159
C2	3.927	0.158

The adjusted mean score of E2 was the highest followed by C2, C1 and E1 respectively. The results did not reveal whether the differences were significant or not. This was determined using ANCOVA test.

Table 19 shows SMQ post-test mean scores analysis using ANCOVA.

Table 19

SMQ post-test mean scores using ANCOVA

	Ss	df	ms	F	sig
Contrast	2.070	3	0.690	1.739	0.163
Error	44.052	111	0.397		

*F(3,111) =1.74, p>0.05

The results F(3,111) = 1.74, P > 0.05 from Table 19 reveal that the mean differences were not significant at 0.05 level ,P=0.163. The null hypothesis that says there is no statistically significant difference between motivation of students taught using constructivist strategy and those taught using conventional methods is accepted. Therefore the motivation of students taught using conventional methods is more positive than those exposed to constructivist teaching strategy. Table 20 shows ANCOVA post-hoc

Table 20

ANCOVA Post-hoc

Group	mean difference	p-value
E1-C1	-0.116	0.559
E1-E2	-0.378	0.043*
E1-C2	-0.283	0.154
E2-C1	0.263	0.226
C2-C1	0.167	0.406
C2-E2	0.095	0.669

*$p<0.05$ represents a statistical significant difference

The significant difference between group E1 and E2 could be associated with implementation of constructivist teaching strategy. The variation could be brought about by teacher differences in understanding of the CTS during training or understanding of the manual. The difference also could be due to equipping of the chemistry laboratories.

4.6 Comparison of achievement scores of boys and girls taught using constructivist strategy

Generally the female students enrolment in the co-educational classes is lower than male enrolment.

The comparison of boys and girls achievement scores was done by using gain analysis and post-test analysis. Table 21 shows gain analysis by gender on CAT.

Table 21
Gain Analysis by Gender on CAT-Gain difference

Group	Gender	post-test	pre-test	mean gain	df	t-value	p-value
C1	Male	75.14	59.43	15.71	46	-1.086	0.283
	Female	81.15	61.54	16.61			
E1	Male	62.66	41.45	21.45	44	-1.931	0.060
	Female	70.67	40.33	30.33			
Overall	Male	69.18	50.98	18.41	92	-2.311	0.0234*
	Female	75.54	50.14	25.36			

*t(92) =--2.311 , p>0.05

The data from Table 21 indicates that the female students had a higher mean gain than the male students although the difference was significant since P>0.05.Therefore the gain difference was significant at p=0.0234. There was need to carry out post-test analysis.

Table 22 shows post-test analysis by gender on CAT.

Table 22
Post-test analysis by Gender on CAT

Group	Gender	N	X	SD	df	t-value	p-value
C1	Male	35	75.14	8.70	46	-1.907	0.063
	Female	13	81.15	12.10			
E1	Male	32	62.66	15.66	45	-1.645	0.107
	Female	15	70.67	15.34			
C2	Male	10	52.50	12.08	17	-0.683	0.508
	Female	9	56.11	10.83			
E2	Male	9	61.11	15.37	14	-0.307	0.764
	Female	7	63.57	16.76			
Overall	Male	86	66.40	14.83	128	-1.15	0.252
	Female	44	69.66	16.23			

*t(128) = -1.15 ,p>0.05

The data from Table 22 shows that the female students had a higher overall mean than the male students although the difference was not significant at 0.05 level. Therefore the null hypothesis that states that there is no statistically significant difference between achievement scores of boys and girls taught using constructivist teaching strategy is accepted. The achievement scores of boys and girls taught using conventional methods are different. From Eshiwani (1985) in his earlier studies, confirmed that boys perform better in sciences than girls but using constructivist teaching strategy there is no difference.

4.7: Differences in motivation of boys and girls taught using constructivist teaching strategy

These differences were determined using gender analysis on SMQ and post-test analysis on SMQ. Table 23 shows gender analysis on SMQ.

Table 23

Gender analysis on SMQ

Group	gender	N	post-test	pre-test	mean gain	df	t-value	p-value
C1	Male	32	3.54	3.58	-0.04	41	-1.150	0.257
	Female	11	3.85	3.49	0.35			
E1	Male	21	3.78	3.36	0.42	33	1.58	0.141
	Female	14	3.71	3.65	0.06			
Overall	Male	53	3.64	3.49	0.14	76	-0.225	0.823
	Female	25	3.77	3.58	0.19			

*$t(76)= 0.225$ $p>0.05$

The data in Table 23 indicates that the female students were fewer than the male students. The difference between the two groups is not statistically significant $t(76)=-0.225$, $p>0.05$. The level of motivation of both male and female students went up although the differences were not significant.

Table 24

Post-test analysis by gender on SMQ

Group	Gender	N	x	SD	df	t-value	p-value
C1	Male	32	3.55	0.74	41	-1.102	0.277
	Female	11	3.85	0.87			
E1	Male	21	3.78	0.63	33	0.296	0.769
	Female	14	3.71	0.56			
C2	Male	6	3.98	0.41	12	0.156	0.879
	Female	8	3.94	0.55			
E2	Male	8	4.28	0.37	15	2.181	0.045*
	Female	9	3.91	0.34			
Overall	Male	67	3.75	0.68	107	-0.692	0.491
	Female	42	3.83	0.61			

*t(107) =0.692,p>0.05

The data from Table 24 indicates that E2 group showed significant difference between male and female students on SMQ (p<0.045).The overall difference is not significant. The null hypothesis which states that there is no statistically significant difference between motivation of boys and girls taught using constructivist strategy is accepted.

4.8 Discussion of The Results

4.8.1 Effects of Constructivist Teaching Strategy on Chemistry Achievement

The reseacher found out that the students who were taught using CTS achieved significantly higher scores than those taught using conventional methods. According to Agulana and Nwachukwu (2004) constructivist teaching strategy focuses on meaning – making and knowledge construction and mere memorization. In this approach learners learn by personally and uniquely developing an understanding and making sense of information. Constructivist teaching strategy focuses on problem solving , constructing and reconstructing ideas and methods (Etuk &Etuk 2011). Most learners understand easily by doing as it simplifies the content for better understanding. Etuk and Afangide (2008) called constructivist strategy an experiental approach. The strategy subsumed under this model involve learners as active participants in the learning process.

Attention has therefore shifted from subject content to the method used in imparting the knowledge especially in chemistry which is viewed by most learners as difficult. Okere M.O (1996) says that constructivist strategy simplifies content that proves difficult to students. In this study it was clearly seen since achievement scores went up compared to the initial scores.

The use of the teaching strategy therefore enabled learners to be active cognitively and hence be in a position to grasp chemistry concepts. Kithaka (2004) working for strengthening of science and mathematics in secondary Education (SMASSE) project in Kenya argued that there is a general feeling among students that science subjects are difficult. This feeling according to Kithaka is as a result of poor performance at national examinations, where negative outcomes inhibits learning efforts; saturation of job market which discourage students; socio-cultural attitude and too much theoretical teaching of sciences. The use of constructivist teaching strategy has proved interesting and stimulates critical thinking and hence better understanding of scientific concepts leading to improved achievement.

4.8.2 Effect of Constructivist Strategy On Students Motivation To Learn Chemistry

The findings of this study have shown that constructivist teaching strategy does not have any effect on motivation of students to learn chemistry.

According to constructivist theory, learning is an active process requiring effort, so students need to be motivated to make that effort. In a constructivist classroom, teachers should therefore aim to arouse students and maintain their motivation at optimum levels throughout the learning process. However, motivation by itself only means that students are willing to engage in learning - it does not ensure that they will develop scientifically acceptable knowledge structures (Pintrich et al., 1993).

A study by Solomon (1986) on motivation showed that active involvement of learners enhances their understanding of new situations. In this study, C.T.S did not capture students interest to learn chemistry. Anxiety levels appears to be a particularly important consideration for science students, many of whom have been found to be acutely affected by anxiety, particularly in chemistry courses (Udo, Ramsey, Reynolds-Alpert, & Mallow,2001). Anxiety inhibits motivation. This could have been brought about by the new teaching strategy. To reduce this problem, teachers should create supportive and pleasant classroom atmospheres, for example by "smiling, empathetic listening, voice moderation, frequent use of student's name, appropriate and reassuring facial gestures, affirmative head nodding, and general attentiveness" (McCabe, 2003). If these features were not used by the teachers involved or were used inappropriately affects student motivation negatively. Furthermore, considering the time that the study only took two weeks was not enough to bring about motivational change using these features.

Davis (1997) reported that, although their students "sometimes showed clear signs of being exhilarated by open-ended classroom debates, at other times they were frustrated when the teacher would not simply tell them the right answer or when they had to wrestle with a conceptual confusion. Thus, if students are expected to develop the scientific view themselves, but are unable to do so, then there is the potential for a learning failure rather than a learning success, and motivation could be inhibited. Considering the definition of the study having the teachers' main role is to replace the pre-existing ideas.

4.8.3 Comparison of achievement scores of boys and girls taught using constructivist teaching strategy

The results of the study showed that there was no statistically significant difference in achievement scores of boys and girls taught using constructivist strategy. The C.T.S did not favour any gender in terms of chemistry achievement. From the study, boys and girls were mixed up in groups during class experiment lessons.

According to Okere .M.O (1996),constructivists view learning as constructing meaning through a social process where students interacts with each other as well as the teacher. Therefore C.T.S favoured discussion amongst students not amongst any of the gender. He says that a characteristic of C.T.S is noise heard from the groups as they try to resolve the dispute where the teacher can intervene at this point. The noise is healthy as long as they are discussing the findings. The strategy considers meaning making out of their experiences

.These experiences are unveiled through a social process which is uniform in terms of gender. The teaching process provides experiences, interaction and negotiation.

4.8.4 Comparison of Motivation of Boys and Girls Taught Using Constructivist Teaching Strategy

The result of this study indicates that there was no statistically significant difference in motivation of boys and girls taught using constructivist teaching strategy. The classroom environment and events plus the verbal statements of the teacher that affects motivation negatively did not favour either sex. In this study there were more boys than girls who were proportionally distributed in the groups. Although earlier research findings like Eshiwani (1985) showed that boys were more interested than girls to learn science hence showed better performance than girls is not reflected here. Also the findings of Keeves & Kotte, 1992; Dawson 2003; Proko, Trucer & Chuda (2007) show that girls are more motivated to learn biology than boys which is also a science subject . All these findings contradicts the study. This may be attributed to the fact that as Wachanga (2000) has argued that teachers treat boys and girls differently and in ways that often are not beneficial to girls motivation and achievement .Puhan and Hu (2006) in their study also found that motivation is an important predictor of science achievement than gender.

CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The present study entailed the development and implementation of a constructivist teaching strategy to teach chemistry in form two secondary school setting. In this chapter, summary of major findings and conclusions have been reached, and the implications of the findings. Also some recommendations and areas that require further research are highlighted.

5.2. Summary of the major findings

On the basis of the analysis of data presented in Chapter Four, the following conclusions were reached;

(1) Constructivist teaching strategy led to better chemistry achievement scores of students compared to those taught using conventional teaching methods.
(2) Students' motivation to learn chemistry is not affected by the use of constructivist teaching strategy.
(3) There is no difference between achievement scores of boys and girls taught using constructivist teaching strategy.
(4) There is no difference in motivation to learn chemistry of boys and girls taught using constructivist teaching strategy.

5.3 Conclusions

From the findings presented above, the following conclusions were reached :-

1. Students who were taught chemistry through constructivist strategy learn better than those who were taught using conventional teaching methods.
2. Secondary school students who are taught chemistry through CTS acquire the same motivation as those who were taught through conventional teaching methods.
3. Gender has no effect on secondary school students' achievement when they are taught chemistry through CTS.
4. Gender has no effect on secondary school students' motivation to learn chemistry when they are taught through CTS.

5.4 Implications

A close scrutiny of the findings of this study has a number of implications. First, constructivist teaching strategy enhances students' chemistry achievement than conventional teaching methods. It did not facilitate social interaction but instilled confidence among the students. Notable from the study also is the fact that teachers can have an ample time when teaching chemistry and can meet individual needs for the students. It can save time spent when teaching the subject since the students will be actively involved and a single teacher can handle several groups at the same time.

The instructional material can be shared amongst groups hence can easily be afforded by most schools especially those with limited laboratory apparatus.

5.5 Recommendations

Based on the findings of this study, it is evident that constructivist instructional strategy, is an effective method in teaching chemistry. Despite the fact that absenteeism did not affect the findings of the study, it is therefore recommended that;

(1) The constructivist teaching strategy should be emphasised in teacher education curriculum at all levels to enable good background of the strategy.

(2) Textbook authors should expose readers more to the use of constructivist strategy by writing about it in their books.

(3) Teachers should as much as possible use constructivist teaching strategy in teaching topics in chemistry topics

(4) KIE and the ministry of education should organise workshops ,seminars at intervals on use of constructivist strategy in teaching chemistry or incorporate the use of the strategy in SMASE training sessions.

5.6 Suggestions for Further Research

The following are suggestions for further research namely:-

(1) From the findings of this study, there is no difference in performance of boys and girls in chemistry while literature states that male do better in the subject than females. Therefore there is need to find out the major factors that have led to improvement of girls in chemistry with time.

(2) The study shows that constructivist teaching strategy does not affect motivation of students. There is therefore need to carry out a study on the major determinants of motivation since it can be easily affected by other factors that were not catered for in this study like learning resources or teacher experience.

(3) Future research should also focus on the same study being conducted in boys or girls schools separately, since this was conducted in co-educational schools.

(4) It is also necessary for the method to be investigated over a longer period of time like over a month or a term to determine its effectiveness.

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APPENDICES

APPENDIX I:

Chemistry Achievement Test. (CAT)

Student No____________________________ Class __________ Gender _________

INSTRUCTIONS

1. **Take your time but do not spend too much time on one question.**
2. **Read each question carefully and try to understand before answering.**
3. **If you do not understand something, please ask for help from the teacher.**
4. **Tick (√) the correct answer.**

Questions

1. Identify one property of graphite that makes it suitable for use as an electrode. (1 mark)

    a). Has positively charged ions.

    b). Presence of delocalized electrons.

    c). Gains electrons to form neutral atoms.

    d).Presence of localized electrons.

2. Sodium chloride forms which type of bonding.(1 mark)

    a). Molecular b). Ionic

    c). Metallic d). Covalent

3 Graphite rod connected to the positive terminal of the battery is called:- (1 mark).

    a). Anode b). Cathode

    c). Cat ion d). An ion

4 Identify the substance that conducts electricity in solution form. (1 mark).

    a) Sugar b) Candle wax

    c) Urea d) Sodium chloride

5 What is the reason for the conductivity of the above identified solution. (1 mark)

    a) Presence of delocalized electrons.

    b) Mobile ions.

c) Mobile electrons.

d) Active atoms.

6 An electrolyte exists in which state? (1 mark)

a) Solid/gas

b) Liquid/solid

c) Solution/molten

d)Liquid

7 A binary electrolyte contains:- (1 mark)

a) Two types of cations and one anion

b) One type of cation and one type of anion

c) Two anions

d) Two cations

8 Apart from graphite not reacting with other electrolytes, what makes it to be used as an electrolyte ? (1 mark)

a) Has neutral atoms.

b) Its negatively charged.

c) Its cheap.

d) It's positively charged.

9 Which is not an application of electrolysis? (1 mark)

a) Extraction of sodium.

b) Purification of salts.

c) Purification of metals.

d) Manufacture of pure chemicals.

10. During electrolysis, the anode attracts: - (1 mark)

a) Cations

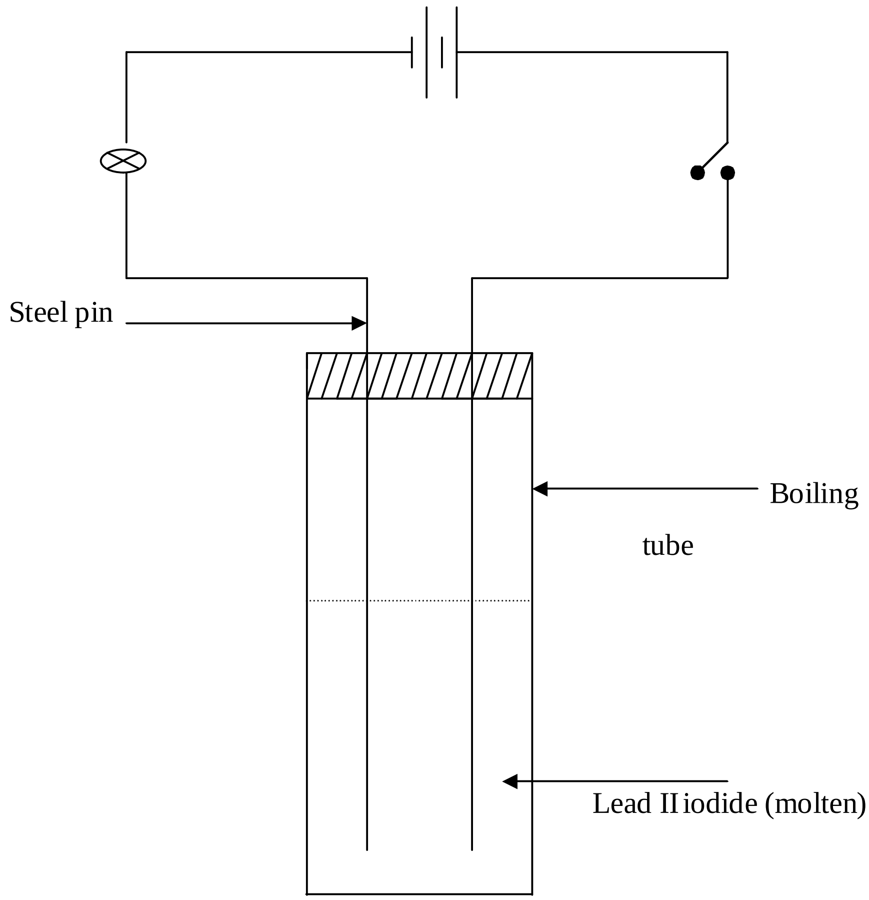
b) Anions

c) Electrons

d) Protons

11. The diagram below shows a set up which is used by a student to investigate the

effect of electricity on molten lead (II) iodide. (1mark)



What happens to lead II iodide during electrolysis?

a) Decomposes to iodine and chlorine

b) Decomposes to two lead ions

c) Forms iodide

d) No change

12. Why should the above experiment be done in fume chamber? (1mark)

a) The bulb is bright

b) For the circuit to be complete

c) Iodine is poisonous

d) To switch on the bulb

13. Identify the cathode equation for binary electrolyte lead (II) bromide. (1mark)

a) $Pb^{2+}_{(aq)} + 2e^- \longrightarrow Pb_{(s)}$

b) $2Cl^-_{(aq)} \longrightarrow Cl_{2(aq)} + 2e^-$

c) $Pb^{2+}_{(aq)} + 2Cl^-_{(aq)} \longrightarrow PbCl_{2(s)}$

14. A student wants to electroplate a nickel jug with silver metal. Which apparatus are not necessary in her set-up? (1mark)

a) Silver nitrate solution

b) Copper wire

c) Dry cells

d) Nitrate electrodes

15. During discharging of ions at electrodes, anions or cations are converted to: - (1mark)

a) Atoms b) ions

c) Neutrons d) electrons

16. Aqueous solutions are prepared by: - (1mark)

a) Dissolving a solute in water

b) Melting the solute

c) Mixing two solutes

d) Boiling solutions

17. Identify the charge in anions. (1mark)

a) Negative

b) Positive

c) Neutral

18. Identify the charge in cations. (1mark)

a) Negative

b) Positive

c) Neutral

19. Identify the kind of structure in sugar. (1mark)

a) Ionic

b) Molecular

c) Giant atomic

d) Metallic

20. In an electrolysis set-up, electrons migrate from: - (1mark)

    a) Negative to positive terminal

    b) Positive to negative terminal

    c) In one direction

    d) Towards the terminals

APPENDIX II:

Students' Motivation Questionnaire

STUDENT'S NO._____________CLASS_______GENDER_____

Instructions: This is not a test and there is no right or wrong answer.

1. It is important that you tell us your honest feeling.
2. Read the items carefully and try to understand before choosing what truly reflects your opinion.

3. Tick (√) the appropriate box with the letter that corresponds with how you feel towards the new strategy.

4 The letter choices are **SA** – Strongly Agree, **A** – Agree, **D-** Disagree, **SD** – Strongly Disagree, **U-** Undecided.

		SD	**D**	**U**	**A**	**SA**
1	I look forward to studying chemistry					
2	I always need help in Chemistry					
3	I love learning chemistry					
4	Always expect to apply chemistry in life situations					
5	Learning chemistry is easy					
6	Chemistry lessons were meaningless					
7	I always expect to be successful in chemistry Assignments given by the teacher					
8	Learning chemistry gives me chance for personal I improvement					
9	I practice solving chemistry questions during holidays					
10	The hours I spend doing chemistry are the hours I enjoy most					
11	I always expect to perform well in chemistry and related subjects.					

12	Chemistry assignments are useful					
13	I will continue learning chemistry					
14	I am able to work alone in chemistry exercises outside classroom.					
15	I expect to be able to solve chemistry problems anywhere I come across if they are my level.					
16	I expect high scores in chemistry tests.					
17	I do not feel uneasy during chemistry lessons.					
18	I am satisfied with my participation in classroom					
19	I find lesson activities in chemistry useful. Chemistry subject is related to daily activities.					
20	The apparatus and Chemicals used in chemistry experiments made me;- (a) Appreciate chemistry					
	(b) Dislike chemistry					
	(c) Interested in chemistry					
	(d) Scared of chemistry					
	(e) Like chemistry					
21	I am happy with the way chemistry is taught					
22	I am happy with my performance in chemistry exams.					
22	I feel am confident of the way chemistry is taught					
23	I expect to be able to learn chemistry in daily situations.					
24	I would like a career that require chemistry					
.25	The topic taught by the teacher was simple					

26	I am comfortable with the way chemistry lessons are taught					

APPENDIX 111:

A Module for Teaching Using Constructivist Strategy

TOPIC: EFFECTS OF ELECTRIC CURRENT ON SUBSTANCES

LESSON 1

Sub-topic: Introduction

Phase/time	Teacher's Activity	Students' Activity
Orientation (5 min)	Exposes learners to various laboratory electrical appliances.	Identify and describe the working of the appliances
Elicitation (5 min)	Handles the appliances by switching on and off.	Handle the appliances considering the safety measures
Restructuring (25 min)	Asks learners to identify various sources of electricity and define current based on atomic structure.	Identify sources of electricity. Define electric current based on atomic structure. Distinguish between alternating current and direct current.
Application (3 min)	Explain the lighting of a torch.	Give other examples of uses of energy apart from a torch.
Review (2 min)	Explain the arrangement of dry cells.	Make a set-up that brings about flow of electric current.

LESSON: 2+3

Sub-topic: Electrical conductivity in solids.

Phase/time	Teachers' activity	Learners' activity.
Orientation (7 min)	Provide the learners with the solids. Ask the learners to collect solids from around	Distinguish between solids and other states. give the properties of solids.
Elicitation (8 min)	Encourage learners to give their views about solids.	Give other ideas about solids.
Restructuring (55 min)	Guide the learners in setting up an experiment on conductivity of solids. Guide in the definition of insulators and conductors.	Set-up experiment to investigate conductivity of solid .classify insulators and conductors.
Application (5 min)	Ask learners to give uses of conductors and insulators.	Give their views about the role of conductors and insulators.
Review (10 min)	Ask the learners to derive conclusion from observations made.	Derive conclusion from observation. Draw a circuit and show the direction of electron flow. Explain why metals are conductors.

LESSON: 4

Sub-topic: Conductivity of electricity in molten substances.

Phase/time	Teacher's Activity	Learners' activity
Orientation (5 min)	Asks learners to give examples of molten substances.	Give examples of molten substances and how to convert solid states to

		molten.
Elicitation (5 min)	Provides learners with a molten liquid.	Handles the liquid and tries to distinguish with non-molten liquid.
Restructuring (25 min)	Demonstrates the set-up using lead (II) Iodide.	Make observations and draw conclusions .Explain what brings about conductivity.
Application (2 min)	Asks learners to give examples of molten substances	Give examples of molten substances.
Review (3 min)	Asks learners to give the causes of conductivity and the procedure of the experiment.	Give the procedure and clearly explain the cause of electrical conductivity of substances inn molten state.

LESSON 5

Sub-topic: Electrical conductivity by aqueous solutions.

Phase/time	Teacher's activity	Learners' Activity
Orientation (5 min)	Asks the learners to give examples of soluble salts.	Outline the soluble salts. Give a procedure of preparing aqueous solutions.
Elicitation (5min)	From the given examples, the teacher asks the learners to give their formula.	Write down the formula of the given salts.
Restructuring (25min)	Demonstrate s the set – up of using saturated copper II chloride solution.	Make observations, draw conclusions by explaining the lighting of the bulb.
Application (3 min)	Asks the learners to give specific the uses of aqueous solutions .	Give the uses of aqueous solutions.

Review (2 min)	Asks the learners to recall the arrangement of the above set-up.	Draw and label the set-up. Show the direction of electron flow.

LESSON: 6+7

Sub-Topic: Electrolytes and Non-Electrolytes.

Phase/Time	Teacher's Activity	Learners' Activity
Orientation (7 min)	Provide solutes, solutions and other apparatus.	Identify the solutes then prepare solutions from them.
Elicitation (8 min)	Based on the previous settings the teacher direct the learners to set-up the apparatus.	Set-up the apparatus to based on their previous settings.
Restructuring (55 min)	Guides the learners on the on the setting of apparatus and making of observations.	Carry out the experiments ,make clear observations and draw conclusions.
Application (5 min)	Directs on the applications of the process.	Identifies the application of the process.
Review (5 min)	Asks the learners to classify electrolytes and non-electrolytes.	Classify electrolytes and non-electrolytes. Give ten more examples of electrolytes.

LESSON: 8

Sub-topic: Why Electrolytes conduct Electricity.

Phase/Time	Teacher's Activity	Learners' Activity
Orientation (5 min)	Give a list of solutions.	Classify the given solutions as electrolytes

		and non-electrolytes.
Elicitation 5(min)	Allow learners to give reasons for their identifications.	Justify their classification as per orientation phase.
Restructuring (25 min)	Directs learners to discuss on one electrolyte then clarify.	Find out the meaning of electrolysis, anions, cations, anodes and cathodes
Application (5 min)	From the definition give the significance as used in electrolysis.	Discuss the uses of half equation.
Review (5min)	Direct review of the lesson.	Discuss the meaning of the terms used.

LESSON: 9

Sub-Topic: Binary Electrolytes

Phase/Time	Teacher's Activity	Learners' Activity
Orientation (5 min)	Ask the learners to identify the common electrolytes.	List down the electrolytes with the ions present.
Elicitation (5 min)	Work on the examples given by the learners.	Confirm that the ions given have opposite charges.
Restructuring (20 min)	Guide the learners in writing half equations from the examples.	Name the charges in the ions and give the possible observations with the half equations.

Application (5 min)	Clarify the use of half – Equation in redox reaction.	Show the importance of half equation in relation to observation made at the electrodes
Review (5 min)	Ask the learners to define terms commonly used.	Define the commonly used terms. Identify the ions present in an electrolyte and show their direction of movement during discharging.

Lesson : 10+11

Sub-Topic: Applications of electrolysis and possible areas tested

Phase/time	Teachers' Activity	Learners' Activity.
Orientation (20 min)	Talks about migration in terms electron flow and relates the mobile ions in the electrolytes.	Demonstrates by moving as a group to a particular direction ie those sweaters whereas their counterparts without sweaters move in an opposite direction.
Elicitation (20 min)	Asks learners to give the applications of electrolysis.	Learners outline the applications.
Restructuring (20 min)	Clarifies the given applications by asking learners to give specific examples.	Match the specific examples with the applications.
Application (10 min)	Explains the usefulness of knowledge of electrolysis	Give their daily experiences with electrolysis in preparation for Electrochemistry.

Review (10 min)	Asks questions on the topic.	Answer questions from commonly tested areas in the topic.