

**EFFECTS OF SCIENCE PROCESS SKILLS MASTERY LEARNING APPROACH ON
SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND ACQUISITION OF
SELECTED CHEMISTRY PRACTICAL SKILLS IN KOIBATEK DISTRICT
SCHOOLS, KENYA**

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

EGERTON UNIVERSITY

MARCH, 2011

DECLARATION AND RECOMMENDATION

DECLARATION

This thesis is my original work and has not been presented for a degree or diploma in any other university.

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RECOMMENDATION

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DEDICATION

This work is dedicated to my family; my husband Peter and dear daughters Esther and Sarah for their patience, encouragement and forbearance.

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ABSTRACT

Chemistry is one of the science subjects which are taught in Kenyan secondary schools. One of the objectives for teaching chemistry is to enable learners to use knowledge and skills acquired to solve problems in everyday life. Achievement of this objective depends on the methods and techniques employed by teachers during instruction. The method used can either enhance or hamper the learner's interest in the subject and hence affect the overall performance of school learning. The Kenya National Examinations Council (KNEC) reports that secondary school students' performance in chemistry practical papers is poor and this affects their overall achievement in Chemistry. Poor achievement in chemistry may be a result of the methods teachers use. This study was designed to investigate the effectiveness of Science Process Skills Mastery Learning Approach (SPROSMALEA) on students' achievement and acquisition of selected science processes skills. The study was carried out in Koibatek District, Kenya, where a persistent low achievement in the subject has been registered. The study focused on the topic "salts" in Form Two chemistry syllabus. The Solomon Four Group, Non-equivalent Control Group Design was employed in the study. Four co-educational schools were purposively selected from the 35 secondary schools in the District and randomly assigned to serve as experimental group (E_1), experimental group (E_2) control group (C_1) and control group (C_2). Data were collected from a sample of 160 Form Two students. Three instruments namely, Chemistry Achievement Test (CAT), Science Process Skills Performance Test (SPSPT) and Classroom Observation Schedule (COS) were used for data collection. The instruments were pilot tested in two secondary schools in Koibatek District which were not part of the study but had similar characteristics as the sampled schools. This was to ascertain their suitability, establish its validity and reliability. Two groups, the experimental (E_1) and control group (C_1) were pre-tested, experimental group (E_2) and second control group (C_2) were not. All groups were taught the same course content for a period of four weeks, with the experimental groups receiving their instruction by use of (SPROSMALEA) approach and control groups using the conventional teaching method. During the teaching COS was used to observe and record the activities of the teachers and learners. A post-test on CAT and SPSPT was administered to all groups after the completion of instruction on the chemistry topic on salts. Both descriptive and inferential statistics were used to analyse the data using the Statistical Package for Social Sciences (SPSS) version 12.0 for Windows. ANOVA and ANCOVA were used to analyse differences in the four means of post-test scores. A t-test was used to get the differences between two means. Hypotheses of the study were tested at $\alpha=0.05$ level of significance. The results of the study indicate that students in the experimental groups outperformed the control groups in the achievement and the acquisition of selected chemistry practical skills. The findings further indicate that students' and teachers' activities during the instruction in the experimental groups had higher mean frequencies in COS than in the control groups. Science teachers, educators and policy makers are likely to benefit from the results and recommendations of the study in that it provides them with an alternative teaching approach which is capable of improving their achievement in the subject and acquisition of the desired practical skills.

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LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|------------|--|
| ANCOVA | Analysis of Covariance |
| ANOVA | Analysis of Variance |
| CAT | Chemistry Achievement Test |
| COS | Classroom Observation Schedule |
| JICA | Japan International Cooperation Agency |
| KCSE | Kenya Certificate of Secondary Education. |
| KIE | Kenya Institute of Education |
| KNEC | Kenya National Examinations Council |
| MOEST | Ministry of Education, Science and Technology |
| NCTM | National Council of Teachers of Mathematics |
| SAPA | Science a Process Approach |
| SMASSE | Strengthening of Mathematics and Sciences in Secondary Education |
| SPROSMALEA | Science Process Skills Mastery Learning Approach |
| SPSPT | Science Process Skills Performance Test |
| SPSS | Statistical Package for Social Science |
| SSP | School Science Project |

CHAPTER ONE

INTRODUCTION

1.1 Background Information

It is held that science is an organized body of knowledge about natural phenomena (Ogunniyi, 1986). But to others, it is an attempt to organize our sense data or experience into meaningful systems of descriptions and explanations. Lederman (1983), observed that science is a dynamic on-going activity rather than a static accumulation of information. The present state of knowledge is important because it is a base for further scientific theory and research. The acid test of new ideas is therefore not only its success in explaining and correlating the known facts but, much more its success or failure lies in its ability to stimulate further experiments and observations which in turn are fruitful.

Chemistry is a branch of science that deals with the study of matter and the changes it undergoes (Chang, 1998). The earliest record of man's interest in chemistry was approximately 3,000 BC in the fertile crescent of Egypt (Durant, 1950). At that time chemistry was considered more of an art than a science. Tablets records the first known chemist as women who manufactured perfumes from various substances. By 1000BC, chemical arts included smelting of metals and the making of drugs, dyes, iron and bronze. Many groups contributed to these developments; among them were ancient Egyptians, Greeks, Hebrews, Chinese and Indians. Chemistry knowledge has been used to solve problems affecting communities. For example, world population problems can be discussed in the light of chemistry contributing to improve agriculture techniques, production of drugs, soap and plastic (Wachanga, 2005).

The history of curriculum in Kenya has gone through three stages. The first stage was adoption of the British curriculum, the second stage was its adaptation. The third stage (which is the current 8-4-4 system) was the production of curriculum that was expected to meet the need and aspirations of the Kenya people (Eshiwani, 1988; Sifuna, 1987). The 8-4-4 programme faced persistent donor opposition. They felt that the system was inappropriate and too expensive for the country. The Kenyan government reacted to the above problems and criticism by carrying

out reviews of the curriculum in 1990, 1995 and 1999 (Oluoch, 2002). Chemistry curriculum has undergone several changes since independence 1963. There has been changes in the contents taught at different levels owing to the various changes in the systems of education that has taken place. It aimed at having a child centred investigatory approach of teaching. The current chemistry curriculum was released in 2002 and implemented in 2003 (K.I.E, 2002). Despite the importance of chemistry, student achievement is still generally low. Table 1 shows the performance in KCSE chemistry examination in Koibatek District between 2004-2006.

Table 1

Analysis of K.C.S.E Chemistry Performance, Koibatek District for 2004-2006

| Year | Grades | A | A- | B+ | B | B- | C+ | C | C- | D+ | D | D- | E | X | Y | Entry | District | Max. |
|------|--------|----|----|----|----|----|----|-----|-----|-----|-----|-----|----|---|---|-------|----------|-------|
| | | | | | | | | | | | | | | | | | grade | grade |
| | | | | | | | | | | | | | | | | | mean | score |
| 2004 | | 3 | 5 | 26 | 36 | 46 | 70 | 123 | 133 | 149 | 415 | 192 | 7 | 5 | 0 | 1210 | 4.2865 | 12 |
| 2005 | | 19 | 23 | 25 | 46 | 45 | 68 | 120 | 116 | 138 | 412 | 328 | 49 | 2 | 0 | 1391 | 4.155 | 12 |
| 2006 | | 8 | 7 | 24 | 30 | 34 | 60 | 83 | 135 | 123 | 358 | 317 | 47 | 5 | 0 | 1231 | 3.7914 | 12 |

Source : Koibatek District secondary school academic committee page 7 and 8

From the table 1 the following observation can be made:

- (1) The district mean scores are not only very low but, there has been a drop for three years from 4.2865 to 3.7914.
- (2) The number of student's who got grades A's and B's are few compared to those who got D's.

Generally the student's performance in Chemistry is very low, probably because of the teaching methods used by the teachers. However, the incorporation of mastery learning in teaching of science process skills in Chemistry lessons might help to curb this problem of low achievement. Mastery learning is an alternative method of teaching and learning in which the students should reach a level of predetermined mastery of units of Chemistry instruction before being allowed to progress to the next unit (Davis & Sorrell, 1995). Science process skills are the sequences of

events that researchers engaged in while taking part in scientific investigation and all those activities that contribute to scientific learning (Arena, 1996). They are classified into basic science process skills and integrated science process skills. Basic science process skills are observations, measuring, classifying, inferring, communicating and predicting. Integrated science process skills are graphing, hypothesizing, experimenting, interpreting data, formulating models, investigating, analyzing data and evaluating.

In the present study, the skills to be observed were experimenting, observation and inferences. They had been selected from the wider list of the process skills because they were some of the skills tested in the K.C.S.E examination practicals. In the practicals the learners were given unknown salt, where they performed an experiment and gave the observation and inferences. Also teaching these skills might enhance achievement of chemistry objectives as outlined by the K.I.E (2002) as follows:-

- i) Make accurate observation and draw logical conclusion from experiments.
- ii) Identify patterns in the physical and chemical behaviour of substance.
- iii) Follow correct experimental practices and recall safety procedures.
- iv) Use of knowledge and skills acquired to solve problems in everyday life.

The study is aimed at integrating existing Science Process Skills and Mastery Learning in an effort to come up with a new Science Process Skills Mastery Learning Approach (SPROSMALEA). The effectiveness of the new approach had not been studied; hence the study investigated the effects of SPROSMALEA on student's achievement and acquisition of Chemistry practical skills among Form two students in Koibatek District.

1.2. Statement of the Problem

One of the demands in sciences in the 21st century for the learners of science is the acquisition of scientific skills (KNEC, 2006). The Ministry of Education has tried to enhance the teaching of Chemistry in most schools by introducing projects such as Strengthening Mathematics and Sciences in Secondary Education (SMASSE), in order to improve performance. In Education Insight Issue report of 2006, Japan International Cooperation Agency (JICA) sponsored programme showed a general improvement in chemistry performance. However, the students performance in practical examination papers at KCSE exam is still poor and students end up

getting low grades in Chemistry (KNEC 2006). Currently, Chemistry is taught by a combination of learning/teaching methods, which have not helped in improving student's achievement in Chemistry. The use of SPROMALEA could help to curb the problem. However, no studies have been conducted to document its effectiveness in Chemistry practical teaching in Koibatek District Secondary Schools. Therefore, there was need to investigate the effect of SPROMALEA on students' achievement and acquisition of selected science processes.

1.3 Purpose of the Study

The purpose of the study was to determine the effects of Science Process Skills Mastery Learning Approach (SPROMALEA) on Students' Achievement and acquisition of selected Chemistry practical skills.

1.4. Objectives of the Study

The study was guided by the following specific objectives.

- i) To compare the achievement of students who are taught chemistry through SPROMALEA and those who are taught through conventional teaching/learning methods.
- ii) To investigate the effects of SPROMALEA on Students Acquisition of selected Chemistry process skills of experimenting, observation and inferences.
- iii) To identify and describe the student-student, student-teacher and student activities transpiring during instructional process.

1.5 Hypotheses of the Study

To achieve the objectives of the study the following null hypotheses were tested at $\alpha=0.05$.

Ho₁: There is no statistically significant difference between students Chemistry achievement of those who are exposed to SPROMALEA and those who are not.

Ho₂: There is no statistically significant difference in acquisition of selected Chemistry practical skills of experimenting, observations and inferences between students who are exposed to SPROMALEA and those who are not.

1.6 Significance of the Study

The results of this study may be valuable to teachers who are the implementers of curriculum in that, they may incorporate and adopt the approach in teaching various topics in chemistry and

other science subjects. Curriculum developers, policy makers and text book writers may also benefit because they will be provided with a tool for expressing certain broad chemistry concepts. Learners will also benefit once they acquire a skill they may transfer to new area of application. For example a skill of observation in chemistry, a learner can use the same in biology or physics subjects. It is believed that learners do not forget the skill they have acquired very easily, hence they may use such skills later in life. The chosen science processes, experimenting, observation and inference are critical in that, they are tested in the Kenya Certificate Secondary Examinations (KCSE) practical exams. If the learners master these skills their performance may steadily improve, hence solve the problem of low performance in Chemistry.

1.7 Scope of the Study

The proposed study covered four selected District co-educational secondary schools in Koibatek district Kenya. Form two chemistry students were drawn from the selected schools. A total sample of 160 students (40 from each school) were used. Emphasis was on the use of SPROSMALEA on the topic salts in the chemistry syllabus.

1.8 Limitations of the Study

The following were the limitations in this study

- i) The groups involved in the research were as they were naturally found in the school. It was difficult to reorganise pupils in a class, since school authorities cannot permit any reorganization of intact classes for research purposes once they are constituted.
- ii) The topic covered was salt as presented in the revised (K.I.E, 2002). The generalizability of the findings was limited to the Chemistry lessons contained in the teaching manual developed in the study rather than chemistry as a subject.

1.9 Assumptions of the Study

The following assumptions were made in this study:-

- i) The students involved in the study would cooperate to do what is required and also provide genuine and accurate data.
- ii) Teachers in the study would take new approach positively.

1.10 Definitions of Terms

The following were definitions of few terms used in this study;

Achievement – The realization of scores in achievement tests. In this study it refers to student attainment scores in chemistry achievement test.

Chemistry Practical Skills-In this study it refers to the science process skills of experimental, observations and inferences.

Co-educational Secondary Schools – These are secondary schools in which boys and girls learn together.

Conventional teaching method – A traditional instruction method where the teacher normally has a total control of the entire lesson. The teacher maintains control of the subject matter to be learned and tests are used for awarding grades to the learner. This is teacher centered as opposed to learner centered teaching approach.

Experimenting - Carrying out an experiment by carefully following directions of the procedure, so that results can be verified by repeating the procedure several times. It is the skill of arranging and organizing experiment to test a given data.

Inferring - This skill involves formulating assumptions or possible explanations based upon observations.

Kenya National Examinations Council (KNEC) - This is a body responsible for administering national examinations in Kenya. KNEC was established by an act of parliament (Cap 225A, Laws of Kenya) in 1980. It operates under the Ministry of Education.

Mastery learning - An instructional method whereby students are not to advance to a subsequent learning unit until they demonstrate predetermined proficiency level in the current one.

Module – A standard format, organized for use in instruction of learners in a section of their course. In this study it refers to work plan to be used in SPROSMALEA in learning Chemistry lessons on topic salts in the experimental secondary schools.

Observing - Using your senses to gather information about an object or event. It is a description of what is actually perceived.

Science Process Skill Mastery Learning Approach (SPROSMALEA) – This is an integration of science process skills and mastery learning. This approach emphasizes mastery of the selected skills.

Science Process skills – These are the rational activities that contribute to students achievement in science in this study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter represents a summary of review of the literature on, definition of the term science, curriculum reform in science education, teaching science in secondary schools in Kenya, chemistry teaching in secondary schools, methods currently used in teaching and learning chemistry, advantages and disadvantages of these methods. It is followed by literature on performance in chemistry at KCSE level, science process skills and mastery learning in schools. Conceptual framework is given at the end of the chapter.

2.2 Definition of the Term Science

The word science is a noun derived from a Latin term “sciential” meaning knowledge or knowing (Ross, 2000). According to Ross science is a process or way of arriving at a solution to a problem or understanding an event in nature that involves testing a possible solution. Science is distinguished by how knowledge is acquired, rather than the act of accumulating facts. Ross therefore define science as a particular way of investigating the world and note, that not all investigation are scientific. Scientists are observers and through their observation they determine the general principle that govern over physical world.

Science is recognized widely as being of great importance internationally both for economic well-being of nations and because of the need for scientifically literate citizenry (Fraser & Walberg, 1995). Knowledge of science and technology is therefore a requirement in all countries and all people globally due to its ability to address the many challenges that are facing them. These challenges include emergences of new drug resistant diseases, effect of genetic experimentation and engineering, ecological impact of modern technology, dangers of nuclear war and explosions and global warming among others (Alsop & Hicks, 2001). As a result there are rapid changes taking place in industry, Communication, agriculture and medicine. Science as an instrument of development plays a dominant role in bringing about these changes by advancing technological development, promoting national wealth, improving health and industrialization (Wambugu & Changeiywo, 2007).

2.3 Curriculum Change in Science Education

“Science for all” as a curriculum development movement is often denoted as the second wave of science curriculum reforms, referring to the development over the past decades since 1950s (Ware,1992; Keeves & Aikenhead 1995). This curriculum development wave often describes particularly the situation in USA and UK, the two countries that tends to dominate the international sciences education literature. The first wave put particular emphasis on the preparatory role of secondary science education for further studies. This curricula was considered difficult by teachers and students, and caused many students to shy away from science studies (Waiberg, 1991; Ware, 1992).

In USA participation in sciences streams dropped from 54% to 21% of the age group between 1970 and 1983 and the percentage of the age group not taking any science at this level rose from 18% to 49% (Keeves & Ainkenhead, 1995). The second wave of science was preparation for general citizenship and science knowledge needed for life after school. Shamos (1995), advocated a curriculum for “scientific awareness” which would have a technological emphasis. The new curriculum being implemented in such countries as Australia, England and new Zealand , along with the proposals from the natural sciences learning area committee in south Africa all placed much greater emphasis on skills and processes than the previously heavily fact laden syllabuses. The nature of science is seen by teachers as being an area where they have little confidence in their ability to teach (so much so that it has been removed from the UK national curriculum as a separate attainment target).

The curriculum of most African countries are linear descendant of western curriculum, but there have been attempts in recent years to shift away from these inappropriate imported models. In Botswana for example curriculum planners have tried to involved a broad range of stakeholders in the curriculum development process, with teachers being considered an important group (Nganunu,1990; Ogunniyi , 1995).

For science to be accessible to learners in rural areas, learning programmes should be shaped around real issues, technologies and situations found in those areas. Knamiller (1995) in discussing these issues in relation to Tanzania refers to the need for curriculum to become

“operant” with intention to transform school learning into everyday skills. There are a number of examples in Africa where such approach has been tried from which we can learn. These include the Uganda “link projects” and “the science through investigation” in Botswana. Kuiper (1996) argued that science teaching has long been seen as being irrelevant to the students that graduate from high school because they would often be unable to apply their scientific knowledge in later life. An important reason for this inability is the teaching approach used by science teachers and also advocated through curriculum and syllabus documents. Putsoa (1992) investigated the ability of Swazi high school leavers in applying their scientific knowledge in every day situations and found that majority of pupils had great difficulty in reproducing scientific knowledge application or problem solving.

2.4 Teaching of Science in Secondary School

In Kenya, education is aimed at enabling the youth to play a more effective role in the life of the nation. This is achieved by imparting to them the necessary knowledge and skills required for national development as well as inculcating the right attitudes (Republic of Kenya 1981). Introduction of 8-4-4 system of education in Kenya put more emphasis on technical and vocational education. This was away of ensuring that school leavers at all levels have some scientific and practical skills that can be utilized for either wage employment, self employment or for further training (Ministry of Education, 1992, Shiundu & Omulando 1992).

Effective science learning depends on the method and techniques employed by the teachers during instructional process (Das, 1985). Students learn science best when the teaching methodology enables them to get involved actively in class activities. They should participate actively in doing experiments, carrying out demonstrations, class discussion and other relevant learning experience. The way science is taught in schools seems to either enhance or hamper learners interest in the subject and hence affect overall performance of school education (Ogunniyi, 1999). Perhaps the poor performance in science subjects is the one that prompted the government of Kenya through the Ministry of Education Science and Technology (MOEST), with assistance of the government of Japan through Japan International Cooperation Agency (JICA), to initiate a programme on strengthening of Mathematics and Science in Secondary Education (SMASSE) (Changeiywo, 2000). This programme has been implemented in all 57 administrative districts in Kenya. In Education Insight issue report of (2006), it was observed

that there was a general improvement in the science grades in the 2005 KCSE results. It is hoped that this will make the students performance in Chemistry examination to be even much better.

2.5 Teaching of Chemistry in Secondary Schools

Chemistry occupies a central position amongst the science subjects. It is a core subject for the medical sciences, textile technology agricultural sciences, synthetic industry, printing technology, pharmacy, chemical engineering. As important as the subject is and inspite of the effort of both the federal and state governments in Nigeria to encourage chemistry education, students still shun the subject (Jegade, 2003). It has been observed that so many students fear chemistry and such fear is characterized by mass disenchantment among students towards the subject. The end product is declining popularity of the subject over the years. According to Keeves and Morgenstern (1992) student's anxiety towards the learning of chemistry makes them to loose interest in the sciences. This supports the findings of Busari (1991) that established a positive relationship between teachers, quality and interest of students in science subjects. Harwood and McMahan (1992) studied the effect of integrated video media on students' achievement and attitudes in high school chemistry class. They found that it facilitated achievement and positive change in attitude.

In Kenya, Wachanga and Mwangi (2004) found that the cooperative class experiment teaching method facilitated student's chemistry learning. This method also increased student motivation to learn. Wachanga and Gamba (2004), studied the effect of mastery learning approach on secondary school students achievement in chemistry and found it enhances learning than the conventional teaching/learning method. Therefore use of appropriate teaching method is critical to the successful teaching and learning of chemistry.

Chemistry curriculum in Kenya has undergone several changes since Kenya's political independence in 1963. From that time Chemistry curriculum was formulated and developed in the African Science centre now called the Kenya Institute of Education (KIE). The Chemistry syllabus that resulted was a teacher and book centred in its approach to teaching and learning. This curriculum overlooked that students had a wide range of abilities, interests and potentials. It

was a content centred and did not bother about experiments (Kenyan Government, 1976; Kimiti, 1984).

In 1967 another syllabus was developed called UNESCO Pilot Project. In this the teacher did all the experiments while the pupils merely observed and wrote information. There were no enough finances laboratories, hence relied on teacher demonstration. Teacher used centred learning method (Wachanga & Mwangi, 1984).

In 1968, another curriculum was developed in Kenya. It was meant to be in line with curriculum changes that were taking place in USA and the United Kingdom. In UK, Science curriculum was developed by Nuffield Foundation. This was adopted in Kenya. In the Nuffield approach instead of the child being in front of the original discoverer as in the UNESCO project it put the child at the centre of scientific work. It emphasizes learning of science by discovery or the problem solving method. Nuffield science project involved importation of huge quantities of books and apparatus. This materials proved to be unsuitable for the Kenyan environment. Nuffield failed to meet the needs of Kenyan learner. In 1970, a new science curriculum was developed which was called School Science Project (S.S.P). S.S.P was similar to Nuffield Project in teaching methodology; but aimed at using locally available materials as it required equipped laboratories and competent teachers and good school environment. Many Kenyans could not afford those requirements (Kimiti, 1984).

In 1973, an alternative syllabus was introduced called the traditional syllabus. It had three options; Pure syllabus, Physical science and General science.

Traditional syllabus was offered alongside the S.S.P. A school could choose either the traditional syllabus or the S.S.P for its pupils. 1981 the Ministry of Education came up with syllabi that could be unified and be offered in most schools called New Kenya Examination Council Syllabi. In 1984-85, a new syllabus called the 8-4-4 Chemistry syllabi was introduced. The syllabus was revised in 1992 and later in 2000. It aimed at having a child centered investigatory approach in teaching. The use of project work in teaching chemistry was emphasized. The options available in it were 8-4-4 Chemistry syllabus and the 8-4-4 physical science syllabus. The revision done in

year 2000 resulted in pure chemistry syllabus. All secondary schools were to offer pure chemistry syllabus (Kimiti, 1984).

There has been changes in the content taught at different level owing to the various changes in the system of education that has taken place. The current chemistry curriculum was released in 2002 and implemented in 2003. The chemistry syllabus has been re-organized to address the following aspects; overlaps within topics and across the subject, overload within the topics, objectives are re-organized and re-stated to ensure clarity, contemporary issues such as environmental pollution, industrial and technological transformations have been addressed (K.I.E, 2002).

2.6 Teaching Methods in secondary schools chemistry

Chemistry is a practical subject and should be taught by way of discovery through investigation. Learner central approach is therefore most appropriate. However, learners requires the teachers guidance. An integration of the two approaches maybe necessary in certain topic.

There are four major methods which can be used in teaching of chemistry (K.I.E, 2006); Class experiment, teacher demonstration, class discussion and projects. Besides these four, there are other instructional methods that may be incorporated such as question and answers, informal lecture and field trips.

2.6.1 Class experiment teaching method

It involves learning by doing, here students engage in practical learning activities and also provides an opportunity to the learners to put theory into practice. The learner develops manipulative and managerial skills. Learners also gain scientific skills and first hand knowledge (KIE, 2006; Mohanty, 2003).

Advantages

- i) The student develops manipulative and managerial skills.
- ii) Students develop thinking and skills in making careful observations.
- iii) The students learn to follow instruction and work independently.

Disadvantages

- i) Expensive in terms of materials and equipment
- ii) Relatively less content will be covered
- iii) Time consuming
- iv) In case of large class sizes, some students may not get the opportunity to carry out the practical.

2.6.2 Teacher demonstration method

It involves an experiment or a series of experiments performed by the teacher with the assistance of the learners. This method is used in situations where apparatus and supply of chemicals is limited. It is also useful in experiments with potential hazards. For example burning of hydrogen in air/oxygen, preparation of poisonous gases, and reactions involving very reactive substances such as sodium, potassium and phosphorous. This method when compared with the class experiment is less demanding in terms of both the materials required and teachers preparations. It requires much planning and preparation. It is teacher-centred hence learners have no opportunity to manipulate the learning materials (Nayak & Singh, 2007; KIE, 2006).

Advantages

- i) It adds to learning by giving the learners the opportunity to see and see what's actually happening.
- ii) Phenomena too expensive and or dangerous for laboratory work can be illustrated.
- iii) The learners can build associated skills and attitudes.
- iv) This method can afford an excellent means of introducing or approaching a new topic.
- v) It can be used to illustrate ideas principles and concepts for which the words are inadequate.

Disadvantages

- i) Student participation may be limited to a few of the most verbal children.
- ii) The phenomena demonstrated may not be seen equally well by all member of the class.

- iii) The teacher may use too much direct influence and illustrate teacher problem solving rather than involving pupils in problem-solving situations (KIE, 2006).

2.6.3 Class discussions

It is a teaching method usually employed whenever the concept cannot be illustrated by way of experiment. However these discussions are based on experiments and follow the general pattern of teaching chemistry that is Experiment – Discussion – Conclusion. Some of the topics where this method can be used include atomic structure, radioactivity, industrial process such as Solvay, Haber and Frasch. It can also be used in schools where practicals cannot be performed due to inadequate facilities. The teacher and the learner rely mainly on textbooks and other teaching aids such as charts, tables, models, diagrams, pictures, articles and periodicals. Biographical materials and audio visual aids are also useful (Nayak & Singh, 2007; KIE, 2006).

Advantages

- i) It stimulates critical thinking
- ii) It helps learners to gain respect on positions of others.
- iii) It involves the whole class

Disadvantages

- i) Time consuming
- ii) It is not the best technique of presenting information and facts.
- iii) Few members ill dominate it
- iv) It may give unbalanced presentation like lecture method. It involves more talk than action and require careful planning.

2.6.4 Project work

Project work is extension or expansion of class experiment, demonstration and class discussion. It provides for laboratory activity that permits self direction, exploration, the nurturing and satisfaction of scientific curiosity and creativity. Each learner has a chance to achieve certain objectives according to one's ability and interest. The project activities can be done through, special classes, chemistry club, science club. Ideally, the learners should find problems and

projects for themselves. However, most learners will need stimulating suggestions, possibly in form of a list of suitable projects (Wachanga, 2005; KIE, 2006; Rogus, 1985).

Advantages

- i) It provides pupil with opportunity to undertake investigations for the solution of problems.
- ii) It helps in the transfer of chemical knowledge to solving problems encountered in day to-day experiences.
- iii) It arouses curiosity on the role of Chemistry in society.
- iv) Helps learners to gain confidence in manipulative skills.
- v) It demonstrates abilities, attitudes and skills towards originality, creativity and presentation of scientific information in a logical manner.

Disadvantage

- i) It is expensive in terms of materials and equipment.
- ii) It is time consuming.
- iii) Students by themselves are incapable of planning projects and activities they need assistance from the teachers.

2.6.5 Question and answer method

This method is used to review a previous lesson, introduce a new topic or review past examination questions. For effective use of this method, the teacher should think of the questions that will enable one carry out the session to the end of the lesson. The teachers should vary the questions as the lesson advances. The learner should be involved as much as possible by encouraging them to also suggest some questions on the review. The teacher should guide and summarise the learner's questions and responses to focus on the objectives of the lesson (Nayak & Singh, 2007; KIE, 2006).

Advantages

- i) Stimulate analytical thought
- ii) Diagnosis that student difficulties.
- iii) Encourages a new application and attitudes

- iv) It motivates the learners
- v) Determine progress towards specific goals
- vi) Helps to get feedback for teachers as well as pupils.

Disadvantages

- i) Learners feel discouraged when there are many incorrect answers.
- ii) It is as lower process of dealing with information.
- iii) It is difficult to design questions to measure certain types of learning

2.6.6 Informal lecture method

This method can be used when introducing a lesson, introducing a new concept or when summarizing the lesson. Informal lecture takes a very short time of about 3-5 minutes and their interaction between the teacher and the learners as the lesson progress (Wachanga, 2005; KIE, 2006, Mohanty, 2003).

Advantages

- i) It can be used during introduction of lessons to reinforce the previous work or used for further clarification.
- ii) It may be used to summarise the lesson and inform the learner what is expected of them.
- iii) It stimulates the learners to think.
- iv) It enhances discipline.

Disadvantages

- i) It ignores the personality of the learner or the individual difference
- ii) It has delayed or poor feed back.

2.6.7 Field Trip

Field trips involve visits to places outside the classrooms such as industries, water purification and treatment plants, sewage disposal/treatment plants, laboratories. They help in correlating classroom work to real life experiences. The exposure has a special appeal and teaching/learning value. The trips also enrich coursework by stimulating learners and utilizing of local/community resources. When using field trips as a teaching/learning method, thorough preparation is

essential. The teacher must explore the place to be visited and arrange the details. The teacher should prepare guidelines to be followed by the learners. The guidelines should be based on education value of the trip. In particular the guidelines should clearly show that objectives have to be met during the visit. The timing of the visit must be properly integrated with the topics being covered (Nayak & Singh, 2007: KIE, 2006).

Advantages

- i) It enriches course work by stimulating learners and utilizing local community resources.
- ii) Helps in correlating classroom work to real life experiences.
- iii) It permits students to observe and study something which cannot be brought into the classroom.

Disadvantages

- i) Arranging a good field trip consumes a considerable amount of time.
- ii) It is also expensive e.g. transporting students.

2.7 Students Achievement in Chemistry in Secondary Education.

The Table below shows the students performance in chemistry during the five years (2002-2006) at KCSE chemistry examinations.

Table 2

Candidates overall performance in chemistry for the five years between 2002 and 2006

| YEAR | PAPER | CANDIDATURE | MAXIMUM MARK | MEAN MARK | STANDARD DEVIATION |
|---------|---------|-------------|--------------|-----------|--------------------|
| 2002 | 233/1 | 187,261 | 70 | 22.25 | 16.44 |
| | 233/2 | | 80 | | |
| | 233/3 | | 40 | 12.25 | 6.19 |
| | Overall | | 190 | 34.27 | 21.29 |
| 2003 | 233/1 | 198,016 | 70 | 22.85 | 16.75 |
| | 233/2 | | 80 | | |
| | 233/3 | | 40 | 14.55 | 7.02 |
| | Overall | | 190 | 37.42 | 22.86 |
| 2004 | 233/1 | 214,520 | 70 | 25.40 | 16.19 |
| | 233/2 | | 80 | | |
| | 233/3 | | 40 | 14.22 | 5.46 |
| | Overall | | 190 | 39.62 | 20.00 |
| 2005 | 233/1 | 253,508 | 70 | 24.50 | 18.24 |
| | 233/2 | | 80 | | |
| | 233/3 | | 40 | 13.56 | 5.90 |
| | Overall | | 190 | 38.05 | 23.00 |
| 2006 | Paper | 236,831 | | | |
| | 1 | | 80 | 20.79 | 14.95 |
| | 2 | | 80 | 17.56 | 13.82 |
| | 3 | | 40 | 11.48 | 5.10 |
| Overall | | 200 | 49.82 | 32.00 | |

Source: Kenya National Examination Council page 87- for years between 2002 and 2005
Page 73-for 2006

Chemistry examination at the KCSE in Kenya involve theory and practical papers. 233/1 and 233/2 are theory papers which test the entire syllabus and particular topics in depth. 233/3 or paper 3 is the practical paper. They tests candidates on various skills for example measuring volumes, time, temperature and analysis of compounds to identify their compositions.

From the table above the following observations can be made:-

- (i) There was a slight drop in performance in the theory papers where the candidate mean score dropped from 25.40 in the year 2004 to 24.50 in the year 2005. The same can be said of the practical paper (233/3) where the candidates mean score has been dropping from 14.55 in the year 2003 to 13.56 in the year 2005. In the year 2006, candidates sat for

the KCSE examination under the revised curriculum. Practical paper was still marked out of 40, but the mean was still very low 11.48. It was the lowest mean attained in the five years between the year 2002 and 2006.

- (ii) Questions which candidates performed poorly were highlighted. In year 2005, in practical paper, question 3 was performed poorly. This question was on qualitative analysis. Also in year 2006, the same question on qualitative analysis was performed poorly. In this question, unknown substance was given to candidates and they were expected to carry out experiments to find out its composition or functional group present in it. The question tested on candidates ability to select suitable apparatus for various tests, heat substances in test-tubes, make accurate observations and record them using acceptable scientific language. They were also to make accurate inferences based on the observations.

The following were the weaknesses noted:-

- (a) Candidates did not take precaution when carrying out experiments, hence the observations were inaccurate. They were unable to make accurate inferences and communicate them using acceptable scientific language.
- (b) Some of the observations were forgotten and thus the inferences made were wrong.

This analysis gives a better reason why salts is an important topic to research on. The selected science process skills (experimenting, observations and inferences) are critical in that they are still tested in the KCSE practical examinations. In 2008 Examination Performance, Candidates performed poorly than the previous years. Candidates performed poorly in 15 out of the 28 subjects offered in the exams. They performed particularly badly in English, Kiswahili, Biology, Physics and Chemistry which are required for university admission and entry into required professions (Nation correspondent, 2010). The use of SPROMALEA might improve the candidates performance in practicals Chemistry examination, hence improve the general performance in the chemistry in KSCE exams.

2.8 Science Process Skills in Science Education

In science education attempts have been made to distinguish between skills and processes. According to Fairbrother (1989) the Secondary Science Curriculum Review (SSCR) of UK, defined a skill as a specific activity which a learner can be trained to do. For example observing and measuring. A process is a rational activity involving the application of a range of skills such

as drawing conclusions, predicting and inferring. Okere (1996) suggests that it is more convenient to refer to all those activities that contribute to scientific learning as process skills. This statement combines the psychomotor related skills of observing, measuring, with cognitive dominated analytical techniques for coding and conceptualizing the specific bits of sensory information.

Padilla, Okey and Dillashow (1983), argued that scientific method, scientific thinking and critical thinking are terms used at various times to describe the science skills. The term science process skills is commonly used to popularise the curriculum project. Science - a process approach SAPA. SAPA, grouped process skills into two types basic and integrated. Basic (simpler) process skills provide a foundation for learning the integrated (more complex) skills. Science process skills are defined by Arena (1996), as the sequence of events that are engaged by researchers while taking part in scientific investigations. Brotherton and Preece (1995), classified the basic science process skills as observation, classification inferring, communication, recording predicting, controlling variables, collecting data. They classified integrated science process skills as graphing, hypothesing, experimenting, interpreting data, formulating models. Hence the selected science process skills in this study are basic and integrated skills.

2.8.1 Learning Basic Science Process Skills in School

Numerous research projects have focused on the teaching and acquisition of basic process skills. For example: Padilla Cronin and Twiest (1985) surveyed the basic process skills of 700 middle school students with no special process skills training. They found that only 10% of the students scored above 90% correct on basic process skills, even at the eighth grade level. Several researchers have found that teaching increases level of skill performance. Padilla and Pyle (1996) identified three steps that may be followed during the learning of basic science process skills, namely brainstorming, observations about an object or phenomenon, creating inferences based on observations and testing the inferences through simple experiments. Studies focusing on the science curriculum improvement study (SCIS) and Science A Process Approach (SAPA) indicated that students in elementary schools if taught process skills abilities, not only learn to use those processes but also retain them for future use (Wideen,1975).

2.8.2 Learning Integrated Science Process Skills in School

Several studies have investigated the learning of integrated science process skills. For instance Wright (1981) found that students can be taught to formulate hypotheses and that this ability is retained overtime. The same considerations in the learning of basic science process skills are needed for the learning integrated science process skills. Miller and Driver (1987) describe experimenting as an integrated process skill that includes other process skills like observations, interpretation planning, reporting and self reliance. Observation refers here to the ability to observe accurately and read instructions in correct sequence. Mackenzie and Padila, (1984) systematically integrated experimenting lessons into a middle school science curriculum. One group of students was taught a two week introductory unit on experimenting which focused on manipulative activities. A second group was taught the experimenting unit, but also experienced one additional process skill activity per week for fourteen weeks. Those having the extended treatment outscored, those experiencing the two week unit.

2.8.3 Reasons for Teaching Science Process skills in School

Jenkins (1989) and Okere (1996), gave reasons for teaching science process skills. The main reason is based on the notion of transferability of learning. Once a skill has been acquired it may be transferred to new areas of applications. For example if a student has acquired the skill of experimenting in chemistry, one would expect such a student to apply the same skills in another subject, such as biology or physics. A second reason is that a process skill enhances the idea of "science for all". It is believed that pupils don't forget the skills they have acquired very easily, hence they can use those skills later in life. A third reason is that it enhances pupils attitude towards learning science. The supporters of the argument advance the theory that, many pupils shy away from science because of the content approach which they believe makes the learning science more difficult. Finally it is believed that the process skill approach is more flexible, makes the knowledge more relevant to the pupils and hence motivating.

2.8.4 Effects of Teaching Science Process Skills School

Brotherton and Preece (1995), Miller and Driver (1987), found from their studies that science process skills can: actively involve learners in learning and so reflect a more progressive pedagogy, help learners to integrate new information into their existing body of knowledge and; improve learners interest, motivation, concentration values and attitude towards science.

Biology students program at the university of Washington taught students science process skills that they believed were needed for success in the introductory biology courses. These students who participated in the research reap numerous benefits such as learning a topic in depth, thinking like a scientists and also gain valuable skills (Dirks & Cunningham, 2006). Further studies on experimenting abilities shows that they are closely related to the formal thinking abilities described by Piaget. A correlation of 0.73 between the experimenting and formal thinking was found in one study (Padilla, Okey & Dillashaw, 1983).

2.9. Mastery Learning

Mastery learning is an instructional strategy that allows students to study material until they master it (Dembo, 1994). It emphasizes students mastery of specific learning objectives and uses corrective instruction to achieve the goal. Mastery learning assumes that virtually all students can learn what is taught in school if their instruction is approached systematically, and if students are helped when they have learning difficulties. Students are given sufficient time and instructional strategies so that all can achieve the same level of learning (Levine, 1985; Bloom,1981).

Instructing for mastery involves:

- a) Clear stated objectives representing the purpose of the course.
- b) The content is divided into relatively small learning units, each with their own objectives and assessments.
- c) Learning materials and instructional strategies are identified, teaching modeling, practice formative evaluation, reteaching and reinforcement are all considered in planned lessons.
- d) Each unit is preceded by brief diagnostic test or formative assessment.
- e) The results of diagnostic test are used to provide supplementary instructions to help students overcome problems.

Time for learning must be adjusted to fit aptitude. No student is allowed to proceed to new material until basic and prerequisite material is mastered (Guskey, 1997). In this study, the in cooperation of mastery learning in teaching science process skills in Chemistry lessons was implemented. It was to find out from an experimental mode how student's achievement and acquisition of science process skills was affected.

2.9.1. Mastery learning in schools

Mastery learning has been widely applied in schools and training settings. Researches show that it can improve instructional effectiveness (Block, Eftim & Burns, 1989; Slavin, 1987). Gallagher & Pearson, (1989), reviewed several studies on classroom practices and reported that from 1893 to 1979 instructional practices remained about the same.

Ngesa (2002) reported that mastery learning programme resulted in higher students achievement in secondary school Agriculture than the conventional teaching method. He argued that the results were significant with regard to classroom instruction and teacher education in Agriculture. Wachanga & Gamba (2004), from their research reported that mastery learning resulted in higher students achievement and thus should be used in chemistry teaching in secondary school level. Guskey and Gates (1986) conducted a metaanalysis which contained 27 studies addressing five areas: student achievement, student retention, time variables, student affect and teacher variables. They found that achievement results were overwhelmingly positive but varied greatly from study to study. Students in mastery learning programs at all levels showed increase gains in achievement over those in traditional instruction program.

Kulik, Kulik and Bangert – Drowns (1990) conducted a meta-analysis involving 108 evaluations of mastery learning programs. The outcome measures used performance on examinations at the end of instructions, attitude towards instruction, attitude towards content and course completion. Performance of examinations at the end of instruction showed positive effects on students achievement. Arredondo and Block (1990) discussed the integrated efforts necessary to make the connections between educational models and education environment. They looked at the efforts of two school districts that had successfully integrated mastery learning along with thinking skills into the curriculum. Both districts began their integration in the early 1980's and had spent considerable time deciding on specific content to be taught and evaluated. Each district had shown considerable increase in achievement while at the same time students have been provided with basic framework necessary to connect one fragment of instructions with another (Smith, 1989). The department of labour's secretary's commission on achieving necessary skills (SCANS, 1991) reported, outlines the requirements of today's ever changing technology. The SCAN'S report provide a blue print of basic foundations necessary for basic skills, thinking skills and personal qualities. The research and implementation studies on mastery learning show

significant positive effects in each of these areas. By using mastery learning programs in the basic skills areas, academic foundations for success in the twenty first can easily be reached by the vast majority of our student population.

2.9.2 Essential elements of mastery learning

After Benjamin Bloom represented his ideas on mastery learning, others described procedures for implementation and numerous programs based on mastery learning principles sprung up in schools and colleges throughout the United States and around the World (Block & Anderson, 1975). These programs differed from setting to setting, those true to Bloom's ideas included two essential elements:

- i) The feedback, corrective and enrichment process
- ii) Instructional alignment (Guskey, 1997).

2.9.2.1 Feedback corrective and enrichment activities

Teachers who use mastery learning provide students with frequent and specific feedback on their learning progress, typically through the use of regular, formative classroom assessments. Feedback is both diagnostic and prescriptive. It indicates what students were expected to learn, identifies what was learned well and what needs to be learned better. The National Council of Teachers of Mathematics emphasized these same elements in its latest iteration of standards for school mathematics (NCTM, 2000). NCTM stress the use of assessment that support learning and provide useful information to both teachers and students. Significant improvement requires feedback to be paired with corrective activities that offer guidance and direction to students on how to remedy their learning problems. Correctives activities must be qualitatively different from initial teachings. Developing effective correctives can be challenging. Many schools find that providing teachers with time to work collaboratively sharing ideas, materials and expertise, greatly facilitates the process (Guskey, 2001).

Enrichment activities offer students exciting opportunities to broaden and expand their learning. Teachers implement the feedback, corrective and enrichment activities in a variety of ways. Many short paper and pencil quizzes are used as formative assessments to give students feedback on their learning progress. But formative assessment can take the form of essays projects, reports, performance tasks, skills demonstrations, or any device used to gain evidence on students learning progress. In this study learners were given home assignments after a unit and feedback given the following day.

2.9.2.2 Instructional alignment

Feedback, correctiveness and enrichment activities are important but, alone do not, however constitutes mastery learning. Bloom (1977), stressed that they must be combined with instructional alignment to reduce variation in student learning and closing achievements gaps. This requires clarity and consistency among instructional components. Ensuring alignment among instructional components requires teachers to make several crucial decisions. They must decide on what concept or skills are most important for student to learn and most central to student's understanding. Also teachers must decide what evidence best reflects students mastery of those concepts or skills. This study will give feedback in time and remedial where the learners have not mastered the skills.

2.9.3. Science Process Skill Mastery learning Approach

Arredondo & Block (1990), looked at the efforts of two school districts that had successfully integrated mastery learning along with the thinking skills into their curriculum. Both districts began their integration in the early 1980s and spend considerable time deciding on the specific content to be taught and evaluated. Each district had shown considerable increase in achievement while at the same time, students had been provided with the basic framework necessary to connect one fragment of instruction with another (Smith, 1989). By using mastery learning programs in the basic skills areas, the academic foundation for success in the twenty first century can easily be reached by the vast majority of our student population as reported by Department of labours Secretary's Commission on Achieving Necessary Skills (SCANS, 1991). Dirks and Cunningham (2006), did a research aiming to teach students science process skills that they believed were needed for success in the introductory biology courses. The skills were taught using Scaffolding approach, that progressively challenge students to master the skills, while weaving them together through individual, homework assignments and small group work in class. Those who participated in the research benefit a lot such as learning a topic in depth, thinking like a scientists and gaining variable skills.

The process skills to be acquired in this study are, experimenting, observation and inference, on the topic salts which is central in the chemistry syllabus and they are the skills tested at the KCSE. Learners will be taught in such away that they master these skills, one at a time. Objectives of the topic will be made known to the learners. The procedures on how to instruct for mastery learning will be used as indicated by Levinel (1985). Learners have to master certain skills before being allowed to progress to the next skill.

Summary

According to Ross (2000), science is a process or way of arriving at a solution to a problem. From this study the problem was to find the effect of science process skills mastery learning approach on secondary school students' achievement and acquisition of selected chemistry practical skills. Chemistry teachers in schools have been using combination of learning/teaching methods in teaching. These are, class experiment, teacher demonstration, class discussion, project work, question and answer method. These methods have not helped in improving students achievement in Chemistry. Table 2 shows the performance in Chemistry during the five years (2002-2006) at KCSE Chemistry examination. The performance in the theory and practical papers have been poor, mean scores have been dropping. Questions which candidates perform poorly and their weaknesses have been highlighted.

The literature on science process skills, mastery learning and their effects in teaching in secondary schools have been given. The selected science process skills, experiments, observation and inferences are critical in that they are tested in the KCSE practical examination. Incorporation of mastery learning in teaching science process skills in chemistry lessons was used to enhance the achievement and acquisition of selected science process skills in the study.

2.10 Theoretical Framework

This study was guided by the theory developed by Bloom (1981) and Levine (1985) for mastery learning. Padilla, Cronnin and Twiest (1985): Brotherton and Preece (1995) theory on science process skills. The theory on mastery learning has resulted in a radical shift in responsibility for Chemistry teachers. It states that blame for a students failure rests with the instruction not lack of ability on the part of the student. In this type of learning environment, the challenge becomes providing enough time and employing instructional strategies so that all students can achieve the same level of learning. The theory of science process skills states that teaching of skills increases levels of skills performance. Skills can be taught and when learned can be readily transferred to new situations (Tomera, 1974). Secondary school students, if taught process skills abilities, not only learn to use those processes, but also retain them for future use.

2.11 Conceptual Framework

Figure 1 is a representation of the conceptual framework of the study.

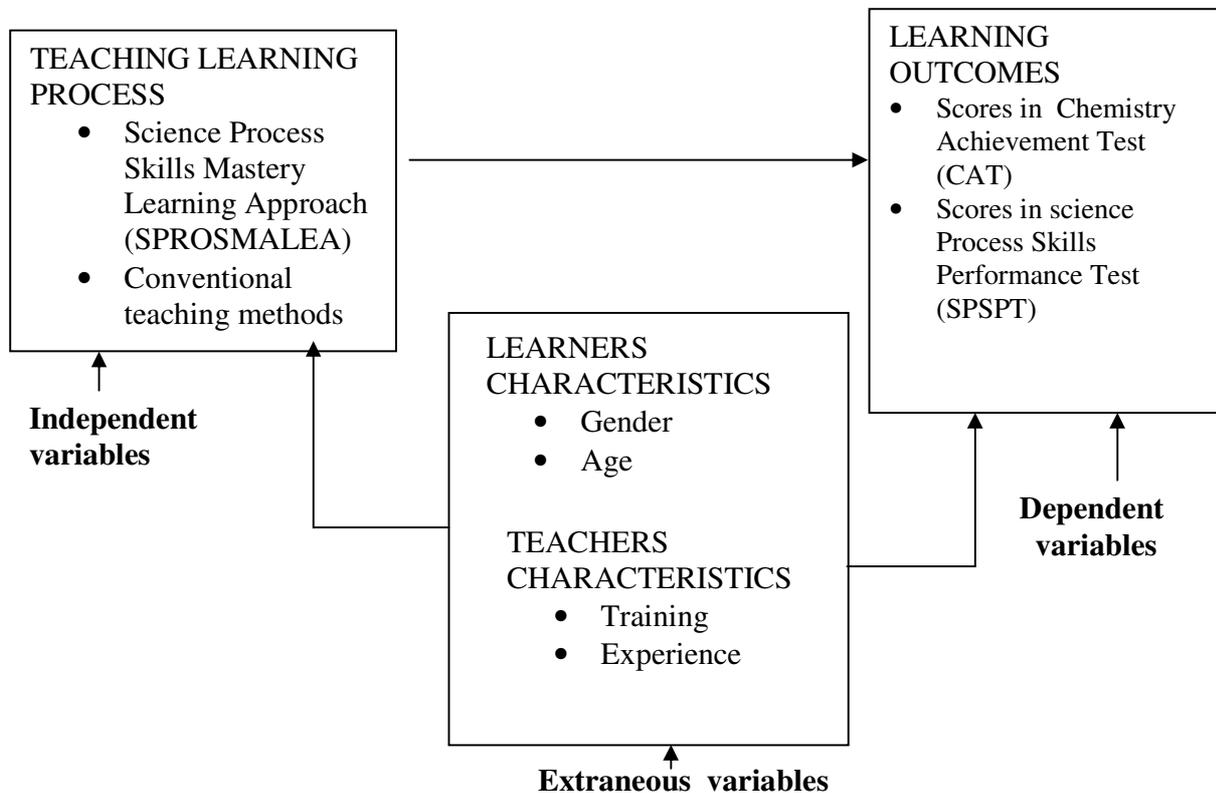


Figure 1: Conceptual framework showing the relationship of variables for determining the effects of Science Process Skills Mastery Learning (SPROSMALEA) on student's achievement and acquisition of Science processes.

The independent variables includes SPROSMALEA and conventional teaching/learning method. These variables are conceptualized as factors influencing the dependent variable of the study. The researcher manipulated the independent variables during the research in order to determine its effect on the dependent variable. That is, student achievement in chemistry and acquisition of selected science process skills. The extraneous variable can influence the independent and dependent variables by either the researcher not being aware of their existence or if aware she/he has no control over them. The teacher characteristics were controlled by involving trained teachers with teaching experience of two years and above. Learner's age was controlled by involving form two students who were approximately of the same age. Student gender was controlled by use of co-educational district schools in Koibatek District.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This chapter describes the methodology the researcher used in this study. It consists of the proposed research design, population of study, sample and sampling procedure, instrumentation, data collection and data analysis procedures.

3.2. Research Design

The study used Solomon Four Non-equivalent control Group Design. The design helps to achieve the four main purposes: To assess the effect of the experimental treatment relative to control conditions, to assess the interaction between pre-test and treatment condition, to assess the effect of pre-test relative to no pre-test and; to assess the homogeneity of the groups before administration of the treatment (Borg & Gall, 1989; Mugenda & Mugenda, 2003).

This design has the following advantages: the use of both a pre-test and post-test, the temporal precedence of the independent variable to the dependent variable can be established. This gives the researcher more confidence when inferring that the independent variables was responsible for the changes in the dependent variable, the use of pre-test allows the researcher to measure between group differences before exposure to the intervention. This could substantially reduce the threat of selection bias by revealing whether the groups differ on the dependent variable prior to the intervention (Fraenkel & Wallen, 2000; Borg & Gall, 1989).

Table 3

Solomon Four Non-Equivalent Control

| Group | Pretest | Treatment | Post-test |
|----------------|----------------|------------------|------------------|
| E ₁ | O ₁ | X | O ₂ |
| E ₂ | - | X | O ₃ |
| C ₁ | O ₄ | - | O ₅ |
| C ₂ | - | - | O ₆ |

Source; Fraenkel & Wallen (2000 p.291)

- (O) - Indicates observations or outcomes at pretest and post-test phases
- (X) - Indicates treatment
- (----) - Indicates the use of non-equivalent groups.

The Table 3 shows four groups of participants, the Experimental Group One (E₁), the Experimental Group Two (E₂), The Control Group One (C₁) and the Control Group Two (C₂) was used. Groups E₁ and E₂ formed the experimental groups which received treatments (X), while C₁ and C₂ were the control Groups without treatment. Groups E₁ and C₁ received pre-test (O₁ and O₄), while O₂, O₃, O₅ and O₆ represented the post-test.

The experimental treatment was the use of SPROMALEA in teaching the topic salts while the control groups C₁ and C₂ were taught using the conventional methods. A post-test (O₂, O₃, O₅ and O₆) was administered to all groups at the end of the study. To avoid interaction of students from different groups that may contaminate the results of the study, one class from a school constituted one group of subjects, hence four schools were required for this study. The selected classes were randomly assigned to the experimental and control groups. This study involved the quasi-experimental research because the secondary school classes once constituted exist as intact groups and school authorities do not allow such classes to be broken up and reconstituted for research purposes (Mugenda & Mugenda, 2003; Borg & Gall, 1989; Mutai, 2000).

3.3. Population of the Study

The target population of the study consisted of form two students in public schools in Koibatek District, Kenya. The sample was drawn from accessible population of form two students in district mixed secondary schools. This population formed sampling frame of the study. Form two students were chosen because the topic salt is mainly taught at this level in all Kenyan secondary school (K.I.E, 2002). The research included head of science departments and chemistry teachers from these schools.

3.4. Sample Size and Sampling Procedure

3.4.1. Sample size

Mugenda and Mugenda (2003) argued that the sample size depends upon the number of variables in the study, the type of research design, the method of data analysis and the size of accessible population. For experimental studies at least 30 students per group is recommended. In this study four schools were sampled and one stream from each school included in the study. The actual sample size that participated was 160 form two students, sampled as shown in Table 4.

Table 4

Sample Size of the Study

| Groups | Number in each group |
|----------------|-----------------------------|
| E ₁ | 38 |
| E ₂ | 39 |
| C ₁ | 46 |
| C ₂ | 37 |
| Total | 160 |

3.4.2. Sampling Procedure

Purposive sampling was used to select the four district co-education secondary schools in Koibatek District. This is because not all schools possessed the required characteristics. Only schools with laboratories, apparatus, at least a trained and two years of experience teacher teaching chemistry and accessibility of the school from the road. The sampling frame comprised schools with minimum enrolment of 40 students in form two chemistry classes. The researcher visited the schools to ascertain that they were suitable for research and obtained information on

class composition, learner and teacher characteristic. For schools that had more than one stream taking chemistry, simple random sampling was employed to pick one stream per school as advocated by (Borg & Gall, 1989). Selected classes were randomly assigned to experimental and control groups.

3.5 Instrumentation

This section indicates the instruments that were used for data collection and how they were developed. Three instruments were used:

- i. Chemistry Achievement Test (CAT).
- ii. Science Process Skills Performance Test (SPSPT).
- iii. Class Observation Schedule (COS)

The CAT and SPSPT were to measure students' achievement and acquisition of selected Chemistry Practical Skills before and after the course of study. The COS was used to capture the teacher and students' activities during instruction.

3.5.1 Chemistry Achievement Test (CAT)

The Chemistry Achievement Test (CAT) (See Appendix A) was used to assess the learners' mastery of content on the topic salts in secondary chemistry. There were fifteen items of short answers questions and structured questions on salts. These items tested knowledge, comprehension and application of learned materials. The total possible score was 50. The instrument was pilot-tested in two secondary school in Koibatek District, which were not part of the study but having similar characteristics as the sample schools. Reliability was estimated using Kuder-Richardson (K-R)₂₁ since it is suitable for calculation of reliability when items can be scored as right or wrong (Borg & Gall, 1989; Fraenkel & Wallen, 2000). The reliability coefficient of the instrument was 0.96. For research purposes, a useful rule of thumb that reliability should be 0.7 or higher (Fraenkel & Wallen, 2000). The value in this study is above 0.7 hence acceptable. This implied that there was a good internal consistency of items. The CAT was pre-tested with the experimental (E_1) and control group (C_1) before the commencement of the topic salt and to all groups after the course. The items were scored using a standardized marking scheme and the obtained scores recorded and used during data analysis.

3.5.2 Science Process Skills Performance Test (SPSPT)

The SPSPT (See Appendix B) was used to evaluate the performance of process skills (experimenting, observation, inferences) by the students. It contained two practical items on salts. The total possible score was 30. This instrument was pilot-tested in two schools in Koibatek District not included in the study. Reliability was estimated using K-R 21 and had a reliability of 0.88. The reliability coefficient level is above 0.7, hence acceptable. This implied that there was a good internal consistency of items. The SPSPT was pre-tested with the Experimental (E_1) and Control group (C_1) before used and to all groups after the course. The treatment groups were taught with more emphasis on mastery of these science process skills. Table below shows the Science Process Skills to be assessed, the skill the student had to display in order to demonstrate competence in using the given process skill and assessment tool to be used.

Table 5
Science Process Skills and Method of Assessment

| Science process skills | Skill practiced | Assessment tools |
|-------------------------------|---|-------------------------|
| Experimenting | <ul style="list-style-type: none"> • Select and design appropriate process or experiment for a particular object • Select and design apparatus for a particular object • Employ the process of observing | SPSPT |
| Observing | <ul style="list-style-type: none"> • Recalls and recognizes the properties of objects and phenomena using senses. • Identifies changes occurring in a reaction | SPSPT |
| Inferring | <ul style="list-style-type: none"> • Distinguishes objects properties. • Identify observable characteristic in a given reaction • Identify and specify observations which would be needed to justify a particular generalization. • Infers relationship between phenomena. • Infers an effect by identifying the cause | SPSPT |

The items were scored using a standardized marking scheme. The obtained scores were recorded and used during data analysis (Fraenkel & Wallen, 2000, Bhatt, 2003).

3.5.3 Classroom Observation Schedule

The classroom observation schedule (COS) (see Appendix C) was adapted from (Flanders, 1970, cited in Kathuri & Pals 1993; Kiboss 1997) and modified to suit the study. The COS was used to observe four lessons on the topic salt to provide data on teachers and students activities during instruction processes. It had two sections which provided data on the teachers and students activities respectively. It contained eleven teachers and sixteen students' related items. The instrument was pilot tested in two schools in Koibatek District; not included in the study.

Sixteen items were used in the calculation of Cronbach's alpha (α) for the test of how reliable the student activity was and a Cronbach's alpha of 0.97 was obtained. Cronbach alpha is used to in calculating the reliability of items that are not scored right versus wrong (Fraenkel & Wallen, 2000). This implied that there was a good internal consistency of items in the scale since alpha is above 0.7. In the teachers activity eleven observations were used in calculation of the Cronbach's alpha (α). This teacher activity scores were observed in two different schools. Cronbach's alpha coefficient of 0.93 was obtained. This implied it had high reliability coefficient hence acceptable since alpha was above 0.7.

This instrumentation was included to provide qualitative data or insight on what would actually transpire during the instructional process.

3.5.4. Validation and Reliability of Instruments

The validity of a research instrument is defined as the accuracy with which it measures what it is intended to measure. Reliability of an instrument is the degree of consistency with which it measures and what it is expected to measure. It refers to the consistency of the information supplied by the instrument.

3.5.4.1 Validity of CAT

The test items in CAT and scoring key were validated by the supervisors, secondary school chemistry teachers and moderated by six experts in education. comments from the experts were used to improve the instruments thus making it appropriate for use in the research study.

3.5.4.2 Validity of SPSPT

The validity of SPSPT was determined by the supervisors, Chemistry teachers in secondary school and moderated by a team of six experts in education. Their comments were used to improve the instrument.

3.5.4.3 Validity of COS

Validity of COS was determined by the supervisors and a team of six lectures in education. They examined the instrument and suggested any modification that could be made on it, in order to make it more appropriate for observing teachers and learners activities in the classroom during instruction.

3.6 Development and use of Teaching Materials

The content to be used in the class instruction was developed and based on the revised KIE 2002 chemistry syllabus, teachers guide, students textbook and other relevant materials. Teachers' manuals included the content to be covered and lesson plans to be used in teaching the topic "salts" in form two chemistry. Student manuals were the worksheets including the guidelines and procedures the learners would use when performing experiments in the laboratory. These manuals were only used in the experimental groups. The teacher had to mention the expected objectives the learner had to achieve at the end of the lesson, introduced the lesson, discussed the results of the experiment, give assignments and remedial work to those learners who had not mastered the concepts and skills.

In control groups, the conventional teaching/learning methods of teaching were used. The teachers in the experimental groups were trained in the new approach, given teaching modules and student manuals by the researcher. Classes in all the four groups used the same curriculum materials and spent about the same time (four weeks) on topic salts as recommended in the syllabus. The two instruments CAT and SPSPT were used in all the groups, control and experimental groups.

3.7 Data Collection Procedures

The researcher first got introductory letter from graduate school and then research permit from the National Council for Science and Technology office. She contacted the head teachers of the selected schools and sought to be introduced to the chemistry teachers of form two classes. A pre-test was conducted in one experimental group (E_1) and one control group (C_1) in order to measure the students entry behaviour before the treatment. In experimental groups E_1 and E_2 SPROSMALEA was used, while in control groups C_1 and C_2 conventional teaching method was used. At the end of the treatment period, they administered the post-test (CAT and SPSPT) for all groups. CAT and SPSPT was used to measure students achievement and acquisition of science processes respectively. The researcher supervised the teaching and scored the pre-test and post-test. COS that was used to provide data in the teachers and students activities. Data was collected from at least four lessons taken from each of the experimental and control groups. The frequency of the classroom activities observed in the study was calculated as means.

3.8 Data Analysis

Both descriptive and inferential statistics were used to summarize the data. Descriptive statistics such as frequencies, mean and standard deviation needed for further analysis was used. Inferential statistics was used to analyse the data and test the research hypothesis. ANOVA and ANCOVA was used to analyse differences in the four means of post-test scores. It was used to determine whether the difference was significant. A t-test was used to get the differences between two means. Hypothesis was tested at $\alpha=0.05$ level of significance. Analysis was done with the aid of the Statistical Package for Social Sciences (SPSS) version 12. A summary of statistical analyses used in the study is given in Table 6.

Table 6**Summary of Data Analysis**

| Hypothesis | Independent variable | Dependent variable | Method of data analysis |
|---|---|---|---|
| Ho ₁ : There is no statistically significant difference between the achievement scores in chemistry of students who are exposed to SPROMALEA and those who are not. | Science Process Skill Mastery Learning approach Conventional teaching method | Scores in Chemistry achievement test (CAT) | One way ANOVA t-test ANCOVA Frequency |
| Ho ₂ : There is no statistically significant difference in scores, in the acquisition of science processes (experimenting, observation and inferences) between students who are exposed to SPROMALEA and those who are not | Science Process Skill Mastery Learning approach Conventional teaching method | Scores in Science Process Skills Performance test (SPSPT) | One way ANOVA t-test ANCOVA Frequency |

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. Introduction

In this chapter, the research data obtained are presented using descriptive and inferential statistics. The findings are presented in the form of tables and graphs. The results and their implications are discussed. ANCOVA, ANOVA and t-test were used to test the hypotheses of the study. The sections that follow contain information in the following areas:-

- (i) Results of the pre-test
- (ii) Effect of SPROMALEA on students' achievement in Chemistry.
- (iii) Effects of SPROMALEA on students acquisition of Science Process Skills (experimenting, observation and inferences)
- (iv) Results of classroom observation schedule.

The study comprised of four groups, two experimental groups (E_1 and E_2) were taught using mastery process skill module (treatment), while the control groups (C_1 and C_2) were taught using the conventional method. E_1 and C_1 were pre-tested and all E_1 , E_2 , C_1 and C_2 were post-tested.

4.2. Analysis of Pretest

Two instruments the CAT and SPSPT were used to pre-test. This was done to enable the researcher to check their entry behaviour and to determine whether the groups were similar before the commencement of the Chemistry topic on salts. Experimental group (E_1) and control group (C_1) sat for the pre-test. The results are presented in Table 7.

Table 7

Comparison of Pre-test Means and SD of Groups on CAT and SPSPT

| TEST | GROUP | N | MEAN | STD DEVIATION |
|-------|-------|----|-------|---------------|
| CAT | E_1 | 38 | 17.18 | 9.53 |
| | C_1 | 46 | 20.02 | 8.62 |
| SPSPT | E_1 | 38 | 36.41 | 13.22 |
| | C_1 | 46 | 39.11 | 12.89 |

CAT Maximum Score = 100
SPSPT Maximum Score = 100

Table 7 shows that the mean scores and standard deviation's (SD) of the pre-test of E₁ and C₁ were different. A t-test was undertaken to determine whether the differences were statistically significant or not at the level of 0.05.

Table 8

Independent Samples t-test of the Pre-test Scores on CAT and SPSPT

| TEST | GROUP | N | MEAN | SD | t-value | P-value |
|-------|-------|----|-------|-------|---------|---------|
| CAT | E1 | 38 | 17.18 | 9.53 | 1.48 | 0.14 |
| | C1 | 46 | 20.02 | 8.62 | | 0.14 |
| SPSPT | E1 | 38 | 36.41 | 13.22 | 0.95 | 0.34 |
| | C1 | 46 | 39.11 | 12.89 | | 0.34 |

Mean difference not significant at 0.05

Results in Table 8 revealed that the difference in students scores in the CAT between E₁ and C₁ were not statistically significant at $t(82)=1.48$ $P>0.05$. Also the difference were not statistically significant when SPSPT were used, since $t(82) =0.95$ $P>0.05$. Mean score of the two groups on both CAT and SPSPT were not statistically significant. This indicates that the groups used in the study exhibited comparable characteristics and therefore suitable for the study.

4.3. Effects of SPROMALEA on Students Achievement on Salts in Secondary School Chemistry

To determine the relative effect of SPROMALEA on students achievement in Chemistry, an analysis of the students post-test CAT scores was carried out. The first hypothesis of the study sought to find out whether there was any statistically significant difference between achievement of students who were exposed to SPROMALEA and those who were not. Table 9.

Table 9

CAT Post-test Mean Scores obtained by the Students in Four Groups

| Group | N | Mean Score |
|----------------|----------|-------------------|
| E ₁ | 38 | 37.89 |
| E ₂ | 39 | 41.05 |
| C ₁ | 46 | 27.20 |
| C ₂ | 37 | 32.27 |
| Total | 160 | 34.60 |

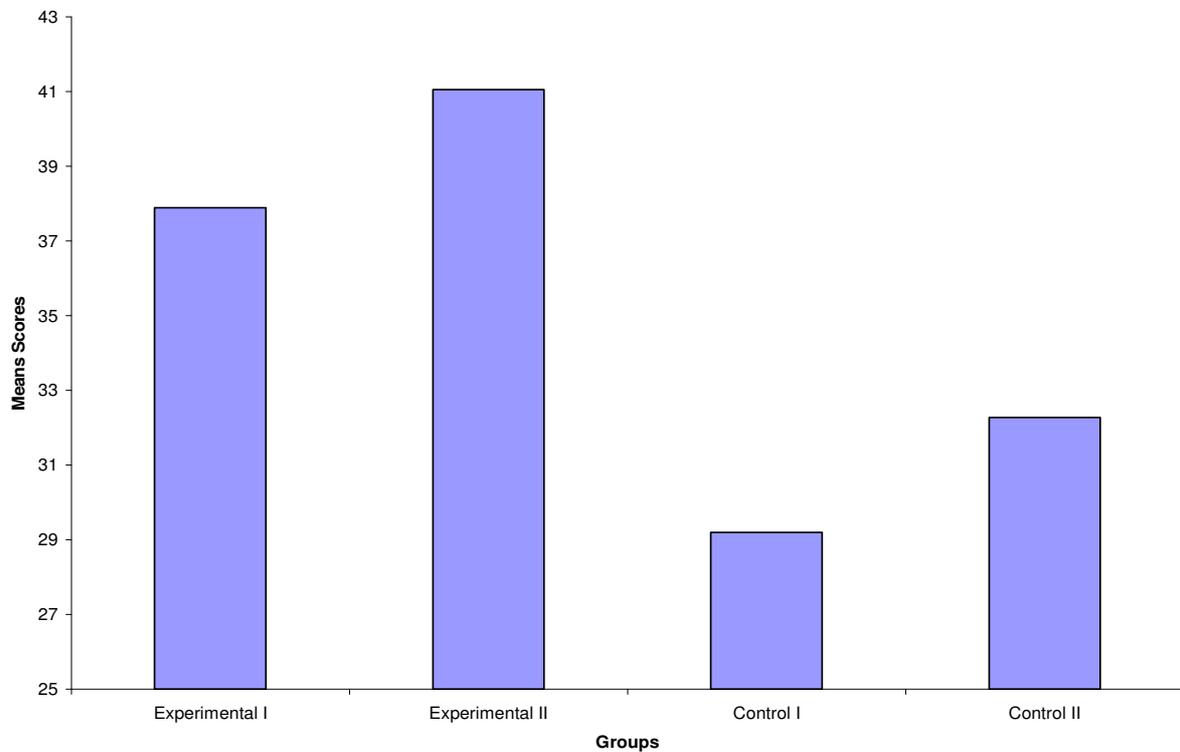


Figure 2: CAT Post-test means

Results shown in Table 9 and Figure 2 indicate that experimental groups E₁ and E₂ achieved higher mean scores than control groups C₁ and C₂. This shows that SPROMALEA had an effect of improving performance as compared to the conventional teaching method. ANOVA was also carried out to establish whether the groups mean scores on the CAT were statistically significantly different as shown in Table 10.

Table 10**ANOVA of the Post-test Score on the CAT**

| Test | Group | SS | DF | Mean Square | F | P-Value |
|-------|----------------|----------|-----|-------------|------|---------|
| CAT | Between groups | 4146.46 | 3 | 1382.15 | 9.79 | 0.00 |
| | Within groups | 20620.36 | 156 | 141.24 | | |
| Total | | 24766.82 | 159 | | | |

Mean difference is significant at 0.05 level

Results in Table 10 indicate that a statistically significant difference exists between the subjects mean scores because the p-value $F(3,156)=9.79$, $P<0.05$ is less than 0.05. While the null hypothesis could be rejected, findings do not indicate which groups are similar and which are different. To establish this, it was necessary to carryout the Least Significant Difference (LSD) post hoc test.

Table 11**Post Hoc Comparisons of the CATs Post-test Means for Four Groups.**

| I Group | J Group | Mean differences (I-J) | P-value |
|----------------|----------------|------------------------|----------|
| E ₁ | E ₂ | -3.16 | 0.25(NS) |
| | C ₁ | 10.64* | 0.00 |
| | C ₂ | 5.62* | 0.04 |
| E ₂ | E ₁ | 3.16 | 0.25(NS) |
| | C ₁ | 13.80* | 0.00 |
| | C ₂ | 8.78* | 0.00 |
| C ₁ | E ₁ | -10.64* | 0.00 |
| | E ₂ | -13.80* | 0.00 |
| | C ₂ | -5.02 | 0.07(NS) |
| C ₂ | E ₁ | -5.62* | 0.04 |
| | E ₂ | -8.78* | 0.00 |
| | C ₁ | 5.02 | 0.07(NS) |

* Significant at $P<0.05$ level
(NS) – Not Significant

Table 11 shows results of post hoc comparisons, test of significance for a difference between any two means. The CAT means of groups E₁ and C₁, groups E₁ and C₂, groups E₂ and C₁ and groups E₂ and C₂ were statistically significantly different at 0.05 level. However, there was no statistically significant difference in the means between groups E₁ and E₂, and groups C₁ and C₂

From this results, the subjects in the experimental conditions outperformed the subjects that were in control groups. It can therefore be concluded that the SPROSMALEA approach used by the experimental group led to a relatively higher achievement in the learning of salts than the conventional method used in the control group. The study involved non-equivalent control group design, there was need to confirm these results by performing analysis of covariance (ANCOVA) using students Kenya Certificate of Primary Education (KCPE) scores as Covariate.

Analysis of covariance reduces the effects of initial group differences statistically by making compensating adjustments to the post-test means of the groups involved (Borg & Gall, 1989; Wachanga, 2002). Table 12

Table 12
Adjusted CAT post-test Mean scores for ANCOVA with KCPE scores as covariant

| Group | N | Mean Score |
|----------------|----------|-------------------|
| E ₁ | 38 | 37.91 |
| E ₂ | 39 | 41.00 |
| C ₁ | 46 | 27.05 |
| C ₂ | 37 | 32.35 |

Table 13
Analysis of Covariance (ANCOVA) of the Post-test Scores of CAT with KCPE as covariate

| | Sum of Square | DF | Mean squares | F | P-value |
|-------|----------------------|-----------|---------------------|----------|----------------|
| KCPE | 668.06 | 1 | 668.06 | 4.39 | 0.04 |
| Group | 3525.72 | 3 | 1175.24 | 8.08 | .00 |
| Error | 22552.90 | 155 | 145.50 | | |

F=8.08, DF=3, P<0.05 Covariate KCPE Marks = 279.48

Table 13 shows the ANCOVA results based on the adjusted means of the four groups displayed in Table 11. The results confirm that the difference between the means are significant at the 0.05 level $F(3,155) = 8.08$ $P < 0.05$.

Table 14
Pairwise Comparison's Post-test Scores of CAT

| I Group | J Group | Mean differences (I-J) | P-value |
|----------------|----------------|------------------------|----------|
| E ₁ | E ₂ | -3.09 | 1.02(NS) |
| | C ₁ | 8.76* | 0.01 |
| | C ₂ | 5.56* | 0.03 |
| E ₂ | E ₁ | 3.09 | 1.02(NS) |
| | C ₁ | 11.85* | 0.00 |
| | C ₂ | 8.66* | 0.02 |
| C ₁ | E ₁ | -8.76* | 0.01 |
| | E ₂ | -11.85* | 0.00 |
| | C ₂ | -3.20 | 1.00(NS) |
| C ₂ | E ₁ | -5.56* | 0.03 |
| | E ₂ | -8.66* | 0.02 |
| | C ₁ | 3.20 | 1.00(NS) |

* Significant at $P < 0.05$

(NS)= Not Significant

The post hoc pairwise comparisons based on the ANCOVA Table 14, shows that there is a statistically significant difference in the following groups.

- (i) Groups E₁ and C₁
- (ii) Groups E₂ and C₁
- (iii) Groups E₁ and C₁
- (iv) Groups E₂ and C₂

Difference between groups E₁ and E₂ and groups C₁ and C₂, were not significant. It is evident the SPROSMALEA had similar effects to both experimental groups. But the control groups C₁ and

C₂ denied of this treatment had a lower mean scores and hence were outperformed by the experimental groups.

The results of ANOVA and ANCOVA confirm that there is a statistically significant difference in the mean scores of the experimental and control groups. Therefore Ho₁ is rejected.

4.4 Effects of SPROMALEA on Students Acquisition of Selected Chemistry Practical Skills (SPSPT)

The second hypothesis of the study sought to find out whether there was any statistically significant difference in scores in the acquisition of science process skills (experimenting, observation and inferences) between students who were exposed to SPROMALEA and those who were not. Table 15 shows (SPSPT) post-test mean score obtained.

Table 15
SPSPT Post-test Mean Scores Obtained by the Students in Four Groups

| Group | N | Mean Score |
|----------------|------------|-------------------|
| E ₁ | 38 | 58.16 |
| E ₂ | 39 | 60.58 |
| C ₁ | 46 | 53.24 |
| C ₂ | 37 | 51.81 |
| TOTAL | 160 | 55.84 |

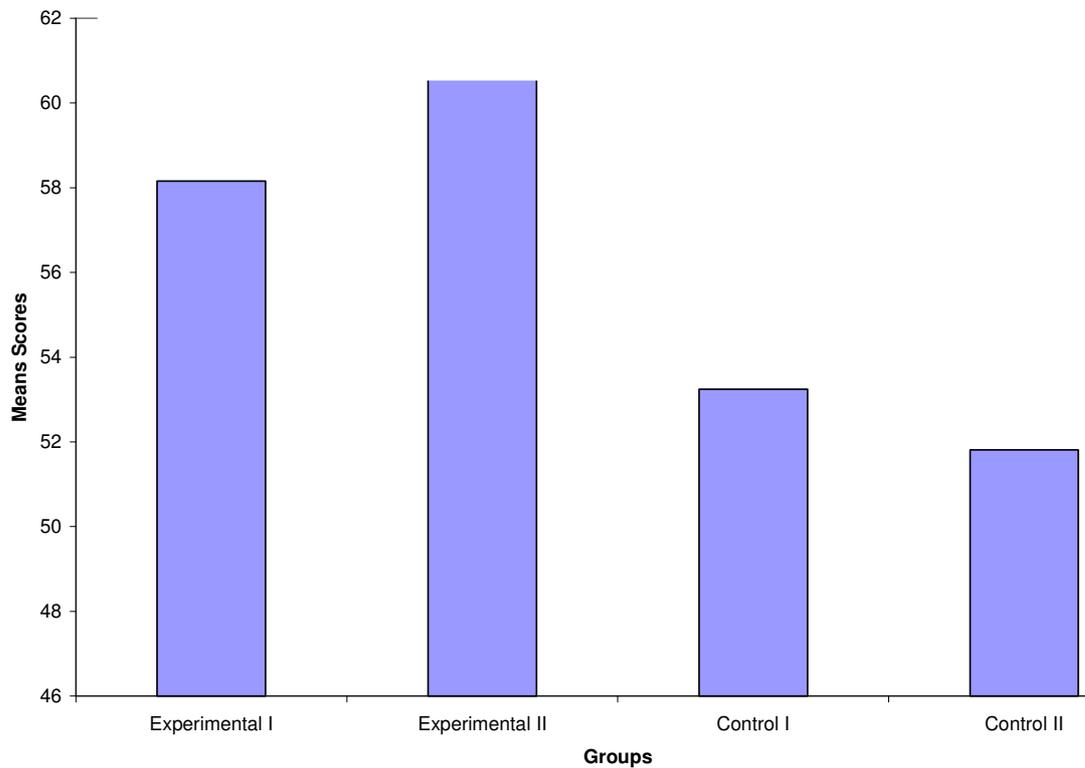


Figure 3: SPSPT Post-test means

Results in Table 15. And figure 3 shows that the experimental groups E_1 and E_2 achieved higher mean scores than the control groups C_1 and C_2 . This could have been contributed by the treatment in the experimental groups. ANOVA was carried out to establish whether the groups mean score in the SPSPT were statistically different Table 16.

Table 16

ANOVA of the Post-test Scores on the SPSPT

| Test | Group | SS | DF | Mean Square | F | P-Value |
|-------|----------------|----------|-----|-------------|------|---------|
| SPSPT | Between groups | 1969.39 | 3 | 656.46 | 6.38 | .000 |
| | Within groups | 15956.36 | 155 | 102.94 | | |
| Total | | 17925.75 | 158 | | | |

Mean difference is significant at 0.05 level

Table 16 indicates that a statistically significance difference exists between mean scores of the groups $F(3,155) = 6.38, P < 0.05$. The null hypothesis could be rejected but the findings could not indicate where the difference was. It was necessary to carryout, Least Significant Difference (LSD) post hoc comparisons, to know which groups were statistically significant different.

Table 17
Post hoc Comparisons of SPSPT Post-test Means for Four Groups

| I Group | J Group | Mean differences (I-J) | P-value |
|----------------|----------------|------------------------|----------|
| E ₁ | E ₂ | -2.42 | 0.30(NS) |
| | C ₁ | 4.92* | 0.03 |
| | C ₂ | 6.35* | 0.01 |
| E ₂ | E ₁ | 2.42 | 0.30(NS) |
| | C ₁ | 7.34* | 0.00 |
| | C ₂ | 8.77* | 0.00 |
| C ₁ | E ₁ | -4.92* | 0.03 |
| | E ₂ | -7.34* | 0.00 |
| | C ₂ | 1.43 | 0.53(NS) |
| C ₂ | E ₁ | -6.35* | 0.01 |
| | E ₂ | -8.77* | 0.00 |
| | C ₁ | -1.43 | 0.53(NS) |

* Significant at $P < 0.05$

(NS)= Not Significant

Table 17 shows the results of post hoc comparisons test of significance for a difference between two means.

The SPSPT means of groups E₁ and C₁, groups E₁ and C₂, groups E₂ and C₁, groups E₂ and C₂ were statistically significant different at 0.05 α level.

However there was no statistically significant difference in the means between groups E₁ and E₂ groups C₁ and C₂. From this, the students in the experimental conditions outperformed students in the control groups. It can therefore be concluded that SPROSMALEA approach used by

experimental groups led to a relatively higher acquisition of practical skills (experiment, observation and inferences in the learning of salts, than those who used the conventional method.

Since the study involved non-equivalent control group design, there was need to confirm these results by performing analysis of covariance (ANCOVA) using students Kenya Certificate of Primary Education (KCPE) scores as covariate.

Analysis of covariance reduces the effects of initial group differences statistically by making compensating adjustments to the post-test means of the groups involved (Borg & Gall, 1989; Wachanga, 2002).

Table 18
Adjusted SPSPT Post-test Mean Scores for ANCOVA with KCPE Scores as Covariate

| Group | N | Mean Score |
|----------------|----------|-------------------|
| E ₁ | 38 | 58.16 |
| E ₂ | 39 | 60.58 |
| C ₁ | 46 | 53.18 |
| C ₂ | 37 | 51.94 |

Table 19
Analysis of Covariance (ANCOVA) of the Post-test Score of SPSPT with KCPE.

| | Sum of Square | DF | Mean squares | F | P-value |
|-------|----------------------|-----------|---------------------|----------|----------------|
| KCPE | 3317.62 | 1 | 3317.62 | 32.07 | 0.00 |
| Group | 1900.31 | 3 | 633.44 | 6.12 | 0.00 |
| Error | 15933.35 | 154 | 103.46 | | |

F=6.122 DF = 3 P<0.05

Mean difference is significant at 0.05 level

Table 19 shows ANCOVA results based on the adjusted means of the four groups displayed in Table 18. There is statistically significant difference in the SPSPT mean score of the four groups. $F(3,154)=6.12$, $P<0.05$. P value is less than 0.05.

Table 20

Post hoc Pairwise Comparisons: Post-test Score of SPSPT

| I Group | J Group | Mean differences (I-J) | P-value |
|----------------|----------------|-------------------------------|----------------|
| E ₁ | E ₂ | -2.36 | 0.32(NS) |
| | C ₁ | 4.98* | 0.03 |
| | C ₂ | 6.22* | 0.01 |
| E ₂ | E ₁ | 2.36 | 0.32(NS) |
| | C ₁ | 7.33* | 0.00 |
| | C ₂ | 8.57* | 0.00 |
| C ₁ | E ₁ | -4.98* | 0.03 |
| | E ₂ | -7.33* | 0.00 |
| | C ₂ | 1.24 | 0.59(NS) |
| C ₂ | E ₁ | -6.22* | 0.01 |
| | E ₂ | -8.57* | 0.00 |
| | C ₁ | -1.24 | 0.59NS) |

* Significant at $P < 0.05$

(NS)= Not Significant

The post hoc pairwise comparison based on ANCOVA Table 20, shows that there is a statistically significant difference in the following groups.

- (i) Groups E₁ and C₁
- (ii) Groups E₂ and C₁
- (iii) Groups E₂ and C₂
- (iv) Groups E₁ and C₂

The differences in means of the groups E₁ and E₂ and groups C₁ and C₂ were not statistically significant. The results of ANOVA and ANCOVA confirm that there is a statistically significant difference in the mean scores of the experimental and control groups. Therefore Ho₂ is rejected.

4.5 Analysis of Teachers and Students Activities during Chemistry Lessons

Results of Classroom Observation Schedule

Data were collected from four lessons taken from each of the experimental and control groups. The frequencies of the classroom activities observed in the study was calculated as means and the results reported in Table 21.

Table 21
Comparisons of Teachers and Students Activities During Chemistry Lessons on Salts

| Teachers Activity | | Means of Frequencies | | | |
|-------------------|---|----------------------|----------------|----------------|----------------|
| | | Groups | | | |
| | | E ₁ | E ₂ | C ₁ | C ₂ |
| 1. | Reinforce appropriate response | 6.90 | 9.50 | 4.50 | 3.75 |
| 2. | Ask questions | 3.00 | 4.75 | 4.75 | 1.50 |
| 3. | Demonstrate a skill | 3.25 | 4.50 | 3.00 | 2.00 |
| 4. | Re-read problems | 6.50 | 8.75 | 5.50 | 5.75 |
| 5. | Re-state problems | 5.50 | 8.25 | 5.25 | 2.25 |
| 6. | Supervises activities | 8.00 | 6.25 | 4.75 | 5.25 |
| 7. | Give precautions | 6.25 | 7.50 | 5.25 | 4.00 |
| 8. | Encourage students to give observations | 8.50 | 8.00 | 5.50 | 2.00 |
| 9. | Encourage students to write orderly results | 6.75 | 5.00 | 3.75 | 2.50 |
| 10. | Review results | 3.75 | 5.30 | 5.50 | 4.00 |
| 11. | Encourage to give inferences | 5.75 | 5.25 | 3.50 | 3.50 |
| Total | | 63.25 | 73.05 | 51.25 | 36.50 |
| Student Activity | | Means of Frequencies | | | |
| | | Groups | | | |
| | | E ₁ | E ₂ | C ₁ | C ₂ |
| 1. | Respond to teachers question | 5.50 | 5.25 | 2.75 | 3.25 |
| 2. | Follow instructions | 5.75 | 5.70 | 1.25 | 4.00 |
| 3. | Perform experiment | 8.25 | 7.50 | 3.25 | 4.75 |
| 4. | Makes observations | 5.00 | 5.75 | 4.50 | 4.50 |
| 5. | Recalls properties | 6.50 | 2.75 | 3.25 | 2.00 |
| 6. | Identify changes occurring in a reaction | 6.75 | 6.00 | 3.25 | 5.50 |
| 7. | Identify observable characteristics | 5.75 | 5.00 | 2.50 | 3.50 |
| 8. | Infer relationship | 5.00 | 7.50 | 2.00 | 3.75 |
| 9. | Infer an effect | 5.00 | 3.75 | 1.75 | 3.50 |
| 10. | Ask questions | 3.75 | 3.25 | 1.50 | 2.50 |
| 11. | Consult other students | 6.75 | 5.75 | 4.25 | 3.25 |
| 12. | Express agreement or disagreement with action | 3.75 | 6.50 | 3.50 | 5.00 |
| 13. | Repeat experiments to clarify the results | 2.25 | 2.00 | 1.75 | 2.50 |
| 14. | Take precautions | 5.75 | 8.75 | 2.50 | 2.75 |
| 15. | Contribute during class discussion | 4.75 | 5.00 | 4.50 | 5.00 |
| 16. | Give conclusions | 2.75 | 3.75 | 2.75 | 1.25 |
| Total | | 85.5 | 83.25 | 45.25 | 59.25 |

Table 21 shows the classroom activities observed during instructions. It attempts to identify possible similarities or differences among teacher/students activities when SPROSMALEA and conventional method were used in Chemistry lessons.

A perusal of the results indicates that the teacher activities in the experimental groups (E_1 and E_2) outperformed those in the control groups (C_1 and C_2). The total mean scores of teacher activities in the experimental group were 63.25 and 73.05 while in the control group were 51.25 and 36.5. In experimental, teachers manual (Appendix D) guided the teacher on what to do. The teacher had to make sure that the objectives were achieved before moving to the next instruction. Learners were required to master the Science Process Skills (experimenting observation and inferences).

Student activities in the experimental groups had a higher mean frequencies than the control groups. This is evident by the total mean score of 85.5 and 83.25 in the experimental groups and 45.26 and 59.25 in the control groups. Use of student manual (Appendix E), must have made learners in the experimental group to be orderly and active, compared to those in the control groups.

Comparing the teacher/student activities, we can see that the students did more activities than the teachers. This is evident by the means of students of 85.5, 83.25, 45.25 and 59.25, teacher activities of 63.25, 73.05, 51.25 and 36.5. This was a learner centre approach, since learners were more involved than the teachers.

From the findings the use of SPROSMALEA was effective in enhancing the teacher/student activities during instruction.

4.6. Discussion of the Results

This study used Solomon Four Group Design. Students were put into four groups such that;

E_1 was experimental group which was pre-tested

E_2 was experimental group which was not pre-tested

C_1 was the control group which was pre-tested.

C_2 was the control group which was not pre-tested.

This arrangement was to enable the researcher to:

- (i) Determine the similarity of groups before applying the treatment and generalize to the groups which did not receive pre-test.
- (ii) Determine presence of any interaction between pre-test and SPROMALEA (treatment)

Pretest in Table 8, CAT and SPSPT mean scores revealed that there was no significant difference between the entry levels of the groups involved in the study e.g. CAT $t(82) = 1.48$ $P > 0.05$ and SPSPT $t(82) = 0.95$ $P > 0.05$.

The results indicate that the groups were similar before the administration of the treatment. To address any initial differences in the groups, the analysis of covariance (ANCOVA) was used to adjust statistically for any experimental error (Wachanga, 2002). The post-test in CAT and SPSPT results in the study did not indicate any interaction between the pre-test and the SPROMALEA (treatment). The groups which took the pre-test would have obtained different results from the other groups (Borg & Gall, 1989).

4.6.1. The Effect of SPROMALEA on Students Achievement in Chemistry

The researcher found that students who were taught through SPROMALEA achieved significantly higher scores in CAT compared to those taught through conventional method. This implies that the use of SPROMALEA is effective in enhancing students' achievement than the conventional method. This observations are in agreement with finding of similar studies carried out earlier. Smith (1989), cited two districts that successfully integrated mastery learning along with thinking skills into their curriculum. Each district showed considerable increase in achievement and at the same time students were provided with a basic framework necessary to connect one fragment of instruction with another.

The scientific method, scientific thinking and critical thinking are terms used to describe science process skills. In this study, experimenting, observations and inferences are skills which teach students to think. Brotherton & Preece (1996), investigated the effect of teaching science with special emphasis on science process skills and found that there were subsequent gains in science achievement. Chemistry as a science subject fits in this category. In this study emphasis was on mastery of content and the selected science process skills. The objectives had to be achieved before embarking in the next instruction. This made it easy for learners to link one subject matter to another, hence enhancing achievement.

4.6.2 The Effect of SPROMALEA on Students Acquisition of Selected Science Process

Skills

From the results the students who used SPROMALEA achieved significantly higher mean scores in the SPSPT than those who did not use. The use of SPROMALEA offered a departure from the traditional methods of teaching in a classroom and made the learners to be practical oriented. Practical tests measures the development of the practical skills of the learner in the teaching of chemistry. In this study, the experimental groups out performed the control groups. Experimental groups were able to master the selected process skills (experimenting, observation and inferences) better than the control groups. Allsops & Woolnough (1985): Hudson (1990) in their research showed that practical work in science aids in acquisition of science process skills and scientific knowledge. This approach encouraged practical work, since most of the lessons in this topic salts were mainly class experiments or teacher demonstration. Galyam & Lecrange (2003) did a study in teaching learners some thinking skills and how to improve their use in science. There was improved use of thinking skills, increase of critical discussions and use of meta cognitive abilities as well as acquisition of content knowledge.

Cunningham & Dirk (2006), did a research aimed to teach science process skills that they believed were needed for success in the introductory biology courses. The skills were taught using scaffolding approach that progressively, challenge students to master the skills, while weaving them together through individual homework and small groups work in class. Those who participated learned a topic in depth, think like a scientist and also gain valuable skills. In this study the use of remedial, assignments and feedback helped the learners to master the skills. Feedback helps students identify what they have learned well and what they have not learned well. Areas that were not learned well are allocated more time to achieve mastery. Bizar & Hyde (1989), argued that in many cases learners have to be debriefed identify some of the finer points of what has been observed. The activities are designed however for student investigation not teacher explanation. So debriefing should occur only after experimenting and attempts to make inferences will have been exhausted. Not only must students be actively engaged to learn chemistry but, the teachers must give adequate guidance, support and encouragement while at work when scientific problem is proceeding. The teacher acts as a facilitator creating learning

conditions in which students actively engage in experiments, interpret, explain data and negotiate understanding of findings with co-experimenters and peers (National Research Council, 2005).

Teachers in the experimental groups facilitated the practical work done by the students. They moved from one working group to the other, to check whether students were following instructions, making correct observations and recording correct inferences. This enhanced the acquisition of science process skills. Rillero (1998) from his research argued that exhaustive knowledge of science content is impossible, mastery of science process skills enables students to understand a much deeper level, the content they do know and equips them for acquiring content knowledge in the future. Use of SPROMALEA enhanced the acquisition of science process skills.

4.6.3. Analysis of Teachers and Students Activities During Chemistry Lessons

Quantitative analysis was supplemented by qualitative description to provide fuller picture of the findings particularly in those areas that are not easily amenable to quantification. From Table 20, learners and teachers activities in experimental groups E₁ and E₂ outperformed those in control groups. In the teacher manual (Appendix D) the teachers in the experimental groups had to state the objectives to be achieved at the start of the lesson, introduce the topic and also monitor the learners activities during instruction. KIE (2006), recommends that learner centre approach is most appropriate, however learners requires teacher guidance. Gavora & Hannafin (1995), from his research said that learning does not occur by only observation but by doing. This implies that interaction should be able to maintain attention and fasten the creation and storage of knowledge and skills. In this study the teacher created an environment for interaction between teacher/learner and learner/learner. This gives an added strength to SPROMALEA in improving students achievement and acquisition of science process skills.

CHAPTER FIVE

CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

5.1. Introduction

This chapter presents the summary of major findings, conclusions, implications of the study, recommendations and areas for further study.

5.2. Summary of Major Findings of the Study

From the analysis of the data presented in chapter, the following conclusions have been reached.

1. Although the pre-test mean score of both the experimental group E_1 and control group C_1 were identical. The post-test scores; with respect to the CAT and SPSPT were different.
2. Significant learning gains were achieved by the learners exposed to the SPROMALEA (treatment) (E_1 and E_2) on both the CAT and SPSPT tests compared to the low learning gains realized by those not exposed to treatment.
3. The use of SPROMALEA allows students to have enough time to master the prerequisites before making progress because all students are catered for.
4. In the conventional method laboratory, the teacher tend to dominate classroom talks and to manipulate the learning activities whereas in the SPROMALEA classes, neither the student nor the teachers dominate. There was a good interaction between learner/ learners and teacher/ learners with the guidance of the teacher in all interactions.

5.3. Conclusions

Based on this study the following conclusions have been made

- i) The learners who were taught chemistry through SPROMALEA achieved significantly higher mean scores in CAT compared to those conventional method.
- ii) Use of SPROMALEA enhanced the acquisition of science process skills than use of conventional teaching methods. This is evident by the significantly high mean scores in the SPSPT attained by the experimental groups than those in the control groups.
- iii) SPROMALEA enhanced learners – learners and teachers-learners interactions.

5.4. Implication of the Study

Use of SPROMALEA resulted in higher students' achievement and acquisition of science process skills and thus should be used in chemistry teaching at secondary school level. When the approach is implemented in secondary school, achievement and acquisition of skills is likely to improve and performance at KCSE exams would be better. But more investigations covering a larger area would be necessary to reach a meaningful conclusion about the approach.

Teachers need to make use of more interactive approaches that actively involve learners in the teaching-learning process. This would ensure effective acquisition of science skills and concepts. The use of conventional methods, for example, lecture method or writing notes, cannot adequately achieve a meaningful learning. The classroom learning used, benefits mainly the bright students, weaker students are disadvantaged since they are not able to master the concepts taught, they need more time and remedial. Use of SPROMALEA would cater for all groups of learners, the higher achievers and low achievers.

Teachers should be sensitized on the importance of new teaching methods. Science teacher colleges, universities, should emphasis SPROMALEA in their teaching and preparation of the classwork.

5.5. Recommendations

Based on the results of this study, SPROMALEA lead to high student achievement and acquisition of the practical skills in chemistry in secondary school. It is therefore recommended that:-

- (i) Chemistry teacher incorporate this method in teaching chemistry at secondary school level especially in the topic salts, where more of the work is experimenting, making observation and inferences.
- (ii) The content of SPROMALEA should be included in the regular in-servicing of teachers for example in SMASSE.

5.6. Areas of Further Research

Though the study has found that SPROMALEA lead to higher achievement and acquisition of science practical skills. The following areas need further investigation.

- (i) A study should be carried out to determine the influence of gender on SPROMALEA on achievement and acquisition of chemistry practical skills in secondary school.
- (ii) A study should also be carried out to investigate the effects of SPROMALEA on students' Achievement, attitudes and motivation toward other areas of science.
- (iii) A study should be carried out to determine the students' perception of the classroom environment when they are taught through SPROMALEA in Chemistry classes in secondary schools.

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APPENDICES

APPENDIX A

CHEMISTRY ACHIEVEMENT TEST (CAT)

Admission Number..... School

Class.....

INSTRUCTIONS

1. Write your name, admission number and class in the spaces provided.
2. Please answer all the questions
3. Read the questions carefully before writing your answer
4. Write your answer in the spaces provided in the question paper

QUESTIONS

1. Give one example for the following type of salts

i. Acid salts (1 mrk)

.....

ii. Double salts (1 mrk)

.....

iii. Normal salts (1 mrk)

.....

2. State two methods of preparation of salts (2 mrk)

.....

.....

3. Define the following terms

i. Deliquescent (1 mrk)

.....

.....

ii. Hygroscopic (1 mrk)

.....

.....

4. Give the observations and write a balanced equation when Copper carbonate is heated.

i. Observations (1 mrk)

.....
.....

ii. Equation (1 mrk)

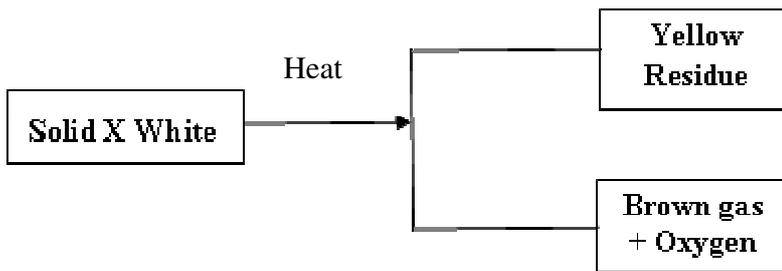
.....
.....

5. Give two uses of salts (2 mrks)

i.

ii.

6. Study the scheme below and answer the questions that follow



Name:

i. Solid X (1 mrk)

.....
.....

ii. The yellow residue (1 mrk)

.....
.....

7. Which sulphate is not affected by heat? Give a reason. (2 mrks)

.....
.....

8. Write an equation for the following



(1mk)

.....

9. Below are instructions which should be followed in carrying out an experiment to prepare lead (ii) sulphate. The instructions are not given in order. Arrange them in order, so that the experiment can be carried out successfully. Refer to each instruction by its letter (6 mrks)

Q....Let the solid settle

R....Filter and dry the solid between filter papers

S....Add excess of magnesium sulphate

T....Mix the solution using a glass rod

U.... Place about 10cm³ of lead nitrate in a beaker

V....Wash the solid with distilled water

W....Pour off the liquid

10. Both Potassium carbonate and calcium carbonate are white solids. Give two simple tests that you would use to distinguish them (2 mrks)

a)

b).....

11. The nitrate of the metals A, B and C were heated over a Bunsen burner flame. The tube below shows the products of the reactions. Study it and answer the questions that follow. A, B and C are not the actual symbols of the metals.

| Nitrate of Metal | Products |
|------------------|---|
| A | Metal nitrite and oxygen gas |
| B | Free metal, nitrogen (iv) and oxygen gas |
| C | Metal oxide, nitrogen (iv) oxide and oxygen gas |

a) Which of the metals is most likely an alkaline metal? (1 mrk)

.....

b) Which of the metals is lowest in the reactivity series? (1 mrk)

.....

c) Name a metal that could possibly be C. Give the complete equation for the decomposition of its nitrates. (2 mrks)

.....

.....

12. In all methods of salt preparation that involve reacting an acid with a solid substance, the reaction must be allowed to go until a little solid remains unreacted.

a) Why is it necessary to use excess of the solid reactant? (1 mrk)

.....

b) How is the excess solid reactant removed? (1 mrk)

.....

c) How is the salt recovered? (1 mrk)

.....

13. Copy the following table and put a tick (✓) if a precipitate is formed when the solutions are mixed and a cross (X) if no precipitate is formed. (5 mrks)

| Solutions | Silver nitrate | Sodium sulphate |
|--------------------|----------------|-----------------|
| Sodium chloride | (½ mrk) | (½ mrk) |
| Barium chloride | (½ mrk) | (½ mrk) |
| Lead (ii) nitrate | (½ mrk) | (½ mrk) |
| Calcium chloride | (½ mrk) | (½ mrk) |
| Magnesium sulphate | (½ mrk) | (½ mrk) |

14. Briefly explain how you can distinguish between the following pairs of compounds

a) $\text{PbCl}_2(\text{s})$ (white) and $\text{NaCl}(\text{s})$ white (2 mrks)

.....
.....

b) $\text{ZnO}(\text{s})$ and $\text{PbO}(\text{s})$ (2 mrks)

.....
.....

15. With the aid of a labeled diagram, explain how you can prepare a sample of Zinc sulphate from dilute sulphuric acid and Zinc powder. (10 mrks)

APPENDIX B

SCIENCE PROCESS SKILL PERFORMANCE TEST

Admission Number.....School.....

Class.....

INSTRUCTIONS

1. Write your admission number and class in the spaces provided.
2. Answer ALL the questions in this paper in the spaces provided.
3. You are NOT allowed to start working with the apparatus for the first 10 minutes of the 1½ hour allowed for this paper. This time is to enable you read the questions paper and make sure you have all the chemicals and apparatus that you may need.

Q1. You are provided with two solids W and T. You are required to carryout the test below and write your observations and inferences in the spaces provided.

| | Experiment | Observation | Inference/deduction |
|----|---|----------------------|----------------------------|
| 1. | Describe the appearance of solid W and T | Solid W | (½) |
| 2. | | Solid T 1 (m) | (½) |
| 3. | Place a spatula of solid W in a test tube. Add about 6cm ³ of distilled water and shake well. Test the solution W with red and blue litmus paper | 2m | 1m |
| 4. | Repeat the same procedure b(i) above with solid T | 2m | 1m |
| 5. | Place a spatula end full of solid W in a dry test tube. Heat the solid over a Bunsen burner gently and strongly. Test for any gases evolved with | 1m | 1m |
| 6. | A glowing wooden splint | 1m | |
| 7. | Moist red and blue litmus paper | 1m | 1m |
| 8. | Calcium hydroxide | 1m | |

| | | | |
|-----|---|----|----|
| 9. | Repeat the procedure in c(i) above with solid T | 1m | |
| 10. | A glowing wooden splint | 1m | |
| 11. | Moist red and blue litmus paper | 1m | |
| 12. | Calcium hydroxide | 1m | 1m |

13. You are provided with two solutions, lead nitrate and magnesium sulphate. Put 10cm^3 of lead nitrate in a beaker. To the same beaker, add excess magnesium sulphate solution. Mix the solution using a glass rod. Let the solid settle, pour off the liquid, wash the solid with distilled water. Filter and dry the solid between filter papers

(4mks)

Answer the following questions

14. Which ions are present in the reactant? (2mks)

15. What observations are made when lead (ii) nitrate and magnesium sulphate solutions are mixed (1mk)

16. Which ions react to form the solid (1mk)

17. Write a balanced equation for the reaction (1mk)

APPENDIX C

CLASSROOM OBSERVATION SCHEDULE

LESSON _____ DATE _____ TIME _____

| | TEACHING ACTIVITY | Tally |
|------|--|--------------|
| (i) | Reinforce Appropriate response: praise nodding head or saying go on etc. | |
| ii) | Ask question about the content or procedure based on students ideas. | |
| iii) | Guides or demonstrates how to perform an experiment a) A procedure b) Re-read problems c) Re-state problems | |
| iv) | Goes round to ensure students are proceeding well with a given activity | |
| v) | Giving precautions, directions or commands to which students are expected to agree | |
| vi) | Encourage students to write the observations | |
| vii) | Promote analysis, organization and communication skills by having students state or write their observation orderly logical form | |
| ix) | Review the results through questions and answers session | |
| x) | Encourages students to make generalization about observations, concepts | |

| | STUDENT ACTIVITY | Tally |
|-------|--|--------------|
| (i) | Respond to teachers question | |
| ii) | Follow instructions to: <ul style="list-style-type: none"> a) Perform experiment <ul style="list-style-type: none"> i) Select and design appropriate process for particular object ii) Select and design apparatus for a particular object iii) Employ the process of observing | |
| | b) Give observations <ul style="list-style-type: none"> i) Recalls and recognize the properties ii) Identify changes occurring in a reaction | |
| | c) Give inference <ul style="list-style-type: none"> i) Identify observable characteristic in a given reaction ii) Infer relationship between phenomena iii) Infer an effect by identifying the cause | |
| iii) | Asks questions or seek clarity over ideas presented | |
| iv) | Consult other students | |
| v) | Express agreement or disagreement with action | |
| vi) | Repeat some experiments to clarify the results | |
| vii) | Take precautions as the he/she performs experiment | |
| viii) | Contribute during the class discussion | |
| ix) | Give conclusion of the experiment done. | |

APPENDIX D

TEACHER'S MANUAL

MASTERY LEARNING OF SCIENCE PROCESS SKILLS MODULE ON SALTS IN CHEMISTRY

INSTRUCTIONS

- i) Use the following module in teaching the topic salts.
- ii) Provide the learners with objectives of the lesson and levels of performance before the lesson.
- iii) Monitor student's work providing corrective feedback as necessary and assess the performance of different groups in determining whether the classes are ready for the next instruction.
- iv) Give extra time to the slow learners to finish their experiment.
- v) Give remedial work to the weak students.

LESSON 1

CLASS DISCUSSION

TOPIC: SALTS

Subtopic: Types of Salts

Objective: By the end of the lesson the learners should be able to:

- i) Define the term salt
- ii) State the types of salts and give some examples
- iii) Write the chemical formulae of this salts.

Introduction (5min)

The teacher introduces the lesson by reviewing previous lesson by way of question and answer method

Teacher leads the class in review of formation of salts in form one work example reaction of

– Acids + Base

- Acid + Metal

- Acids + Carbonates

- Teacher provides the learners with objective of the lesson and levels of performance.

LESSON DEVELOPMENT (30 MINUTES)

- Teacher explains the new concept salts
- Teacher and learners discuss the following:-
 - The definition of the term salts
 - The types of salts and some of the examples
- Teacher uses question and answer method
- Learners take brief notes

Teacher monitor students work, providing corrective feedback as necessary, and asses the performance of the group in determining whether the class is ready for the next instructions.

CONCLUSION (5 min)

Teacher summarises the lesson

Teacher gives assignment which the learners have to hand in later

Teachers marks the assignment before next lesson. He/she reteaches the concepts which the learners did not understand.

LESSON 2 and 3

CLASS EXPERIMENT

TOPIC: Salts

Subtopic: Solubility of salts in water

Objectives: By the end of the lesson the learner should be able to:

- i) Carryout simple experiments to identify soluble and insoluble salts, make accurate observation and inferences
- ii) To give a summary of solubility of a common salts.

Introduction (10min)

The teacher introduces the lesson by reviewing the previous lesson by way of question and answer method.

- The teacher provides the objectives of lesson and level of performance.
- Teacher discusses the procedure of the lessons, the different parts of the lesson and student's responsibility during each activity.
- Teacher encourages every learner to participate in performing the experiment. He/she advice them to take precautions
- When carrying out experiments
- Teachers advice/learners to make accurate observations, accurate inferences and communicate them using acceptable scientific language.
- Learners proceed to their working groups.

LESSON DEVELOPMENT (50mins)

Teacher explains the new skills.

- Teacher moves from group to group monitoring student's work providing corrective feedback as necessary and assess performance of the groups in determining whether the class is ready for the next instruction.
- She/he encourages learners to take precautions when performing experiments, hence they will get accurate observations, inferences and communicate them using acceptable scientific language.
- Extra time is given to the learners who are slow in performing the experiment.
- Teachers moves to discussion when all learners have performed their experiments.

Discussion (15min)

The teacher and learners discuss the result/observations on each experiment on solubility of salts. This is done by way of question and answer method. The teacher guides the learners through the discussion to arrive at accurate observations and inferences

- Teacher guides the learners through the discussion to arrive at accurate inferences.
- Learners take down brief notes.
- Teacher gives learners the summary of solubility of common salts.

Conclusions (5 mins)

The teacher summaries on the subtopic and give assignments to be done and handed later
Teacher marks assignment before next lesson
Reteach the skill that was not understood.

LESSON 4

CLASS EXPERIMENT

Topic: Salts

Subtopic: Solubility of bases in water and effect of resulting solutions on litmus paper.

OBJECTIVES: By the end of the lesson the learners should be able to:

- i. Carryout simple experiment to identify soluble and insoluble bases makes accurate observational inferences.
- ii. Explain the effects of resulting solution on litmus paper.

Introduction: (5mins)

The teacher introduce the lesson by reviewing the previous lesson by question and answer method.

- Teacher provides objectives of the lesson to the learners and the level of performance required.
- Teacher discusses the procedures of the lesson the different parts of the lesson and student's responsibility during each activity.
- Teacher advices then to take precautions when performing experiments so as to get accurate observations, accurate inferences and communicate them using acceptable scientific language.
- Learners proceed to their working groups.

Lesson Development (25mins)

The teacher assist the learners in carrying out simple experiments

- Teacher monitor student's work providing corrective feeds back is necessary and assesses performance of the group in determining whether the classes ready for the next instruction.
- Slow learners are given extra time to finish their experiments before the next step.

Discussion/Conclusion (10 min).

The teacher and learners discuss the results /observations of each experiment.

- Teacher guides the learners through discussion to arrive at accurate observation and inferences.
- Learners take down brief notes .
- Teacher summarize the lesson and gives an assignment to be done and handed later.
- Teacher marks the assignment before the next lesson and reteach the skill that was not understood.
- Teacher gives a quiz or diagnostic test on solubility of salts in water.

LESSON 5

Class Experiments

TOPIC : Salts

Subtopic : Preparation of soluble salts : preparation of copper (II) sulphate Crystals.

Objectives- By the end of the lesson the learners should be able to:

- i. Prepared crystals of copper(ii) sulphate from a solution of Copper(ii) sulphate.
- ii. Explain the terms saturated and crystallization

Introduction (5 mins)

Teacher introduces the lesson by reviewing the previous lesson by question and answer method.

- Teacher provides the objectives of the lesson to the learners and level of performance required.
- Teacher discussed the procedures of the lesson, the different parts of the lesson and students responsibility during each activity.
- Teacher advises the learners to take precautions when performing experiment so that they get accurate observations accurate inference as and communicate them using acceptable scientific language.
- Learners proceed to their working groups.

Lessons Development (25 mins)

The teacher assists the learners to carryout the simple experiments

- Teacher monitor students work, providing corrective feedback as necessary and assess the performance of the different groups in determining whether the classes are ready for the next instruction
- Extra time given to the learners who are slow in performing the experiments.

Discussion/ Conclusion (10 mins)

Teacher and learners discuss the results/observation of the experiment.

- Teacher explains the terms saturation crystallization
- Learners taken down the notes
- Teacher summarizes the lesson and gives the assignment to learners to do and hand in the work later.
- Teacher marks the assignment before the next lesson she/he reteaches the concepts or skills learners didn't understood.

Lesson 6 and 7

Class experiment

Topic: Salts

Subtopic: Preparation of soluble salts by reaction of acids with metals and acids with metal oxides.

Objectives: By the end of the lesson the learners should be able to:-

- Select and use appropriate methods of preparing Zinc sulphate and copper sulphate.
- Write equation in preparation of these salts ‘
- Define the term neutralization.

Introduction (10 min)

The teacher introduces the lesson by reviewing the previous lesson by the way of question and answer method.

Teacher provides the objectives of the lesson and level of performance required.

Teachers discuss the procedure of the lesson the different parts of the lesson and students responsibility during each activity.

Teacher advises the learners to take precautions when performing experiments so as to get accurate observation, accurate inferences and communicate them using acceptable scientific language.

Learners proceed to their working groups

Lessons Developments (50min)

The teacher assist the learners carry out simple experiments on preparation of salts.

- Teacher monitor the learners work providing corrective feedback of necessary and assess performances of the groups in determining whether the class is ready for the next instruction.
- Learners note the observations as they performs
 - Learners who are slow are given extra time to finish their experiment before next stop.

Discussion (15 min)

The teacher and learner discusses the results/observation of each experiment or this is done by way of question and answer method.

Teacher guide the learners through the discussion to arrive at accurate observations and inferences

Learners take down brief notes.

Teacher writes the equation of the reactions on preparation of soluble salts.

Teacher gives the definition of the term neutralization.

Conclusion (5 min)

The teacher summarize the work covered, gives assignment to be done and handed later.

Teacher marks the assignment before next lesson, and gives remedial work to those who didn't do well.

Lesson 8

Class Experiment

Topic - Salts

Subtopic: Preparation of soluble salts by reaction of acids and bases.

Objectives :- By the end of the lesson the learner should be able to :

- i. Prepare soluble salts by reactions by reaction of acids and hydroxide e.g. $\text{NaOH} + \text{HCl}$ and $\text{H}_2\text{SO}_4 + \text{NaOH}$
- ii. Explain the term neutralization
- iii. Write chemical equation for this reactions

Introduction (5 mins)

The teacher introduces the lesson by reviewing the previous lesson by questions and answer methods.

- Teacher provides the objectives of the lesson to the learners and the level of performance required.
- Teacher discusses the procedure of the lesson ,the different parts of the lesson and student responsibility during each activity.

- Learners are advised to follow procedure and take precaution so as to get accurate results.
- Learners move to their respective work stations

Lessons development (25 mins)

The teacher assists the learners to carry out simple experiments on preparation of soluble salts.

- Teacher monitors the learners' work providing corrective feedback as necessary and assesses performance of the group in determining whether the class has got the skill of experimenting, observation and inference and is ready for the next instruction.

Discussion /conclusion (10 min)

Teacher and learners discuss the results of the experiment

- Teacher explains the terms neutralization
- Learners take down brief notes and contribute in the discussion
- Teacher writes equations of the reactions of other bases and acids on the blackboard.

Teacher summarizes the lesson and gives assignment to be done by individual students.

- Learners to do the work and hand -in latter. Teacher marks the assignment, return it before the next lesson. Remedial to be done to those who did not understand the concepts well.
- A quiz will be given to the class on what has been covered throughout the week.

Lesson 9

Class experiment

Topic: - salts

Subtopic: - Preparation of soluble salts by reaction of acids with metal carbonates and metal hydrogen carbonate.

Objectives: - By the end of the lesson the learners should be able to :-

- i. Prepare a soluble salt by reaction of acids and metal carbonates e.g Lead carbonate and Nitric acid, Calcium carbonate and dilute hydrochloric acid
- ii. Write the chemical equations on these reactions

Introduction (5 min)

The teacher introduces the lesson by reviewing the previous lesson by questions and answer methods.

- Teacher provide the objectives of the lesson to the learners and the level of performance required.
- Teacher discusses the procedure of the lesson, different parts of the lesson and students responsibility during each activity.
- Learners are advised to plan for the precautions they should take in order to ensure accurate results are obtained, correct observation and inferences.

Lesson Development (25mins)

The teacher assist the learners to carryout simple experiments on preparation of soluble salts.

- Teacher supervise by walking from group to group discussing , asking and answering questions concerning the experiment and correcting mistakes.
- Learners to follow procedure accurately so that they can make accurate observations and inferences.

Discussion/ conclusion (mins).

Teacher learners discuss the results the observations of the experiment .

Learners take down brief notes and contribute in the discussions.

Teacher writes chemical equations of the reaction and those of other salts that can be prepared in a similar way.

Teacher give the assignment to be done by learners and be handed later.

Teacher marks the assignment and return it before the next lesson. Remedial is offered to those learners who did not perform well.

Lesson (10- 11)

Class experiments

Topic : salts

Subtopic: Preparation of insoluble by precipitation

Objective: By the end of the lesson the learners should be able to:-

- i. Prepare an insoluble salt by precipitation e.g. Lead sulphate from Lead nitrate and Magnesium sulphate.
- ii. Write ionic equations for these reactions
- iii. Define the terms, double decomposition, spectator ions, precipitation

Introduction (10mins)

The teacher introduces the lesson by reviewing the previous lesson way of question and answer methods.

- Teacher provide the objectives of lesson and the level of performance required.
- Teacher discuss the procedure of the lesson, the different parts of the lesson and students responsibility during each activity.
- Teacher inform learners to take precautions in performing experiment so that they get accurate, results, observations and inferences.
- Learners proceed to their working stations

Lesson Development (50 mins)

The teacher assists the learners to carry out simple experiments on preparation of insoluble salts.

- Teacher monitor students work, providing corrective feedback as necessary and assesses performance of the group in determining whether the class is ready for the next instruction or whether they have got the skill of experiments, observing and inferring.

- Teacher encourages each learners to participate experiment

Discussion (15min)

The teachers and the learners discuss the results and observation of each experiment. This is done by question and answer.

- Teacher guide these learners through the discussion to arrive to accurate generalization
- Teacher explains the terms, double decompositions spectoration precipitation reactions.
- Learners take done brief notes
- Teacher explains to them how to write a chemical equations then ionic equation.
- Learners practice on writing ionic equations.

Conclusion (5 min)

Teacher and learners conclude the lesson.

- Teacher gives assignments to the learners which will be handed later.
- Teacher marks and return before next lesson.
- Remedial will be given to learners who have not understood the concept well.

LESSON 12

Lesson Experiments

Topic : Salts

Subtopic: Action of heat on carbonates

Objectives :- By the end of the lesson should be able to :-

- i. Describe and explain from experimental observation the action heat on carbonate
- ii. Write equation for the reaction which occurs when some metal carbonate were heated.
- iii. Explain the relationship between ease of decomposition of metallic carbonate and the position of the metal in the reactivity series.

Introduction (5 mins)

The teacher introduces the lesson by reviewing the previous lesson by way of question and answer method.

- Teacher provides objectives of lesson and level of performance required.
- Teacher discuss the procedures of the lesson, the different parts of the lesson and students responsibility during each activity.
- Learners are encourage to make accurate observation and records them using acceptable scientific language make accurate inferences based on the observations .

Lesson development (25 mins)

The teacher assists the learners carryout this experiments in heating carbonates.

- Teacher monitor the students work providing corrective feedback as necessary and asses performance of the group in determining whether the class ready for the next instruction.
- Teacher check whether the class has the skill of experimenting observation and inferences.
- Learners performs the experiments

Discussion conclusion (10 mins)

The teacher and the learners discuss results /observation of each experiment. This is done by way of question and answer.

- Teacher guides the learners through the discussion to arrive at accurate generalizations.
- Learners take brief note during discussion
- teacher write equation on the blackboard.
- Teacher summarize the topic give assignment to be done individually hand their work later.
- Teacher to mark their work and give remedial to those who perform poorly. Teacher gives them a quiz at the end of the week.

Lesson 13-14

Class experiment

Topic : salts action of heat on nitrates and sulphates

Subtopic:- by the end of the lesson the learners should be able,

- i. Describe and explain from experimental observation the action of heat nitrate and sulphate.
- ii. Identify the product when each of this salts are heated.
- iii. Write equation for the reaction that occurred when metal nitrate and sulphate are heated.

Introduction (10 mins)

Teacher introduces the lesson by reviewing the previous lesson by way of question and answer methods.

- Teacher provides the objectives of lesson and level of performance requires.
- Teacher discussed the procedures of lesson, the different parts of the lesson and students responsibility during each activity.

- Teacher advice them to carry out experiments, make accurate observations inferences using acceptable scientific language .
- Learners proceeds to their stations

Lesson Development (50 mins)

Teacher assists the learners carryout simple experiments on actions of heat nitrates and sulphate.

- Teacher move around the class to monitor students wok providing corrective feedback as necessary and assesses performance of the group in determining whether the class is ready for next instructions.
- Teacher still emphasis on taking precaution to get accurate observations and inferences.
- Teacher encourage then to repeat an experiment if results are not clear .

Discussion (15 mins)

The teacher and the learners discusses the results of the observations of each experiment; using question and answer methods.

- Teacher guides the learners through the discussion to arrive at accurate generalizations.
- Teacher writes equations of the reactions on the blackboard
- Teacher explain the trend in action of heat on nitrates and in sulphates

Conclusion (5 mins)

The teacher summarizes the lesson and gives assignment top the learners to be handed the work, and give remedial those who perform before the next class.

Lesson 15

Class discussion

Topic salts

Sub topic : -What happens when salts are exposed to the atmosphere

-Uses of some salts

Objectives : - By the lesson the learners should be able to :

Define the following terms and gives examples

- Deliquescent
- Hygroscopic
- Efflorescent
- State the uses of some salts

Introduction (5 mins)

The teachers introduces the lesson by reviewing the previous lesson by way of question and answer methods

- Teacher provides the learners with the objectives of the lesson and level of performance.

Lesson development (30 mins)

- Teacher explains the new concepts from observation of the experiments perform the day before by exposing salts in the atmosphere overnight.
- Explains the terms
- Diligent, hygroscope and efficiencies
- Teachers uses question and answer methods
- Teacher explains some of the uses of salts
- Learners takes brief notes.

Conclusion (5 mins)

Teacher summarize the lesson

- Teacher gives assignment, which learners have to hand in later.
- Teacher marks the assignment before next lesson. He or she reteaches the concepts learners did not understand.

- Teacher gives a test on the content covered and a performance test at the end of the topic.
 - i) CAT- chemistry achievement test
 - ii) SPSPT – Science Process Skills Performance Test

- vii) Repeat the experiment using similar salts of potassium magnesium, calcium, aluminium, zinc, iron, lead copper and barium.

| Anion Cation | Sulphate | Chloride | Nitrate | Carbonate |
|-------------------------------|-----------------|-----------------|----------------|------------------|
| Sodium | | | | |
| Potassium | | | | |
| Calcium | | | | |
| Magnesium | | | | |
| Zinc | | | | |
| Iron | | | | |
| Lead | | | | |
| Copper | | | | |
| Barium | | | | |

Questions

1. Which metal ions form salts that are soluble in water?
2. Which anion form salts that are soluble in water?
3. From the results observed, list down insoluble (a) Sulphate (b) Chloride.
4. Using the results of experiment, list down the soluble carbonates.

2

Name

Class.

Instruction :

Read and make sure you have all the chemicals and apparatus you require for the experiment.

Topic: Salts

Experiment: Solubility of bases in water

Introduction

Bases are metal oxide and hydroxides. Some are soluble and others are insoluble in water. Bases soluble in water are called alkalis

Apparatus

4 boiling tubes

Spatula

Chemicals

Oxides and hydroxides of potassium, sodium, calcium

Magnesium, Zinc, Aluminium, Copper

Litmus paper.

Procedure

- i) Place about 10cm^3 of water into boiling tube.
- ii) Put a half spatula of calcium oxide in the boiling tube.
- iii) Shake the mixture and test the resulting solution with a litmus paper. Record your observation in the format shown in the table.
- iv) Repeat the experiment using oxides of magnesium, lead, zinc, aluminium and copper.
- v) Repeat the experiment using hydroxides of sodium, potassium, calcium, zinc, copper and aluminium.
- vi) Put a tick (\checkmark) if the salt is soluble, a cross (x) if the salt is insoluble, SS if the salt is slightly soluble.

| Cation | Solubility | | Effects of resulting solution on litmus paper | |
|-----------|------------|-----------|---|-----------|
| | Oxide | Hydroxide | Oxide | Hydroxide |
| Potassium | | | | |
| Sodium | | | | |
| Calcium | | | | |
| Magnesium | | | | |
| Zinc | | | | |
| Aluminium | | | | |
| Copper | | | | |

Questions

- Which oxides are
 - Soluble
 - Insoluble
- Which hydroxides are
 - Soluble
 - Insoluble
- What is the nature of the solutions formed when bases dissolve in water.

3

Name

Class

Instruction

Read through the worksheet and make sure you have all apparatus and chemicals required for the experiment

Topic: Salts

Experiment: Preparation of Copper (II) Sulphate crystals from a solution of Copper (II) Sulphate

Introduction

Most salts contain a fixed amount of water in their crystalline structure. This is called water of crystallization. It is acquired as the salts crystallize from an aqueous solution. During the crystallization process water molecules get trapped in the crystal structure. The water is essential to the shape and sometimes the colour of the crystals salts that contain water of crystallization are called hydrated salts. A salts without its water of crystallization is called anhydrous salt.

Apparatus

Chemicals

Evaporating dish

Copper (II) sulphate crystals

Beaker

Wire gauze

Tripod stand

Measuring cylinder

Bunsen burner.

Procedure

- i) Measure about 20cm^3 of water in a beaker.
- ii) Add a spatula full of Copper (II) sulphate crystals in the beaker and stir. If it dissolves, continue adding more until it does not dissolve anymore at the same temperature.
- iii) Decant a portion of the solution into an evaporating dish.
- iv) Place the evaporating dish on water bath and heat.
- v) Evaporate the solution until the solution is about to form crystals. To find if this point has been reached, dip a clean glass rod into the solution and hold it up in the air to cool.

- vi) Examine the rod to find out whether the crystals have formed on it. Continue heating until crystals are seen on the glass rod when the rod is dipped in the solution.
- vii) Allow the solution to cool and crystals will form slowly. Observe the crystals with a hand lens.
- viii) To obtain larger crystals, keep the evaporating dish with a perforated paper. Leave the set up undisturbed and observe after 12 hours.
- ix) Filter off the crystals and dry them between filter papers.

Questions

1. How can you tell that all Copper (II) sulphate has dissolved.
2. What is the shape of the crystals.
3. Explain why evaporating is not done to dryness.
4. Why are the crystals not dried by heating.

4

Name

Class

Instruction

Make sure you have all apparatus and chemicals required for the experiment before you start

Topic: Salts

Experiment: Preparation of Zinc sulphate by reacting zinc powder and dilute sulphuric acid.

Introduction

The method used in the preparation of salt depends on whether it is soluble in water or not. When a soluble salt is formed in a chemical reaction, it remains in solution. It is then recovered by evaporation of excess water followed by cooling of the remaining solution.

Apparatus

Chemicals

Beakers

Zinc powder

Glass rods

Dilute sulphuric acid

Filter paper

Filter funnel

Evaporating basin

Gauze wire

Tripod stand

Bunsen burner

Measuring cylinder.

Procedure

- i) Measure about 20cm³ of dilute sulphuric acid and pour it into a beaker.
- ii) Add zinc powder into the beaker a little at a time as you stir with glass rod. Continue adding zinc powder until the powder is in excess and effervescence stops.
- iii) Filter the mixture and collect the filtrate.
- iv) Transfer the filtrate to an evaporating basin and evaporate the filtrate into the basin to reduce the amount of water until crystals are about to form.

- v) To find out if this point has been reached, dip a glass rod into the solution and hold it up in air to cool. Examine the end of the rod that was dipped into the solution to check whether any crystals have formed.
- vi) Continue the heating until crystals are seen on the glass rod. Stop heating and allow the solution to cool and crystals to form slowly.

Questions

1. Explain why zinc powder is added in excess.
2. Why is filtration is necessary in this experiment?
3. Write an equation for the reaction between zinc powder and dilute sulphuric acid.
4. Suggest other salts that can be prepared in a similar way.
5. Write equation for the reactions in 4 (i).

5

Name **Class**

Instruction

Read the worksheet and make sure you have all apparatus and chemical required for the experiment.

Topic: Salts

Experiment: Preparation of Copper (II) Sulphate by reacting dilute sulphuric acid and Copper (II) oxide

Introduction

The method for preparing a salt depends on solubility of the salt in water .soluble salts can be prepared by action of acid on insoluble base(metal oxide or hydroxide).

Metal + acid - salt + water.

This type of reaction is called neutralization.

Apparatus

Measuring cylinder

2 glass beakers

Spatula

Glass rod

4 filter papers

Filter funnel

Chemicals

Dilute sulphuric acid

Copper (II) oxide

Water

Procedure

- i) Measure about 20cm³ of dilute sulphuric acid and pour it into a glass beaker.
- ii) Warm the acid in the beaker
- iii) Using a spatula, add Copper (II) oxide to the warm acid a little at a time while stirring with a glass rod until no more oxide can dissolve.
- iv) Filter and collect the filtrate
- v) Transfer the filtrate to the evaporating basin. Evaporate the filtrate over water bath to saturation.
- vi) Stop heating and allow the saturated solution to cool to form crystals. Dry the crystals between filter papers.

Questions.

1. Why was Copper (II) oxide added in excess
2. Explain why the acid was warmed before adding Copper (II) oxide.
3. Besides the salt, what is the other product
4. Why evaporation was done over a water bath.
5. Write an equation between Copper (II) oxide and dilute sulphuric acid.

6

Name **Class**

Instruction

Make sure you have all apparatus and chemicals you require before you start the practical.

Topic: Salts

Experiment: Preparation of sodium chloride by reacting dilute hydrochloric acid and sodium hydroxide.

Introduction

Soluble salts can be prepared by the action of an acid on alkali. This methods of preparing salt involves neutralization. It is necessary to use an indicator(phenolphthalen) because the reactants and products are colourless and it would be difficult to know the neutralization point or endpoint.

Apparatus

2 beaker

Evaporating basin

Measuring cylinder

Chemicals

Dilute hydrochloric acid

Sodium hydroxide

Phenolphthalein indicator

Universal indicator paper.

Procedure

- i) Measure 25cm^3 of dilute hydrochloric acid and pour it in a beaker.
- ii) Dip universal indicator paper into the beaker. Record the pH.
- iii) Measure 25cm^3 of sodium hydroxide and pour it in another beaker. Record its pH also.
- iv) Add 2-3 drops of phenolphthalein to sodium hydroxide.
- v) Pour the hydrochloric acid slowly in the beaker containing sodium hydroxide until the pink colour just disappears. Test the resultant solution with universal indicator paper.
- vi) Pour about 25cm^3 of the resultant solution into a clean evaporating basin, evaporate the solution until it is saturated.
- vii) Allow the saturated solution to cool for crystals to form.

Questions

1. Explain the role of phenolphthalein in this experiment.
2. Write an equation for the reaction that takes place between sodium hydroxide and hydrochloric acid.

- 3 (i) Name the acid and base that can be used to prepare
 - a) Potassium nitrate
 - b) Sodium sulphate
 - c) Ammonium chloride
4. Write balanced equations for the reactions that produce the salts in 3 (i) (a) and (c) above.

7

Name **Class**

Instruction

Read through the work sheet and make sure you have all the chemicals required for the practical

Topic: Salts

Experiments: Preparation of lead nitrate from Lead (II) carbonate and dilute nitric acid.

Introduction

Soluble salts can be prepared by action of an acid on an insoluble carbonate. Acid reacts with metal carbonate to form salts, water and carbon (IV) oxide. The salt can be obtained by slow cooling of the products.

Apparatus

Chemical

2 glass beaker

Lead carbonate

Stirring rod

dilute nitric acid

Filter paper

Filter funnel

Evaporating

Procedure

- i) Measure about 25cm³ of dilute nitric acid and pour it into a glass beaker. Warm the acid in the beaker gently.
- ii) Add Lead carbonate to the warm acid a little at a time and stir.
- iii) Continue adding the carbonate while stirring until effervescence stops. Stop warming and filter off the carbonate not reacted.
- iv) Evaporate the filtrate to saturation and cool to obtain crystals.

Questions

1. How would you tell when the reaction is complete?
2. What are the products of the reaction?
3. Write an equation for the reaction between lead (II) carbonate and nitric acid.
4. Write equations to show how the following salts may be prepared from their corresponding carbonates.
 - i) Zinc nitrate

- ii) Calcium chloride
- iii) Ammonium sulphate
- iv) Sodium nitrate.

8

Name **Class**

Instruction

Make sure you have all the apparatus and chemicals required for the experiment before starting the practical.

Topic: Salts

Experiment: Preparation of Lead (II) sulphate by reacting Lead (II) nitrate and Magnesium sulphate solution.

Introduction

When an insoluble salt is formed in a chemical reaction,, it forms a precipitate which falls at the bottom of the container , the salt is then recovered through filtration. In this reaction the metal ions of the reaction is called double decomposition.

Apparatus

2 beakers
glass rod
4 filter paper

Chemicals

Lead nitrate
Magnesium sulphate

Procedure

- i) Put 10cm^3 of lead nitrate in a beaker
- ii) To the same beaker, add excess magnesium sulphate solution
- iii) Mix the solutions using a glass rod and let the solid settle.
- iv) Pour off the liquid and wash the solid with distilled water
- v) Filter and dry the solid between filter papers.

Questions

1. Which ions are present in the reactants
2. What observations are made when Lead (II) nitrate and magnesium sulphate solutions are mixed?
3. Which ions react to form the solid?
4. Write an equation for the reaction between Lead (II) nitrate and Magnesium sulphate.
5. Choose any pair of salts that react to form
 - i) Barium chloride

- ii) Silver chloride
 - iii) Copper carbonate
- b) Write balanced equations in 5 (i) to (iii)
- 6) Write balanced ionic equations for the reactions in 5 (i) to (iii).

9

Name **Class**

Instruction

Read through the work sheet and make sure you have all apparatus and chemicals that required for the experiment.

Topic: Salts

Experiment: Effect of heat on carbonates

Introduction

The effects of heat in salts varies widely. Some salts are very stable and do not undergo any chemical change on heating other salt are visible and undergo decomposition when heated. The effects of heats on metal carbonates can be linked to the reactivity series like the reaction of metals themselves.

Apparatus

Chemicals

| | |
|--------------------|---|
| Spatula | Calcium hydroxide |
| 6 glass test tubes | Solutions |
| Test tube holder | Carbonates of potassium, calcium |
| Bunsen burner | Sodium, Zinc, Lead, Ammonium and copper |
| Glass rod | |
| Test tube holder | |

Procedure

- i) Put a spatula full of Sodium carbonate in a test tube
- ii) Heat the sample gently and then strongly until no further change occurs.
- iii) Tests the gas given off by placing a glass rod dipped in calcium hydroxide solution at the mouth of the test-tube.
- iv) Read your observations as shown in the format shown in the table.
- v) Repeat the experiment using the carbonates of Potassium, Calcium, Zinc, Lead, Ammonium and Copper.

Effects of heat on carbonates

| Carbonates | Colour before heating | Colour after heating | Effect on calcium hydroxide solution |
|---------------------|-----------------------|----------------------|--------------------------------------|
| Sodium carbonate | | | |
| Potassium carbonate | | | |
| Calcium carbonate | | | |
| Zinc carbonate | | | |
| Copper carbonate | | | |
| Ammonium carbonate | | | |
| Lead carbonate | | | |

Questions

1. Which carbonates are not affected by heat? Explain
2. Write equations for the reactions which occurred when some metal carbonates were heated.
3. What is the relationship between ease of decomposition of a metallic carbonate and the position of the metal in the reactivity series?

10

Name

Class

Instruction

Make sure you have all the apparatus and chemicals that is needed before the start of the experiment

Topic: Salts

Experiment: Effects of heat on nitrates

Introduction

The action of heat on nitrate vary according to the position of the metal reactivity series. The ease with which natal nitrates decompose on heating increases down the reactivity series of metals.

Caution : ammonium nitrate should be heated in the laboratory because it explodes on strong heating

Apparatus

Bunsen burner

Wooden splint

6 Ignition tubes

Test tube holder

Spatula

Chemicals

Sodium nitrate

Potassium nitrate

Calcium nitrate

Zinc nitrate

Lead nitrate

Copper nitrate

Procedure

- i) Heat a spatula full of potassium nitrate in an ignition tube.
- ii) Test for the gases evolved and observed the residue.
- iii) For hydrated nitrates, do not test the gases until all the water of crystallization is driven off. Repeat your observations as shown in the table.
- iv) Repeat the experiment using the nitrates of Sodium, Calcium, Zinc, Lead and Copper.

Action of heat on nitrates

| Nitrate | Observation |
|-------------------|-------------|
| Potassium nitrate | |
| Sodium nitrate | |
| Zinc nitrate | |
| Lead nitrate | |
| Copper nitrate | |

Questions

1. Identify the products when each nitrate is heated.
2. Write equations for the reactions that occurred when the metal nitrates were heated.
3. What is the general trend of the action of heat on nitrates.

11

Name **Class**

Instruction

Read through the worksheet and make sure you have all apparatus and chemicals needed for the experiment

Topic: Salts

Experiment: Effect of heat on sulphates

Introduction

The sulphates of the alkali metals and alkaline earth metals do not decompose on heating. The sulphate of other metal decompose on heating to give the metal oxide sulphur (iv) oxide and or sulphur (vi)oxide. When hydrated iron(ii) sulphate is heated it first loses its water of crystallization to form anhydrous iron (ii) sulphate

Apparatus

Chemicals

| | |
|------------------|-------------------------------|
| Test tube | Hydrated Iron (II) sulphate |
| 6 test tubes | Hydrated Zinc sulphate |
| Spatula | Hydrated Copper (II) Sulphate |
| Test tube holder | Hydrated Magnesium sulphate |
| Bunsen burner | Hydrated Sodium Sulphate |
| | Hydrated litmus paper. |

Procedure

1. Place a spatulaful of hydrated Iron (II) Sulphate in a test-tube
 2. Heat the test-tube gently at first and then strongly.
 3. Test any gas evolved with a moist litmus paper
 4. Repeat the experiment using the hydrated sulphates of sodium, magnesium, zinc, copper.
- Record your observations as shown in the table.

Effect of heat on sulphates

| Sulphates | Observations |
|-----------------------|--------------|
| Magnesium sulphate | |
| Sodium sulphate | |
| Zinc sulphate | |
| Iron (I) sulphate | |
| Copper (II) sulphate. | |

Questions

1. Which sulphates are not affected by heat? Give a reason.
2. Write equations for the reactions that occur when some metal sulphates are heated.

APPENDIX F

RESEARCH AUTHORIZATION

REPUBLIC OF KENYA



NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telegrams: "SCIENCETECH", Nairobi
Telephone: 254-020-241349, 2213102
254-020-310571, 2213123
Fax: 254-020-2213215, 318245, 318249
When replying please quote

P. O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref: **NCST/5/002/R/759/5** Date: **21st August 2009**

Ms. Roselyn J. Chebii
Egerton University
P.O. Box 536
NJORO

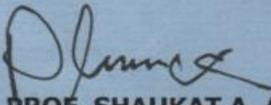
RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on '*Effects of Science Process Skills Mastery Learning Approach on Secondary School Students' Achievement and Acquisition of Selected Chemistry Practical Skills in Koibatek District Schools Kenya*'

I am pleased to inform you that you have been authorized to undertake your research in Koibatek District for a period ending 30 September 2009

You are advised to report to the District Commissioner and the District Education Officer Koibatek District before embarking on your research project.

Upon completion of your research project, you are expected to submit two copies of your research report/thesis to our office.


PROF. SHAUKAT A. ABDULRAZAK Ph.D, MBS
SECRETARY

Copy to:

The District Commissioner
Koibatek District

The District Education Officer
Koibatek District

APPENDIX G

RESEARCH PERMIT

PAGE 2

PAGE 3

THIS IS TO CERTIFY THAT:

Prof./Dr./Mr./Mrs./Miss..... ROSELYNE
J. CHEBII

of (Address)..... EGERTON UNIVERSITY
PO BOX 536 NJORO

has been permitted to conduct research in.....

.....Location,
KOIBATEK.....District,
RIFT VALLEY.....Province,

on the topic..... Effects of science process
skills mastery learning approach
on secondary students' achievement
and acquisition of selected chemistry
practical skills in Koibatek District
schools Kenya. 30TH SEPT, 20 09
for a period ending....., 20.....

Research Permit No. NCST/5/002/R/759

Date of issue 10. 08. 2009

Fee received SHS 1000



[Signature]
Applicant's
Signature

[Signature]
Secretary
National Council for
Science and Technology

CONDITIONS

1. You must report to the District Commissioner and the District Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit.
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2)/four(4) bound copies of your final report for Kenyans and non-Kenyans respectively.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice



REPUBLIC OF KENYA

RESEARCH CLEARANCE PERMIT

GPK 6055—3m—10/2009

(CONDITIONS—see back page)