EFFECT OF SCIENCE PROCESS SKILLS ADVANCE ORGANIZER ON SECONDARY SCHOOL PHYSICS STUDENTS' PERFORMANCE AND MOTIVATION IN ELECTRIC CIRCUITS, LAIKIPIA COUNTY, KENYA

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A Thesis Submitted to Institute of postgraduate Studies of Kabarak University in Partial Fulfillment of the Requirements for the Award of the Degree of Doctor of Philosophy in Education (Physics Education).

KABARAK UNIVERSITY

OCTOBER, 2017

DECLARATION

The research thesis is my own work and to the best of my knowledge it has not been presented for the award of a degree in any university or college.

Signed : ______________________________ Date: ____________________

Josephat Kariru Kigo

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RECOMMENDATION

To the institute of postgraduate studies:

The thesis entitled "Effect of Science Process Skills Advance Organizer on Secondary School Physics Students' Performance and Motivation in Electric Circuits, Laikipia Kenya" and written by Josephat Kariru Kigo is presented to the institute of Postgraduate Studies of Kabarak University. We have reviewed the research thesis and recommend it be accepted in partial fulfillment of the requirements for the award of the degree of Doctor of Philosophy in Education (Physics Education).

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ABSTRACT

Physics concepts have played a significant role in the development of technology, industries and social development. There are exciting and productive careers emanating from good understanding and application of physics principles, concepts and science process skills learned in physics education. In Kenyan secondary schools, one is allowed to sit for at least two sciences at the Kenyan Certificate of Secondary Education (KCSE) examinations. Students are allowed to choose any two science subjects from among Biology, Chemistry and Physics while at Form Three but can also choose to do all the three subjects at the end of the secondary level. Despite the importance of physics, few students choose physics as their learning subject and the performance is lower compared to the other sciences at KCSE examinations. Fewer girls choose to do Physics at KCSE and their performance is also lower than that of boys. The poor performance and low enrolment in physics at Kenya Certificate of Secondary Examination may be due to lack of motivation or inappropriate teaching strategies among others. This study investigated the effects on performance and motivation after exposing Form two students to science process skills advance organizer (SPSAO) before the teaching of physics concepts in electrical circuits as required by the KCSE syllabus. The science process skills (SPS) exposed to students were observing, measuring, predicting, experimenting and hypothesizing. These skills were exposed to students as treatment before the lesson. Four mixed day public schools from Laikipia Central Sub-County were randomly assigned to Solomon four-group design for data collection and evaluation of the effect of the science process skills advance organizer on student's motivation and performance in Electric current circuits in secondary school physics. A total of 191 form two students participated in the study. Multistage sampling was used to select the four schools that participated in the study. The instruments for data collection were physics Achievement tests (PAT) that was administered as pretest and posttest and a students' motivation questionnaire (SMQ) which was given to students who were treated with the SPSAO. The instruments were pilot tested before subjecting them to students for results reliability. The SPSS (Statistical package for social sciences) output for reliability of the piloted results for (PAT) and (SMQ) were Cronbach's alpha 0.951 and 0.799 respectively. The (PAT) pretest and posttest were administered to students between two weeks while the (SMQ) was administered to students who were exposed to the science process skills advance organizer (SPSAO) after the posttest. Data collected was analyzed using the ANCOVA, the t-test, ANOVA and the factor analysis. Hypotheses were accepted or rejected at a significance level of alpha of 0.05. The results of the study may provide a radical shift from teacher-centered methods of teaching physics and motivate students to higher level science process skills and give secondary school students confidence to engage in physics as a learning subject. The findings of the study indicated that Science Process Skills Advance Organizer improved Physics performance in the electric circuit topic, motivated students towards physics and showed no gender dependence. From the findings of the study, valuable information yielded will inform secondary school physics teachers, curriculum developers, teachers' educators and policy makers on appropriate measures to improve on teaching methods, trainee teacher education programs and designing of workshops to in-service practicing physics teachers and tutors.

Key words : Physics, Science Process Skills, Advance Organizer, Performance, Motivation

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ABBREVIATIONS AND ACRONYMS

ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
CEBR	Centre for Economics and Business Research
EPS	European Physical Society
GOK	Government of Kenya
GVA	Gross Value Added
IUPAP	International Union of Pure and Applied Physics
KCSE	Kenya Certificate of Secondary Education
KICD	Kenya Institute of Curriculum Development
KNEC	Kenya National Examination Council
NACOSTI	National Commission for Science, Technology and Innovation
PAT	Physics Achievement Test
SMQ	Student Motivation Questionnaire
SPSAO	Science Process skill Advance Organizers
SPS	Science Process Skill
RTM	Regular Teaching Method

OPERATIONAL DEFINITIONS OF TERMS

Advance Organizer Material presented before the actual learning was used to anchor what was to be learned. In this study, science process skills of observation, measuring, predicting and hypothesis were used as advance organizer.

Co-educational/Mixed School A school where boys and girls learn together usually under one teacher.

Gender Socially constructed definition of women and men. It is not the same as sex (biological characteristics of women and men) and it is not the same as women. Gender is determined by the conception of tasks, functions and roles attributed to women and men in society and in public and private life. In this study, gender was taken to mean female and male for girls and boys respectively in form two Physics classes.

Motivation Encouragement for enrolment in physics at higher levels and liking to participate in physics activities. SMQ were used to collect data for analysis. In this study, motivation was indicated by students' improvement of post test results over pretest after treatment with SPSAO.

Performance Ability to apply science process skills to accomplish specific tasks in physics. In this study, performance was taken as change of student score from the pretest scores to post-tests scores.

Regular teaching method A method where the teacher is the director of the learning process and student interaction to understand the content during the lesson is minimal. In this study no extra activities related to the teachings of physics were introduced to the students prior to the physics lessons.

School Environment The general organization of the school that makes learning possible. The Schools' ideals that create a good learning atmosphere. In this study the general culture of the school was maintained during the teaching of lessons. Only the classes being treated with SPSAO had extra activities introduced to the teachings of physics.

Science process skills Science process skills are activities that attribute to achievement in science, (Okere, 1996). In this study, the skills were observing, measuring, predicting, hypothesizing and experimenting.

Teacher Characteristics General visible and hidden characteristics of the teacher that motivate students to like and be motivated to undertake tasks to be accomplished in physics learning. In this study teachers teaching in respective schools were trained to continue with their role of teaching and to implement their advanced organize

CHAPTER ONE

1.1 Introduction

This Chapter discuss contributions and uses of Physics in advancing human living and also the challenges of performance and enrolment in the secondary schools in Kenya.

1.2 Background Information

A statement adapted by the International Union of Pure and Applied Sciences(IUPAP), in March 1999, describes physics as the study of matter, energy and their interactions and it is an international enterprise, which plays a key role in the future progress of humankind. The importance of physics to the economies of Europe is described in Table 1.

Table 1.1:

Contributions of different Physics-Based Subsectors to total physics-based Gross Value Added (GVA)

Physics Based Sub-sector	Contributions Percentage
Manufacturing	44.9
Information & Communication	20
Professional Scientific & Technical	16.8
Oil & Gas activities	9.6
Energy Production	7.2
Transportation	1.3
Treatment of Hazardous	0.2

SOURCE: European Physical Society (January 2013)

It is important to understand that different sub-sectors of physics-based industry contribute different levels of added value. Averaged over the 2007-2010 period, the three major contributions to physics-based Gross Value Added (GVA) in Europe were from manufacturing (44.9%), information and communication (20.0%), followed by professional, scientific and technical activities in physics-based fields such as architecture, engineering and Research and Development (R&D) (16.8%). Similar distributions are observed in employment data. Averaged over the period 2007-2010, the dominant areas of physics-based employment were manufacturing (55%), information and communication (12%), and professional, scientific and technical activities in fields where physics is important such as architecture, engineering and R&D (27%). In the years 2007-2010, the variation in physics-based employment in manufacturing suggests that manufacturing activities utilizing some degree of physics are becoming more important in the overall manufacturing sector within Europe. Other physics-based sub-sectors contributing to GVA and employment are transportation, energy production, oil and gas activities, and the treatment of hazardous materials, European Physical Society (Jan 2013). The Kenya Vision 2030 is a vehicle for accelerating transformation of our country into a rapid industrializing middle-income nation by the year 2030 and physics is important for the country to achieve this. (GOK, 2007).

Reasons stated by International Union of Pure and Applied Sciences (IUPAP) (1999) to support Physics education and research include among others the ability of Physics to excite intellectual adventure that inspires young people and expand the frontiers of our knowledge about Nature. Studying physics helps in generating fundamental knowledge needed for the future technological advances that will continue to drive the economic engines of the world and contributing to the technological infrastructure thus provide trained personnel needed to take advantage of scientific advances and discoveries. Also physics is an important element in the education of chemists, Engineers and Computer scientists, as well as, practitioners of the other physical and biomedical services.

Physics extends and enhances our understanding of other disciplines, such as the earth, agricultural, chemical, biological and environmental sciences, plus astrophysics and cosmology, which are subjects of substantial importance to all the people in the world. It improves our quality of life by providing the basic understanding necessary for developing new instrumentation and techniques for medical applications, such as computer tomography, magnetic resonance imaging, position emission tomography, ultrasonic imaging and laser surgery, International Union of Pure and Applied Sciences (IUPAP) (1999)

Despite its importance to society as expressed by IUPAP and EPS, many reports indicate poor performance of physics at Kenya Certificate of Secondary Education (KCSE) compared to other science subjects examined at the same level. Aina (2013) identifies that lack of qualified science teachers, lack of instructional materials; low students interest and lack of motivation among others are causes of low enrolment in science. Elsewhere as cited by Udo and Ubana (2013) referencing Abiam (1997) IIoputaife (1997) and Orji (2000) states that physics has the lowest popularity index among other sciences taught in Nigerian schools. They further suggest for efforts towards looking for innovative strategies that could be used to enhanced students' achievement and retention of physics concepts taught in Nigerian schools. This study aimed at promoting performance and enhancement of motivation in electric circuits among form two students taking physics as a learning subject.

Kenya Vision 2030 recognizes that the process of the emergence of the knowledge economy is always associated with the increase in science-related and technology-related activities (GOK, 2007).Physics which is widely recognized as the most fundamental of all the sciences has also been recognized as the foundation of our society (Pravica, 2005) and as being indispensable in many professions for economic development (Stokking, 2000). Table 2 indicates disparity in Enrollment among the sciences at KCSE from 2006 to 2014 (KNEC, 2015). In the Kenya secondary school physics syllabus, the topic of electrical current circuits forms the basic foundation to many other topics in secondary school physics and materials required to engage students practically are easily available and not expensive. With students improving in the performance of electric circuits concepts in physics by being exposed to science process skills advance organizer this could motivate a desire among students to like physics and encourage more students to take physics as a learning subject. The science process skills advance organizer activities of observation, recording, reading meters measuring current and voltages, deciding on graph scales for readings recorded, drawing of graphs showing relationships of currents and voltages with different numbers of cells and resistors connected in series and parallel could make students have a positive feeling of owning the process of knowing how electrical circuits operate. This could lead to a better understanding of physics concepts taught in class and hence improve on performance when tested on concepts of electric circuits in physics.

Table 1.2:

National Enrolment of students at KCSE 2006 - 2014

Year	% of Physics Candidates	% of Chemistry Candidates	% of Biology Candidates
2006	29.69	97.28	89.41
2007	30.15	96.57	89.38
2008	30.61	97.92	89.79
2009	31.33	98.48	89.34
2010	30.73	97.87	88.76
2011	29.29	98.34	88.76
2012	27.29	98.39	89.00
2013	26.83	98.49	88.95
2014	27.03	98.71	89.03

Source: KNEC (2015)

In Laikipia Central District, a total of 952 students were enrolled in form one in 2011(Education office, Laikipia 2015). The enrollment of physics at KCSE in 2014 was only 174(18.28%) students out of those who joined form one in 2011. Reasons informing the students on not choosing physics as a learning subject in form three and four range from poor performance of physics at KCSE for a long time , lack of physics teaching facilities and fear of the mathematical aspect of physics. The enrolments in Chemistry and Biology in form three and four at the same time were 773(81.20%) and 728(76.47%) respectively. Kenya Certificate of Secondary Examination 2012 registration data for Laikipia East and Central Districts indicate only 25.98% of the candidates registered for physics. Whereas there was an enrollment of 98.70% and 94.67% for Chemistry and Biology respectively during the same period (Education office, Nanyuki, 2015).Table 1.3 indicates the overall performance and the achievement of quality

Grades (Grades A to C+) in physics at KCSE in Laikipia Central in 2013 and 2014. Attaining grades A to C+ in physics allows students to be admitted in what is considered as prestigious programs in the Universities and other higher learning colleges.

Table 1.3:

KCSE Performance and Quality Grades. (A to C+ grades)

Year	Mean Score	Quality Grades Percentage	Number of students with quality grades out of :
2014	4.37	21.83	38 of 174
2013	4.43	25.40	48 of 189

Source: Education Office, Nanyuki (2015)

The performance with few students taking physics in Kenyan secondary schools is below the common expectation of good performance with small classes. Many schools in Kenya have small classes in physics but the small classes do not perform as expected. Keil & Patell (1997) found that increasing class size lowers students' achievements at a decreasing rate. Siringi & Waihenya (2002) refer to students enrolled in physics at Kenya Certificate of Secondary Education (KCSE) as the few bright and are expected to attain high grades at KCSE. The use of Science process skills advance organizer is in this study expected to enhance performance and encourage many students of both gender to enroll for physics at KCSE. This is because one of the reasons for using science process skills advance organizer is that they are motivating and make science relevant. Performance of physics has remained below 50% on the scale of 1-100. Table 4: below indicates KCSE performance in physics countrywide between 2006 and 2014.

Table 1.4:

National KCSE Performance in Physics from 2006 to 2014

Year	Percentage Mean Score (Male and Female)	Female	Male
2006	40.32	39.07	40.82
2007	41.32	39.04	42.23
2008	36.71	36.10	36.95
2009	31.31	29.93	31.88
2010	35.13	33.46	35.76
2011	36.64	34.55	37.42
2012	37.87	36.22	38.48
2013	40.10	38.19	40.82
2014	38.84	38.29	39.06

Source: KNEC 2005 and 2006, KNEC 2006 to 2015

The data in table1.4 indicate gender disparity in physics performance. Many reasons ranging from attitude towards physics by students, low student motivation to learning physics, poor teaching approaches by physics teachers, language used by teachers in classrooms, perceived difficulty of the subject, inadequate instructional supervision from the Ministry of Education, Science, and Technology are attributed to poor performance of physics at KCSE (Njoroge, Changeiywo & Ndirangu, 2014) . Reasons attributed to low enrollment according to Semela, (2010), range from inadequate lower level preparation, weak Mathematical background, lack of job opportunities outside the teaching profession, inadequate teacher qualification as well as possession of below standard pedagogical content knowledge. In their study on teaching physics for retention using graphic advance organizer, Udo and Ubana (2013) express worry on how physics is taught to retain the physics concepts in the cognitive structure of the learner.

In the study to determine if gender-based performance on a particular physics test, McCullough, (2011) states, if context affects performance, and performance affects interest and participation, then there is need to be sure of tests in physics classroom that are not hindering women's performance and possibly their participation. Baram-Tsabari &Yarden (2008) argue for using contexts that are girl-friendly as a way to help increase girls' participation in physics, and perhaps to help make physics more appealing to everyone. Hilal & Omer (2008), in their study on the effect of the scientific skill training on students' scientific creativity, achievement and attitude concluded that students who had Science Process Skill (SPS) training succeeded more than students who had traditional training. Giving SPS training increased the academic achievement of students. Similar results by Ardac and Mugaloglu, (2002) show that there was an increase in the achievement levels of the students at the end of the SPS training done in science courses and the training done based on the activity (Turpin, 2000). This study purposes to investigate the effect of science process skills advance organizer in performance and motivation in the physics of electric circuits.

This study proposed to expose students to science process skills advance organizer through manipulation / rearrangement of basic electrical circuit components before a regular physics lesson. Students were guided to acquire skills like predicting the range of current in various circuits they created, make generalizations about circuit arrangements, describe bulb brightness with various arrangements of resistors and sources(cells) connections and carry out simple experiments to show relationships between identified circuit components. This was important because Science process skills can be gained by students through certain science education activities (Harlen, 1999; Huppert, Lomask and Lazarorcitz, 2002).

The purpose of science education is to enable individuals to use scientific process skills. Hilal and Omer (2008) explain science process skill as the ability to be able to define the problems, to observe, to analyze, to hypothesize, to experiment, to conclude, to generalize and apply the information one has using the necessary skills. The use of science process skills advance organizer was to investigate their effect on students' motivation and achievement in physics. Advanced organizers are a cognitive instructional strategy to promote learning and retention of new information. According to Ausubel and Fitzgerald (1961), these are tactics to activate prior knowledge through cues questioning used by teachers to help their students make connections between their prior knowledge, new information and concepts to be taught. Novak (1980) describes advance organizers as a kind of cognitive bridge, which teachers use to help learners make link between what they know and what is to be learnt.

This study also intended to investigate student motivation towards physics when taught using science process skills advance organizer. Sources of intrinsic motivation that have been highlighted by researchers include, challenge, curiosity, control and fantasy. Challenge involves activities that challenge students' skills, while curiosity presents ideas that are surprising or inconsistent with the learners existing beliefs. Control involves activities that provide student with a sense of control with academic outcomes (html study.com).

1.3 Statement of the Problem

Many students joining secondary schools show great motivation to achieve in careers that have strong foundations in physics even with no idea what the subject entails. This initial motivation is not translated to good performance of physics at KCSE. Also, it is noted that few students enroll for physics in Form Three. Some of the reasons given by students for low enrollment in physics include, among others: poor results at KCSE, physics is difficult, there is too much mathematics in physics, practical lessons are difficult, the syllabus is wide, negative statements about physics from peers, lack of physics teachers, teachers are "tough", physics language is difficult to understand, application questions are hard, physics is not related to careers of their choice and girls think physics is for boys. The low performance of students in Physics at KCSE from 2006 to 2014 compared to the performance of Biology and Chemistry could be due to lack of motivation and interest in Physics among students in secondary schools. Achievement of below 50% within the same period and by a small number of students may reflect poor teaching methods and lack of understanding of basic concepts in Physics among others. Exposing students to SPSAO may create engagement with facilities that may enhance conceptualization of basic concepts in electric current circuit and the students may also add time in studying physics. This study investigated the effects of exposing science process skills advance organizer before the physics lessons on students' performance and motivation in the topic of electric circuits' in physics, in Laikipia Central sub county.

1.4 Purpose of the Study

This study investigated the effect of science process skills advance organizer on students' performance and motivation in electric circuits in Secondary school physics of Laikipia Central sub county, Laikipia County.

1.5 Objectives of the study

The following objectives were used to guide the study:

(i) To determine the effects of science process skills advance organizer on students' performance in electric circuits in Physics.

(ii) To investigate whether science process skills advance organizer has effect on students' performance in electric current circuits physics based on gender.

(iii) To determine the number of factors among the variables in each of the six items of the students' motivation questionnaire that explain the motivation of students on electric current circuits having been exposed to science process skills advance organizer.

1.6 Hypotheses of the Study

To achieve the objectives of the study the following hypotheses were formulated and tested at 0.05 level of significance.

H_o1: There is no statistically significant difference in performance in electric current circuits in physics between students taught after exposure to science process skills advance organizer and those taught using regular methods only.

H_o 2: There is no statistically significant influence of science process skills advance organizer on performance of electric current circuits in physics based on gender.

H_o3: There are no factors explaining students' motivation on electric current circuit on having been exposed to SPSAO.

1.7 Research Question

The study sought to find answer(s) to each of the six items of the students' motivation questionnaire (Appendix V) by extracting factor(s) from each of the items that describe or explain students' motivation to learning electric current circuits in physics when exposed to Science Process skills advance organizer before a physics lesson.

1.8 Significance of the Study

The use of science process skills advance organizer may sprout students' positive belief in their own ability to study physics and see value in what they learn. Teachers may be encouraged to appreciate the students' ability to connect the advance organizer activities with the physics concepts being taught during physics lessons in the classroom. Teacher tutors in colleges and Universities may help prospective teachers to construct useful advance organizers for various topics in physics and other teaching subjects as well as guide them on how to identify specific science process skills to achieve specific objectives in their lesson topics. Programme designers may also benefit in developing teaching materials. This study may have a positive effect on aspects related to learning and performing in electric circuits and other physics topics.

1.9 Scope of the Study

The study involved Form Two students from four Day Mixed Secondary Schools in Laikipia Central Sub County randomly assigned to Solomon four quasi-experimental designs. The topic covered was Basics to Current Electricity taught in Form Two. The use of Science Process Skills (SPS) advance organizer was hoped will motivate students to choose Physics in their form three choices of subjects for Kenya Certificate of Secondary Examinations (KCSE). The engagement of students in the science process skills advance organizer activities was intended to make them have a feeling of self-discovery of Physics concepts during the Physics lesson. For this study the specific Science process skills advanced organizer exposed to the experimental group before the physics lesson were: observing, measuring, predicting, experimenting and hypothesizing. The study took place in one school term.

1.10 Limitations of the Study

At the beginning of the data collection process the teachers were not attracted by the fact that there were tests to be administered to the students. The teachers were assured that the results would only be used for the purpose of the study and they were also encouraged to work within the research period and meet other school deadlines. Ensuring constant presence of students during the experimental session was a challenge in that some students missed classes due to school administrations decisions. This affected the duration of the experimental process. Students' interests and misconceptions in the area of electric current circuits were not addressed. The effectiveness of the science process skills advance organizers was only limited to the electrical current circuits and in Laikipia Central of Laikipia County.

1.11 Assumptions of the Study

The study assumed that:

(i) The students were not to be affected by the new teaching approach. This was more on the experimental schools where the teacher was not expected to relate the Science Process Skills activities with the lesson to be taught.

(ii) The students' motivation questionnaire will be honestly undertaken by the treated groups.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The importance of physics as a basis for technology and achievement of Kenya's vision 2030 is obvious although the number taking physics at secondary schools and tertiary institutions is low. The enrolment of candidates at KCSE from 357,488 to 483.630 from 2010 to 2014 shows an increase of 35.29% (KNEC, 2015). The candidates enrolling for physics at KCSE at the same time changed from 109,811 to 131,410, an increase of 19.67% while the candidature of Chemistry and Biology increased by 37.20% and 26.754% respectively. The figures indicate low esteem in physics among the Kenyan secondary school students. Noting that the success of vision 2030 is pegged on a large Kenyan population being scientifically literate, the lack of interest in a fundamental science should be a cause to worry. The performance of physics at KCSE is also low compared to other science subjects offered at the same level. Few students attain C+ (Plus) and above grade that is required for science oriented courses at local Universities. Students' attitude towards physics, difficulties experienced by teachers handling various topics in physics and the science background from primary schools are some among many reasons given as associated with poor performance and enrolment of physics at secondary school level.

The knowledge and skills acquired from physics are known to have contributed enormously to industrial efficiency, engineering, telecommunication, transport and also in employment. Moreover, physics provides a foundation base to other disciplines such as medicine, chemistry and biology. In physics, learners develop skills necessary for problem solving (Adeoye, 2010). Research in physics education has reported on many factors that bring about differences in students' performance in physics. The factors include: the content itself and its characteristics, learner interpretation on what is happening around his or her environment (Svinicki, 2008) and gender, teacher qualification and laboratory facilities (Onah and Ugwu,2010). Other factors that cause performance differences in physics as cited by Amunga, Amadalo & Musera (2011, citing, Wasanga, 1997; Lee and Lockheed, 1990; Bali, 1997; and Kahle & Lake, 1983) include school categories, teacher perception on gender abilities in science and other gender stereotypes. On teacher interaction with gender, Dee (2007) suggests that students benefit academically from having teachers who are of the same gender as themselves. It is clear from the many physics education research that there are equally many inputs (independent) variables that determine students' performance outcomes (dependent) variables in a classroom learning situation. It is unfortunate that in a given classroom situation, a combination of independent variables may be operating together making an educational research complicated. In this chapter, a few of the learning processing and motivational processing theories which focus on learner centered are outlined as a foundation to determine the effect of science process skills advance organizer as a teaching strategy to enhance students' performance and motivation in the electric current circuits in Form two physics course. The specific objectives stated for the study of electric circuits in form two physics syllabus by the Kenya institute of curriculum development (KICD) include among others drawing and setting up simple electric circuits, identifying circuit symbols, defining electric current and stating its S1 units. The science process skills acquired at this level are expected to lay a strong foundation to enable students understand and achieve other objectives to be achieved in form three and four physics syllabus. Some of the specific objectives to be achieved at higher levels include stating Ohm's Law, verifying Ohm's law, solving simple problems involving Ohm's law, describing the transmission of electric power from the generation station and describing the domestic wiring system among others. The exposure of student to science process skills advance organizer was assumed would help students make meaning of what was to be learned during the physics lesson on the concepts of electric circuits. Students were expected to relate the skills of observation, measuring, predicting and recording learned during the advance organizer presentation to understand the concepts learned in a physics class. The chapter also discusses among others; Science process skills, advanced organizers and their various types and uses, bridging analogies, Ausubel's theory of meaningful learning, gender and performance in physics and the study's theoretical framework.

2.2 Theories of Learning

Many learning theories differ from each other in contextual positions, major and minor functions, and in the type of data they explain .The spectrum of the learning theories is very broad. Subtle differences exist when one moves from one theory to another but broadly speaking; learning theories stress the following features to a varying extent (Vaidya, 2003):

(i) The pupil is active by nature. And is curious as well as eager to learn on his own environment.

(ii) Past experiences, repetition and practice, motivation, reinforcement, organized learning and goal setting play an important role in learning.

(iii) Learning situation should be open to the learner under certain conditions, novel behavior can be enhanced.

(iv) Learning with understanding, guided discovery, discovery learning and creativity are important aspects of learning worth cultivation at school.

(v) Conflict and punishment arise in learning but can be controlled (Hilgard and Gordon H. Bowler, 1975).

Burns (1995) conceives of learning as a relatively permanent change in behaviors with behavior including both observable activity and internal process such as thinking, attitudes and emotions. It is clear that Burns includes motivation in definition of learning. Burns considers that learning might not manifest itself in observable behavior until sometime after the educational program has taken place.

In 1968, David Ausubel developed the concept of advance organizers as a means to help students place new information into meaningful context of cognitive frameworks. Memories and knowledge are more likely to be stored in retrievable form when they are interwoven with prior knowledge at the time of storage. In addition, research has consistently demonstrated that well-constructed advance organizers promote the application of learned information to new situations (Mayer, 1987).

The status, role and image of science have changed with time (Baez, 1976). A closer look at the history of science and recent developments in science fueled by the newly emerging philosophies of science such as Kuhn's and Popper's have put into question the role of teaching strategies employed by teachers in science education (Lee, 1967; Jerons, 1969). The new developments in cognitive sciences especially the works of Piaget, Ausubel, Bloomand others have spearheaded the call for more appropriate teaching strategies during classroom instruction (Huitt, 2011). In view of the changing trends in teaching and learning of physics there is need to explore the effectiveness of new teaching strategies being used by teachers to present scientific concepts to students. One such strategy is the use of an advance organizer. A good deal of research has been done concerning the effects of advance organizers on learning.

2.2.1 Bruner's Theory of Discovery Learning

Bruner (1974, 1983 & 1991) is renowned in cognitive psychology as chief advocate of the discovery learning theory. This approach to learning emphasizes the importance of understanding the structure of a subject being studied, the need for active learning as the basis of true understanding and the value of inductive reasoning in learning (Woolfolk, 1996). According to Bruner, learners are constantly being bombarded with stimulation to all their senses more than what they can process at the same time. He states that the students should learn how to discover what they need to learn and know. The importance of this is that it gives the students more control over their own learning process and allows them to discover how ideas relate to each other and to existing knowledge.

According to Bruner (1983), true learning involves "figuring out how to use what you know in order to go beyond what you already think". He argues that discovery learning leads to development of problem solving skills, an increase of students' confidence about their learning abilities and ability to adapt in the new world. However, Bruner's structural view of learning has been vehemently opposed by other psychologists, more so by Ausubel who is very critical of Bruner's suggestion that learners do not require services of teachers; that the most valuable and long lasting learning is that which occurs as the result of the child's own discovery of the material before him. When an advance organizer is used, cognitive processing of the to-be-learned would be expected to be easier for the student leading to better conceptualization. This is consistent with Bruneian views of mental development.

2.2.2Ausubel's Theory of Meaningful Learning

Ausubel (1963, 1977) offers a contrasting view of learning to that of Bruner. He is known as a champion of meaningful reception learning as opposed to rote learning. He sees the teacher in the learning situation and insists that the teacher’s responsibility is to convey meaningful learning through actual teaching. He stresses the fact that material is easily learnt if it is arranged in a logical sequence. He suggest that before presenting any material a teacher must carefully study, analyze and take note of the concepts and the terminologies that are contained in it and arrange these in order or priority. This involves elaborate and careful planning and scheming. During the actual presentation of the actual matter the teacher must move slowly from what the learners know to what they do not know. According to this theory a primary process of learning is subsumptionin in which new material is related to relevant ideas in the existing cognitive structure on a substantive, non-verbatim basis. More specifically then, meaningful learning requires firstly that the material to be learnt must be related to some hypothetical cognitive structure, some kind of framework or model. The framework forms a cognitive structure and the student learns new material by relating it appropriately with a more inclusive conceptual system (Ausubel and Anderson, 1966).

In pursuing this argument in favor of meaningful verbal learning, Ausubel (1977) compares it with rote learning. In the words of Woolfolk (1996), “rote memorization is not considered meaningful learning since material learnt by rote is not connected with existing knowledge” (Pg. 319). He is of the view that pupils resort to rote learning in situations where the material to be learnt lacks logical meaningfulness and that it occurs when learners lack relevant ideas in their cognitive structures. However, while Ausubel’s guided discovery learning has greatly influenced educational practice it is not as effective as its enthusiasts first thought, due perhaps to problems like class sizes among others (Slavin, 1995). With too much emphasis on the role of the teacher, Ausubel’s technique has not yet produced clear evidence to show that pupils do not remain passive during instructional programme. According to Woolfolk (1996), many experienced teachers prefer Ausubel's technique to Bruner's while the young and inexperienced, not to speak of the untrained ones, cannot effectively use Ausubel's approach. It is challenging to design an appropriate advance organizer that will meet an effective conceptualization of the intended learning objectives. It would be of interest therefore to test the effect of using advance organizer on students' conceptualization of scientific concepts. The present study sought to find out whether students conceptualize electric current flow better when exposed to advance organizers than when not.

2.2.3 Constructivists' Theory of Learning

Recent research has led to the development of constructivist theories in which learners are seen as constructing meaning from input by processing it through existing cognitive structures and then retaining it in their long-term memory. This is done in ways that leave the input open to further processing and possible reconstruction (Okere, 1996). Constructivists view learning as depending on the degree to which learners can activate cognitive structures or construct new ones to subsume the new input (Bartlett, 1932). The leaner can facilitate his / her own meaningful learning due to personal interpretation of ideas (Driver and Duit, 1991). They stress that meaningful learning is the active creation of knowledge structures that are based on personal experience. Constructivists view learning as an activity, which involves constructing meaning through a social process whereby learners interact with each other as well as with their teacher. This objective can be achieved in a physics lesson through class experiments whereby pupils work in groups and discuss their findings (Okere, 1996).

2.3 Science Process Skill

According to Bybee et al. (1989) and Ango (1992), the basic Science process skills comprise: observing, measuring, classifying, communicating, inferring, using number, using space/time relationship and questioning while integrated Science process skills are: controlling and manipulating variable, hypothesizing, defining operationally, formulating models, designing experiment and interpreting data.

Akinbobola and Afolabi (2010) state that physics practical skills are Science process skills and are taught as part and parcel of the physics curriculum. They are cognitive and psychomotor skills employed in problem solving and are used in problem-identification, objective inquiry, data gathering, transformation, interpretation and communication. They can be acquired and developed through training such as are involved in Science practical activities and are the aspect of Science learning which is retained after cognitive knowledge has been forgotten. Using Science process skills is an important indicator of transfer of knowledge which is necessary for problem-solving and functional living. The science process skills used in this study were: observing, measuring, predicting, experimenting and hypothesizing.

2.4 Advance Organizer

An advance organizer is a device that teachers use to help students make connections between what they know and what is to be learnt. They are thus frameworks for facilitating students' learning of new ideas. The concept of advance organizers was proposed by Ausubel (1960). To him, effective advance organizers are presented by teachers at a higher level of abstraction, generality and inclusiveness than the material to be learnt. They can be useful devices at the start of a unit, before a discussion, video show and many other classroom situations.

The mode of functioning of an advance organizer has been explained (Ausubel, 1960) as comprising the drawing and mobilization of existing subsumes in the learners' cognitive structure for facilitating the incorporation into a working memory of new but unfamiliar concepts as well as the provision of optimal anchorage for such entrant concepts. This cognitive restructuring process is expected to result in some positive learning outcome (Egbugara, 1985). Four points in the use of advance organizer have to be noted. First, advance organizers are presented before the lesson. Secondly, they are abstract, and advance organizers are presented at a higher level of abstraction than the material presented later and finally they make explicit the connection between prior knowledge and the lesson to be taught. The Science Process Skill advanced organizer was expected to act as prior knowledge to the concepts of electric current circuits to be taught in the lesson after exposure.

2.4.1 Types of Advance Organizers

Advance organizer assumes various forms. One form is used when the material is completely new or unfamiliar. This is termed expository organizer because it presents a description or exposition of relevant concepts (Ausubel and Youssef, 1963). Another type is called a comparative organizer. This is used when the material to be learnt is somewhat familiar and therefore it is likely to draw similarities and differences between new material and existing cognitive structure.

Graphic organizers provide a visual holistic representation of facts and concepts and their relationships within an organized frame. They exist in a variety of forms which include sequence chain, story map, main idea table, flowchart, matrix, Venn diagram and others (Anders, Bus and Filip, 1984). Graphic organizers may be productively utilized before instructional activities such as reading or viewing a film, to activate prior knowledge, to provide a conceptual framework for integrating new information and to encourage student prediction. During instruction, they can help students to actively process and re-cognize information. And after instruction, graphic organizers may be used to summarize learning, encourage elaboration, help organize ideas for writing, provide a structure for review and assess the degree of student understanding (Dansereau, 1985).

Concept mapping is another form of advance organizers that are used in a variety of disciplines. Gains and Shaw (1995) state that concept maps have been used in education policy studies and the philosophy of science to provide a visual representation of knowledge structures and argument forms. Cognitive maps are designed to show individual's organization and structure of a particular area of knowledge. Concept mapping is a method of representing knowledge which assists in the development of schema which represents structural knowledge (Novak, 1978).From the teaching point of view; concept mapping can be used to do a number of things.

They can be used to explore a student's understanding of a limited aspect of a topic. The relationship shown describes the perceived relationships between concepts and this has implications for student understanding (Boyer, 1997). They can also be used to promote discussions where learners' diverse perspectives are illustrated by their maps. Then the teacher can also use concept mapping to assess students' understanding of the purpose of the instruction through comparing the students' maps accepted model (Novak &Godwin, 1984). Both graphic and verbal forms of advance organizers were used in the study. This study used Expository advance organizers for students to learn series and parallel electrical circuits for the first time.

2.4.2 Use of Advance Organizers in Learning

The advent of the internet, hypermedia/multimedia has given rise to a broad range of possible representations that may be utilized as advance organizers. Modern advance organizers take the form of text passages (Herron, 1994; Kang 1996), graphical representations (Gay & Mazur, 1991), maps (Jones Farguhar & Surry, 1995), and description plus pictures (Herron, Hanley &

Cole, 1995). When applied to hypermedia, advance organizers might present global concepts, indicate paths through the content, or foster access to individual components. Krawchuk (1996) present taxonomy of advance organizers that include traditional textual summaries and basic themes that are presented before instruction, organizations rendered in line and arrows (like flow charts), and pictorial graphic organizer. The latter category includes concept maps that present non-linear representations of information and knowledge to be learned. This brief discussion of the literature documents, the variety of advance organizers that might be utilized for a course of study. It is apparent that advance organizers have been used in a variety of ways to help students learn about a topic of study (Coffey, 2000). In this study, Science process skill advance organizer was to help student's anchorage of the electric current circuit concepts. Appendix I describe the teacher induction guide for the implementation of the activities that are the science process skills advance organizer of this study.

2.4.3 Effectiveness of Using Advance Organizer in Learning

Advance organizers have been effective in a variety of forms for a number of learning tasks. Mayer (1977) reported a series of studies supporting the positive but conditional effects of advance organizers. These conditions include occasions where learners lack pre-requisite skills or knowledge, the material to be learnt is poorly organized or difficult for learners to assemble, and where generalized outcomes will be measured.

Advance organizers are specifically effective for helping students learn the key concepts or principles of a subject area and the detailed facts and bits of information within these concept areas. According to Weil and Murphy (1982), an advance organizer is a highly effective instructional strategy for all subject areas where the objective is meaningful assimilation of concepts and principles. Research studies have shown all forms of advance organizers to be effective. Their merit in facilitating the meaningful learning of expository materials has been recorded by numerous researchers (Ausubel, 1960, 1978; Allen, 1970; Lawton & Wanka, 1977; Mayer, 1979; Egburgara, 1985). By using the tools of physics in their teaching, instructors can move children from mindless memorization to understanding and appreciation (Wieman, 2001). Students must develop the skills in order to learn science through inquiry. Science process skill will expose the students to the tools of physics before engaging into self-acquisition of the skill. Effective instructions are those which change the way students think about physics problems solving and cause them to think more like experts-practicing physicist (Hammer, 1997). Ndem & Ubana, (2013) conclude that retention in Physics is higher when graphic advance organizer is used and recommended that for better retention in Physics, teachers of Physics should be encouraged to adopt appropriate advance organizers in conjunction with other appropriately selected teaching methods. The good feelings of students while meeting the goals of physics may affect their performance and encourage more students to enroll. Students who require hands on methods to study are likely to benefit from this study. Physics teachers may appreciate the art of structuring their classrooms to maximize task involvement. Mayer (1979) on his evaluation of the assimilation theory stated that advance organizers should have a stronger effect for poorly organized text than for well-organized text and should have positive and stronger effect for the learners lacking prerequisite knowledge and prerequisite abilities respectively. However, there are researchers who have failed to prove the merit of organizers (Barnes &Clawson, 1975; Ibegbulam, 1980; Nwankpa, 1981). Explanations have been sought in terms of the nature and manipulation / rearrangement of various materials used. While studies have shown advance organizers to be effective with all grade and ability levels, the retention by lower ability students tends to profit most (Egbugara, 1985). This is not surprising for these students may be the most in need of these organization cues and the least able to generate them on their own. Studies indicate that the effectiveness of advance organizers is proportional to the level of unfamiliarity, difficulty and technicality of the material to be learned (Luiten, Wilbur &Gary, 1980). This provides teachers with the rule to follow in deciding when to invest the planning time needed to develop a good advance organizer to introduce a body of new information (Hartley &Davies, 1976). Because of the unfamiliarity of the concept of electric current flow to students, the use of an advance organizer would be expected to elicit a significant difference in conceptualization of the concept between the students exposed to the advance organizer and those not exposed. This is one of the objectives of the present study.

2.5 Bridging Analogies Advance Organizers

Perhaps the most effective type of advance organizer is the analogy or what Ausubel calls comparative advance organizers because they can be optimized to fit background of a particular student population (Eggen, Kauchak & Harder, 1979). Advance organizers have been described as bridges from student' previous knowledge to whatever is to be learned. They can call fourth general organizational patterns and relationships already in mind that students may not necessarily think to use in assimilating the new material (Egbugara, 1985). According to Zietsman and Clement (1996), analogical advance organizer becomes a conceptual bridge from the prior knowledge to the information to be learned. It gives the student a "what to look for" frame of reference or provide hooks or anchors to knowledge previously acquired. For example Babikian (1971) measured significant gains in high school students' understanding of the concept of force using several experimental lessons that were based on anchoring examples such as the hand pushing on the spring.

In general, the value of analogy as an advance organizer depends on the familiarity of the analogy to the students and the degree of overlap between the ideas to be taught and the analogy used (Ausubel, 1960). While considerable research has been conducted on the effectiveness of advance organizers on students' retention of the material learnt, very little has been done on their effectiveness as anchoring conceptions towards conceptualizations of higher level learning material. Oloyede (2011) citing Herron, 1994 describes retention as the term used to denote the demonstration that learning has been maintained over time. It may be displayed through recognition or recall.

2.6 Science Process Skill, Advance Organizers and Instructional Material

The study assumes that the students' exposure to science process skill advance organizer in the topic of current electricity will enhance their performance. Science process skills have been described as mental and physical abilities and competencies which serve as tools needed for the effective study of Science and Technology as well as problem solving, individual and societal development (Nwosu & Okeke, 1995).Table 2.1 below shows the science process skills advance organizer model for this study.

Table: 2.1
Science Process Skills Advance Organizer Model for the Study

Phase One: Advance Organizer Activities	**Phase Two:** Preparation of learning task or material	**Phase Three** Strengthening Cognitive Organization
• The aim of the lesson is clarified • Present the components of electric circuits to be used, for example cells, resistors, bulbs, connecting wires, switches, measuring current and voltage instruments. • Students arranged the components in an operational order of an electric circuit. • Change cell terminal in the circuit and comment on meter readings. • Increase number of resisters in the circuit and comment on meter readings. • Re-arrange the cells to be in series and then parallel comment on voltmeter readings.	• Prepare lessons to show achievement of the following objectives**:** • Batteries connected in series increase circuit voltage**.** • Similar batteries (of individual battery voltage) connected in parallel provide the voltage of one battery in the circuit- each batter supplies a fraction of the total current. • Increasing resistance in series reduces current in the circuit for the same battery • Increasing number of batteries in series in the circuit increases circuit current when resistors remain the same.	• Help the students relate their observation(s) with the specific activities during the presentation of the science process skills advance organizer**.** • Promote active understanding of the learning process by group discussion and answering questions to evaluate concepts reception

• Re-arrange the resistors to be in series and then parallel comment on the current reading for currents passing through each resistor. • Comment on the current in series and in parallel circuits for cells in parallel and in series.	• Arranging batteries of the same voltage in parallel does not change the voltage across the resistor. (same as if only a single battery were present). • Current through resistors connected in series is the same for each of the resistors. • Sum of voltage drops across each resistor is series equal the voltage of the battery in the circuit. • The equivalent resistance for resistors in series is the sum of the individual resistors in the circuit. • The voltage drop across resistors connected in parallel is the same. • The voltage drop across resistors connected in parallel is the same.	

	• The current through resistors in the parallel is the sum of the current from the battery.	

The model table 2.1 shows the specific engagement activities in phase one that students will do during the presentation of the science process skills advance organizer. The activities help the student achieve the characteristics that bring about meaningful learning. At the end of the presentation of the science process skills advance organizer, students are expected to achieve some general objectives like the relationships of various circuit components that will hopefully be linked to the specific objectives of phase two of the model. During phase three of the model that is intended to strengthen cognitive organization, students are expected to show acceptance of the specific objectives stated in phase two by giving examples of their experiences in phase one of the science process skills advance organizer presentation. Increasing of number of batteries in the circuit during the presentation of the advance organizer makes the bulbs glow brighter and this can be related with increasing of current when the number of batteries is increased during phase two of the model. Increasing the number of resistors in series in a circuit and reading the ammeter during the phase one of the models will be linked to the specific objective in phase two where the current through resistors connected in series is the same for each of the resistors. Showing the reading of the voltmeter to be the same for one battery with that of a number of batteries connected in parallel will be easily linked with the objective in phase two of the model that states that similar batteries connected in parallel provide the voltage of one battery in the circuit. Deliberate effort to link new knowledge with higher order concepts in cognitive

Structure and learning related to experience with events or object are considered to be characteristics of meaningful learning.

Advance organizers assume various forms. One form is used when the material is completely new or unfamiliar. This is termed expository organizer because it presents a description or exposition of relevant concepts (Ausubel and Youssef, 1963). Another type is called a comparative organizer. This is used when the material to be learnt is somewhat familiar and therefore is likely to draw similarities and differences between material and the existing cognitive structure. Form Two students have no idea of current electricity circuits as covered in Form one and two classes according to the KICD, (previous KIE) syllabus (KIE, 2002). In this study science process skill advance organizer were expository.

2.7 Gender and Performance in Physics

The index of performance in physics by gender has been an issue of discussion and research for a long time. The differences in male and female performance have been pegged on biological differences (sex) between men and women which are universal and cannot change. Socially defined differences, culturally and socially ascribed roles and responsibilities have also been attributed to gender gap. One clear thing about the gender gap in performance or otherwise is that the identified variables may vary from individuals, community ideals, goals, level, different subjects, same subject topics or even methods of engagement. Eddy (2016) found that male students underestimate their female peers' knowledge and that stereotypes pose another obstacle.

The desire to bridge the gender gap in science performance has also been consistent. Butler and Nesbit (2008) suggest the following as key aspects of motivation to learning science, making science real, making the science relevant and making the science rigorous. Obafemi and Debora

(2015) citing studies by Nsofor (2001), Akinboboa (2005), Onwioduokit, Akinboboa, & Udoh (2008), Iorchugh (2006) and Wambugu & Changeiywo (2008) state that girls and boys could equally perform well if exposed to the same conditions of learning and that gender has no significant influence on students' achievement. In bridging gender gap in the physics classroom study, Obafemi and Deborah (2015), point out demonstration method as effective in bridging gender gap in learning of difficult physics concepts like light waves. They also state that there are differences between males and females in the application of light waves but no differences in the understanding and analysis of light waves. The guided-discovery method contributed more to the differences in application of light waves according to Obafemi and Deborah (2015). In another study, Adeoye (2010), found that girls achieve better than boys when the physics test items are based on physics concepts that require learners of low numerical ability. This study focused on investigating the effectiveness of science process skills advance organizer on students' (both male and female) performance and motivation in electric circuits in secondary school physics in Laikipia Central of Laikipia County.

2.8 Performance

Performance has been explained to mean the action or process of carrying out or accomplishing an action, task, or function. In the secondary school education, performance is rated with grades A to F with A as the highest and F as a failure. In this study performance was taken as the increase of score from the Pretest score to posttest score after the treatment was done for groups that were treated and for other groups that were in the experimental design used. Table 2.2(a) shows Experimental group 1 increasing in mean score from pre-test at 4.74 to posttest at 5.56 an indication of treatment or any other unconsidered variable influence. The standard deviation of Experimental group 1 also reduced from 2.030 to 1.959. Table 2.2(b) shows the control group 1 mean score for the post test was 7.49 up from 7.34 at pretest. The standard deviation reduced to 1.648 from 1.954 at pretest. The reduction of the standard deviation and the increase of the mean score for the control group 1 might be due to other independent variables.

Table 2.2:
Descriptive Statistics for field data for Experimental Group 1 and Control Group 1

(a) Experimental Group 1 Descriptive Statistics

	N	Range	Min	Max	Sum	Mean	Std. Dev	Var.	Skewness	
	Stat.	Stat.	Stat.	Stat.	Stat.	Stat.	Stat.	Stat.	Stat.	Std. Error
Exp.pre	54	10	1	11	256	4.74	2.030	4.120	.395	.325
Exp.post	54	8	2	10	300	5.56	1.959	3.836	.015	.325
Valid N (listwise)	54									

Key: Exp.pre-Experimental group 1 pretest, Exp.post-Experimental group1 post test

Issues of poor performance in physics at Kenya Certificate of Secondary Education and the accompanying low enrolment in physics in Kenyan Secondary Schools are a great concern especially at this time when the country is geared towards achieving vision 2030. Reasons for the poor performance vary from stake holder to stakeholder. Parents have their reasons, school administrators have their reasons, and teachers of other subjects have their reasons while physics teachers have theirs. Students and even by gender have their reasons for enrolling or not enrolling for physics at the national examination. Looking at table 1.4, national KCSE performance in physics between 2006 and 2014, and the performance is well below fifty percent for both male and female. In their conclusion on relationship of academic intrinsic motivation and psychological well-being among students, Bhat and Naik (2016) argue that “there is a significant, but negative correlation between the dimensions of extrinsic motivation that is peer acceptance, power motivation and fear of failure and psychological well-being among male students. While as in female students, there was a low positive relationship between peer acceptance, a dimension of extrinsic motivation, and psychological well-being and an inverse relationship between need achievement, dimension of intrinsic motivation, and psychological well-being. A very low correlation was found between rest of the dimensions and well-being in both males and females. The findings could not find a significant difference between the mean scores of males and females. The results also reveal that there was a significant mean difference of males and females on extrinsic motivation". Shia, (Online, retrieved 19/10/2017) citing (Archer, J., 1994, Cordova, D. I., et.al., 1996, Dev., P. C., 1997, Garcia, T. et.al., 1996, Hoyenga, K. B., et.al., 1984,. Miller, K. B., et.al. 1996, Schraw. G., et.al. 1994.) discusses assessing academic intrinsic motivation: A look at students' goals and personal strategy as follows, "Academic intrinsic motivation is a factor that is essential for college success. A large number of students carry out education to or past the college level. The motivations behind such academic persistence vary across many intrinsic and extrinsic factors. Many college students find that their level of motivation is not sufficient enough to guide them in carrying out their academic careers. An example would be the student who is studying to be a doctor because his father wants him to be a doctor. In the college atmosphere, the student's parents are not there to make him do the work necessary to become a doctor; therefore, the motivation is lost. Such a student may seek academic counseling in hopes to find an answer to why such motivation is lost. The purpose of this study is to propose an inventory that will assess student motivations in the classroom. This inventory is designed for academic counselors to administer to students whom seek guidance for the purpose of understanding the student's motivation in a classroom setting. The knowledge that the counselor would gain about the student will allow the counselor to direct counseling techniques toward a specific academic problem.

Intrinsic motivation has been defined as (a) participation in an activity purely out of curiosity, that is, for a need to know about something; (b) the desire to engage in an activity purely for the sake of participating in and completing a task; and (c) the desire to contribute (Dev, 1997). Intrinsic motivation requires much persistence and effort put forth by an individual student. Students with intrinsic motivation would develop goals such as, the goal to learn and the goal to achieve. A mastery goal, the desire to gain understanding of a topic, has been found to correlate with effective learning strategies, positive attitudes toward school, the choice of difficult tasks as opposed to a simple task, perceived ability, effort, concern of future consequences, self-regulation, the use of deep cognitive processes, persistence, achievement, choice and initiative (Archer, 1994; Miller, Greene, Montalvo, Ravindran, & Nichols, 1996; Garcia & Pintrich, 1996).

Past research on intrinsic and extrinsic motivation groups students into three main academic dimensions; those who have a (a) mastery or task orientation, (b) ego orientation, or (c) work avoidant orientation. Mastery or task orientation refers to the student who engages in an activity simply to gain knowledge, skill, or to contribute to the field of knowledge. This type of motivation can be seen as a non-need approach to education: The motive behind task engagement is not to fulfill a personal need. However, two prominent motivation researchers, Edward Deci, and Richard Ryan (1985), found that intrinsic motivation could stem from the organism's need to be competence and self-determining. With this in mind, I propose yet another factor that makes up for the task orientation (rather than a learning orientation) involving a need to prove competence to one's self, the need for achievement. This leaves the intrinsic motivation dimension to be made up of two factors: Mastery orientation and The need for achievement.

The 16 Personality Questionnaire (1986) defines one with the need for achievement as "Mature, forceful, strong, dominant, demanding, and foresighted; as being independent and self- reliant; and as having superior intellectual ability and judgment." I generalized this description to match up with academic behavior as a model for designing the need for achievement subscale for my questionnaire. Also as a model, I used their description of one with "intellectual efficiency" to describe those with a mastery orientation: "Efficient, clear-thinking, capable, intelligent, progressive, planful, thorough, and resourceful; as being alert and well-informed; and as placing a high value on cognitive and intellectual matters."

Extrinsic motivation refers to motives that are outside of and separate from the behaviors they cause; the motive for the behavior is not inherent in or essential to the behavior itself (Hoyenga & Hoyenga, 1984). If a student studies hard to do well on a test because a good grade will result in a brand new car, then the motive behind studying is not what it is intended to do: obtain knowledge. Studying information is a prerequisite to learning; however, it is often manipulated to lead toward other things such as money, acceptance, or power. Adding an extrinsic incentive to study or complete a task has also been found to decrease intrinsic motivation (Hoyenga & Hoyenga, 1984). Such a finding is detrimental to education. It is important to research extrinsic variables so they will not be reinforced in the classroom. To help students develop academic intrinsic motivation, it is important to define the factors that affect motivation (Dev, 1997).

Researchers have studied factors such as family expectations, teacher expectations, money, and peer acceptance (pleasing others). All of these factors involve proving oneÕs competence to another. Extrinsic students prove oneÕs competence while intrinsic students improve their competence (Schraw, Horn, Thorndike-Christ, & Bruning, 1995). However, these factors do not fully explain why certain student persists in a task although they prefer not to. Two extrinsic factors that need to be further explored are 1) power motivations and 2) fear of failure.

Power motivations are often seen in students, especially in a college setting. A student who is motivated by power feels the need to control his/her environment. The best way they find to do this is to prove their competence to others. Power motivations are difficult to spot in students because unlike other extrinsic motivations, they increase achievement measures (Hoyenga & Hoyenga, 1984). This may be because achievement decreases helplessness. This motivation can be seen as an individual need that must be met in order to feel competent as a student. Fortier, Vallerand, and Guay (1995), performed a study that confirmed perceived academic competence to be directly related to autonomous academic motivation, which is directly related to school performance. Putting all this information together, we can infer that power motivations (when led to successful outcomes) can be easily mistaken for intrinsic motivation. Both appear the same; however when a block occurs in the process of reaching the goal, the intrinsic motivator will find a strategy to get around the block: the power motivator may feel frustrated and helpless (Hoyenga & Hoyenga, 1984). If this is the case, then we would find that intrinsic students would continue to persist in challenging tasks while a student with power motivations would give up in the face of difficulty. The fact is that the two goals are entirely different, only the means are the same. Although this variable may be difficult to differentiate from intrinsic motivation, it is extremely detrimental to allow such a student to experience such intense anxiety when it comes to classroom work. This type of behavior can lead to an aversive reaction toward education. Fear of failure is inhibitory no matter which theory or example one uses to explain it. It brings about avoidant approaches to situations in order to avoid such fear. The motive to avoid failure is a general disposition to avoid failure or the capacity to react with shame and embarrassment when the outcome of an achievement task is failure. The only way to avoid failure is to avoid achievement tasks. One can see that this avoidant behavior lacks intrinsic motivation. Research shows that fear of failure is noticed most when such students are given moderately difficult task to achieve (Hoyenga & Hoyenga, 1984). Reasons for this may be that these students expect to fail at difficult tasks, and often do succeed at relatively simple tasks. If the task is simple, then the need to avoid failure will motivate the student to find the necessary means to achieve. However, if the task is moderately difficult, the anxiety that may build up could cause avoidant reactions to such a task and inhibit the necessary means to achieve.

Both of these factors clearly inhibit the characteristics of intrinsic motivation. Not only do they inhibit positive behavior, but they may cause students to avoid academics all together. One way of finding out if these variables is, in fact, extrinsic motivators are to create an inventory that includes all factors of intrinsic and extrinsic motivation and perform several reliability and validity studies".

(b) **Control Group 1 Descriptive Statistics**

	N	Range	Min	Max	Sum	Mean	Std. Dev	Var.	Skewness	
	Stat.	Stat.	Stat.	Stat.	Stat.	Stat.	Stat.	Stat.	Stat.	Std. Error
Ctlr Grp 1 pre	79	8	4	12	580	7.34	1.954	3.818	-.075	.271
Ctlr Grp 1 post	79	7	4	11	592	7.49	1.648	2.715	- .094	.271
Valid N (listwise)	79									

Key: Ctrl Grp 1 pre . – Control Group 1 Pretest, Ctrl Grp 1 post- Control group 1 post test

2.9 Motivation

Reiss (2004) in his five year qualitative longitudinal study of secondary science students in England found that teacher influence was crucial in enhancing students' engagement with and liking of science. This research also found that over time there was a reduction in enthusiasm for science among almost all the participating students, in part because many of the students failed to see the connection between school science and their daily lives. Tollefson (2000) explaining the attribution theories of motivation states that students are constantly in the process of selecting among a diverse set of educational and personal goals, collecting information about the task or how they have performed on the task relative to the performance of others and making and testing their judgments about the amount of effort needed to achieve the goals. Many students in Kenyan secondary schools do not choose Physics after Form Two when it is not compulsory. One of the possible reasons is that students have already formed a negative attitude towards physics. Tamjid and Michael (2008-2009), in their study explored the factors associated with 15 year-old students' intentions to study Physics post-16, when it is no longer compulsory in England and the findings indicated that extrinsic material gain motivation in Physics was the most important factor associated with intended participation. They also found that girls had less positive experiences of their Physics lessons and Physics education than did the boys. Amadalo, Ocholla and Memba (2012) in their study concluded that practical work in Physics disposed the respondents (students) favorably to the subject. The experimental group to control group enrolment ratio was 2.2:1(70.97% : 31.25%) clearly the waning interest in Physics at secondary school level can be checked and even reversed if the students are exposed to meaningful practical in the earlier secondary classes. The study intended to find the effect of science process skills advance organizer on students' performance and motivation towards electric circuits in physics.

2.10 Theoretical Framework

The use of advance organizers in instruction is tied to Ausubel's theory of meaningful learning. According to this theory new ideas and concepts can be learnt and retained in episodic memory, provided that relevant and inclusive concepts are clear and available in the learner's cognitive structure and act as support for the new concepts (Ausubel, 1960). When the information interacts with prior concepts it acquires the meaning for the learner and in this way it can be assimilated. Learning is a continuing process where new concepts are progressively differentiated through new relationships or prepositional links with other related concepts (Brown, 1980). To make organization of the information possible, Ausubel believes that it is necessary for the information to be related to prior knowledge structures. The learner then makes a deliberate and conscious effort to establish relationships. According to Brown (1980), hierarchical organization of information to be processed includes placing the most inclusive, most general concepts at the top and going downwards to progressively less inclusive, more specific concepts. The mode of functioning of advance organizers is a structure for facilitating the incorporation into a working memory of new but unfamiliar concepts. The organizers are introduced in advance of learning itself and are also presented at a higher level of abstraction, generality and inclusiveness. They act as a subsuming bridge between new learning material and existing related ideas. Prior exposure of students to the advance organizer with activities that showed relationship of current variation with different resistors and cells arrangements will help students' conceptualization of Ohm's law of electric circuits.

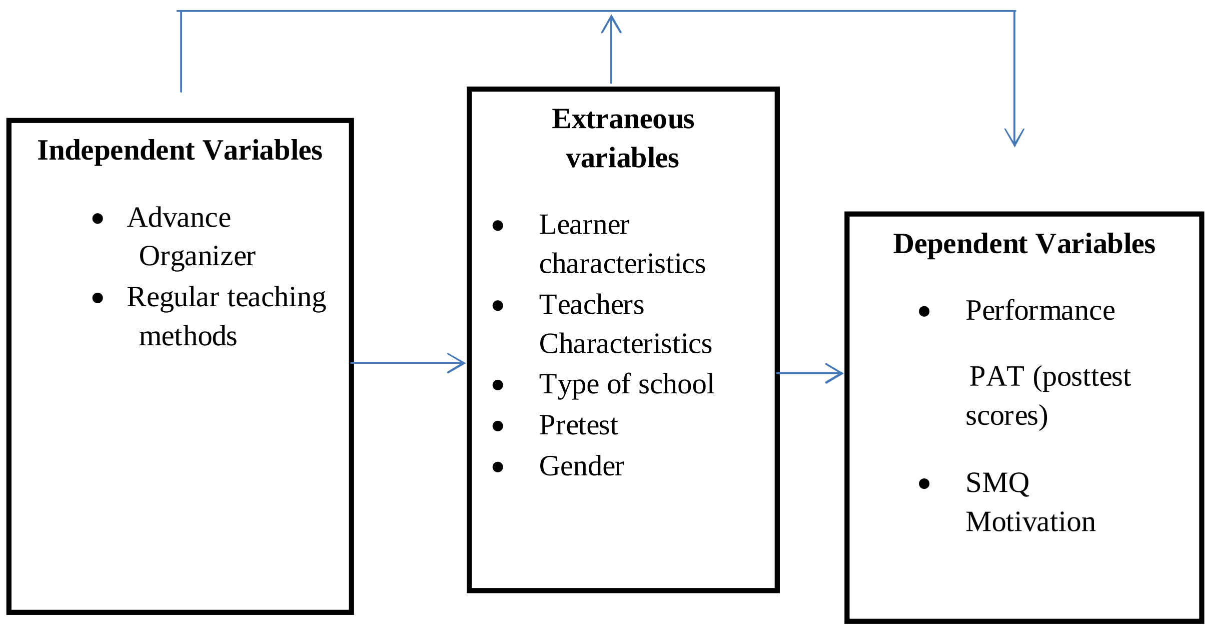


Figure 2.1: Relationship between the Independent and dependent variables of the study

In this study, regular teaching methods and the exposure to advance organizer formed the independent variables. The intervening variables of the study were the type of school, the learner and teacher characteristics. The learner characteristics were to be controlled in that only County schools participated. County schools admit students with the same abilities. Teachers with at least two years of experience and trained participated in the study. Most district schools have similar basic facilities for teaching physics. Students' score on a physics achievement test (PAT), and the questionnaire (SMQ) responses were the dependent variables. The variables in the study are diagrammatically represented in Figure 2.1

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter discusses the process used to achieve the objectives of the study. Details of the methodology used to investigate the effect of science process skills advance organizer as a strategy to enhance performance and motivation in electric circuits in secondary school physics for both boys and girls are discussed. The research design adopted, the targeted population and instruments developed for the study are discussed. Data collection procedures and statistical methods used in analyzing the data to make conclusions are also described.

3.2 Research Design

The study employed Solomon Four Quasi Experimental Design. Kenneth and Bruce (2014) describe pure quasi-experimental designs as those that resemble experimental designs but use quasi-independent rather than true independent variables. A quasi-independent variable is a correlational variable that resembles an independent variable in an experiment. It is created by assigning subjects to groups according to some characteristics that they possess, rather than using the random assignment (Kenneth S. B. & Bruce B. A, 2014).Schools have intact classes that have been constituted by means other than random selection. Campbell and Stanley (1965) describe the Solomon Four-Group Design as one of three one-treatment condition experimental designs, the other two being the pre- and post-test control group design and the posttest only control group design. The Solomon Four-Group Design is adequate to assess the effect of the treatment and is immune from most threats to internal validity and adds a higher degree of external validity (Braver & Braver, 1988). The dashed lines separating the parallel rows in Table 5 indicate that the experimental and control groups have not been equated by randomization-hence the term ‘non-equivalent’. The major problems with the quasi experiment relate to issues of internal validity but Kenneth and Bruce (2014) suggest a partial solution to these problems. This involves including appropriate control groups in the quasi experiment. The Solomon Four Quasi-Experimental Design is given in Fig 3.1.

GROUP	PRE TEST	TREATMENT	POST TEST
1	$\mathbf{O_1}$	**X**	$\mathbf{O_2}$
2	$\mathbf{O_3}$		$\mathbf{O_4}$
3		**X**	$\mathbf{O_5}$
4			$\mathbf{O_6}$

Fig 3.1: Solomon Four Quasi Experimental Design

The Solomon Four-Group Design has the advantage of being able to assess the presence of pretest sensitization (Braver and Braver1988). Helmstadter (1970, Pg. 110) states that, the Solomon four-group design adds a higher degree of external validity and therefore the “most desirable of the basic designs”. Oliver and Berger (1980) have argued that conclusions may become far more complicated using the Solomon four-group design because of the number of comparisons it permits. Braver and Braver (1988) assert, the complexity of a phenomenon or an analysis is certainly not a scientifically justifiable reason to fail to conduct. In the study, pretest-posttest control group quasi-experimental method was used. Form two students from Laikipia Central formed the study groups. The groups treated (Group 1 and Group 3) were exposed to the electric current experiments (Appendix A) and the control groups (Group 2 and 4) were taught using the conventional methods, the topic of electric current circuits. Physics Achievement Test (PAT) having 15 multiple choice questions was used to collect data on students' performance. Pretests were applied on group 1 (experimental group) and group 2 (control group) one week before application of the activities. The experimental groups were exposed to the apparatus of the practical activities (Appendix A) and guided to carry out skills that form the basis of understanding electric current. Series and parallel circuits to explain the relationships of current-resistance and current-potential relationships in relation to Ohm's law were asked before students were traditionally required to solve problems related to circuit operations. The science process skills of observing, measuring, predicting, experimenting and hypothesizing were emphasized during the intervention. Three weeks (9 lessons) after the activities, all the groups were post tested.

3.3 Location of the study

The schools selected for the study are in the central sub-county of Laikipia County Kenya.

3.4 Population of the Study

The population targeted by the study was all form two Secondary school Students in Laikipia County of Kenya. The county had a total population of 22,700 students in all the Secondary schools as per the county Education Office. The county which has five sub-counties and one sub county was purposely selected for the study. Laikipia Central Sub-county was selected for the study and had a total population of 4,100 students in all classes and 1,202 students in Form Two.

There were four categories of schools in the sub-county as shown in table 3.1:

Table 3.1:
Categories of Schools &Form Two Student Population in Laikipia Central Sub-County

Category	Number	Population
Public Day Mixed Schools	14	736
Public Day Single Sex	3	242
Public Boarding Schools	3	193
Private Schools	2	31
Total	22	1,202

Laikipia Central Sub-county has three administrative Educational zones. The two private schools, three public single sex schools and the three public Boarding schools were removed from participating in the study for they were not evenly distributed in all the zones and students in private schools were not all residents of Laikipia Central sub-county. Four of the remaining fourteen day Public Schools were eliminated due to the student population in form two classes. Ten schools were considered to be representative of the students in Form Two for the study. The ten schools were spread in the three zones as shown in table 3.1.

Table 3.2:
Accessible Population as per the zones

Zone	No. of Schools	Number of Students
A	3	162
B	4	384
C	3	112
Total	10	658

The zones in Table 3.2 were labeled as A, B and C to conceal the real names of the zones for purpose of confidentiality. The study focused on all form two secondary school students in Laikipia County of Kenya, with a total population of 22,700 students in secondary schools. The accessible population was form two physics students in the Central Sub-County with a population of 4,100. Form two students study physics before choosing subjects to be enrolled for at Kenya Certificate of Secondary Examination. Since the study investigated the effect of science process skills advance organizer on both gender, mixed schools were selected for the study on students' performance and motivation.

3.5 Sampling Procedure and Sample Size

3.5.1 Sampling Procedure

Laikipia County has five sub counties. One sub-county of the Laikipia County was purposely selected for the study as it had many schools. Of the 22 listed schools in Laikipia Central, 14 schools were mixed day schools. The numbers of students in class for 6 of the 14 schools were low and therefore those schools were eliminated. The 8 remaining schools were subjected to simple random sampling to participate in the study. 191 students from four selected schools participated in the study. Kathuri and Pals as cited by Kigo (2005) state that simple random sampling gives random samples which yield data that can be generalized within margins of error that can be determined statistically. In this study, simple random sampling was done to select one school from zone A and zone C which had 162 and 112 students respectively (table 3.2). Two schools were randomly selected from zone B which had a population of 384 form two students. This allowed for proportionate representation of students in the study. Schools were far from each other and the study was done simultaneously to reduce effects of contamination due to student interaction.

3.5.2 Sample Size

The sample size for this study was calculated using the formula explained by Scott (qualtrics.com) as Sample size = Z^2*Std. Deviation*(1- Std. Deviation)/Margin of $Error^2$. Where Z=1.96 (corresponding to 95% confidence level), Std. Dev. = 0.5 and Margin error = 0.7.The calculated sample size was 196.The actual sample size for the study was 191 (boys=92 and girls =99).

Table 3.3:

Number of Students that participated in the Study from Selected Schools

	Number of students	**Male**	**%**	**Female**	**%**
(Experimental) Group 1	54	15	27.78	39	72.22
(Control) Group 1	79	45	56.96	34	43.04
(Experimental) Group 2	18	14	77.78	4	22.22
(Control) Group 2	40	18	45.00	22	55.55
Total	**191**	**92**	**48.17**	**99**	**51.83**

Source: Field data

Levin and Rubin (1991) in explaining the central limit theorem argued that a sample does not have to be very large for the sampling distribution of the mean to approach normal. Statisticians use the normal distribution as an approximation to the sampling distribution whenever the sample is at least 30, but the sampling distribution of the mean can be nearly normal with samples of even half that size. The significance of the central limit theorem is that it permits us to use sample statistics to make inferences about population parameters without knowing anything about the shape of the frequency or the distribution of that population other than what we can get from the sample. In this study, the presence of 18 student would not affect the study as stated by the Central limit theorem. The Levene's test for equality of variance shown in table 4.19(b) for experimental group 2 and control group 2 of the Solomon four design independent sample T-test for boys with 18 students in group 2 and 14 students in group 3 show the group variances are equal

3.6 Instrumentation

The instruments used in the study were Physics Achievement Tests (PAT) and Students Motivation Questionnaire (SQM). The instruments were validated by the researcher on consultation with the supervisors before the commencement of the study.

3.6.1 Physics Achievement Test (PAT)

The PAT was developed and used as the pretest and then re-organized and used as the posttest (See Appendix II). The tests contained 15 multiple choice questions on electric current circuits, the topic of study. The questions tested science process skills which included observing, measuring, predicting, experimenting, hypothesizing and problem solving. The total achievable score was15 marks. Experts were used to moderate the test before being piloted and after. Kunder-Richardson method (Gronlund, 1981) was used to calculate the reliability coefficient.

3.6.2 The Student Motivation Questionnaire (SMQ)

Keller's ARCS Motivation Theory (Hohn, 1995) was used to construct the Questionnaire. The study adopted a modification of the SMQ (Appendix C) developed and used by Kiboss (1997); Wachanga (2002); Buntting, Coll and Campbell (2006). The Cronbach's coefficient alpha was used to estimate the reliability of the instrument after it was pilot tested. Experts were used to validate the questionnaire.

3.7 Pilot Testing

A pilot study was carried out in a school in Laikipia that did not participate in the investigations to ascertain practical issues of the study. A pilot study is a miniature version of the study to be sure that the chosen procedure and materials work the way that you think they will (Kenneth S. and Bruce B. 2014).Two tests were administered and results used for validation of both (PAT) and (SMQ). Experts and the supervisors of the study validated the study instruments

3.7.1 Validity of the Instruments

The validity of a measure is the extent to which it measures what you intend it to measure (Kenneth S. and Bruce B. 2014). In this study, the Physics achievement test (PAT) was validated to measure the intended science process skills after exposure to the Science process skill advance organizer. The student motivation questionnaire (SMQ) was validated to reflect student desire to engage in Physics lessons for better results. Results of the pilot study were used for validation of both (PAT) and (SMQ). Experts and the supervisors of the study discussed the physics achievement test and students' motivation questionnaire results with the researcher so as to validate the study instruments.

3.7.2 Reliability of the Instruments

The reliability of a measure concerns its ability to produce similar results when repeated measurements are made under identical conditions (Kenneth S. and Bruce B. 2014). In this study, the pilot results for PAT and SMQ were Cronbach's alpha 0.951 and 0.799 as shown in Appendix IX (a) and (b) respectively. The schools selected for the pilot study were within the region study. Items in the physics achievement test and student motivation questionnaire which gave low reliability were discarded.

3.8 Data Collection Procedure

The Kabarak University gave a go ahead to seek permission from the National Commission of Science, Technology and Innovation to collect data for the study. Authority was also sought from the County director of education and the County commissioner and the school heads for data to be collected. Teachers of the selected schools teaching physics in form two were consulted and inducted two weeks before the study to help in the data collection process. The experimental group one (1) was pre tested before being exposed to the science process skills (SPS) advance organizer while experimental group two (2) was only subjected to the advanced organizer before both were post tested to investigate the effects of the advanced organizer. Control group one (1) and control group two (2) were also post tested after group one (1) was pre tested. The process of data collection took six (6) weeks.

3.8.1 Data Analysis

Kenneth and Bruce (2014) recommend the use of T- test for independent samples when the data are from two groups of participants who were assigned at random to the two groups. In this study, the subjects were assigned according to some characteristics, form two students of a selected mixed day public secondary schools which are intact formed the groups. Kenneth and Bruce (2014) add that "because the subjects come into the experiment already assigned into their treatment level, it is always possible that any relationship discovered may be due to the action of some third, unmeasured variable that happens to correlate well with the quasi-independent variable. T-test is known for its superior quality in detecting differences between two groups (Borg et. al.1996).

The analysis of variance (ANOVA) was also used to compare the posttest means of all the groups in the study. The study had more than two groups. ANCOVA was used to cater for initial differences among the groups. The effect of ANCOVA is to make the two groups equal with respect to one or more control variables (Borg & Gall, 1996). Table 3.4 shows how the hypotheses were tested. Factor analysis was used to reduce variables of every item of the students' motivation questionnaire to manageable subjects that would explain students' motivational inclination of the item statements. All tests of significance were performed at α is equal 0.05 significance level.

Table 3.4:
Summary of Hypotheses Testing / Research Question

Hypotheses	Independent variable	Dependent variable	Statistical tests
H_o 1: There is no statistically significant difference in performance between students exposed to science process skills advance organizer and those taught using traditional methods.	PP/RTM	Posttest score in PAT	One- way ANOVA ANCOVA Post hoc
H_o 2: There is no statistically significant influence of science process skills advance organizer on performance of electric circuits in physics based on gender.	Gender	Posttest score in PAT	T-test for independent sample ANOVA Post hoc
Are students motivated to learn electric circuit when exposed to Science Process skills advance organizer before the actual lesson	PP/RTM	Scores from motivation questionnaire	Factor Analysis

3.9 Ethical Considerations

For the sake of confidentiality the individual's scores and questionnaire answers were not to be disclosed to the public. Teachers relating science process skills advance organizer with the expected lesson content would be considered unethical for the validity of the experiment. Teachers were cautioned on sustaining experimental validity.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND DISCUSSION

4.1 Introduction

This study sought to investigate the effect of science process skills advance organizer on student's performance and motivation in electric circuit's for form two physics. The physics achievement test (PAT) results for both pretest and posttest were analyzed to make conclusions. The responses from the student motivation questionnaire were analyzed using the factor analysis to explain the students' motivation after exposure to science process skills advance organizer. The Physics Achievement Test (PAT) fifteen items were aimed at investigating the effect of science process skills advance organizer on students' performance on electric circuits for form two physics. Performance measured included assessing the student's ability to show understanding of the role of various circuit components, effects on current flowing in the circuits when different circuit components are arranged differently. The effect of different materials conductivity of current was also included in assessing the performance of students after they were exposed to the science process skills advance organizers before the physics lesson. Table 4.1 shows the percentage of correct and wrong answers attained by students in the items of Physics Achievement Test as per the objective set.

4.2 General and Demographic Information

4.2.1 General Information

Teacher and students participated as expected in the study and the school principals' were supportive. The response rate in both the (PAT) and the (SMQ) was almost 100% as indicated by the data collected. Table 4.1 below indicates the performance of each question in the PAT. Appendix IV also shows how students' performed by gender for each of the questions in the physics achievement test. Appendix VI indicates students responses to students' motivation questionnaire.

Table 4.1

Students' Performance of the Physics Achievement Test.

Item No	**Item objective**	**No of Students**	**Percentage of students with correct answer**	**Percentage of students with wrong answers**
1.	Explain the effect of battery voltage on amount of current flowing in a circuit	40	45	55
2.	Explaining the effect of reversing battery terminals in an electric circuit	40	62.5	37.5
3.	Explaining the role of resistors in an electric circuit	40	50	50
4.	Explaining the effect of arranging resistors in series on current flowing in the circuit	40	35	**65**
5.	Explaining the effect of	40	32.55	**67.5**

	resistors in series on energy required to drive current in each resistor in the circuit			
6.	Explaining the effect of switching on or off in a parallel circuit arrangement	40	37.5	62.5
7.	Explaining current flow in a circuit with identical resistors placed in parallel	40	20	**80**
8.	Explaining current flow when one parallel circuit is switched off.	40	50	50
9.	Explaining conservation of current in parallel circuit with resistors of different resistance	**-**	**-**	**-**
10.	Explaining the effects of resistors of different resistance placed in	**-**	**-**	**-**

	parallel on current flow			
11.	Explaining conservation of current in parallel circuit arrangement	40	27.5	**72.5**
12.	Explaining the effect of battery EMF on current in the circuit	40	25	**75**
13.	Explain the effect of identical bulbs placed in series on current flowing in the circuit	40	27.5	**72.5**
14.	Explain the effect of materials conductivity in a current circuit	40	42.5	**57.5**
15.	Explaining current conductivity in an electric circuit in relation to the nature of materials used.	40	22.5	**77.5**

Table 4.1 shows difficulties in achieving the objectives of physics achievement test. Explaining the effect of the battery voltage on the amount of current flowing in the circuit was difficult for students. Only forty five percent achieved correctly while fifty five percent were wrong. Many

students sixty two and a half percent were able to explain the effect of reversing the battery terminals in an electric circuit. Explaining the role of resistors in an electric circuit was attained at fifty percent but students were not able to explain the effect of arranging resistors in series in an electric circuit. Relating energy required in driving current through resistors arranged in series was difficult to students. Only thirty two and a half percent, which is thirteen of the forty students who sat for the PAT were able to achieve correctly. Students were not able to explain the flow of current in a parallel circuit with identical resistors when one of the circuit is switched off or on. Only twenty percent, eight of the forty students were able to get correct choice of the item in the physics achievement test. Students were not able to explain the conservation of current in parallel circuits. More than seventy percent of the students were not able to describe the brightness of identical bulbs placed in series in an electrical circuits. Explaining the effect of material conductivity in an electric circuit was difficult for students. Twenty two and half of the students were able to explain current flow in a circuit on replacing the circuit materials with materials of different conductivity ability. One among the many reasons that may explain the poor performance of electric circuits is the misconceptions held by students about electricity. According to Kambouri (2010), Misconceptions refer to children incorrect or incomplete ideas.

Further, Kambouri explaining the results of a research investigating teachers' response to early years' children's misconceptions in Cyprus states that "Often teachers do not acknowledge the existence of these misconceptions and this is likely to be an obstacle for children's learning." Citing Henriques, 2002, Kambouri (2010) continues to explain that it is generally accepted in the science Education community that children enter the classroom with their own understanding of the world and that as stated by Black and Lucas (1993), some of this knowledge is incorrect and remarkably resistant to change. If teachers addressed the misconceptions held by students about electric current circuits during administration of the science process skills advance organizer, probably the achievement test objective of physics achievement test objectives would have improved. The Kenya institute of curriculum development syllabus for secondary school physics has not emphasized on Teachers addressing misconceptions in physics and therefore teachers may be teaching as they were taught. This as Kambouri (2010) referenced Valanides, (2006), may constitute a significant obstacle to learning. Devereux, 2007 as cite by Kambouri (2010) argues that school science should be about researching possible conclusions by explaining relationships between ideas and events and it is essentially about understanding. This Devereux (2007) also incorporates the testing of ideas and the proposal of original theories and questions, which change all the time as ideas, skills and knowledge are developed through new research and data. The ministry of Education in Cyprus (1996) as cited by Kambouri (2010) agrees with Devereux (2007) and points out that school science is about teaching children the skills they need in order to be able to observe, explore and experience events. The science process skills advance organizer for this study had one of its skills as observation. Citing Rezba (1995), Myers (2006) states that science process skills are the skills scientist use to do science and they include, observing, inferring, predicting, classifying, measuring and communication. Further Myers (2006) explains that experimentation is the most interesting aspect of science class and students cannot do experiments without science process skills for if students are not experimenting with their questions, they will be memorizing the results of other scientists and memorization decreases their interests and motivation. Many researchers in physics education who have qualified have described advance organizer role in aiding retention. Myers (2006) in her thesis on personal study of science process skills in a general physics classroom also states the following on experimentation, “Experimentation is more than just learning the right answer by following a procedure. Although taking direction is important, students learn how ideas actually interact. For example, they learn how friction, mass, and force all interact under Newton's 2^{nd} Law when they perform an experiment. Students will remember the experiment much longer than the lecture. Plus experiments can allow students to test their own ideas." In this study, the activities undertaken to have the students manipulate components of an electrical circuit by arranging the components differently in the circuit was expected to give the students an anchorage of concepts that were to be taught in a physics class. Further the activities were expected to have students learn permanent skills in handling electric circuit components. Each attempt to make a complete working electric circuit during advance organizer presentation would provide students an opportunity to learn physics concepts in electric current circuits. The exposure of science process skills advance organizer enhances students' learning of the process of science that gives them ability to do science with minimal assistance of a teacher.

4.2.2 Demographic Data

There were 191 students who participated in the study with 99 being female and 92 being male from the four sampled schools for the study. Table 4.2 shows performance of physics achievement test (PAT) by gender and groups. The means for Experimental group 1, indicates a rise in means from pretest to posttest for both genders and the overall performance is also enhanced from a mean score of 4.741 to 5.556. The males and females performance for the Control group 1 declined from pretests scores of 8.891 and 7.143 to 7.733 and 7.176 respectively. The overall mean score for the Control group 1 also declined from 8.238 to 7.494. The Control group1 pretest means are higher than those of Experimental group 1 pretest indicating a different entry point. The differences between groups may be due to different school's traditions which may include among others syllabus coverage and methods used in teaching physics. In all the groups except group 4, boys show higher mean score than the girls. Figure 4.1 is the SPSS output of the posttest results for all the groups as randomly assigned to the Solomon four group pretest-posttest method

Table 4.2:
Physics Achievement Test Scores by Gender and Group

Group	**Gender And Number**	**No of students**	**Pretest Mean Scores**	**Posttest Mean Scores**	**Group Means for both Male & Female**	
					Pre test	**Post test**
Exp.1	Male	**15**	5.467	6.933	4.741	5.556
	Female	**39**	4.462	5.026		
Control 1	Male	**45**	8.891	7.733	8.238	7.494
	Female	**34**	7.143	7.176		
Exp. 2	Male	**14**	--	4.214	-	4.056
	Female	**4**	--	3.500		
Control 2	Male	**18**	--	4.667		4.725
	Female	**22**	--	4.773		

Source: Field Data

Table 4.3:
Descriptive Statistics for Pretests and Posttests by Group
Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
O1	54	1.0	11.0	4.741	2.0298
O2	54	2.0	10.0	5.556	1.9587
O3	79	4.0	12.0	7.342	1.9539
O4	79	4.0	11.0	7.494	1.6476
O5	18	2.0	7.0	4.056	1.6968
O6	40	1.0	8.0	4.725	1.7829
Valid N (listwise)	18				

Source: Field Data

Table 4.3 above shows the descriptive statistics for groups' pretests and posttests. O_1 and O_3 are pretests for experimental group one and control group one respectively. O_2, O_4, O_5 and O_6 are posttest scores for groups one (experimental), group one (control), group two (experimental) and group two (control) as per Solomon four quasi-experimental groups. Though the maximum score attained for experimental group one (O_2) is ten out of the possible fifteen, the standard deviation of the same group reduced to 1.9587 from 2.0298 attained at the pretest for the same group. This indicates the lower performers in the group were positively affected by the science process skills advance organizer administered before the posttest. In his study of the effect of advance organizer teaching strategy on students' academic performance in biology in senior secondary school in Ekiti State, Nigeria, Olatunji (2016) found that there existed a significant difference between control and experimental group's achievement mean scores after treatment in favour of experimental group. The standard deviation of the control group improved significantly from 1.9539 to 1.6476, the minimum score maintained at 4.0, an indication that the lower performers in the control group did not change while the minimum score of the experimental group changed from 1.0 to 2.0 as shown in table 4.3.

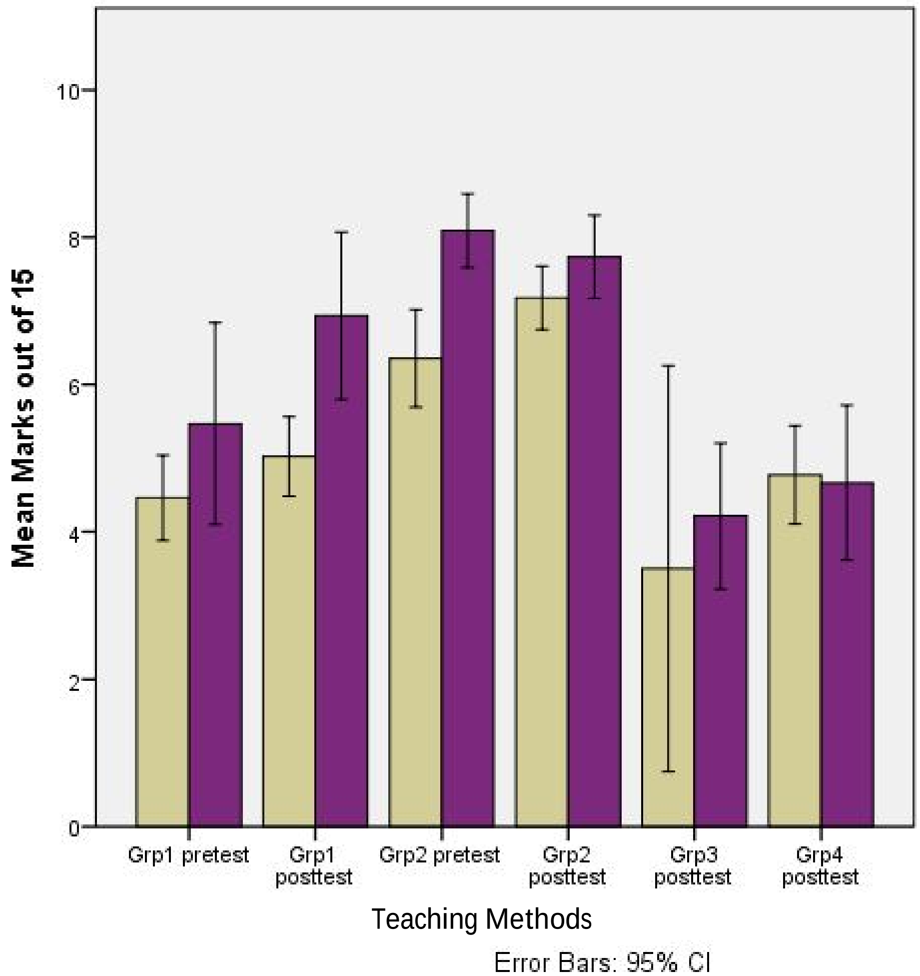


Figure 4.1: Bar graph for PAT pretests and post test results by gender

Key: Grp-Group

The error bars for the experimental groups indicate reduction of variance in both boys and girls after the treatment. The variance for the control groups remains almost the same. The girls' post test results show a decline in variance an indication that might be attributed to pretest sensitization. The starting point of all groups selected to participate in the study are shown to be different in all the groups as indicated by figure 4.1. This may be due to other factors in the various school environments and may include others, syllabus coverage, teachers' teaching skills and school tradition on physics performance, school tradition on subject emphasis and students' interest and motivation in the subject of physics. This study was interested in investigating the effect of science process skill advance organizer as a teaching strategy and hence the conclusions were independent of the starting point of the students in a school. The results as indicated in the figure 4.1 show a positive effect of science process skills advance organizer on each of the schools treated. This study investigated the effect of science process skills advance organizer on students' performance and motivation in electric circuits while taking the pretest as the covariate.

4.3 Analysis of Covariance (ANCOVA) with Pretest as Covariate

The effect of science process skills advance organizer on students' performance of the posttest of the Physics Achievement Test may have been influenced by other variables not considered in this study. Many independent variables that may influence the posttest outcome were speculated to be among others, the teacher characteristics, student gender, school traditions and location, school facilities, students' attitude towards physics and the methods teachers use to teach physics. By including a covariate in an experimental design, one effectively "subtract out '' the influence of covariate (or any variable correlated with it) from the dependent variable (Borden's & Abbott, 2014). The influence of pretest as a factor in Table 4.4 (a) accounts for 145.878 units but reduces to 64.175 units as a covariate in Table 4.6 (a) and to 36.072 in Table 4.8 when gender and treatment are considered factors respectively. The variance error has also been reduced to 348.612 (Table 4.9) when gender and treatment are considered as main effects and pretest as covariate thus improving the sensitivity of the experiment to the effect of science process skills advance organizer.

Table 4.4
ANOVA with Pretest as a Factor

(a) Tests of Between-Subjects Effects

Dependent Variable: Posttests Scores for all Solomon Four groups

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	145.878[a]	11	13.262	4.118	.000
Intercept	2910.655	1	2910.655	903.778	.000
PRE TEST	145.878	11	13.262	4.118	.000
Error	389.686	121	3.221		
Total	6518.000	133			
Corrected Total	535.564	132			

a. R Squared = .272 (Adjusted R Squared = .206)

Table 4.4 (a) shows pretest as a predictor of the posttest results of the experimental group it is administered and accounts for 145.878 units. This effect of the pretest may lead to wrong conclusion of the treatment effect. The results shown in Table 4.2 clearly indicate an existence of science process skills advance organizer effect on the posttest results. The experimental design used in this study, the Solomon four groups design, may not be able to control for other independent variables that cause variation in the independent variable. Borden's and Abbott (2014) describing the requirements of experimental design state that holding variables constant can reduce the generality of your findings, whereas randomizing their effects across treatments can produce error variance that obscures the effects of your independent variable. Tables 4.5 (a) and 4.7 (a) show the effect of gender and treatment on the posttest results without a covariate respectively. Gender and Treatment show a significant value of p= .009 and p= .000 respectively and hence have an effect on the posttest scores. Tables 4.6 (a) and 4.8 (a) with pretest as covariate show a reduction of significance of both gender and treatment though still significant predictors of the posttest scores. The accounting units for gender reduced from 32.136 without covariate to 17.617 with pretest as covariate while that of treatment reduced from 85.735 without covariate to 35.312 with covariate.

Table 4.4 (b)
Levene's Test of Equality of Error Variances

Dependent Variable: Post Test Scores

F	df1	df2	Sig.
5.450	1	189	.021

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

Design: Intercept + Gender

The Levene's results in table 4.4(b) indicate violation of assumption of homogeneity but variance ratio of this data is 5.8564/ 4.777 =1.6747 which is less than about 2.

Table 4.5:

ANOVA for Gender without Covariate

(a) **Tests of Between-Subjects Effects**

Dependent Variable: Post Test Scores

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	32.136[a]	1	32.136	6.937	.009	.035
Intercept	6997.686	1	6997.686	1510.588	.000	.889
GENDER	32.136	1	32.136	6.937	.009	.035
Error	875.528	189	4.632			
Total	7880.000	191				
Corrected Total	907.665	190				

R Squared = .035 (Adjusted R Squared = .030)

The Levene’s Test of Equality of Error Variance Table 4.5 (b) shows no variance differences between post test results in the design groups.

Table 4.5 (b)

Levene's Test of Equality of Error Variances[a]

Dependent Variable: **Post Test Scores**

F	df1	df2	Sig.
.483	1	131	.488

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + PRETEST + GENDER

Table 4.6:
ANOVA for Gender Posttest Results with Covariate Included
(a) Tests of Between-Subjects Effects

Dependent Variable: **Post Test Scores**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	138.861[a]	2	69.430	22.752	.000	.259
Intercept	284.043	1	284.043	93.081	.000	.417
PRETEST	64.175	1	64.175	21.030	.000	.139
GENDER	17.617	1	17.617	5.773	.018	.043
Error	396.703	130	3.052			
Total	6518.000	133				
Corrected Total	535.564	132				

a. R Squared = .259 (Adjusted R Squared = .248)

(b)Table 4.6(b)
Between-Subjects Factors

		N
Treatment	1	72
	2	119

Table 4.7:

ANOVA for Treatment Posttest Results without Covariate

(a) Tests of Between-Subjects Effects

Dependent Variable: **Post Test Scores**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	85.735[a]	1	85.735	19.714	.000
Intercept	6186.531	1	6186.531	1422.571	.000
TREATMENT	85.735	1	85.735	19.714	.000
Error	821.930	189	4.349		
Total	7880.000	191			
Corrected Total	907.665	190			

a. R Squared = .094 (Adjusted R Squared = .090)

(b) Table 4.7(b)
Between-Subjects Factors

		N
Treatment	1	54
	2	79

Table 4.8:
ANOVA for Treatment Posttest Results with Covariate Included
(a) Tests of Between-Subjects Effects

Dependent Variable: **Post Test Scores**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	156.556[a]	2	78.278	26.849	.000
Intercept	309.288	1	309.288	106.086	.000
PRETEST	36.072	1	36.072	12.373	.001
Treatment	35.312	1	35.312	12.112	.001
Error	379.008	130	2.915		
Total	6518.000	133			
Corrected Total	535.564	132			

a. R Squared = .292 (Adjusted R Squared = .281)

(b) Table 4.8(b)

Between-Subjects Factors

		N
Treatment	1	54
	2	79
Gender	1	60
	2	73

Table 4.9:

ANOVA for Gender and Treatment Posttest Results with Covariate Included

(a) Tests of Between-Subjects Effects

Dependent Variable: **Post Test Scores**

Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	186.952[a]	4	46.738	17.161	.000
Intercept	316.170	1	316.170	116.088	.000
Pretest	21.037	1	21.037	7.724	.006
Treatment	20.506	1	20.506	7.529	.007
Gender	21.748	1	21.748	7.985	.005
Treatment * Gender	15.698	1	15.698	5.764	.018
Error	348.612	128	2.724		
Total	6518.000	133			
Corrected Total	535.564	132			

a. R Squared = .349 (Adjusted R Squared = .329)

The model as whole remaining significant is an indication that gender can also be used to predict the posttest results of the physics achievements test. This contradicts Owoeye (2006) who stated that gender was not a significant predictor of students' academic performance in Biology.

4.4 Comparison of pretests

The comparison of pretest scores for Exp. group 1 and Control group 1 was to evaluate the efficiency of the randomization process. Table 4.10 (a) summarizes the information of data collected from the pretest scores of the two groups. Table 4.10 (b) shows the independent sample

T-test for the data. The groups pretest scores are significantly different. This may be due to other variables not considered in the study and have not been eliminated by randomization. The Levene's Test for Equality of Variance indicates that the variability of the two pretest scores is about the same at 0.05 level of significance. Thus it is good for the study to use independent T-test.

Table 4.10
Independent Sample T-Tests for Experiment 1and Control 1 Groups Pre tests

(a) Group statistics

	Teaching method	N	Mean	Std. Deviation	Std. Error Mean
Marks/15	Exp. Grp 1 pretest	54	4.74	2.030	.276
	Contr. Grp1 pretest	79	7.34	1.954	.220

In the group statistics box table 4.10(a) the mean for experimental group 1 pretest is 4.74. The mean for control group 1 pretest is 7.34. The standard deviation for experimental group 1 is 1.954. The number of participants for experimental group 1 is 54 and for control group 1 is 79. The mean for control group 1 is about one and half times that of the experimental group 1 an indication those students in the control group were more informed on the concepts of physics in electric current circuits. The standard deviation for the experimental group 1 pretest also indicate that the performance of physics achievement test for the group was more diversed than that of the control group 1 an indication that there were very low performers and very high performers in the experimental group 1. The Levenes' test for equality of variance is 0.706 and hence the variability between the pretest scores for the control groups 1 are about the same despite having different means. Equal or about the same variability is a good condition to subject the pretest scores for both experimental group 1 and control group 1 to the T-test as shown in table 4.10(b).

Table 4.10 (b)

Independent Samples T-Test

	Levenes' Test for equality of variance		t-test for Equality of Means						
	F	Sig	t	Df	Sig.(2-tailed)	Mean Diff	Std. Error Diff	95% Confidence Interval of the Diff Lower	Upper
EVA	.143	.706	-7.421	131	.000	-2.601	.350	-3.294	-1.908
EVnA			-7.368	111.11	.000	-2.601	.353	-3.301	-1.902

Key: EVA - Equal variance assumed, EVnA- Equal variance not assumed

The comparison results for the means of Exp. group 1 pretest and Control group 1 pretest results (table 4.10b) indicates a significance difference in the means of the two groups (131)=-7.421, p=0.000. This may be due to other factors that affected randomization process and were not included in this study. The school learning environment may affect the attitude of students towards physics. The starting point of the two groups was different and the effect of the advance organizer was measured from the different points noting that the variability for the two groups were not different.

4.4.1. Experimental Group 1 Improvement

The effect of the advance organizer treatment on the experimental group one is reflected in the analysis of the scores as indicated below:

Table 4.11:
Independent Sample T-Test for Experiment 1 Group Pretest and Post test

(a) Group statistics

Teaching method		**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Marks/15	Exp. 1 pretest	54	4.74	2.030	.276
Exp. 1 posttest		54	5.56	1.959	.267

The group statistics table 4.11(a) for the experimental group 1 between pretest and posttest mean score at 5.56 from the pretest score of 4.74 for the same group. The standard deviation of the experimental group 1 changed from 2.030 at pretest to 1.959 at posttest. This is an indication that the range changed and students who performed poorly might have improved their grades at posttest. The Levenes' test of equality of variance also indicated in table 4.11(b) shows the variability is equal and the pretest scores and the posttest scores for experimental group 1, the treated group can be subjected to the T-test as indicated in table 4.11(b). The T-test results indicate a significance difference between pretest scores and posttest score for the experimental group 1. The reduction of the standard deviation is an indication of leveling out on the understanding of the concepts of physics in the area of electric current circuits.

Table 4.11 (b)
Independent Samples T-Test

	Levenes' test for equality of variance		t-test for Equality of Means						
	F	Sig	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
EVA	.012	.912	-2.123	106	.036	-.815	.384	-1.576	-.054
EVnA			-2.123	105.865	.036	-.815	.384	-1.576	-.054

Key: EVA- Equal variance assumed, EVnA- Equal variance not assumed

The change of mean from pretest performance to posttest performance for the control group was 0.15 (7.49-7.34) while that of the experimental group was 0.82 (5.56- 4.74). The standard deviations for the posttest scores also reduced from that of the pretest scores. Both groups improved over time but the treated group improved more on mean by 17.3% against 2.0% of the control group. Table 4.11(b) reveals that there is significant difference between pretest and posttest scores of the Experiment group which implies significant impact of the science process skills advance organizer on the experiment group. The levene's Test of Equality of Variance indicates a significance level of greater than 0.05 and hence the group variances are equal as at the starting point.

4.5 Treatment Effect

Table 4.12 (a and b), the group statistics and the independent sample t-test for Exp. Group1 and Control group 1 shows that there is a significant difference between the posttest scores of the two groups.

Table 4.12:
Independent Sample T-Test for Experiment 1 and Control 1 Groups Posttests:

(a) Group Statistics for Exp. 1 and Control 1 Post tests

	Teaching method	N	Mean	Std. Deviation	Std. Error Mean
Marks/15	Exp. 1 posttest	54	5.56	1.959	.267
	CG 1 posttest	79	7.49	1.648	.185

CG-control group

The difference in numbers between the experimental group 1 and the control group 1 of 54 and 79 indicated in the group statistics table 4.12 was due to the schools establishments which were considered for the study. Quasi experiment allows for intact groups to be randomly assigned to the Solomon four group designs. The reduction of standard deviation of the control group from 1.954 at pretest to 1.648 at posttest is a sign of students raising their understanding of the physics concepts in the physics of electric current circuits. This effect of narrowing down standard deviation is also reflected in the experimental group 1 which changed from 2.030 at pretest to 1.959 at posttest scores. The Levenes test of equality of variance table 4.12(b) shows the variability of the experimental group 1 posttest is equal or about the same with that of the control group 1 posttest is equal or about the same with that of the control group 1 posttest and thus fulfilling the condition to subject the data to the T-test table 4.12(b). The independent sample T-test for experimental group 1 and control group 1 posttest results indicate a significant difference between the posttest for the experimental group 1 and the posttest for the experimental group 1 and the posttest for the control group 1. This means the science process skills advance organizer was effective and raised the performance of students exposed to the treatment.

Table 4.12(b)

Independent Samples T-Test for Exp. Group 1 and Control Group 1 Posttests Results.

	Levene' Test for equality of variance		t-test for Equality of Means						
	F	Sig	t	Df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
EVA	3.600	.060	-6.166	131	.000	-1.938	.314	-2.560	-1.316
EVnA			-5.970	100.667	.000	-1.938	.325	-2.582	-1.294

Equity of variance is assumed and there is a significant difference between the posttest means of the Exp. Group 1 and the Control group 1. This is despite the mean scores of the control group increasing possibly due to the pretest influence and the school environment and history of physics performance in the school.

4.5.1 Experimental Group 1 Boys and Girls Post test Analysis

In the Experimental Group 1, there were fifteen boys and thirty nine girls. The boy's Pretest mean score of 5.47 changed to 6.93 on posttest while that of girls changed from a pretest mean score of 4.46 to a posttest mean score of 5.03. Table 4.13(b) shows the variability in the two groups is about the same with Levenes' Test for equality of variance giving a significance of 0.635. From the first row of Table 4.13 (b), the (2-tailed) value indicates a statistically significant difference between the boys' posttest mean scores and the girls' posttest mean scores. The boys' mean score change from pretest to posttest mean score was 1.46 while that for girls was 0.57. The analysis indicated that the Science Process Skills Advance Organizer was more effective to boys than girls though both improved in performance.

Table 4.13:
Comparison of Experimental 1 Post tests by Gender

(a) Group Statistics for Experimental Group 1 by Gender

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Scores	1	15	6.93	2.052	.530
	2	39	5.03	1.662	.266

The number of Girls to boys in the experimental group 1 was thirty nine compared to that of fifteen of the boys. The mean posttest results for the boys increased by 0.57 from a pretest score of 5.47 while that of girls in the same group increased by 0.57 from a pretest score of 4.46. This change indicates that both boys and girls were affected positively by the science process skills advanced organizer administered to the experimental group 1. The standard deviation for Boy's posttest results increased to 2.052 from the entire group standard deviation of 1.959. The standard deviation for girl's posttest results reduced to 1.662 from the entire group standard deviation of 1.959. This may be taken to mean that the girls population of thirty nine in the experimental group 1 were more positively affect by the science process skills advance organizer than the boys were. The levenes test for equality of variance indicated that variability of the fifteen boys' posttest results and that of the thirty nine girls in the experimental group were equal or about the same as indicated by table 4.13(b). Despite the decline in standard deviation for girls from the entire experimental group 1 standard deviation, the independent T-test results for comparison between posttest results for boys and girls exposed to the science process skills advance organizer indicate a statistically significant difference in the posttest results in favor of the boys. These results indicate in that the treatment of boys with the science process skills advance organizer was more positive on the boys than the girls. In this study on teaching physics retention, Udo and Ubana (2013) found that gender does not significantly influence students retention if physics concepts whether taught with graphics advance organizer or not but in the same study, they concluded that the influence of graphic advance organizer on students retention in physics is not the same at all levels of gender. In this study effect of science process skills advance organizer seems to be more pronounced on boys than girls. In this study of “A Meta-analysis of effect of the Advance Organizer on Acknowledgement and Retention of Senior Secondary Schools (SSS) Chemistry” Oloyede (2011) concluded that there is no significant difference between the achievement of male and female chemistry students taught with written organizers. Citing Nsofor (2001) , Oloyede (2011) said that the results as reported confirmed that both female and male could do well in science if exposed to similar learning conditions. Also, Oloyede (2011) cited Dawson(2000) and Prokop et.al. (2007) as having found significant gender differences in biology.

Table 4.13(b)
Independent Samples T-Test Experimental Group 1 by Gender

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Differ.	Std. Error Differ.	Lower	Upper
Scores Eva	.229	.635	3.537	52	.001	1.908	.539	.825	2.990
Evna			3.218	21.456	.004	1.908	.593	.676	3.139

Key: EVA- Equal variance assumed, EVnA- Equal variance not assumed4.5 Pretest Effect on the Experimental Groups 1 and 3

Table 4.14: Experimental Group 1 Posttest and Experimental Group 2 Posttest.

(a)

Teaching method	N	Mean	Std. Deviation	Std. Error Mean
Exp. Grp 1 post test	54	5.56	1.959	.267
Exp. Grp 2 post test	18	4.06	1.697	.400

Both experimental group 1 and experimental group 2 were treated but experimental group 1 was subjected to a pretest. The posttest mean score for the experimental group 1 was 5.56 with standard deviation of 1.959. The posttest mean score for the experimental group 2 was 4.06 with a standard deviation of 1.697. The difference in the standard deviations for the two group indicate that the Experimental group 2 posttest results were less spread than the experimental group 1 posttest results. Table 4.14 describes the posttest results of the two experimental groups. The number of students in the experimental group 2 is only 18 students with fourteen males and four females. The number of students in the experimental group 1 is fifty four with fifteen males and thirty nine females, table 4.2. Table 4.14(b), the independent samples T.test for the two experimental groups indicate the Levenes' test for equality of variance as being equal or about the same. This allows for subjecting of the data to the independent samples T-test despite their differences in population.

Table 4.14(b)
Independent Samples T-Test Experimental Groups 1 and 3

	Levenes' test for equality of variance		t-test for Equality of Means						
	F	Sig	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
	.954	.332	2.903	70	.005	1.500	.517	.470	2.530
EVA			3.121	33.346	.004	1.500	.481	.523	2.477
EVA									

Key: EVA- Equal variance assumed, EVnA- Equal variance not assumed

The levene's Test of Equality of Variance indicates a significance level of greater than 0.05 and hence the groups' variances are equal. The comparison results for experimental group 1 posttest and experimental group 2 posttest table 4.14(b) indicates a significance difference. This means there is a difference between the posttest results for experimental group 1 and the posttest of the experimental group 2. This may be due to pretest administered to experimental group 1. Having undertaken the pretest, students might have inquired among themselves about the test. The behavior of the teachers during the experimental stage might have caused expectancy effect, a known cause of experimenter bias. Kenneth et.al (2014), state that if you believe that your participants are incapable of learning, you may treat them in such a way as to have that expectation fulfilled.

4.6 Control Group1 posttest and Control Group 2 posttests Comparison

The two groups are controls but control group 1 is pretested while group four is not. Table 4.15(a) shows the groups statistics while Table 4.15 (b) gives the independent sample T-test for the two groups.

Table 4.15:
Analyses of Control Group 1 and 2 Post test Results

(a) Group statistics

Teaching Method		N	Mean	Std. Deviation	Std. Error Mean
Marks/15	Control 1	79	7.49	1.648	.185
	Control 2	40	4.73	1.783	.282

The group statistics for control group 1 and control group 2 are shown in table 4.15. Control group 1 had seventy nine students while control group 2 had forty students. The posttest mean score for control group 1 was 7.49 with a standard deviation of 1.648 while the posttest mean score for control group 2 was 4.73 with standard deviation of 1.783. The control group 1 was subjected to the pretest but not treated. Control group 2 was either pretested or treated with the science process skills advance organizer. The Levenes' test for equality of variance in table 4.15(b) indicates the two groups have equal or about the same variance and hence can be subjected to the independent samples T-test as shown in table 4.15(b). Reading from the upper row of table 4.15(b), there is statistically significant difference between the posttest results of the control group 1 and the posttest results of control group 2. This difference may have been caused by control group 1 having been exposed to the science process skills advance organizer, teacher different teaching methods, school history on performance of physics at Kenya Certificate of Secondary Education (KCSE), school general attitude on physics in the secondary school curriculum or general environmental conditions of the school and other motivational orientations in the learning of physics.

Table 4.15(b)

Independent Samples t-test

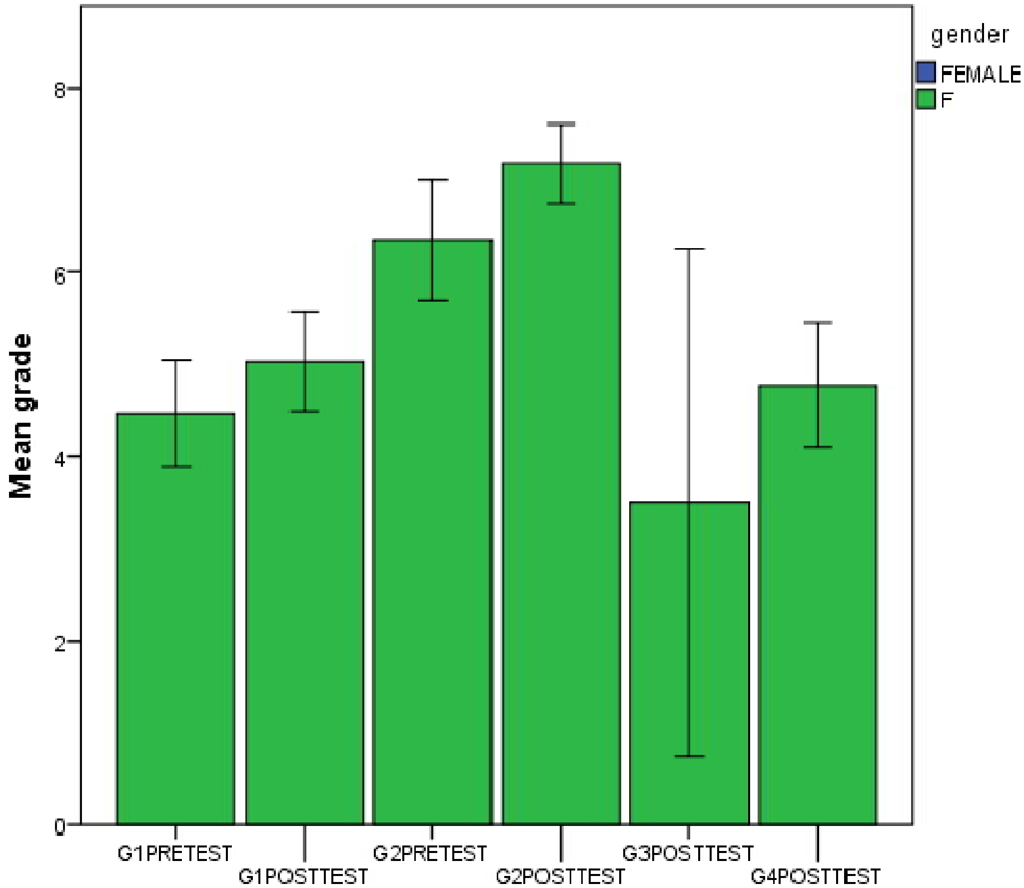
	Levenes' Test for equality of variance		t-test for Equality of Means						
	F	Sig	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
EVA	.05	.784	8.43	117	.000	2.769	.329	2.118	3.420
EVnA			8.26	73.178	.000	2.769	.337	2.096	3.441

Key:EVA- Equal variance assumed, EVnA- Equal variance not assumed

The levene's Test of Equality of Variance indicates a significance level of greater than 0.05 and hence the groups' variances are equal. The comparison results for Control group 1 posttest and Control group 2posttest (table 4. 15) indicates a significance difference. This may be due to pretest administered to Control group 1. Having undertaken the pretest, students might have inquired among themselves about the test.

4.7 Analysis of Girls Performance

The bar graph figure 4.2 presents the performance of pretests and posttests for groups one and two and also posttests for groups three and four for the female groups as per the Solomon four group designs. The lengths of each bar along the y-axis represent the mean score obtained on the variables. According to Kenneth et.al (2014), the bars usually represent estimates of population values based on sample mean. They add that the graph may also present an indication of the precision of the estimate in the form of error bars, whiskers that extend from the top of the main bars showing variability of scores around the estimates. Experimental Group 1 posttest bar is longer than the pretest bar for the same group showing an effect of the science process skills advance organizer. The error bar for posttest results seems slightly shorter than that of the pretest indicating reduction of the variability of the posttest score. This effect of the advance organizer is also supported by the group statistics table 4.16 (a). The vertical change of the pretest mean score of 4.46 for the girls to a posttest mean score of 5.03 in table 4.16(a) reflected not to be statistically significant in the independent samples T-test analysis table 4.16(b). The general perception of the expected impact of the science process skills advance organizer on girls may be captured by Pugh and Girod (2005) in transformative experience: conceptual, illustration and pedagogy while explaining the relationship between experience and learning "the relationship between experience and learning is one of the more common topics of theory and research in education. For example, constructivist perspectives on learning seek to detail how knowledge is constructed through experience and how this knowledge forms a foundation for future learning (Piaget, 1970; Smith, Disessa and Roschelle, 1993). Likewise, sociocultural perspectives describe how interpersonal and cultural experience results in the appropriation of knowledge and the development of formal thought (Rogoff, 1993; Vygot-sky, 1978; 1987). Of note is that both of these perspectives primarily focus on how experience impacts learning and they have less to say about how learning impacts experience. This is typical of most of the theory and research on experience and learning. Dewey's work, however, provides an exception. Overall, Dewey held the pragmatist view that the worth of something is determined by its impact on every day, lived experience. Hence, Dewey(1958) argued that the value of any philosophy could be determined by posing the question, "Does it end in conclusions which, when they are referred back to ordinary life-experiences and their predicaments, render them more significant, more luminous to us, and make our dealings with them more fruitful?” Moreover, he was concerned that formal philosophy was separated from ordinary people and every day, lived experience that the significance of art was found in its impact on everyday experience: ”[Art] 5 quickens us from the slackness of routine and enables us to forget ourselves by finding ourselves in the delight of experiencing the world about us in its varied qualities and forms”. Further, Dewey stated that art introduces us “into a world beyond this world which is nevertheless the deeper reality of the world in which we live our ordinary experiences”. As with formal philosophy, Dewey was concerned that formal art was separated from everyday experience and thus its potential to quicken us and illuminate the deep reality of ordinary experience was not being realized. He stated that when art becomes solely the domain of the museum, theatre, or concert hall and attains “classic status,” it somehow becomes isolated from the human conditions under which it was brought into being and from the human consequences it engenders in actual life experience. . . . Art is remitted to a separate realm, where it is cut off from that association with the materials and aims of every other form of human effort, undergoing, and achievement. These same views about philosophy and art also apply to education. While Dewey’s views on education lay in its impact on every day , lived experience. Further, he was concerned that in ”traditional” education , learning has become separate from everyday experience. He was also concerned that may “so called” progressive educators were simply reacting to traditional education and learning (1938). For this reason, Dewey argued that a theory of experience was needed to guide education and he set out to lay the foundation for such a theory. Central to the theory of experience he presented id the idea that personal experience and education exist in a reciprocal, “organic” relationship. Experience provides a foundation for learning and gives its meaning. On the other hand, learning in the form of educative experience, expands the possibility for richer experience in the future. Hence, learning should not be viewed merely as an end unto itself or a means to some distant disconnected outcome (the mistake made by traditional education), but as a means for expanding experience both now and in the future. Dewey explained, “The central problem of an education based upon experience is to select the kind of present experiences that live fruitfully and creatively in subsequent experiences”. The ways in which learning experiences can expand the possibility for richer future experience are varied. For instance, Dewey suggested that educative experiences (i.e., ones that expand and enrich future experience) are ones that contribute to such things as an ability to regulate action, the development of an interest in learning, and the development of reasoning capacity. In addition, he believe the subject matter should have a more immediate connection with students’ current, lived experience: Experiences in order to be educative must lead out into an expanding world of subject-matter, a subject-matter of facts or information and of ideas. This condition is satisfied only as the education views teaching and learning as a continuous process of reconstructing of experience. This condition in turn can be satisfied only as the educator has a long look ahead, and views every present experience as a moving force in influencing what future experience will be. Elsewhere, Dewey (1990/1902) stated that the teacher is concerned with the subject-matter of science as representing a given stage and phase of the development of experience. Hence, what concerns him, as teacher, is the ways in which that subject may become a part of experience. . . He is concerned, not with the subject-matter as such, but with the subject-matter as a related factor in a total and growing experience. Clearly, learning subject matter is not viewed as an end unto itself or solely as a means for supporting a far distance experience (e.g., work experience) that is disconnected from current experience. Instead the subject matter needs to be developed within the scope of current experience with an eye on both immediate and distant future experience. The relationship between experience and learning is based on learning where there is further transforming, enriching and expanding as a result of experience that deepens and makes meaning for learning. Dewey emphasized that the students experience provides a basis for future learning and also imbues the learning with meaning. This learning, according to Dewey, then has the potential to transform, enrich, and expand the student's everyday experience in two ways: (1) by developing general attitudes and capacities (e.g., interest in learning, regulation of action) and (2) directly through the subject matter (this process will be discussed in greater detail in the following section). It is likely that the relationship between experience and learning does not end there but continues in an ever expanding, spiral relationship. Reintegrating learning with experience by using the subject matter to transform, enrich, and expand everyday experience likely renders a deeper understanding of the subject matter and makes the learning more enduring . This deeper, more enduring understanding then opens the door for a further transformation and expansion of experience. "



Participating groups

Error Bars: 95% CI

Figure: 4.2 Bar Chart for Girls Performance

The bar chart Figure 4.2 shows the performance of girls in each of the participating groups.

Table 4.16: Experimental Group 1 Independent Sample T-Test Analysis for Girls Pretest and Post test Results

Table 4.16

(a) Group Statistics

	Teaching Method	N	Mean	Std. Deviation	Std. Error Mean
Marks/15	Grp 1 pre test	39	4.46	1.790	.287
	Grp 1 post test	39	5.03	1.662	.266

Table: 4.16
(a) Independent Samples t-Test Analysis

	Levenes' test for equality of variance		t-test for Equality of Means						
	F	Sig	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
EVA	.328	.569	-1.442	76	.153	-.564	.391	-1.343	.215
EVnA			-1.442	75.589	.153	-.564	.391	-1.343	.215

Key: EVA- Equal variance assumed, EVnA- Equal variance not assumed

Table 4.16 (a) shows there were 39 girls in Experimental group 1 and the score increased to 5.03 at posttest from 4.46 at pretest. The standard deviation reduced to 1.662 from 1.790 indicating some effect of the treatment.

The Levene's Test of Equality of Variance indicates a significance level of greater than 0.05(p=.569) and hence the groups variance are equal. The comparison of results for Experimental group 1pretest and posttest Table 4.16 (b) indicate a significance level of greater than 0.05(*p*=.153) and hence the group means are not statistically different. These results indicate that the advance organizers had no effect on the posttest results for Experimental group 1 girls though the mean score changed from 4.46 to 5.03 over time. The standard deviation and the standard error of the mean at the same time reduced.

Table 4.17:

Comparison of Experiment Group 1 and Control Group 1 Post test for Girls

Table: 4.17
(a) Group Statistics

	Teaching Method	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Marks/15	Grp1 post test	39	5.03	1.662	.266
	Grp2 post test	34	7.18	1.242	.213

Table 4.17 (a) indicate there were thirty nine girls in the experimental group and thirty four girls in the control group. The mean score for the control group was higher than the mean score for the experimental group 1 but this may not affect the impact of treatment of science process skills advance organizers.

The standard deviation for experimental group 1 girls changed from the entire group standard deviation of the posttest results at 1.959 in table 4.12(a) to 1.662 in table 4.17(a) for girls only. The standard deviation for girls in the control group 1 changed from the standard deviation of the entire control group 1 of 1.648 to that of 1.242 for girls only. The changes in the standard deviation for the two groups indicate the performance of girls in the two groups had low range that is there were no extreme in the girl's performance for both experimental group 1 and control group 1. The standard error for the experimental group 1 girls reduce from 0.267 of the entire group population to 0.266 for girls only while that for the girls from the control group 1 increased to 0.213 from that of the entire control group 1 population of 0.185. The Levenes test for equality of variance in table 4.17 indicates the mean for the two groups and different and from the lower row of table 4.17(b), there is a difference in the means of the two groups. This means the science process skills advance organizer had a positive effect on the girls treated despite variation in the posttest means of the two groups. The untreated (control group 1) had a higher mean score of 7.18 compared with that of the girls in the control group 1 of 5.03.

Table: 4.17

(a) Independent Samples Test

	Levenes' Test for Equality of variance		t-test for Equality of Means						
	F	Sig	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
EVA	4.675	.034	-6.186	71	.000	-2.151	.348	-2.844	-1.458
EVnA			-6.309	69.463	.000	-2.151	.348	-2.831	-1.471

Key: EVA- Equal variance assumed, EVnA- Equal variance not assumed

The levene's Test of Equality of Variance indicates a significance level of less than 0.05 and hence the groups' variance are unequal. The comparison results for Experimental group 1 posttest and Control group 1 posttest for girls table 4.17 (b) second row indicates a significance level of less than 0.05(p=.000) and hence the groups means are statistically significantly different. These results indicate that the science process skills advance organizer had an effect on the posttest results for girls who were treated. This means that the H_O2: that stated that there is no statistically significance difference on performance between gender on those exposed to the science process skills advance organizer and those not exposed were rejected in favor of the girls exposed.

4.8 Analysis of Boys Posttest Performance

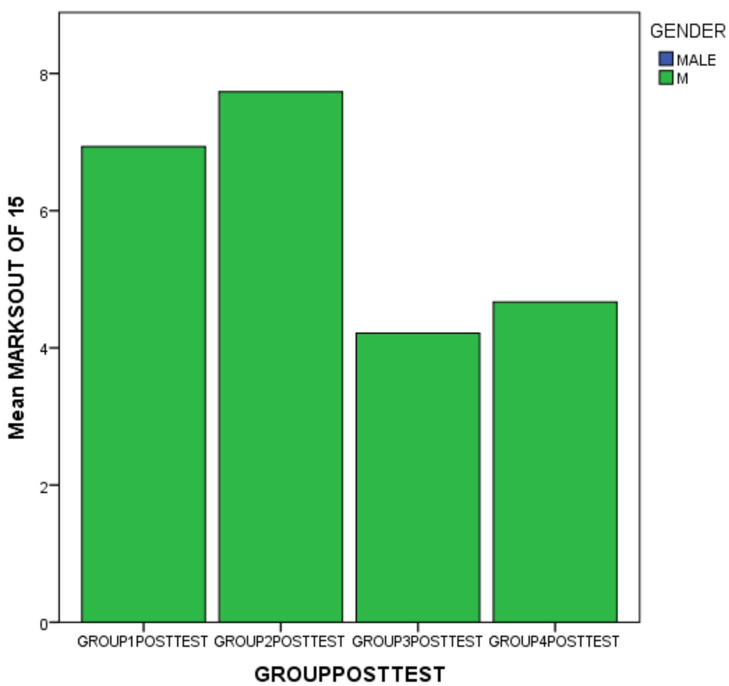


Figure 4.3: Bar charts for boys performance

Figure 4.3 shows the performance of boys in each of the participating groups at posttest. Table 4.18 (a) shows there were fifteen boys in the experimental group 1 and forty five boys in the control group 1. The mean score for boys in the control group was higher than that of boys in the experimental group. The control group posttest mean score reduced by 1.168 from the pretest score of 8.891 while that of the boys in the experimental group increased by 1.466 from the pretest score of 5.467 as shown in Table 4.2.

Table 4.18:
Experimental Group 1and Control Group 1 Post Test analysis for Boys
(a) Group Statistics

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
MARKS	Exp.Grp1	15	6.93	2.052	.530
	Cotr. Grp 1	45	7.73	1.876	.280

The increase of the mean score for boys in the experimental group 1 and the reduction of the mean score for boys in the control group 1 may easily give a conclusion that the science process skills advance organizer was effective for the boys treated. The number of boys in the experimental group 1 and those in the in the control group 1 were fifteen (15) and forty five as shown in table 4.18(a), the group statistics. Both standard deviations for the two groups of the experimental group 1 and control group 1 are higher than the entire group's standard deviations, an indication of higher scattering in the performance of the physics achievement test at the posttest. The standard error for the groups is also higher in the boy's only situation when separated from the total group population. The standard error for boys only in the experimental group 1 moved .530 from .267 of the entire experimental group 1 while that of boys in the control group 1 changed from .185 of the entire group to .280 for boys alone. Despite the variations in the means, standard deviation and standard error, the Levenes test for equality of variance of .936 indicates the variance are equal or about the same and hence the data can be subjected to the independent samples T-Test for analysis. The results for the independent T-Test for the boys in the experimental group 1 and the boys in the control group 1 indicate the means are not different and hence the effect of science process skills advance organizer to the boys was nonexistence.

(b) Independent Samples T-Test for Experimental Group 1 and Control Group 1 Boys Posttests

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Marks	EvA	.006	.936	1.398	58	.167	-.800	.572	-1.946	.346
	EvnA			1.336	22.335	.195	-.800	.599	-2.041	.441

Key: EVA- Equal variance assumed, EVnA- Equal variance not assumed

The levene's Test of Equality of Variance indicates a significance level of greater than 0.05 and hence the groups' variances are equal. The comparison results for Experimental group 1 posttest and Control group 1 posttest (table 4.18b) indicate a significance level of greater than 0.05(p=.167) and hence the groups means are not statistically significantly different though the experimental group improved in the mean score. These results indicate that the science process skills advance organizer had no effect on the posttest results for males.

Table 4.19:

Experimental Groups 1 and 2 Post Tests Comparison for Boys

(a) Group Statistics

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
MARKS	Exp. Grp1	15	6.93	2.052	.530
	Exp. Grp 2	14	4.21	1.718	.459

Boys in the experimental group 1 and those in the experimental group 2 were exposed to science process skills advance organizer but the boys in the experimental group 1 were also pretested. The numbers in the two groups were fifteen and fourteen respectively. This means standard deviation and standard error for the two experimental groups were different as indicated in table: 4.19(a). The Levenes test for equality of variance indicated in table 4.19(b) is .112 and hence the

Variance are equal or about the same. The results for comparison of the means indicate a significant difference. These may be due other predictor factors which are not included in the study.

Table: 4.19

(b) Independent Samples T-Test for Experimental Groups 1 and 2 Boys Post Tests

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Diff	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Diff	Std. Error Diff	Lower	Upper
Marks	EVA	112	.740	3.855	27	.001	2.719	.705	1.272	4.166
	EVnA			3.879	26.704	.001	2.719	.701	1.280	4.158

Key: EVA- Equal variance assumed, EVnA- Equal variance not assumed

The levene's Test of Equality of Variance indicates a significance level of greater than 0.05 and hence the groups' variances are equal. The comparison results for group 1 post test and group 3 posttest (table 4.19b) rejects the null hypothesis hence indicating a difference in the results. These results may be indicating a sensitization of the pretest administered to the experimental group 1.

Table 4.20:

Experimental Group 1 and Control Group 2 Post Test Analysis for Boys

(a) Group Statistics

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
MARKS	Exp.Grp1Post.	15	6.93	2.052	.530
	Ctrl Grp2 Post.	18	4.67	2.114	.498

The experimental group 1 boys were pretested and treated with the science process skills advance organizer before the physics achievement test (PAT) was administered to them was the posttest. The boys in the control group 2 were neither pretested or treated with the science process skills advance organizer but were administered with the physics achievement test (PAT) after having been taught the electric current circuits' topic regularly. The posttests mean scores for the experimental group 1 which had fifteen boys was 6.93 while that of the boys from the control group 2 with eighteen boys was 4.67 as shown in table 4.20(a). The standard deviation for the experimental group 1 boys was 2.052 while that that of the control group 2 was 2.114. despite the differences in the means, standard deviation and the standard error in both groups, the Levenes test for equality of variance indicator that the variance are equal or about the same. The results of table 4.20(b) show a difference in the in the means of the experimental group 1 posttest and the mean of the control group 2 posttest. This may indicating an effect of the science process skills when the effect of the pretest in participated out as indicated by the ANCOVA in tables 4.6(b) through to 4.9(a).

(b) Independent Samples t-Test for Experiment 1 and Control 1 Post Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Marks	Equal variances assumed	.120	.731	3.108	31	.004	2.267	.729	.779	3.754
	Equal variances not assumed			3.116	30.240	.004	2.267	.727	.782	3.752

The levene's Test of Equality of Variance indicates a significance level of greater than 0.05 and hence the groups' variances are equal. The comparison results for Experimental group 1 post test and control group 2 posttest (table 4.20b) rejects the null hypothesis hence indicating a difference in the results. These results may be indicating a sensitization of the pretest administered to the experimental group 1.

Table 4.21:

Experimental Group 2 and Control Group 2 Posttests Analysis for Boys

(a) Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
MARKS	Grp3 Posttest	14	4.21	1.718	.459
	Grp4 Posttest	18	4.67	2.114	.498

The fourteen boys of the experimental group 2 were treated with the science process skills advance organizer while the eighteen boys of the control group 2 were not treated. The mean for the experimental group 2 is 4.21 while the mean score for the control group 2 posttest is 4.67 as shown in table 4.21(a). Experimental group 1had a standard deviation of 1.718 and that of the control group 2 was 2.114. Despite the variation in mean, standard deviation and standard error as indicated in table 4.21(a), the Levenes test for equality of variance indicates the variance of both the data in the experimental group 2 and those in the control group 2 are equal or about the same. The results for table 4.21(b) shows the means for the two groups are not statistically different and therefore the differences between the posttest mean for the experimental group 2 and the posttest mean for the control group 2 are likely due to chance and not the treatment of the experimental group 2 with the science process skills advance organizer.

(b) Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Diff.	Std. Error Diff.	Lower	Upper
MARKS	EVA	.567	.457	-.650	30	.521	-.452	.696	-1.873	.969
	EVNA			-.668	29.919	.509	-.452	.678	-1.836	.932

Key: EVA – Equality of Variance Assumed, EVNA-Equality of Variance Not assumed

The levene's Test of Equality of Variance indicates a significance level of greater than 0.05 and hence the groups' variances are equal. The comparison results for group 2 posttest (experimental group without pretest) and control group 2 posttest (table 4.21b) fail to reject the null hypothesis thus indicating a no significance difference in the results.

4.9 ANOVA Analysis of post test scores for all participating groups

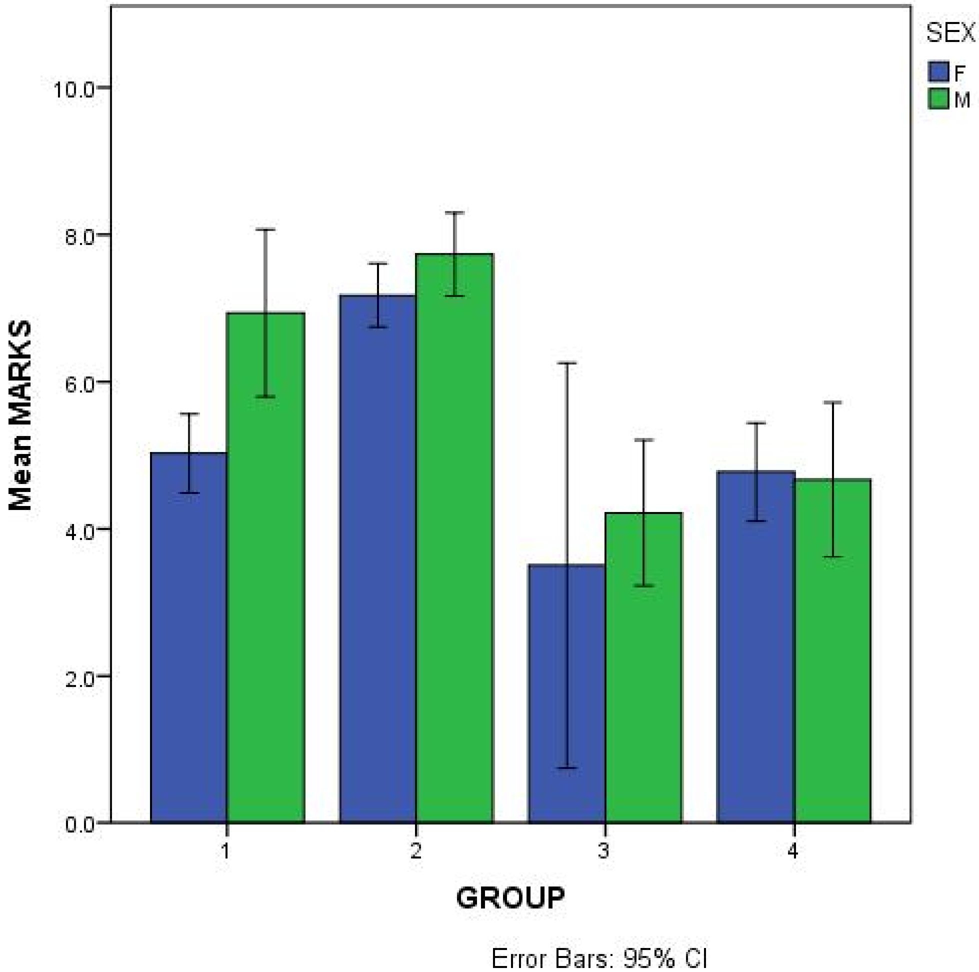


Figure.4.4:Post test results for all Groups by Gender

Key: Grp-Group

The bars shown in figure 4.4 represent estimates of population values based on the sample data. The whiskers show the variability of the scores around the estimates. The X-axis represents the four levels of the independent variables from which the data was collected. One (1) on the X-axis represent the experimental group 1, two (2) represents the control group 1, three (3) represents the experimental group 2 and four (4) represents the control group 2. The blue color on the bars represents the female sample while green color represents the male sample. A look comparison of the error bars (whiskers) for experimental group 1 and control group 1 indicates a small variance for the girl's posttest results on the control group 1. This observation is confirmed in the group statistics table 4.13 (a) and table 4.17 (a) showing posttest standard deviation for experimental group 1 for girls to be 1.662 and that of the control group 1 posttest for girls to be 1.242. The mean posttest scores for both boys and girls in the control group 1 as shown in the bar graph figure 4.4 is higher than for both boys and girls in the experimental group 1. This is shown in group statistics tables 4.17 and 4.18.

The error bars for the experimental groups indicate reduction of variance in both boys and girls after the treatment. The variance for the control groups remains almost the same. The girls' posttest results for control group 1 show a decline in variance an indication that might be attributed to pretest sensitization or other predicting factors not considered in this study. The ANCOVA analysis of the data collected for physics achievement test (PAT) in section 4.2 of this study indicated gender, treatment and even pretest were predictors of the posttest results.

Table 4.22:
ANOVA Analysis for Post test results

	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	319.665	3	106.555	33.887	.000
Within Groups	588.000	187	3.144		
Total	907.665	190			

Table 4.2 shows the posttest means for each of the groups involved in the study. The Analysis of Variance table 4.22 shows a significant difference between the groups in the mean marks of the posttest results F (3,187) =33.887 P< .05. The post Hoc Test Table 4.23 indicates differences in all group comparisons except Experimental group 2 and control group 2.

Table 4.23:

Post Hoc Tests for all groups

Multiple Comparisons

Dependent Variable: Marks

	(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
LSD	1	2	-1.9381*	.3131	.000	-2.556	-1.320
		3	1.5000*	.4826	.002	.548	2.452
		4	.8306*	.3699	.026	.101	1.560
	2	1	1.9381*	.3131	.000	1.320	2.556
		3	3.4381*	.4631	.000	2.524	4.352
		4	2.7687*	.3441	.000	2.090	3.448
	3	1	-1.5000*	.4826	.002	-2.452	-.548
		2	-3.4381*	.4631	.000	-4.352	-2.524
		4	-.6694	.5033	.185	-1.662	.323
	4	1	-.8306*	.3699	.026	-1.560	-.101
		2	-2.7687*	.3441	.000	-3.448	-2.090
		3	.6694	.5033	.185	-.323	1.662

*. The mean difference is significant at the 0.05 level.

Source: SPSS version 23.

The posttest means scores for the experimental group 1 are superior to those of all other groups participating in the study as shown in the table 4.23. This may be due to treatment of the group with science process skills advance organizer. The posttest means score for experimental group 2 also show to be significantly different with the posttest mean score of Control Group 1.

Table 4.24:
ANOVA Analysis for Males only Post test Scores

Marks out of 15

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	204.812	3	68.271	18.311	.000
Within Groups	328.090	88	3.728		
Total	532.902	91			

The Analysis of Variance Table 4.24 shows a significant difference between the posttest mean results for all the groups participating in the study at a significant level $F(3,88) = 18.311$ $P < .05$. The post Hoc Test for males comparison Table 4.25 indicate differences in all groups comparisons except experimental group 1 and control group 1 and also experimental group 2 and control group 2 an indication of no effect of science process skills advance organizer on the male student. The ANOVA analysis and Post Hoc Tests Tables 4.26 and 4.27 for girls post test results indicate effectiveness of science process skills advance organizer on girls.

Table 4.25:
Post Hoc Tests for Males Post test results

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
1	2	-.800	.576	.168	-1.94	.34
	3	2.719*	.718	.000	1.29	4.15
	4	2.267*	.675	.001	.93	3.61
2	1	.800	.576	.168	-.34	1.94
	3	3.519*	.591	.000	2.34	4.69
	4	3.067*	.538	.000	2.00	4.14
3	1	-2.719*	.718	.000	-4.15	-1.29
	2	-3.519*	.591	.000	-4.69	-2.34
	4	-.452	.688	.513	-1.82	.92
4	1	-2.267*	.675	.001	-3.61	-.93
	2	-3.067*	.538	.000	-4.14	-2.00
	3	.452	.688	.513	-.92	1.82

*. The mean difference is significant at the 0.05 level.

Source: SPSS version 23.

Table 4.26:
ANOVA Analysis for Females only Post test Scores

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	129.847	3	43.282	19.324	.000
Within Groups	212.779	95	2.240		
Total	342.626	98			

The Analysis of Variance shows a significant difference between the groups in the mean marks of the posttest results F (3,95) =19.324 P< .05. The post Hoc Test Table 4.27 indicates a difference in experimental group 1.

Table 4.27:
Post Hoc Tests for Males Post test results

Group on comparison	Mean Difference	Standard Error	Sig.
1 and 2	-2.151*	.351	.000
1 and 3	1.526	.786	.055
1 and 4	.253	.399	.528
2 and 3	3.676*	.791	.000
2 and 4	2.404*	.409	.000
3 and 4	-1.273	.813	.121

*. The mean difference is significant at the 0.05 level.

Source: SPSS version 23.

4.10 Factor Analysis of Student Motivation Questionnaire

The questionnaire (Appendix V) had six statements to help the researcher evaluate students' motivation about the physics course taught using science process skills advance organizer prior to the timetabled Physics lessons. Each statement had dimensions (9-10) to allow the students express their inclination about the Physics course in several ways. Each dimension was to be rated as strongly agreed (SA), agreed (A), strongly disagreed (SD), disagreed (D) or undecided (U). Students were only allowed to select one of the ratings per variable. Tables 1 to 6 in Appendix VI, indicates the data collected from the student's responses. Factor analysis was used to determine the dimension(s) underlying students' motivation of electric current circuit's course taught using the advance organizer. An Gie Yong and Sean Pearce (2013) give the purpose of factor analysis as to summarize data so that relationships and patterns can be easily interpreted and understood. They explain that factor analysis is normally used to regroup variables into limited set of clusters based on shared variance and this helps to isolate constructs and concepts. Factor analysis operates by extracting as many significant factors from the data as possible, based on the bivariate correlations between the measures used (Kenneth & Bruce, 2014). A factor is a dimension that consists of any number of variables but those factors with less than 1.0 eigen value (the strength of a factor) are usually not interpreted (Kenneth S. & Bruce 2014). This study aimed at finding the motivational effect of science process skills advance organizer on electric current circuits and hence principle components analysis was used to obtain summary of the data. Principal Components (PCA) is the standard extraction method. It does extract uncorrelated linear combinations of the variables. The first factor has maximum variance. The second and all following factors explain smaller and smaller portions of the variance and are all uncorrelated with each other (http://users.sussex.ac.uk/~andyf/factor.pdf,24/09/2016)

The basic objective of factor analysis is to come up with manageable subset of the predictors for the solution. Communalities tables indicate the amount of variance in each variable that is accounted for while extraction communalities are estimates of the variance in each variable accounted for by the components. In the rotated component matrix table for every item analyzed, a positive factor loading means that a variable positively correlates with the underlying dimension extracted whereas a negative loading means that a negative correlation exists. By convention, a loading are interpreted only if they are equal to or exceed 0.30 (Kenneth & Bruce, 2014). They are highly correlated in the component score coefficient matrix and not lineal correlated with other components are the components representative of all the original variables. The steps taken to analyze the data collected for each of the items with brief discussions are below.

4.10.1. Item One SPSS Factor Analysis

The item placed before the students was 'learning the physics course by the teacher explaining was…' and had the following factors:- fun, satisfying, informative, useful, boring, frustrating, hard, challenging, too demanding, too stressful, for the students to rate as SD – Strongly disagree, D-Disagree, U-undecided, A-agree, and SA- Strongly agree.

The art of the teacher dominating in the classroom contradicts the active engagement student-centered environment described by Redish, (Online, 18/10/2017) as having the following characteristics:

i) The course is student- centered. What the students are actually doing in class is the focus of the course.

ii) Laboratories in this model are of the guided discovery type; that is, students are guided to observe phenomena and build for themselves the fundamental ideas via observation.

iii) The course may include explicit training of reasoning.

iv) Students are expected to be intellectually active during class.

Redish, further explains “Active-engagement classes may occur as part of the large class as recitation or laboratory combined with a tradition lecture. Student’s attention is focused on their work and on their interaction with other students. Their group facilitators roam the room while the students are working, checking the students’ progress and asking guiding questions”.

The descriptive statistics Table :4.28, shows the mean, standard deviation and number of respondents’ (N) who participated in answering the students’ motivation Questionnaire for item one are displayed. Looking at the mean, usefulness with a mean of 4.35 is the most important variable that influences students’ motivation in electrical circuit’s lesson when the teacher takes the role of explaining. The variables informative and boring with means of 3.74 and 1.71 respectively were not responded to by one student each. Too demanding with a mean of 3.00 was not responded to by two students. Useful also shows to have the lowest standard deviation followed by satisfying.

Table: 4.28.

Descriptive Statistics for SMQ Item 1

	N	Minimum	Maximum	Mean	Std. Deviation
METHOD A	77	1	1	1.00	.000
FUN	77	1	5	3.55	1.518
STFG	77	1	5	4.01	1.057
INF	76	1	5	3.74	1.193
USF	77	1	5	4.35	1.023
BRG	76	1	5	1.71	1.175
FSTG	77	1	5	2.19	1.214
HRD	77	1	5	2.32	1.261
CLGG	77	1	5	2.73	1.527
TD	75	1	5	3.00	1.480
TS	77	1	5	1.94	1.301
Valid N (listwise)	73				

Source: SPSS Output for Field Data

The correlation matrix table: 4.29 display the correlation coefficients between a variable and every other variable in the item. The correlation coefficient between a variable and itself is 1 and thus the principal diagonal of the correlation matrix contains 1s. The determinant of the correlation matrix is 0.310 and is shown below the table.

Table: 4.29

Correlation Matrix for Item 1 Data

		FUN	STFG	INF	USF	BRG	FSTG	HRD	CLGG	TD	TS
Correlation	FUN	1.000	.180	.140	-.089	-.080	-.200	-.144	-.059	-.026	-.163
	STFG	.180	1.000	.065	.100	-.044	-.073	-.082	-.248	.107	-.163
	INF	.140	.065	1.000	.275	-.270	-.123	-.141	-.200	-.022	-.259
	USF	-.089	.100	.275	1.000	-.068	.029	.092	-.144	-.048	-.011
	BRG	-.080	-.044	-.270	-.068	1.000	.157	.431	.057	.097	.384
	FSTG	-.200	-.073	-.123	.029	.157	1.000	.062	.093	.018	.351
	HRD	-.144	-.082	-.141	.092	.431	.062	1.000	.092	.199	.245
	CLGG	-.059	-.248	-.200	-.144	.057	.093	.092	1.000	.271	.049
	TD	-.026	.107	-.022	-.048	.097	.018	.199	.271	1.000	-.065
	TS	-.163	-.163	-.259	-.011	.384	.351	.245	.049	-.065	1.000

a. Determinant = .310

The Kaiser- Meyer- Olkin (KMO) and Bartletts' test are shown in the table 4.30. The KMO measures the sampling adequacy and has to be greater than 0.5 for satisfactory analysis to proceed. The KMO for students' motivation questionnaire item one is 0.596. In the same table 4.30, the Barletts test of sphericity is significant at 0.001, meaning its associated probability is less than 0.05 and hence the correlation matrix is not identity matrix.

Table : 4.30

KMO and Bartlett's Test for Item 1 Responses

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.596
Bartlett's Test of Sphericity	Approx. Chi-Square	79.351
	Df	45
	Sig.	.001

Source: SPSS Output of Field Data

Table : 4.31

Reproduced Correlations for Item 1 Variables

		FUN	STFG	INF	USF	BRG	FSTG	HRD	CLGG	TD	TS
Reproduced Correlation	FUN	.477[a]	.386	.011	-.241	-.079	-.366	-.185	-.203	.003	-.291
	STFG	.386	.558[a]	.174	.123	.085	-.291	.079	-.388	.085	-.193
	INF	.011	.174	.565[a]	.489	-.408	-.168	-.171	-.239	-.011	-.378
	USF	-.241	.123	.489	.712[a]	-.083	.102	.171	-.279	.011	-.026
	BRG	-.079	.085	-.408	-.083	.672[a]	.238	.542	.019	.161	.508
	FSTG	-.366	-.291	-.168	.102	.238	.374[a]	.202	.067	-.130	.422
	HRD	-.185	.079	-.171	.171	.542	.202	.612[a]	.128	.387	.341
	CLGG	-.203	-.388	-.239	-.279	.019	.067	.128	.689[a]	.450	-.023
	TD	.003	.085	-.011	.011	.161	-.130	.387	.450	.724[a]	-.172
	TS	-.291	-.193	-.378	-.026	.508	.422	.341	-.023	-.172	.624[a]
Residual[b]	FUN		-.206	.129	.152	-.001	.166	.041	.144	-.029	.128
	STFG	-.206		-.110	-.023	-.129	.218	-.161	.140	.022	.030
	INF	.129	-.110		-.214	.138	.045	.030	.038	-.012	.120
	USF	.152	-.023	-.214		.015	-.073	-.079	.134	-.059	.015
	BRG	-.001	-.129	.138	.015		-.081	-.111	.038	-.064	-.124
	FSTG	.166	.218	.045	-.073	-.081		-.140	.026	.148	-.071
	HRD	.041	-.161	.030	-.079	-.111	-.140		-.036	-.188	-.096
	CLGG	.144	.140	.038	.134	.038	.026	-.036		-.178	.072
	TD	-.029	.022	-.012	-.059	-.064	.148	-.188	-.178		.108
	TS	.128	.030	.120	.015	-.124	-.071	-.096	.072	.108	

Extraction Method: Principal Component Analysis.

a. Reproduced communalities

b. Residuals are computed between observed and reproduced correlations. There are 30 (66.0%) non redundant residuals with absolute values greater than 0.05.

Table 4.32 of communalities shows how much the variance in the variables has been accounted for by the extracted factors. Useful accounted for 72.5%, satisfying accounted for 58.4%, fun 61.3%, Hard 65.8%, Challenging 72.0%, too Demanding 76.3% and too Stressful 61.7%. Table 4.33 shows all the factors of item one of students' motivation questionnaire extractable from the analysis along with their Eigen values, the percent of variance attributable to each factor, and the cumulative variance of the factor and the previous factors. There are five extractable factors in item one with factor one accounting for 20.389%, factor two accounting for 13.758%, factor three accounting for 11.465%, factor four accounting for 10.418% and factor five accounting for 10.322%. All other factors are not significant and have initial Eigen values of less than 1.

The scree plot is a graph of eigenvalues against all the factors. The graph is useful for determining the number of factors to retain. Where the curve starts to flatten is the point of interest. The scree plot figure 4.5 indicates the curve starting to flatten between factor four and factor five. Both factors four and five have eigenvalue of greater than one and hence five factors were retained.

Table 4.34 shows the loadings of the eleven variables on the five factors extracted. The higher the absolute value of the loading, the more the factor contributes to the variable. Informative boring, hard and too demanding show high absolute values with factor one. Useful show high absolute value for factor two while satisfying, hard and too demanding shows high value with factor three while fun and challenging show high absolute values with factors four and five respectively.

The rotated component matrix table 4.35 shows a reduction of factors on which the variables under investigation have high loading. Informative, which was highly loaded for factor one in table 4.34 is now reduced in table 4.35. Useful in table 4.34 is now eliminated and frustrating loaded high. Satisfying, hard and too demanding that were highly loaded for factor three are replaced with informative and useful in rotated matrix table 4.35. The loading of fun in table 4.34 has been raised from 0.595 to 0.716 in table 4.35 for factor four while challenging in table 4.34 has been raised from 0.530 to 0.709 in table 4.35. The new factors after rotation can be used as variables for further analysis.

Table 4.32:
Factor Variance with Variables in item 1 of the Students' Questionnaire

	Initial	**Extraction**
FUN	1.000	.613
STFG	1.000	.584
INF	1.000	.561
USF	1.000	.725
BRG	1.000	.697
FSTG	1.000	.623
HRD	1.000	.658
CLGG	1.000	.720
TD	1.000	.763
TS	1.000	.617
SEX	1.000	.738

Extraction Method: Principal Component Analysis.

Key:

FUN-Fun, STFG-Satisfying, INF-Informative, USF- Useful, BRG-Boring, FSTG- Frustrating- HRD- Hard, CLGG- Challenging, TD-Too demanding, TS-Too stressful.

The extraction communalities, Table 4.32 are estimates of the variance in each variable accounted for by the underlying factor shows high correlation with students' responses. This indicates variables fit well with the factor solution.

Table 4.33:
Retained factors of Item 1 of the Students' Questionnaire

	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of S quared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.243	20.389	20.389	2.243	20.389	20.389	1.760	16.002	16.002
2	1.513	13.758	34.147	1.513	13.758	34.147	1.467	13.335	29.337
3	1.261	11.465	45.612	1.261	11.465	45.612	1.406	12.785	42.122
4	1.146	10.418	56.030	1.146	10.418	56.030	1.372	12.472	54.593
5	1.135	10.322	66.352	1.135	10.322	66.352	1.293	11.759	66.352
6	.912	8.288	74.640						
7	.724	6.584	81.224						
8	.625	5.679	86.903						
9	.531	4.829	91.732						
10	.482	4.378	96.110						
11	.428	3.890	100.000						

For item 1 of the questionnaire seeking to assess students' attitude on teacher domination in a physics class, the students disagreed or strongly disagreed that the teacher was boring and frustrating. Strongly disagree and disagree together accounted for 81.6% while those feeling not frustrated accounted for 66.23%. Probably the students felt the teacher was the only source of information that is required to learn physics. The students may have not been exposed to other ways of learning physics and hence did not have a platform for comparison. 88.31% of the students strongly agreed or agreed with the dominant role of the teacher in the classroom as useful while 80.52% said they agreed or strongly agreed with the role of the teacher in the physics lesson as satisfying. The variable too demanding was agreed and strongly agreed and account for 49.3% in both choices. This may reflect the students' inability to move in the same pace with the teacher during the lesson. The eleven variables exposed to students to assess the teacher's dominant role effect on students' motivation in a physics lesson were collapsed to only five.

The five components with Eigen value of more than 1.0 and accounting for 66.352% explanation of information are shown. The Scree plot Figure 4.5 indicates the Eigen values of all the components and shows a deep drop after the fifth Eigen value. The component matrix Table 4.34 indicates the correlation of the five extracted components and the original variables. It is interesting to note the high correlation between component two and student's gender in relation to the other components. The rotated component matrix Table 4.35 has made the factor more distinct by maximizing high correlations and minimizing low correlations, e.g. Correlation of component 1 and boring is maximized to 0.806 from 0.665 in component matrix. In regard to the ten dimensions to asses students feelings on the dominant role of the teacher, the five solutions are boring, accounting for 16.002%, frustrating, accounting for 13.335%, useful, accounting for 12.785%, satisfying, accounting for 12.472% and too demanding accounting for 11.759%. The resulting five component score variables are representative of, and can be used in place of, the ten original variables with a 33.648% loss of information. Active learning, through which students become active participants in the learning process, is an important means for development of student skills. In the process of active learning, students move from being passive recipients of knowledge to being participants in activities that encompass analysis, synthesis and evaluation besides developing skills, values and attitudes (Karamustafaoglu, 2009).

Table 4.34:
Factor Matrix for Item 1 Students' Questionnaire

	Component				
	1	**2**	**3**	**4**	**5**
FUN	-.387	-.010	.163	.595	.285
STFG	-.330	.176	.521	.415	.021
INF	-.557	.245	.186	-.396	-.008
USF	-.144	.606	.315	-.486	-.043
BRG	.665	.016	.320	.255	-.296
FSTG	.494	.438	-.230	-.038	.364
HRD	.568	.040	.528	-.116	-.202
CLGG	.363	-.488	-.063	-.255	.530
TD	.185	-.352	.607	-.171	.456
TS	.684	.297	-.147	.143	-.137
SEX	.104	.640	-.039	.179	.532

Extraction Method: Principal Component Analysis.

a. 5 components extracted.

Table 4.34 reports the factor loading for each variable on the un-rotated factors. Each number represents the correlation between the item and the un-rotated factor (e.g. the correlation between "fun" and factor 1 is -0.387). There are several variables highly correlated with one factor and this makes interpretation difficult. Factor 1 is highly correlated with boring, hard and too stressed.

Table 4.35:
Rotated Component Matrix for Item 1 of the Students' Motivation Questionnaire

	Component				
	1	**2**	**3**	**4**	**5**
FUN	-.245	.050	-.193	.716	.008
STFG	.091	-.068	.181	.733	-.032
INF	-.325	-.146	.653	.083	-.033
USF	.089	.187	.823	-.041	-.062
BRG	.806	.043	-.213	.023	-.006
FSTG	.136	.741	-.040	-.228	.040
HRD	.760	-.019	.148	-.066	.231
CLGG	-.082	.105	-.302	-.329	.709
TD	.191	-.065	.083	.166	.830
TS	.533	.428	-.216	-.247	-.204
SEX	-.068	.808	.140	.245	-.006

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 8 iterations.

Table 4.35 shows the highest correlation for each variable with a specific factor. Each of the variables describes characteristics of the teacher who does not engage the students in learning physics. Thus the teacher can be boring, frustrating, useful, satisfying or too demanding.

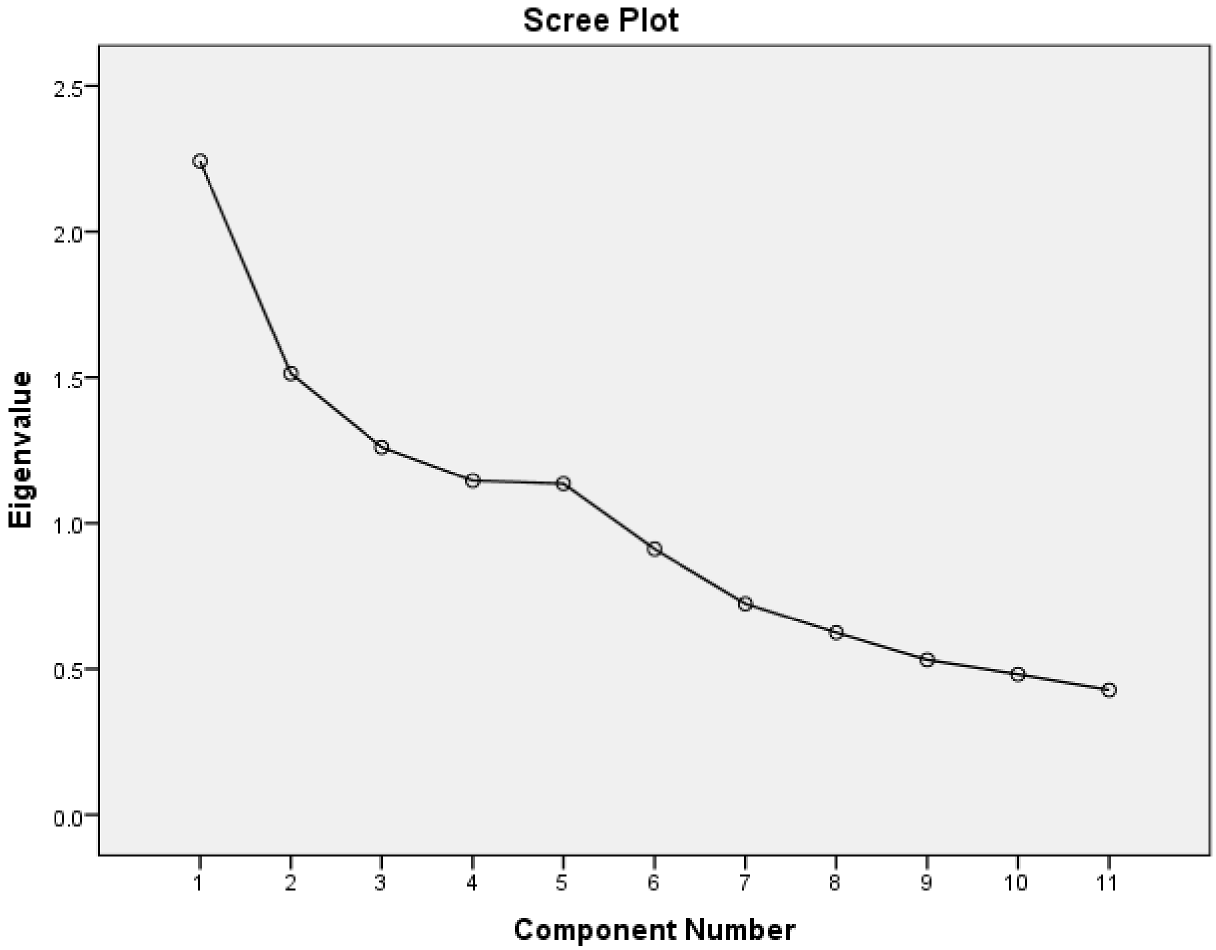


Figure 4.5: SPSS Output for Scree Plot for Item 1 of SMQ

From Table 4.34 the factors highly correlated with component one are Boring (0.806), Hard (0.760), and too demanding (0,533). Factors Frustrating (0.741) and too stressful (0.428) are highly correlated with component 2. Component three is highly correlated with Informative (0.653) and Useful (0.823) while component four is highly correlated with factors Fun (0.716) and Satisfying (0.733).

In the scree plot, the factor with the highest correlation with each of the components has an Eigen value of greater than 1.0 and is plotted as corresponding with 1 for component 1; 2 for component 2; in that order until the last highest.

Table 4.36:

Component Score Coefficient Matrix For Item 1 of SMQ

	Component				
	1	**2**	**3**	**4**	**5**
FUN	-.101	.112	-.230	.550	.035
STFG	.156	-.021	.070	.554	.000
INF	-.125	-.069	.453	-.041	.037
USF	.094	.107	.616	-.091	.008
BRG	.484	-.067	-.101	.123	-.073
FSTG	-.037	.503	-.005	-.114	.047
HRD	.465	-.105	.190	.019	.137
CLGG	-.171	.104	-.153	-.206	.543
TD	.092	-.023	.118	.162	.653
TS	.252	.218	-.117	-.097	-.203
SEX	-.109	.600	.065	.217	.056

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization

Component Scores

4.10.2 Item Two SPSS Factor Analysis

The item placed before the students was ‘learning the physics course by working through an experiment was…’ and had the following factors:- stimulating, rewarding, time wasting, hard, too stressful, satisfying, informative, fun, challenging, boring for the students to rate as SD – Strongly disagree, D-Disagree, U-undecided, A-agree, and SA- Strongly agree.

The mean, standard deviation and number of respondents' (N) who participated in answering the student motivation Questionnaire for item two are displayed in table: 4.37. Looking at the mean column, informative with a mean of 4.04 is the most important variable that influences students' motivation in electrical circuits lesson when students are learning the physics course by working through an experiment. There were no reasons given for the unanswered responses in the six variables including informative with the highest mean of 4.04. Rewarding with a mean of 3.91 has standard deviation of 1.080 and informative has a standard deviation of 1.116. Timewasting and boring has the lowest means and also the lowest standard deviation.

Table: 4.37
Descriptive Statistics for SMQ Item 2

	N	Minimum	Maximum	Mean	Std. Deviation
Stimulating	78	1	5	3.72	1.413
Rewarding	75	1	5	3.91	1.080
Time wasting	76	1	5	1.54	.901
Hard	78	1	5	2.01	1.222
Too stressful	78	1	5	1.95	1.318
Satisfying	76	1	5	3.64	1.421
Informative	74	1	5	4.04	1.116
Fun	77	1	5	3.95	1.255
Challenging	73	1	5	2.67	1.405
Boring	78	1	5	1.46	.907
Valid N (listwise)	65				

Source: SPSS Output for Field Data

The correlation matrix table: 4.38 displays the correlation coefficients between a variable and every other variable in the item. The correlation coefficient between a variable and itself is 1 and thus the principal diagonal of the correlation matrix contains 1s. The determinant of the correlation matrix is 0.110 and is shown below the table.

Table: 4.38
Correlation Matrix for Item 2 Data

		Stimulating	Rewarding	Time wasting	Hard	Too stressful	Satisfying	Informative	Fun	Challenging	Boring
Correlation	Stimulating	1.000	.338	-.292	-.269	-.283	.043	.189	.081	-.151	-.306
	Rewarding	.338	1.000	-.308	-.409	-.330	.209	.426	-.071	-.223	-.329
	Time wasting	-.292	-.308	1.000	.430	.536	-.253	-.329	-.033	.138	.396
	Hard	-.269	-.409	.430	1.000	.489	-.131	-.380	.021	.316	.452
	Too stressful	-.283	-.330	.536	.489	1.000	-.094	-.276	-.138	.175	.316
	Satisfying	.043	.209	-.253	-.131	-.094	1.000	.308	-.220	-.158	-.105
	Informative	.189	.426	-.329	-.380	-.276	.308	1.000	-.163	-.177	-.465
	Fun	.081	-.071	-.033	.021	-.138	-.220	-.163	1.000	.107	.118
	Challenging	-.151	-.223	.138	.316	.175	-.158	-.177	.107	1.000	.144
	Boring	-.306	-.329	.396	.452	.316	-.105	-.465	.118	.144	1.000

a. Determinant = .110

The Kaiser- Meyer- Olkin (KMO) and Bartletts' test are shown in the table. The KMO measures the sampling adequacy and has to be greater than 0.5 for satisfactory analysis to proceed. The

KMO for students' motivation questionnaire item one is 0.804. In the same table: 4.39, the Barletts test of sphericity is significant at 0.000, meaning its associated probability is less than 0.05 and hence the correlation matrix is not identity matrix.

Table : 4.39
KMO and Bartlett's Test for Item 1 Responses

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.804
Bartlett's Test of Sphericity	Approx. Chi-Square	132.143
	df	45
	Sig.	.000

Source: SPSS Output of Field Data

Table : 4.40
Reproduced Correlations for Item 2 Variables

		STIM	RWD	TW	Hard	TS	SF	IFM	Fun	CHG	BR
Reproduced Correlation	STIM	.355[a]	.319	-.412	-.413	-.460	.011	.246	.193	-.143	-.338
	RWD	.319	.449[a]	-.451	-.487	-.417	.279	.465	-.116	-.281	-.452
	TW	-.412	-.451	.518[a]	.537	.536	-.147	-.407	-.080	.242	.466
	Hard	-.413	-.487	.537	.563[a]	.538	-.205	-.460	-.018	.275	.499
	TS	-.460	-.417	.536	.538	.596[a]	-.020	-.324	-.243	.189	.442
	SF	.011	.279	-.147	-.205	-.020	.449[a]	.413	-.476	-.257	-.257
	IFM	.246	.465	-.407	-.460	-.324	.413	.538[a]	-.302	-.328	-.458
	Fun	.193	-.116	-.080	-.018	-.243	-.476	-.302	.623[a]	.194	.081
	CHG	-.143	-.281	.242	.275	.189	-.257	-.328	.194	.201[a]	.276
	BR	-.338	-.452	.466	.499	.442	-.257	-.458	.081	.276	.458[a]

Residual b	STIM		.020	.120	.144	.177	.032	-.057	-.113	-.008	.032
	RWD	.020		.143	.078	.087	-.070	-.039	.045	.058	.123
	TS	.120	.143		-.107	.000	-.106	.078	.047	-.105	-.071
	Hard	.144	.078	-.107		-.048	.074	.080	.039	.041	-.048
	TS	.177	.087	.000	-.048		-.074	.048	.106	-.014	-.125
	SF	.032	-.070	-.106	.074	-.074		-.105	.256	.100	.152
	IFM	-.057	-.039	.078	.080	.048	-.105		.139	.151	-.007
	Fun	-.113	.045	.047	.039	.106	.256	.139		-.087	.037
	CHG	-.008	.058	-.105	.041	-.014	.100	.151	-.087		-.132
	BR	.032	.123	-.071	-.048	-.125	.152	-.007	.037	-.132	

Extraction Method: Principal Component Analysis.

a. Reproduced communalities

b. Residuals are computed between observed and reproduced correlations. There are 29 (64.0%) nonredundant residuals with absolute values greater than 0.05.

Key: STIM – Stimulating, RWD- Rewarding, TW- Time Wasting, TS – Too Stressful, SF- Satisfying, IFM – Informative, CHG – Challenging, BR – Boring.

Table 4.41 of communalities shows how much the variance in the variables has been accounted for by the extracted factors. Too stressful for 59.6%, fun accounted for 62.3%, informative 53.8%, Hard 56.3%, time wasting 51.8%, satisfying 44.9% and rewarding 44.9%. Table 4.42 shows all the factors of item one of students' motivation questionnaire extractable from the analysis along with their Eigen values, the percent of variance attributable to each factor, and the cumulative variance of the factor and the previous factors. There are two extractable factors in item two with factor one accounting for 33.836%, and factor two accounting for 13.645%, . All other factors are not significant and have initial Eigen values of less than 1.

The scree plot is a graph of eigenvalues against all the factors. The graph is useful for determining the number of factors to retain. Where the curve starts to flatten is the point of interest. The scree plot figure 4.6 indicates the curve starting to flatten between factor two and factor three. Factor three has eigenvalue of less than two and hence two factors were retained. Table 4.43 shows the loadings of the ten variables on the two factors extracted. The higher the absolute value of the loading, the more the factor contributes to the variable. Too stressful, Informative, boring, and hard show high absolute values with factor one. Fun and satisfying show high absolute value for factor two.

The rotated component matrix table 4.44 shows a reduction of factors on which the variables under investigation have high loading. Informative, which was highly loaded for factor one in table 4.43 is now reduced in table 4.44 to - .490. Satisfying in table: 4.43 is raise to -.661 in table 4.44 from .565 and fun in table 4.43 is lowered to .756 in table 4.44. The new factors after rotation can be used as variables for further analysis.

Table 4.41:
Factor Variance with Variables in item 2 of the Student Questionnaire

	Initial	**Extraction**
Stimulating	1.000	.355
Rewarding	1.000	.449
Time wasting	1.000	.518
Hard	1.000	.563
Too stressful	1.000	.596
Satisfying	1.000	.449
Informative	1.000	.538
Fun	1.000	.623
Challenging	1.000	.201
Boring	1.000	.458

Extraction Method: Principal Component Analysis.

The communalities in table4.41 are all high except challenging, indicating that the extracted components represent the variables fairly well. The communalities in table 4.41 for the variables, stimulating, rewarding, satisfying, challenging and boring show not fitting as good as fun and too stressful with the factor solution. The ten variables of item two of the students ‘motivation questionnaire exposed to students to evaluate their attitude towards working through an experiment were collapsed to only two. Students disagreed, 75.6% that the activity was too stressful and agreed that the activity of working through the experiment was fun, 80.3%. The expression of not being stressful may be due to the self being in a position to decide on the mode of operation for one to come up with a conclusion. Students must have found fun with the experimental results due to new revelations being brought out by the activities. This motivates the students in search for other platforms to solve physics problems. The process of undertaking an experiment must have involved the student to a point of feeling completely involved in solving a problem. Akinbobola and Afolabi (2010) explain practical work in physics as composed of the following steps, planning, designing a problem, creating a new approach and procedure as well as putting things together in the new arrangement. The act of creativity in a practical lesson helps the students to know how to use the equipment's at his disposal. Involvement in a practical lesson is a process of understanding the nature of science, Kambouri (2010) citing Akinbobola and Ado, (2007) Akinbobola and Afololabi (2010) state that science process orientation has other products like promoting affective reaction to science and stress the attitudes such as honesty, open and critical mindedness, curiosity, suspended judgment and humility. Siting Deverenx, 2007, Kambouri (2010), argues that school science should be about reaching possible conclusions by exploring relationships and explanations between ideas and events and it is essentially about understanding. In this study the process to show the relationships of current and voltage during the science process skills advance organize presentation gave the students an opportunity to learn skills to use instruments that made them observe and measure the quantities of current and voltage in an electric circuit. The results of item three of the questionnaire indicate students strong agreement that their doing the experiment that their doing the experiments as individuals made them feel confident about the physics course, feel eager to learn the physics course and also want to apply the knowledge attained in solving practical problems. Factor analysis for item three (table 4.47 indicate four variables accounting for 66.257% describing the orientation of students towards the physics course while having engaged with an experiment). Asoko (2002) as cited by Kambouri (2010) highlighted that science teaching should involve a process of change in the thinking of the child-learner and this can be with the use of more practical and memorable experiences which can be with the use of more practical and memorable experiences which can be more effective for children's learning.

Table 4.42:
Retained factors of Item 2 of the Students' Questionnaire

	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.384	33.836	33.836	3.384	33.836	33.836	3.069	30.687	30.687
2	1.365	13.645	47.481	1.365	13.645	47.481	1.679	16.795	47.481
3	.934	9.341	56.822						
4	.891	8.910	65.733						
5	.805	8.053	73.786						
6	.692	6.921	80.707						
7	.614	6.135	86.843						
8	.476	4.757	91.599						
9	.446	4.461	96.060						
10	.394	3.940	100.000						

Extraction Method: Principal Component Analysis.

Two components with Eigen value of more than 1.0 and accounting for 47.481% explanation of information are shown. The Scree plot Figure 4.6 indicates the Eigen values of all the components and shows a deep drop after the second Eigen value. The component matrix Table 4.41 indicates the correlation of the two extracted components and the original variables. The rotated component matrix Table 4.44 has made the factor more distinct by maximizing high correlations and minimizing low correlations, e.g. Correlation of component 1 and too stressful is maximized to 0.766 from 0.756 in component matrix. In regard to the ten dimensions to assess student's feelings on learning the physics course by working through an experiment, students expressed stress but also found fun in it. Finding it stressful may due to the fact that many lessons are orally taught giving students no chance to interpret the concepts. The two solutions are too stressful, accounting for 30.687% and fun accounting for 16.795%. The resulting two component score variables are representative of, and can be used in place of, the ten original variables. According to Ausubel as cited by Zaman,et.al (2015), "the most important single factor influencing learning is what the learner already knows''. Exposure of advance organizers before the lesson may induce more fun and hence enhance learning.

Table 4.43:
Factor Matrix for Item 2 Students' Questionnaire

	Component	
	1	**2**
Stimulating	-.511	-.306
Rewarding	-.666	.071
Time wasting	.696	.183
Hard	.742	.110
Too stressful	.667	.388
Satisfying	-.359	.565
Informative	-.665	.308
Fun	.091	-.784
Challenging	.401	-.201
Boring	.676	-.024

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Table 36 indicates only two factors that explain the ten variables responded by the students. Factor 1 has fun below 0.33 and can be discarded. The other nine variables have something in common represented by factor 1. Boring, challenging, hard, time wasting and rewarding in factor 2 are far below 0.33 marks and hence cannot be taken to explain the factor.

Table 4.44
Rotated Component Matrix for Item 2 of the Students' Motivation Questionnaire

	Component	
	1	**2**
Stimulating	-.590	.079
Rewarding	-.584	-.328
Time wasting	.712	.107
Hard	.725	.192
Too stressful	.766	-.093
Satisfying	-.107	-.661
Informative	-.490	-.546
Fun	-.226	.756
Challenging	.289	.343
Boring	.612	.289

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

b. The highest correlating variable for factor 1 is too stressful and that for factor 2 is fun as shown in table 4.44 the variables describes the motivating factors when the students are learning physics while working through an experiment.

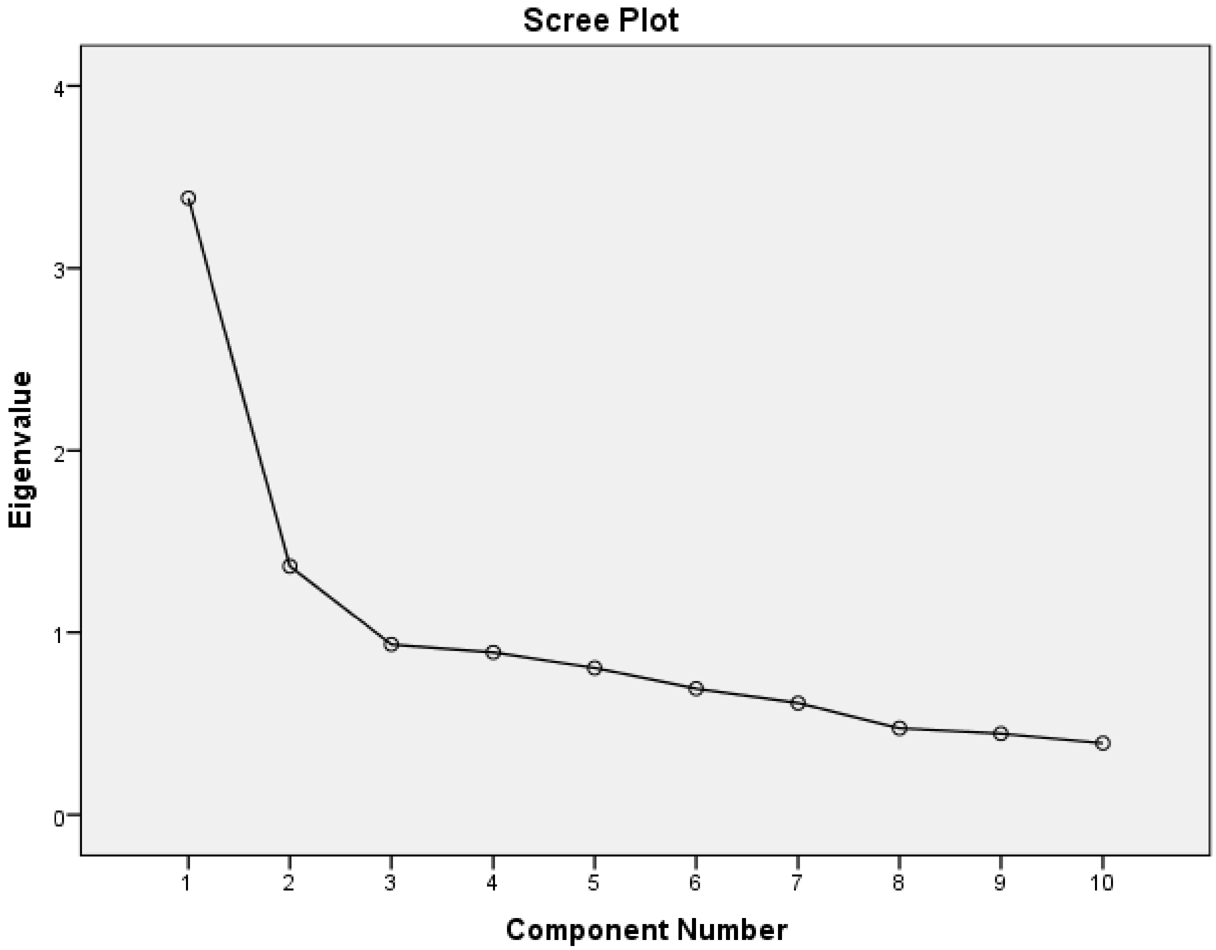


Figure. 4.6SPSS Output for Scree Plot for Item 2 of SMQ

The Scree plot Figure 4.6 show the two extracted factors as corresponding with one on the component number axis for too stressful with a variance (30.687%) and Fun with a variance(16.795%) corresponding with two on the component number axis. Factors Hard (0.725) and Time wasting (0.712) also correlate highly with component one but were not extracted due to their high correlation with component two.

Table 4.45:
Component Score Coefficient Matrix For Item 2 of SMQ

	Component	
	1	**2**
Stimulating	-.227	.146
Rewarding	-.160	-.126
Time wasting	.242	-.042
Hard	.233	.013
Too stressful	.293	-.183
Satisfying	.066	-.423
Informative	-.091	-.285
Fun	-.202	.538
Challenging	.051	.182
Boring	.177	.095

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization

Component Scores

4.10.3 Item Three SPSS Factor Analysis

The item placed before the students was ‘learning the physics course by doing the experiment myself made me…’ and had the following factors:- Feel confident about the physics course, feel eager to learn the physics course, doubt my ability to learn physics, want to apply my knowledge to solve practical problems, happy, exited, feel as if I was wasting time, frustrated, unhappy, interested in physics, for the students to rate as SD – Strongly disagree, D-Disagree, U-undecided, A-agree, and SA- Strongly agree.

The mean, standard deviation and number of respondents’ (N) who participated in answering the student motivation Questionnaire for item three are displayed Table: 4.46. Looking at the mean, feeling confident about the physics course with a mean of 4.32 is the most important variable that influences students’ motivation in electrical circuit’s lesson when students learn the physics course by doing the experiment by themselves. Not all the variables were responded to by all the participants. 73 students of the 77 responded to the variable “doubt my ability to lean physics”. “Feel as if I was wasting time” variable has the least mean and standard deviation.

Table: 4.46.
Descriptive Statistics for SMQ Item 3

	N	Minimum	Maximum	Mean	Std. Deviation
FCPC	76	1	5	4.32	1.191
FEPC	75	1	5	3.40	1.585
DALP	73	1	5	2.44	1.472
WSPP	74	1	5	4.08	1.120
H	74	1	5	4.18	1.243
E	70	1	5	3.77	1.299
FWT	77	1	4	1.61	1.002
F	76	1	5	2.11	1.150
UH	75	1	5	1.84	1.274
IP	74	1	5	3.92	1.402
Valid N (listwise)	56				

Source: SPSS Output for Field Data

The correlation matrix table 4.47 displays the correlation coefficients between a variable and every other variable in the item. The correlation coefficient between a variable and itself is 1 and thus the principal diagonal of the correlation matrix contains 1s. The determinant of the correlation matrix is 0.066 and is shown below the table.

Table: 4.47
Correlation Matrix for Item 3 Data

		FCPC	FEPC	DALP	WSPP	H	E	FWT	F	UH	IP
Correlation	FCPC	1.000	.190	-.190	-.007	.475	.300	-.574	-.390	-.261	.264
	FEPC	.190	1.000	-.105	-.002	.050	.269	-.063	-.172	-.091	.274
	DALP	-.190	-.105	1.000	.001	-.057	-.094	-.025	.216	.162	-.055
	WSPP	-.007	-.002	.001	1.000	.356	.150	-.136	-.014	-.242	.359
	H	.475	.050	-.057	.356	1.000	.617	-.446	-.308	-.390	.252
	E	.300	.269	-.094	.150	.617	1.000	-.280	-.183	-.180	.214
	FWT	-.574	-.063	-.025	-.136	-.446	-.280	1.000	.221	.236	-.504
	F	-.390	-.172	.216	-.014	-.308	-.183	.221	1.000	.188	-.254
	UH	-.261	-.091	.162	-.242	-.390	-.180	.236	.188	1.000	-.380
	IP	.264	.274	-.055	.359	.252	.214	-.504	-.254	-.380	1.000

a. Determinant = .066

The Kaiser- Meyer- Olkin (KMO) and Bartletts' test are shown in the table 4.48. The KMO measures the sampling adequacy and has to be greater than 0.5 for satisfactory analysis to proceed. The KMO for students' motivation questionnaire item one is 0.634. In the same table, the Barletts test of sphericity is significant at 0.000, meaning its associated probability is less than 0.05 and hence the correlation matrix is not identity matrix.

Table : 4.48

KMO and Bartlett's Test for Item 3 Responses

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.634
Bartlett's Test of Sphericity	Approx. Chi-Square	138.544
	df	45
	Sig.	.000

Source: SPSS Output of Field Data

Table: 4.49
Reproduced Correlations for Item 3 Variables

		FCPC	FEPC	DALP	WSPP	H	E	FWT	F	UH	IP
Reproduced Correlation	FCPC	.719[a]	.248	-.142	-.098	.540	.479	-.599	-.495	-.212	.293
	FEPC	.248	.601[a]	-.240	-.057	-.092	.018	-.193	-.329	-.177	.466
	DALP	-.142	-.240	.751[a]	.019	-.120	-.179	-.224	.380	.266	.033
	WSPP	-.098	-.057	.019	.751[a]	.378	.195	-.133	.084	-.479	.441
	H	.540	-.092	-.120	.378	.836[a]	.614	-.526	-.318	-.439	.279
	E	.479	.018	-.179	.195	.614	.478[a]	-.406	-.328	-.325	.213
	FWT	-.599	-.193	-.224	-.133	-.526	-.406	.739[a]	.289	.228	-.499
	F	-.495	-.329	.380	.084	-.318	-.328	.289	.466[a]	.232	-.228
	UH	-.212	-.177	.266	-.479	-.439	-.325	.228	.232	.489[a]	-.441
	IP	.293	.466	.033	.441	.279	.213	-.499	-.228	-.441	.795[a]
Residual[b]	FCPC		-.058	-.047	.091	-.065	-.179	.025	.105	-.050	-.029
	FEPC	-.058		.135	.055	.142	.251	.130	.157	.086	-.191
	DALP	-.047	.135		-.018	.063	.085	.199	-.165	-.104	-.087
	WSPP	.091	.055	-.018		-.022	-.045	-.004	-.098	.237	-.081
	H	-.065	.142	.063	-.022		.003	.081	.010	.049	-.027
	E	-.179	.251	.085	-.045	.003		.126	.145	.145	.001
	FWT	.025	.130	.199	-.004	.081	.126		-.067	.008	-.004
	F	.105	.157	-.165	-.098	.010	.145	-.067		-.044	-.026
	UH	-.050	.086	-.104	.237	.049	.145	.008	-.044		.061
	IP	-.029	-.191	-.087	-.081	-.027	.001	-.004	-.026	.061	

Extraction Method: Principal Component Analysis.

a. Reproduced communalities

b. Residuals are computed between observed and reproduced correlations. There are 28 (62.0%) non redundant residuals with absolute values greater than 0.05.

Table 4.50 of communalities shows how much the variance in the variables has been accounted for by the extracted factors. Feel confident about the physics course accounted for 71.9%, Happy accounted for 83.6%, Interest in physics 79.5%, Feel as if I was wasting time 73.9%, and Exited accounted for 46.6%.

Table 4.51 shows all the factors of item one of students' motivation questionnaire extractable from the analysis along with their Eigen values, the percent of variance attributable to each factor, and the cumulative variance of the factor and the previous factors. There are four extractable factors in item one with factor one accounting for 32.363%, factor two accounting for 12.949%, factor three accounting for 10.884%, and factor four accounting for 10.061% . All other factors are not significant and have initial Eigen values of less than 1.

The scree plot is a graph of eigenvalues against all the factors. The graph is useful for determining the number of factors to retain. Where the curve starts to flatten is the point of interest. The scree plot figure 4.7 indicates the curve starting to flatten between factor three and factor four. Both factor three and four have eigenvalue of greater than one and hence four factors were retained. Table 4.52 shows the loadings of the ten variables on the four factors extracted. The higher the absolute value of the loading, the more the factor contributes to the variable. Feel confident about the physics course and happy show highest absolute values with factor one. Want to apply my knowledge to solve practical problems, feel eager to learn the physics course and doubt my ability to learn physics are respectively high to factors 2,3 and 4.

The rotated component matrix table 4.53 shows a reduction of factors on which the variables under investigation have high loading. Seven variables loaded to factor one in table 4.51 with absolute value greater than 0.500 have been reduced to only four variables with absolute value greater than 0.600 in table 4.53. The new factors after rotation can be used as variables for further analysis.

Table 4.50:
Factor Variance with Variables in item 3 of the Student Questionnaire

	Initial	Extraction
FCPC	1.000	.719
FEPC	1.000	.601
DALP	1.000	.751
WSPP	1.000	.751
H	1.000	.836
E	1.000	.478
FWT	1.000	.739
F	1.000	.466
UH	1.000	.489
IP	1.000	.795

Extraction Method: Principal Component Analysis.

Key: FCPC-Feel confident about the physics course, FEPC-Feel eager to learn the physics course, DALP- Doubt my ability to learn physics ,WSPP- Want to apply my knowledge to solve practical problems, H- Happy, E- Excited, FWT –Feel as if I was wasting time, F - Frustrated, UH - Unhappy, IP –Interested in physics.

The variables unhappy, frustrating and exciting in table 4.50 show not fitting as well as the variables where students felt confident and eager to learn the physics course though they were doubting their ability to learn physics

The communalities in this table 4.50 are all high, indicating that the extracted components represent the variables well

Table 4.51:
Retained factors of Item 3 of the students' Questionnaire

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.236	32.363	32.363	3.236	32.363	32.363	2.487	24.872	24.872
2	1.295	12.949	45.312	1.295	12.949	45.312	1.617	16.172	41.044
3	1.088	10.884	56.196	1.088	10.884	56.196	1.355	13.551	54.595
4	1.006	10.061	66.257	1.006	10.061	66.257	1.166	11.662	66.257
5	.998	9.983	76.240						
6	.713	7.128	83.368						
7	.675	6.754	90.123						
8	.495	4.951	95.074						
9	.272	2.723	97.797						
10	.220	2.203	100.000						

Extraction Method: Principal Component Analysis.

Four components with Eigen value of more than 1.0 and accounting for 66.257% explanation of information are shown. The Scree plot Figure 4.7 indicates the Eigenvalues of all the components and shows a deep drop after the fourth Eigen value. The component matrix Table 4.51 indicates the correlation of the four extracted components and the original variables. The rotated component matrix Table 4.53 has made the factor more distinct by maximizing high correlations and minimizing low correlations, e.g. Correlation of component 1 and feeling confident about the physics course is maximized to 0.793 from 0.701 in component matrix. In regard to the ten dimensions to assess students' feelings on learning the physics course by doing the experiment themselves, students expressed feeling confident (24.872%), having desire to apply the knowledge to solve practical problems (16.172%) as well as feeling eager to learn the physics course (13.551%). The doubting element (11.662%) is probably due to students' inability to interpret experimental results and inability to read the instruments in use correctly. Students showed a desire to learn skills to understand the concepts being taught. The resulting four component score variables are representative of, and can be used in place of, the ten original variables. Learning through experimentation allows a better appreciation of the importance of physics and of the validity of theoretical models (Cristian Bahrim, 2009). Exposure of advance organizers before the lesson may induce more fun and hence enhance learning.

Table 4.52:
Factor Matrix for Item 3 Students' Questionnaire

	Component			
	1	2	3	4
FCPC	.701	-.344	.323	.063
FEPC	.322	-.358	-.402	.455
DALP	-.218	.508	.487	.456
WSPP	.371	.680	-.352	-.164
H	.771	.180	.262	-.374
E	.616	-.021	.174	-.260
FWT	-.695	-.087	-.372	-.330
F	-.516	.442	.053	.037
UH	-.562	-.185	.337	.161
IP	.644	.238	-.329	.465

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

The factor matrix table 4.52 shows four factors that represent the ten variables that the students responded to. Many of the variables correlate highly with the factors and hence not possible to tell which variable is represented by the factor. Variable with less than 0.33 can be discarded.

Table 4.53:
Rotated Component Matrix for Item 3 of the Students' Motivation Questionnaire

	Component			
	1	**2**	**3**	**4**
FCPC	.793	-.106	.266	-.086
FEPC	.037	-.024	.749	-.196
DALP	-.063	-.059	-.096	.857
WSPP	.011	.863	-.028	.079
H	.786	.430	-.167	-.072
E	.632	.231	-.040	-.151
FWT	-.703	-.123	-.320	-.357
F	-.469	.058	-.316	.378
UH	-.259	-.579	-.181	.232
IP	.231	.515	.670	.165

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

The variables, feeling confident, wanting to apply, feeling eager and doubting self-ability are highly correlated with factors 1, 2, 3 and 4 respectively as shown in table 4.53. All these variables describe the motivation of the students while learning physics by doing an experiment.

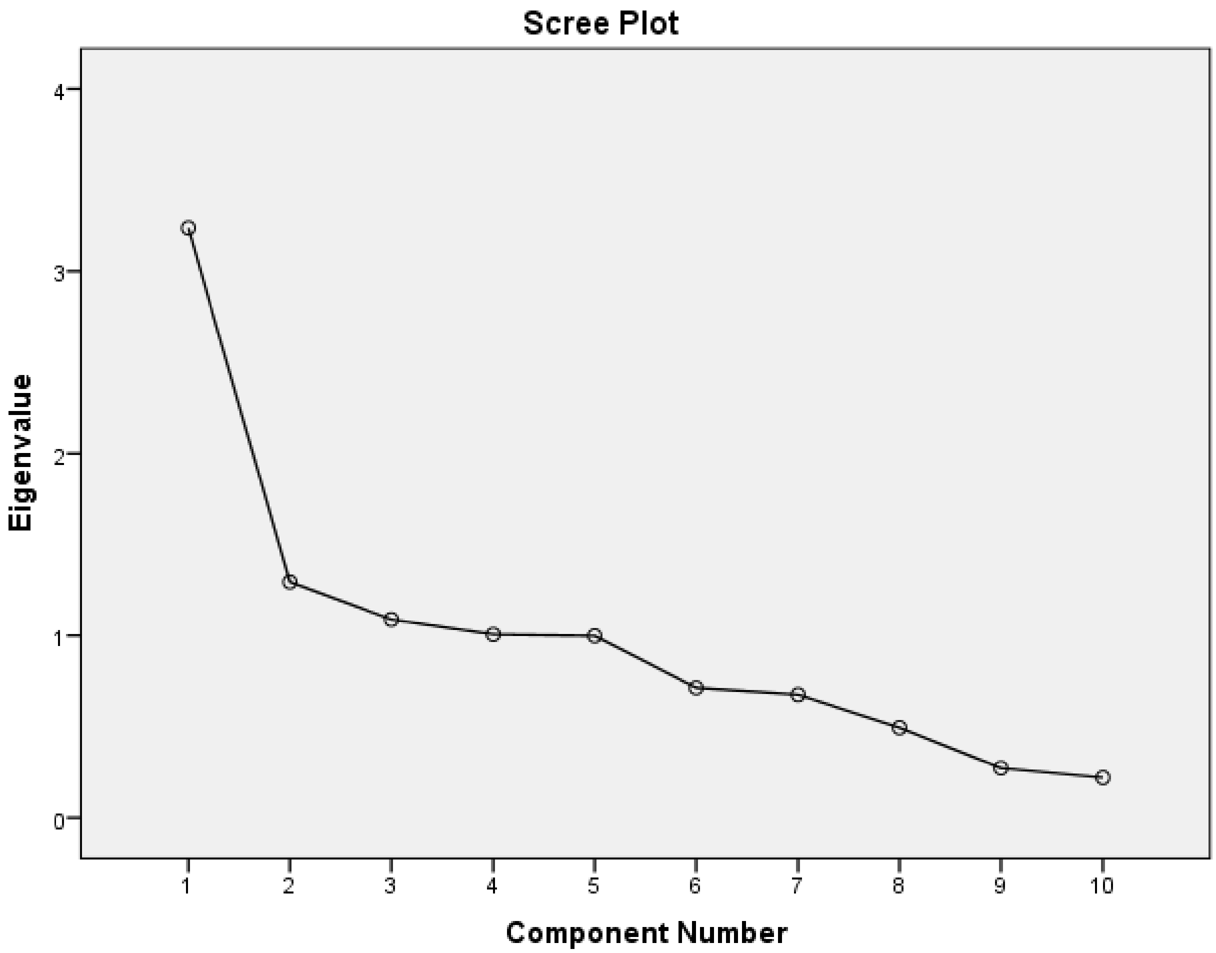


Figure 4.7: SPSS Output for Scree Plot for Item 3 of SMQ

The Scree plot Figure 4.7 plots four extracted factors with Feeling confident about the physics course (0.793), corresponding with component one, Wanting to apply my knowledge to solve practical problems (0.863), Feeling eager to learn the physics course (0.749) and Doubting my ability to learn physics (0.857) corresponding to component four in the component number axis. Happy (0.7896) and Excited (0.632) also correlated highly with component one but also correlated with other components.

Table 4.54: Component Score Coefficient Matrix For Item 3 of SMQ

	Component			
	1	**2**	**3**	**4**
FCPC	.375	-.252	.074	.007
FEPC	-.138	-.079	.626	-.104
DALP	.058	-.057	.009	.747
WSPP	-.153	.622	-.091	.034
H	.352	.173	-.342	-.040
E	.281	.052	-.192	-.102
FWT	-.303	.090	-.159	-.388
F	-.167	.146	-.152	.271
UH	.032	-.363	-.038	.194
IP	-.103	.266	.507	.200

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization

Component Scores

4.10.4: Item Four SPSS Factor Analysis

The item placed before the students was 'drawing conclusions of the experiments done by me was…' and had the following factors:- stimulating, rewarding, time wasting, boring, useful, well organized, frustrating, fun, interesting, hard for the students to rate as SD – Strongly disagree, D- Disagree, U-undecided, A-agree, and SA- Strongly agree.

The mean, standard deviation and number of respondents' (N) who participated in answering the student motivation Questionnaire for item one are displayed in table 4.55. Looking at the mean, interesting with a mean of 4.38 is the most important variable that influences students' motivation in electrical circuit's lesson when "drawing conclusions of the experiments done by me was…" was responded to. The variables useful, well organized, and rewarding also had high means of 4.35, 4.29 and3.82 respectively. Boring had the lowest mean and also the standard deviation was low. Useful, well organized and interesting had the lowest standard deviations.

Table: 4.55.
Descriptive Statistics for SMQ Item 4

	N	Minimum	Maximum	Mean	Std. Deviation
Stimulating	77	1	5	3.57	1.473
Rewarding	78	1	5	3.82	1.297
Time wasting	77	1	5	1.66	1.131
Boring	76	1	5	1.58	1.010
Useful	77	1	5	4.35	.984
W.Organized	78	1	5	4.29	.941
Frustrating	76	1	5	2.32	1.397
Fun	77	1	5	3.77	1.376
Interesting	77	1	5	4.38	.918
Hard	78	1	5	1.99	1.264
Valid N (listwise)	70				

Source: SPSS Output for Field Data

The correlation matrix table: 4.56 display the correlation coefficients between a variable and every other variable in the item. The correlation coefficient between a variable and itself is 1 and thus the principal diagonal of the correlation matrix contains 1s. The determinant of the correlation matrix is 0.054 and is shown below the table.

Table: 4.56
Correlation Matrix for Item 4 Data

		ST	RD	TW	BR	UF	WO	FR	Fun	INT	Hard
Correlation	ST	1.000	.200	.019	-.174	-.120	.183	.047	.143	.140	-.301
	RD	.200	1.000	-.339	-.365	.260	.499	-.186	.214	.471	-.414
	TW	.019	-.339	1.000	.550	-.413	-.496	.408	-.342	-.458	.120
	BR	-.174	-.365	.550	1.000	-.147	-.457	.211	-.341	-.570	.318
	UF	-.120	.260	-.413	-.147	1.000	.192	-.298	.158	.236	-.085
	WO	.183	.499	-.496	-.457	.192	1.000	-.399	.314	.487	-.243
	FR	.047	-.186	.408	.211	-.298	-.399	1.000	-.257	-.383	.231
	Fun	.143	.214	-.342	-.341	.158	.314	-.257	1.000	.382	-.233
	INT	.140	.471	-.458	-.570	.236	.487	-.383	.382	1.000	-.390
	Hard	-.301	-.414	.120	.318	-.085	-.243	.231	-.233	-.390	1.000

a. Determinant = .054

Key: ST – Stimulating, RD –Rewarding, TW-Time Wasting, BR – Boring, UF Useful, WO – Well Organised, FR – Frustrating, INT - Interesting

The Kaiser- Meyer- Olkin (KMO) and Bartletts' test are shown in the table: 4.57. The KMO measures the sampling adequacy and has to be greater than 0.5 for satisfactory analysis to proceed. The KMO for students' motivation questionnaire item one is 0.799. In the same table, the Barletts test of sphericity is significant at 0.000, meaning its associated probability is less than 0.05 and hence the correlation matrix is not identity matrix.

Table : 4.57

KMO and Bartlett's Test for Item 4 Responses

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.799
Bartlett's Test of Sphericity	Approx. Chi-Square	188.681
	Df	45
	Sig.	.000

Source: SPSS Output of Field Data

Table: 4.58
Reproduced Correlations for Item 4 Variables

		ST	RD	TW	BR	UF	WO	FR	Fun	INT	Hard
Reproduced Correlation	ST	.609[a]	.311	.116	-.243	-.305	.180	.136	.154	.227	-.481
	RD	.311	.485[a]	-.400	-.501	.169	.494	-.296	.375	.534	-.447
	TW	.116	-.400	.668[a]	.483	-.514	-.530	.539	-.387	-.545	.191
	BR	-.243	-.501	.483	.531[a]	-.252	-.535	.367	-.403	-.573	.424
	UF	-.305	.169	-.514	-.252	.473[a]	.308	-.430	.217	.302	.041
	WO	.180	.494	-.530	-.535	.308	.547[a]	-.409	.410	.581	-.390
	FR	.136	-.296	.539	.367	-.430	-.409	.439[a]	-.297	-.417	.118
	Fun	.154	.375	-.387	-.403	.217	.410	-.297	.307[a]	.436	-.304
	INT	.227	.534	-.545	-.573	.302	.581	-.417	.436	.620[a]	-.437
	Hard	-.481	-.447	.191	.424	.041	-.390	.118	-.304	-.437	.503[a]

		ST	RD	TW	BR	UF	WO	FR	Fun	INT	Hard
Residual[b]	ST		-.111	-.098	.069	.184	.003	-.089	-.011	-.087	.180
	RD	-.111		.061	.136	.091	.006	.110	-.161	-.063	.033
	TW	-.098	.061		.067	.101	.034	-.131	.045	.087	-.071
	BR	.069	.136	.067		.105	.078	-.156	.062	.003	-.106
	UF	.184	.091	.101	.105		-.116	.132	-.059	-.066	-.126
	WO	.003	.006	.034	.078	-.116		.010	-.096	-.095	.147
	FR	-.089	.110	-.131	-.156	.132	.010		.040	.034	.114
	Fun	-.011	-.161	.045	.062	-.059	-.096	.040		-.054	.070
	INT	-.087	-.063	.087	.003	-.066	-.095	.034	-.054		.046
	Hard	.180	.033	-.071	-.106	-.126	.147	.114	.070	.046	

Extraction Method: Principal Component Analysis.

Key: ST – Stimulating, RD –Rewarding, TW-Time Wasting, BR – Boring, UF Useful, WO – Well Organised, FR – Frustrating, INT - Interesting

a. Reproduced communalities

b. Residuals are computed between observed and reproduced correlations. There are 34 (75.0%) no redundant residuals with absolute values greater than 0.05.

Table 4.59 of communalities shows how much the variance in the variables has been accounted for by the extracted factors. Useful accounted for 47.3%, Boring accounted for 53.1, fun 30.7%, Hard 50.3%, Interesting 62.0%, Rewarding 48.5% and Stimulating 60.9%.

Table 4.60 shows all the factors of item four of students' motivation questionnaire extractable from the analysis along with their Eigen values, the percent of variance attributable to each factor, and the cumulative variance of the factor and the previous factors. There are two extractable factors in item four with factor one accounting for 37.705%, and factor two accounting for 14.136%. All other factors account for less than 10.0% and are discarded for having initial Eigen values of less than 1.

The scree plot is a graph of eigenvalues against all the factors. The graph is useful for determining the number of factors to retain. Where the curve starts to flatten is the point of interest. The scree plot figure 4.8 indicates the curve starting to flatten between factor two and factor three. Factor three has eigenvalue of less than one and hence two factors were retained.

Table 4.61 shows the loadings of the ten variables on the two factors extracted. The higher the absolute value of the loading, the more the factor contributes to the variable. Variables rewarding, time wasting, boring, well organized and interesting show high absolute values with factor one. Stimulating and useful shows high absolute value for factor two while all other variables are below 0.400.

The rotated component matrix table 4.62 shows a reduction of factors on which the variables under investigation have high loading. Well organized, which was highly loaded for factor one in table 4.61 is now reduced in table 4.62 to 0.536. Interesting in table 4.61 is now reduced to 0.603 in table 4.62 and Time wasting in factor matrix is loaded high in the rotated component matrix table 4.62. Stimulating which was loaded high to factor two in factor matrix is now loaded high to factor one in the rotated component matrix. The new factors after rotation can be used as variables for further analysis.

Table 4.59:
Factor Variance with Variables in item 4 of the Student Questionnaire

	Initial	Extraction
Stimulating	1.000	.609
Rewarding	1.000	.485
Time wasting	1.000	.668
Boring	1.000	.531
Useful	1.000	.473
W. Organized	1.000	.547
Frustrating	1.000	.439
Fun	1.000	.307
Interesting	1.000	.620
Hard	1.000	.503

Extraction Method: Principal Component Analysis.

The variables stimulating, time wasting and interesting fitted very well with the factor solution as indicated in table 4.59. It is interesting the variables fun was lowest in the communalities table of variables. The students seeing fun in making conclusions from what they have done is interesting. The extraction in table 4.59 for item four variables indicate a positive correlation with all the variables aimed at assessing students' motivation in drawing conclusions of experiments done. 67.5% strongly agree that the ability to make conclusions on the results of the experiment is simulating. 90.9% also agree or strongly agree that the ability is useful and 71.79% see the exercise as rewarding.

Students' responses also reflected fun strongly though it had a correlation of 0.307 as indicated in table 4.59. The 61.84%, 84.42% and 51% of frustrating, time wasting and boring respectively strongly disagreeing or disagree may be due to students' misinterpretation of the Question they were answering.

Bordens and Abbott (2014) on questionnaire items state, "By offering only specific responses alternatives, restricted items control the participants'' range of responses. The responses made to restricted items are therefore easier to summarize and analyze than the responses made to open-ended items. However, the information that you obtain from restricted item is not as rich as the information from an open-ended item. Participants cannot qualify or otherwise elaborate on their responses. Also, you may fail to include an alternative that correctly describes the participants' opinion thus forcing the participant to choose an alternative that does not really fit."

Table 4.60:
Retained factors of Item 4 of the students' Questionnaire

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.771	37.705	37.705	3.771	37.705	37.705	2.623	26.229	26.229
2	1.414	14.136	51.841	1.414	14.136	51.841	2.561	25.612	51.841
3	.885	8.846	60.687						
4	.814	8.138	68.825						
5	.730	7.297	76.123						
6	.692	6.923	83.046						
7	.601	6.007	89.053						
8	.441	4.410	93.463						
9	.355	3.548	97.011						
10	.299	2.989	100.000						

Extraction Method: Principal Component Analysis

Two components with Eigenvalue of more than 1.0 and accounting for 51.841% explanation of information are shown in table 4.60. The Scree plot Figure 4.8 indicates the Eigenvalues of all the components and shows a steep drop after the second Eigenvalue. The component matrix Table 4.59 indicates the correlation of the extracted components and the original variables. The rotated component matrix Table 4.62 has made the factor more distinct by maximizing high correlations and minimizing low correlations. In regard to the ten dimensions to assess students' feelings on drawing conclusions of the experiments done by them, students expressed

Stimulation at 26.229% variance and usefulness at 25.612%. Giving students an opportunity to interpret experiment results must have made them feel they are constructing the physics concepts on electric current circuits. The resulting two component score variables are representative of, and can be used in place of, the ten original variables. According to Mayer as cited by Owoeye, Pius Olatunji (2016), the most effective advance organizers are those that: allow the students to generate all or most of the logical relationships in the material to be learnt; point out relationships between familiar and less familiar material; are relatively simple to learn; and are used in situations in which the learner would not spontaneously use them. Exposure of advance organizers before the lesson may have raised expectations of the students in learning electric current circuits.

Table 4.61:

Factor Matrix for Item 4 Students' Questionnaire

	Component	
	1	**2**
Stimulating	.234	.745
Rewarding	.665	.209
Time wasting	-.722	.383
Boring	-.722	-.100
Useful	.424	-.542
Well Organized	.740	.009
Frustrating	-.557	.358
Fun	.553	.032
Interesting	.785	.058
Hard	-.521	-.482

Extraction Method: Principal Component Analysis.

a. 2 Components extracted

Factor 2 has five variables, poorly correlated as indicated in table 4.61. It is interesting to note the factor boring is classified poorly correlated negatively with others like rewarding well organized, fun and interesting which are positively correlated.

Table 4.62:
Rotated Component Matrix for Item 1 of the Students' Motivation Questionnaire

	Component	
	1	**2**
Stimulating	.687	-.370
Rewarding	.622	.315
Time wasting	-.250	-.778
Boring	-.587	-.432
Useful	-.075	.684
W. Organized	.536	.510
Frustrating	-.150	-.645
Fun	.419	.363
Interesting	.603	.507
Hard	-.709	-.018

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization

a. Rotation converged in 3 iterations.

Table 4.62 shows, stimulation and useful as the variables highly correlated with factor 1 and 2. These variables indicate the motivation of students when they are able to draw conclusion of the experiment they have done.

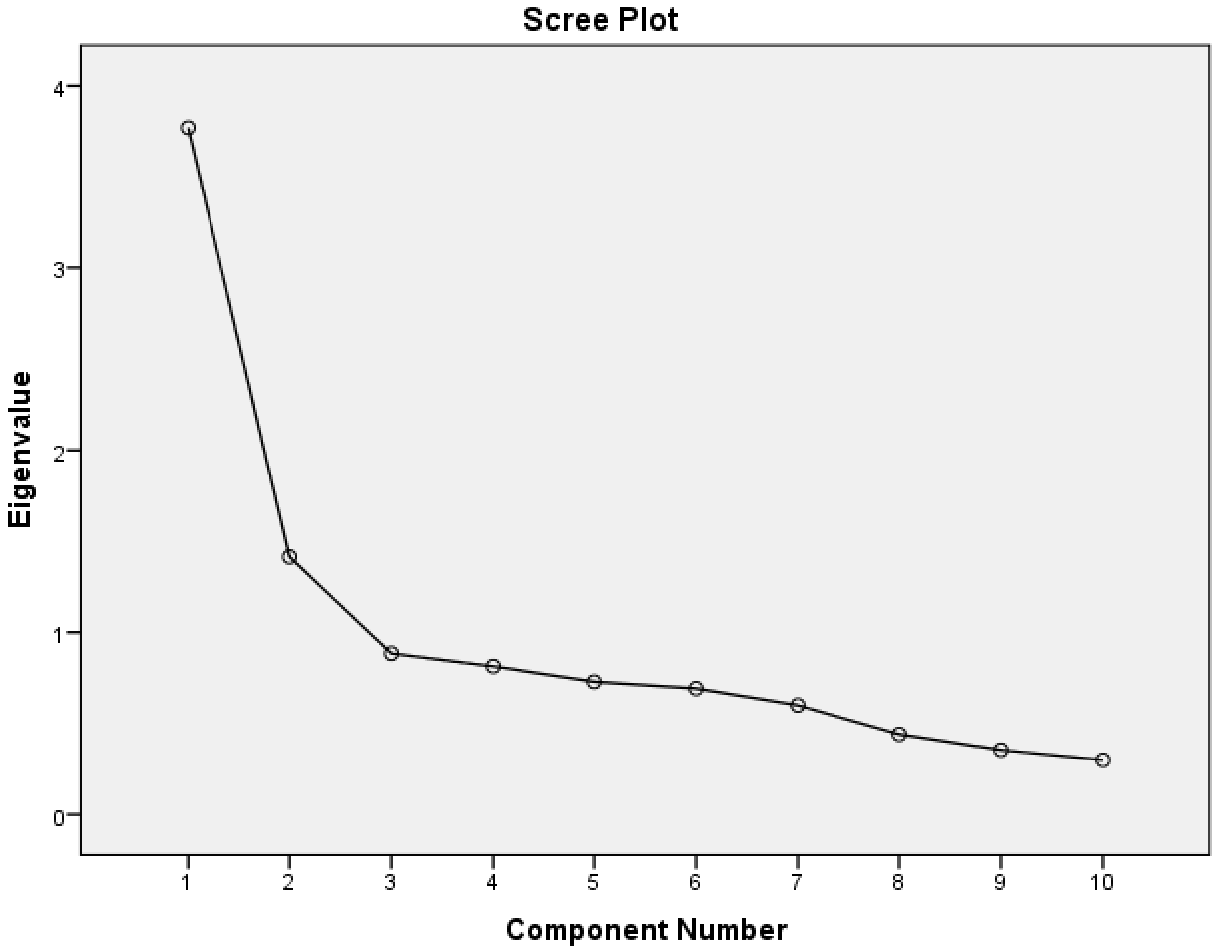


Figure 4.8: SPSS Output for Scree Plot for Item 4 of SMQ

Table 4.62, Rotated Component Matrix shows component one is highly correlated with stimulating (0.687), Rewarding (0.622), Well organized (0.536), Fun (0.419),boring (-.587), hard (-.709) and Interesting (0.603). Stimulating is plotted on the Scree plot as corresponding with component number 1 for it is least correlated with component two. Of the five factors,

Rewarding, Useful, Well organized, Fun and Interesting which are highly correlated with component two, Useful, which is least correlated with component one was extracted to represent the rest.

Table 4.63:
Component Score Coefficient Matrix For Item 4 of SMQ

	Component	
	1	**2**
Stimulating	.412	-.334
Rewarding	.229	.017
Time wasting	.052	-.328
Boring	-.186	-.083
Useful	-.187	.353
W. Organized	.145	.132
Frustrating	.071	-.284
Fun	.121	.086
Interesting	.178	.116
Hard	-.337	.148

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization

Component Scores

4.10.5 Item Five SPSS Factor Analysis

The item placed before the students was 'the practical lessons that I was exposed to before physics lessons were…' the following factors:- stimulating, rewarding, time wasting, boring, useful, well organized, frustrating, fun, interesting, and hard for the students were for the students to rate as SD – Strongly disagree, D-Disagree, U-undecided, A-agree, and SA- Strongly agree

The mean, standard deviation and number of respondents' (N) who participated in answering the student motivation Questionnaire for item five are displayed in Table 4.64. Looking at the mean, useful with a mean of 4.40 is the most important variable that influences students' motivation in electrical circuits lesson when "the practical lessons that I was exposed to before the physics lessons were…" was administered. Other variables that reflect significance to the statement include, stimulating, rewarding, and interesting. Variables timewasting, fear, not enjoyable, doubt and embarrassing had means less than three.

Table: 4.64
Descriptive Statistics for SMQ Item 5

	N	Minimum	Maximum	Mean	Std. Deviation
Stimulating	78	1	5	3.42	1.499
Rewarding	77	1	5	3.90	1.199
Timewasting	78	1	5	1.54	1.101
Fearful	78	1	5	2.12	1.319
Useful	78	1	5	4.40	.972
Interesting	77	1	5	4.26	.909
Not enjoyable	77	1	5	1.70	1.065
Doubtful	77	1	5	2.12	1.181
Embarrassing	78	1	5	1.99	1.304
Valid N (listwise)	74				

Source: SPSS Output for Field Data

The correlation matrix table 4.65 displays the correlation coefficients between a variable and every other variable in the item. The correlation coefficient between a variable and itself is 1 and thus the principal diagonal of the correlation matrix contains 1s. Useful and interesting, timewasting and not enjoyable, reward and interesting, and also fear and doubt have positive correlation while timewasting and reward have negative correlation. The determinant of the correlation matrix is 0.150 and is shown below the table.

Table: 4.65
Correlation Matrix for Item 5 Data

		ST	RW	TW	FF	UF	INT	NEJ	DTF	EMB
Correlation	ST	1.000	.091	-.002	-.121	.019	.165	-.099	.031	-.054
	RW	.091	1.000	-.491	-.212	.370	.407	-.332	-.163	-.213
	TW	-.002	-.491	1.000	.188	-.062	-.232	.410	.323	.234
	FF	-.121	-.212	.188	1.000	-.157	-.212	.301	.555	.162
	UF	.019	.370	-.062	-.157	1.000	.398	-.285	-.124	.004
	INT	.165	.407	-.232	-.212	.398	1.000	-.350	-.116	-.361
	NE	-.099	-.332	.410	.301	-.285	-.350	1.000	.301	.222
	DTF	.031	-.163	.323	.555	-.124	-.116	.301	1.000	.157
	EMB	-.054	-.213	.234	.162	.004	-.361	.222	.157	1.000

a. Determinant = .150

Key : ST- Stimulating, RW-Rewarding, TW-Time Wasting, FF-Fearful, UF- Useful, INT-Interesting, NEJ- Not enjoyable, DTF- Doubtful, EMB-Embarrassing

The Kaiser- Meyer- Olkin (KMO) and Bartletts' test are shown in the table: 4.66. The KMO measures the sampling adequacy and has to be greater than 0.5 for satisfactory analysis to proceed. The KMO for students' motivation questionnaire item one is 0.673. In the same table, the Barletts test of sphericity is significant at 0.000, meaning its associated probability is less than 0.05 and hence the correlation matrix is not identity matrix.

Table : 4.66

KMO and Bartlett's Test for Item 5 Responses

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.673
Bartlett's Test of Sphericity	Approx. Chi-Square	130.990
	Df	36
	Sig.	.000

Source: SPSS Output of Field Data

Table:4.67
Reproduced Correlations for Item 5 Variables

		ST	RW	TW	FF	UF	INT	NEJ	DTF	EMB
Reproduced	ST	.800[a]	-.009	.197	-.223	.037	.331	-.076	.055	-.234
Correlation	RW	-.009	.626[a]	-.494	-.158	.474	.556	-.486	-.169	-.318
	TW	.197	-.494	.668[a]	.226	-.071	-.320	.451	.364	.470
	FF	-.223	-.158	.226	.773[a]	-.181	-.179	.395	.725	.114
	UF	.037	.474	-.071	-.181	.830[a]	.473	-.345	-.088	.184
	INT	.331	.556	-.320	-.179	.473	.645[a]	-.441	-.061	-.351
	NEJ	-.076	-.486	.451	.395	-.345	-.441	.482[a]	.393	.301
	DTF	.055	-.169	.364	.725	-.088	-.061	.393	.791[a]	.117
	EMB	-.234	-.318	.470	.114	.184	-.351	.301	.117	.642[a]

		ST	RW	TW	FF	UF	INT	NEJ	DTF	EMB
Residual[b]	ST		.100	-.199	.102	-.018	-.166	-.023	-.024	.180
	RW	.100		.003	-.054	-.104	-.148	.153	.006	.105
	TW	-.199	.003		-.038	.009	.088	-.040	-.041	-.236
	FF	.102	-.054	-.038		.023	-.033	-.094	-.170	.048
	UF	-.018	-.104	.009	.023		-.075	.060	-.037	-.180
	INT	-.166	-.148	.088	-.033	-.075		.092	-.055	-.010
	NEJ	-.023	.153	-.040	-.094	.060	.092		-.092	-.079
	DTF	-.024	.006	-.041	-.170	-.037	-.055	-.092		.040
	EMB	.180	.105	-.236	.048	-.180	-.010	-.079	.040	

Extraction Method: Principal Component Analysis.

a. Reproduced communalities

b. Residuals are computed between observed and reproduced correlations. There are 21 (58.0%) nonredundant residuals with absolute values greater than 0.05.

Key: ST- Stimulating, RW-Rewarding, TW-Time Wasting, FF-Fearful, UF- Useful, INT-Interesting, NEJ- Not enjoyable, DTF- Doubtful, EMB-Embarrassing

Table 4.68 of communalities shows how much the variance in the variables has been accounted for by the extracted factors. Useful accounted for 83.0%, Reward accounted for 62.6%, Fear 77.3%, Doubt 79.1%, Not enjoyable 48.2%, Stimulating 80.0% and Embarrassing 64.6%.

Table 4.69 shows all the factors of item five of students' motivation questionnaire extractable from the analysis along with their Eigen values, the percent of variance attributable to each factor, and the cumulative variance of the factor and the previous factors. There are four extractable factors in item five with factor one accounting for 32.189%, factor two accounting for 14.133%, factor three accounting for 11.626%, and factor four accounting for 11.575% . All other factors are not significant and have initial Eigen values of less than 1.

The scree plot is a graph of eigenvalues against all the factors. The graph is useful for determining the number of factors to retain. Where the curve starts to flatten is the point of interest. The scree plot figure 4.9 indicates the curve starting to flatten between factor three and factor four. Both factor three and four have eigenvalue of greater than one and hence four factors were retained. Table 4.70 shows the loadings of the nine variables on the four factors extracted. The higher the absolute value of the loading, the more the factor contributes to the variable. Reward, Time wasting, Fear, Interesting and Not enjoyable have high absolute values with factor one. Doubt and Fear with factor two, Useful and Time wasting with factor three and Stimulating with factor four.

The rotated component matrix table 4.71 shows a reduction of factors on which the variables under investigation have high loading. Informative, this was highly loaded for factor one in table 4.70 is now reduced in table 4.71.Reward,Time wasting, Fear, Interesting, Not enjoyable, Doubt and Embarrassing that were highly loaded to factor one have been reduced in value in table 4.71.The value of Useful increased from -.482 in factor matrix to .881 in rotated component matrix. Useful and interesting reduced value while Fear and Doubt increased value from factor matrix to rotated component matrix for factor two. In factor three, time wasting gained in value while useful reduced value. Stimulating gained value in rotated component matrix. The new factors after rotation can be used as variables for further analysis.

Table :4.68
Factor Variance with Variables in item 5 of the Students' Questionnaire

	Initial	Extraction
Stimulating	1.000	.800
Rewarding	1.000	.626
Time wasting	1.000	.668
Fearful	1.000	.773
Useful	1.000	.830
Interesting	1.000	.645
Not enjoyable	1.000	.482
Doubtful	1.000	.791
Embarrassing	1.000	.642

Extraction Method: Principal Component Analysis.

The not enjoyable variables had low variance with the factor solution as indicated in table 4.68. Though the students found the practical lesson stimulating and useful, there was fear and embarrassment for students were probably not sure on whether the practical results would interpret the theory of the topic correctly.

Table: 4.69
Retained Factors of Item 5 of the Students' Questionnaire

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.897	32.189	32.189	2.897	32.189	32.189	1.841	20.454	20.454
2	1.272	14.133	46.322	1.272	14.133	46.322	1.694	18.818	39.272
3	1.046	11.626	57.948	1.046	11.626	57.948	1.642	18.245	57.518
4	1.042	11.575	69.523	1.042	11.575	69.523	1.081	12.006	69.523
5	.864	9.601	79.124						
6	.649	7.206	86.330						
7	.455	5.060	91.390						
8	.445	4.943	96.333						
9	.330	3.667	100.000						

Extraction Method: Principal Component Analysis

Four components with Eigenvalue of more than 1.0 and accounting for 69.523% explanation of information are shown in table 4.69. The Scree plot Figure 4.9 indicates the Eigenvalues of all the components and shows a steep drop after the fourth Eigenvalue. The component matrix Table 4.70 indicates the correlation of the four extracted components and the original variables. The rotated component matrix Table 4.71 has made the factors more distinct by maximizing high correlations and minimizing low correlations, e.g. Correlation of component 2 and the feeling about the practical lesson prior to the physics lesson is maximized to 0.847 from 0.522 in component matrix. In regard to the ten dimensions to assess students' feelings on exposure to practical lessons before the physics lesson, students expressed usefulness (20.454%), having fear (18.818%), being embarrassed (18.245%) and also being stimulated (12.006%). Mshenga (2013) states in her Master's thesis that "advance organizer strategy changes the classroom teaching approach from that dominated by the teacher‘s talk to that of student-student and student-teacher interactions. 'Introduction of the organizers before the lesson may have disoriented students from their 'normal' physics lesson practices. The resulting four component score variables are representative of, and can be used in place of, the ten original variables to explain the impact of introduction of advance organizers before the actual lesson.

Table: 4.70
Factor Matrix for Item 5 Students' Questionnaire

	Component			
	1	2	3	4
Stimulating	-.173	.247	.241	.806
Rewarding	-.691	.297	-.110	-.217
Time wasting	.633	.129	.458	.203
Fearful	.575	.522	-.356	-.207
Useful	-.482	.420	.547	-.349
Interesting	-.655	.447	.026	.126
Not enjoyable	.693	.014	.001	.050
Doubtful	.552	.675	-.173	.031
Embarrassing	.460	-.045	.557	-.345

Extraction Method: Principal Component Analysis.

Factor 1 in table 4.70 has four variables, stimulating, rewarding, useful and interesting highly negative correlated while time wasting, fearful, not enjoyable, doubtful and embarrassing are highly positive correlated. Factor 1 is a bipolar factor.

Table: 4.71
Rotated Component Matrix for Item 5 of the Students' Motivation Questionnaire

	Component			
	1	2	3	4
Stimulating	.057	-.053	-.032	.890
Rewarding	.636	-.080	-.457	-.072
Time wasting	-.214	.253	.695	.274
Fearful	-.126	.847	.053	-.191
Useful	.881	-.098	.209	-.012
Interesting	.630	-.022	-.384	.317
Not enjoyable	-.442	.371	.386	-.021
Doubtful	-.036	.868	.149	.121
Embarrassing	.029	.038	.765	-.235

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization

a. Rotation converged in 5 iterations.

The variables useful, fearful, time wasting and stimulating are highly correlated with the factors 1, 2, 3 and 4 respectively. The factor variables describe the students' situation while they are not able to relate their current activities with what is to come. The practical lessons were presented to students before the lesson was taught.

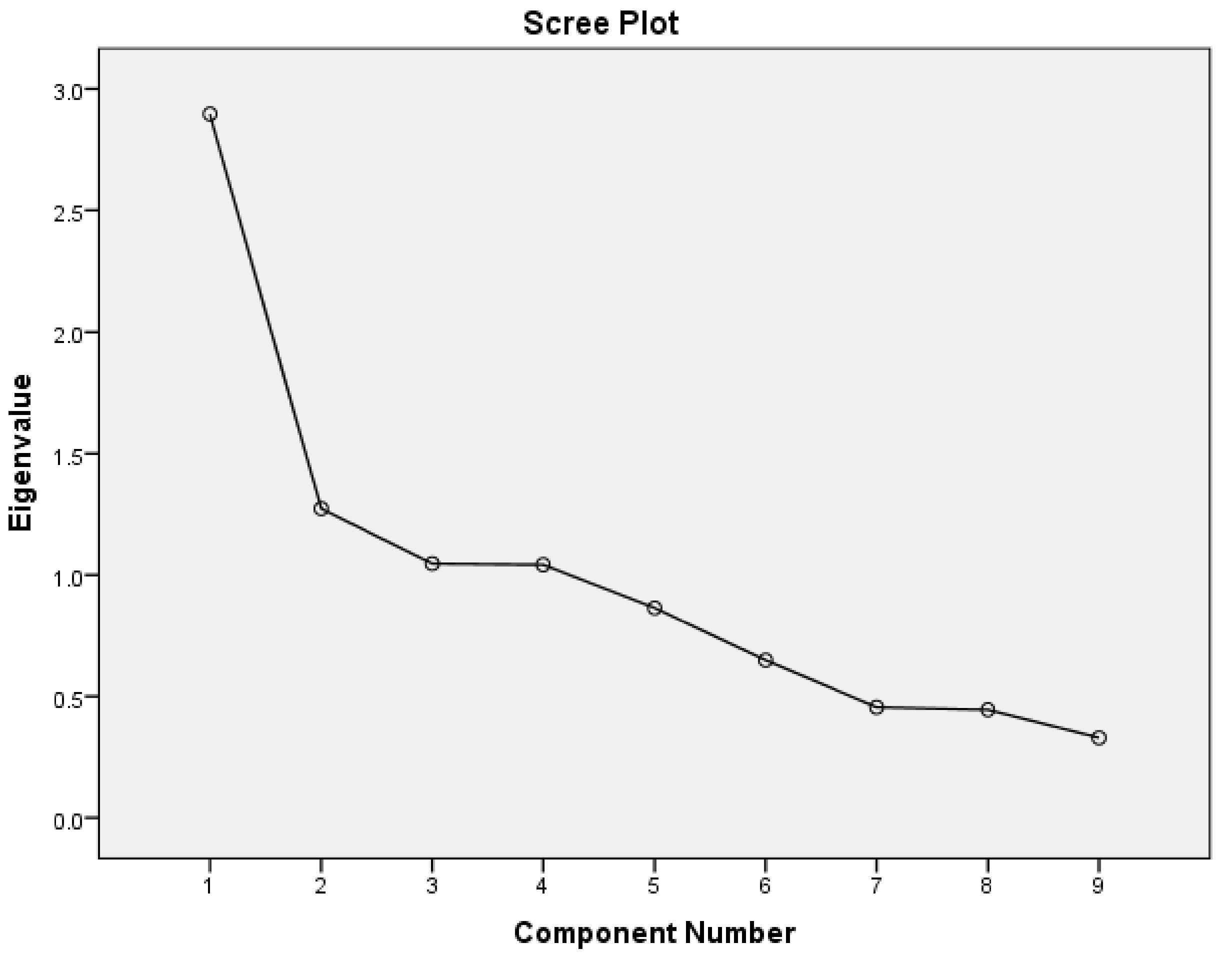


Figure 4.9: SPSS Output for Scree Plot for Item 5 of SMQ

The rotated component matrix helps determine what the component represents. The first component is most highly correlated. Component four is highly correlated with stimulating and component 1 is highly correlated with useful. Other factors correlated with component one are rewarding and interesting while fearful, not enjoyable and doubtful correlate highly with component two. Time wasting, not enjoyable and embarrassing are all related with component three while stimulating and interesting are correlated with component four. The highest correlated of the factors in component 1 is plotted corresponding with one on the component number axis.

Table: 4.72
Component Score Coefficient Matrix For Item 5 of SMQ

	Component			
	1	2	3	4
Stimulating	-.037	-.027	.030	.831
Rewarding	.316	.108	-.196	-.127
Time wasting	.024	.022	.445	.297
Fearful	.048	.557	-.145	-.172
Useful	.618	.007	.369	-.064
Interesting	.309	.132	-.137	.241
Not enjoyable	-.160	.130	.129	.023
Doubtful	.110	.564	-.046	.118
Embarrassing	.208	-.106	.571	-.195

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization

Component Scores

4.10.6 Item Six SPSS Factor Analysis

The item placed before the students was ‘Learning physics through experiments in groups and applying the knowledge to real life situation made me…’ the following factors:- Feel confident about Physics course, feel eager to learn Physics course, doubt my ability to learn Physics, want to apply my knowledge to solve practical problems, happy, excited, feel as if I was wasting my time, frustrated, unhappy, interested in Physics course, hard for the students to rate as SD – Strongly disagree, D-Disagree, U-undecided, A-agree, and SA- Strongly agree

The mean, standard deviation and number of respondents' (N) who participated in answering the student motivation Questionnaire for item six are displayed in Table 4.73.Looking at the mean, Interested in physics with a mean of 4.32 is the most important variable that influences students' motivation in electrical circuit's lesson when the "Learning physics through experiments in groups and applying the knowledge to real life situation made me …" was placed before the students. Feel confident about the physics course, want to apply my knowledge to solve practical problems, happy and excited also had a high mean. Unhappy with the lowest mean also had the lowest standard deviation.

Table: 4.73
Descriptive Statistics for SMQ Item 6

	N	Minimum	Maximum	Mean	Std. Deviation
FCPC	77	1	5	4.21	1.218
FEPC	77	1	5	3.38	1.606
DALP	73	1	5	2.29	1.409
WSPP	77	1	5	4.23	1.025
H	75	1	5	4.11	1.034
E	72	1	5	3.93	1.226
FWT	73	1	5	1.52	.944
F	77	1	5	1.87	1.080
UH	78	1	5	1.63	.927
IP	78	1	5	4.32	1.111
Valid N (listwise)	60				

Source: SPSS Output for Field Data

The correlation matrix table 4.74 displays the correlation coefficients between a variable and every other variable in the item. The correlation coefficient between a variable and itself is 1 and thus the principal diagonal of the correlation matrix contains 1s. The determinant of the correlation matrix is 0.109 and is shown below the table.

Table: 4.74
Correlation Matrix for Item 6 Data

		FCPC	FEPC	DALP	WSPP	H	E	FWT	F	UH	IP
Correlation	FCPC	1.000	.270	-.260	.051	.245	.161	-.089	-.136	-.243	.482
	FEPC	.270	1.000	.102	-.056	-.024	.038	.144	-.087	.028	.243
	DALP	-.260	.102	1.000	-.047	-.230	-.008	.349	.283	.434	-.261
	WSPP	.051	-.056	-.047	1.000	.338	.105	-.328	-.259	-.082	.322
	H	.245	-.024	-.230	.338	1.000	.397	-.501	-.247	-.284	.445
	E	.161	.038	-.008	.105	.397	1.000	-.153	-.174	.048	.133
	FWT	-.089	.144	.349	-.328	-.501	-.153	1.000	.403	.353	-.263
	F	-.136	-.087	.283	-.259	-.247	-.174	.403	1.000	.291	-.201
	UH	-.243	.028	.434	-.082	-.284	.048	.353	.291	1.000	-.241
	IP	.482	.243	-.261	.322	.445	.133	-.263	-.201	-.241	1.000

a. Determinant = .109

The Kaiser- Meyer- Olkin (KMO) and Bartletts' test are shown in table 4.75. The KMO measures the sampling adequacy and has to be greater than 0.5 for satisfactory analysis to proceed. The KMO for students' motivation questionnaire item one is 0.710. In the same table, the Barletts test of sphericity is significant at 0.000, meaning its associated probability is less than 0.05 and hence the correlation matrix is not identity matrix.

Table : 4.75

KMO and Bartlett's Test for Item 6 Responses

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.710
Bartlett's Test of Sphericity	Approx. Chi-Square	121.718
	Df	45
	Sig.	.000

Source: SPSS Output of Field Data

Table: 4.76

Reproduced Correlations for Item 6 Variables

		FCPC	FEPC	DALP	WSPP	H	E	FWT	F	UH	IP
Reproduced	FCPC	.660[a]	.510	-.285	.043	.265	.119	-.085	-.205	-.304	.588
Correlation	FEPC	.510	.611[a]	.090	-.111	.004	.108	.276	.072	.071	.379
	DALP	-.285	.090	.634[a]	-.068	-.238	.156	.431	.358	.635	-.286
	WSPP	.043	-.111	-.068	.443[a]	.505	.402	-.429	-.293	-.069	.254
	H	.265	.004	-.238	.505	.656[a]	.451	-.552	-.425	-.245	.477
	E	.119	.108	.156	.402	.451	.500[a]	-.223	-.169	.149	.296
	FWT	-.085	.276	.431	-.429	-.552	-.223	.658[a]	.460	.429	-.289
	F	-.205	.072	.358	-.293	-.425	-.169	.460	.354[a]	.361	-.324
	UH	-.304	.071	.635	-.069	-.245	.149	.429	.361	.637[a]	-.303
	IP	.588	.379	-.286	.254	.477	.296	-.289	-.324	-.303	.630[a]
Residual[b]	FCPC		-.240	.024	.008	-.020	.041	-.005	.069	.061	-.106

FEPC	-.240		.012	.056	-.027	-.071	-.132	-.159	-.043	-.136
DALP	.024	.012		.020	.008	-.164	-.083	-.075	-.201	.025
WSPP	.008	.056	.020		-.167	-.298	.101	.034	-.013	.068
H	-.020	-.027	.008	-.167		-.054	.050	.178	-.038	-.032
E	.041	-.071	-.164	-.298	-.054		.069	-.005	-.100	-.163
FWT	-.005	-.132	-.083	.101	.050	.069		-.057	-.077	.025
F	.069	-.159	-.075	.034	.178	-.005	-.057		-.070	.122
UH	.061	-.043	-.201	-.013	-.038	-.100	-.077	-.070		.062
IP	-.106	-.136	.025	.068	-.032	-.163	.025	.122	.062	

Extraction Method: Principal Component Analysis.

a. Reproduced communalities

b. Residuals are computed between observed and reproduced correlations. There are 28 (62.0%) nonredundant residuals with absolute values greater than 0.05.

Table 4.77 of communalities shows how much the variance in the variables has been accounted for by the extracted factors. Feel confident about the physics course accounted for 66.0%, Feel eager to learn the physics course accounted for 61.1%, Doubt my ability to learn physics accounted for 63.4%, Want to apply my knowledge to solve practical problems accounted for 44.3%, Happy accounted for 65.6%, Excited accounted for 50.0%, Feel as if I was wasting time accounted for 65.8%, Frustrated accounted for 35.4%, Unhappy accounted for 63.7% and Interested in physics accounted for 63.0%. Table 4.78 shows all the factors of item six of students' motivation questionnaire extractable from the analysis along with their Eigen values, the percent of variance attributable to each factor, and the cumulative variance of the factor and the previous factors. There are three extractable factors in item six with factor one accounting for

30.413%, factor two accounting for 14.527%, and factor three accounting for 12.909%. All other factors are not significant and have initial Eigen values of less than 1.

The scree plot is a graph of eigenvalues against all the factors. The graph is useful for determining the number of factors to retain. Where the curve starts to flatten is the point of interest. The scree plot figure 4.10 indicates the curve starting to flatten between factor four and factor five. Both factors four and five have eigenvalue of less than one and hence three factors were retained.

Table 4.79 shows the loadings of the ten variables on the three factors extracted. The higher the absolute value of the loading, the more the factor contributes to the variable. Factor one has seven variables with more than absolute value of 0.500.Factor two has two variables with Absolute value of more than 0.500 and factor three has three variables with value of more than 0.500.

The rotated component matrix table 4.80 shows a reduction in number, value or elimination of variables under investigation that had high loading with factors one, two or three. Variables feel confident about the physics course and doubt have been eliminated from factor one in the rotated component matrix with values reduced to 0.090 and -0.020 respectively. Also, the variables feel confident about the physics course and feel eager to learn the physics course have been replaced in factor two. The new factors after rotation can be used as variables for further analysis.

Table: 4.77

Factor Variance with Variables in item 6 of the Students' Questionnaire

	Initial	**Extraction**
FCPC	1.000	.660
FEPC	1.000	.611
DALP	1.000	.634
WSPP	1.000	.443
H	1.000	.656
E	1.000	.500
FWT	1.000	.658
F	1.000	.354
UH	1.000	.637
IP	1.000	.630

Extraction Method: Principal Component Analysis.

Key: FCPC-Feel confident about the physics course, FEPC-Feel eager to learn the physics course , DALP- Doubt my ability to learn physics ,WSPP- Want to apply my knowledge to solve practical problems, H- Happy, E- Excited, FWT – Feel as if I was wasting time, F - Frustrated, UH - Unhappy, IP – Interested in physics.

The communalities in this table 4.77 are all high (above 0.3), indicating that the extracted components represent the variables well. The students' responses reflect frustration in carrying out the experiments. This may be due to lack of exposure to experimental teaching. The responses indicate students would be more motivated if experiments engagement is put in place. They were happy and were feeling confident about the Physics although they doubted their ability as indicated in table 4.79.

Table: 4.78
Retained Factors of Item 6 of the Students' Questionnaire

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.041	30.413	30.413	3.041	30.413	30.413	2.086	20.864	20.864
2	1.453	14.527	44.940	1.453	14.527	44.940	2.062	20.621	41.485
3	1.291	12.909	57.850	1.291	12.909	57.850	1.636	16.364	57.850
4	.940	9.396	67.245						
5	.869	8.694	75.939						
6	.623	6.233	82.173						
7	.539	5.395	87.567						
8	.478	4.777	92.345						
9	.420	4.198	96.543						
10	.346	3.457	100.000						

Extraction Method: Principal Component Analysis

Three components with Eigenvalue of more than 1.0 and accounting for 57.850% explanation of information are shown. The Scree plot Figure indicates the Eigen values of all the components and shows a steep drop after the third Eigenvalue. The component matrix Table 4.79 indicates the correlation of the extracted components and the original variables. The rotated component matrix Table 4.80 has made the factors more distinct by maximizing high correlations and minimizing low correlations, e.g. Correlation of component 1 and feeling happy when working in groups is maximized to 0.748 from 0.359in component score coefficient matrix. In regard to the ten dimensions to assess students' feelings on learning physics through experiments in groups, students expressed happiness (20.864%), doubting ability to learn physics (20.621%) and feeling confident about physics course (16.364%). The doubting element is probably due to students' comparison of self and others as they execute group activities. Students show a desire to learn skills of cooperation in understanding the concepts being learnt. The resulting three component score variables are representative of, and can be used in place of, the ten original variables in explaining the usefulness of group activities as advance organizers in the learning of electric circuits in physics. Hudson and Keraro (2009) cite Curzon (1990) as stating that "Effects of the use of advance organizers on learning Research into the use of advance organizers suggests that they are of considerable value where the learner may not be able to recognize his or her prior knowledge as relevant and where the teacher wishes to focus students' attention on relationships among linked parts of an idea and on connections between parts and the whole.''

They further cite Ausubel (1968) stating that " The use of advance organizers proved interesting and stimulating since the learners were exposed to prior information that was to be learnt later.''

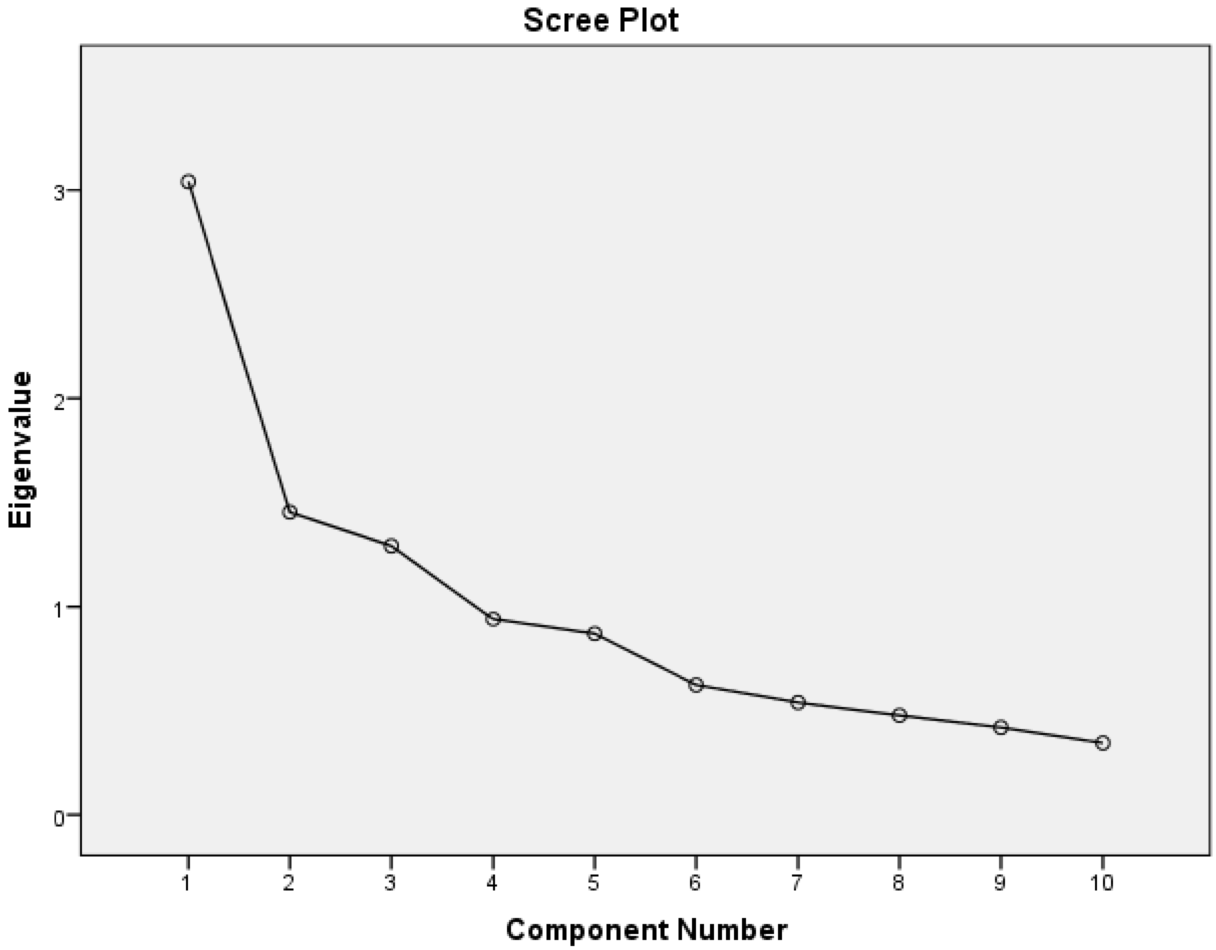


Figure 4.10:SPSS Output for Scree Plot for Item 6 of SMQ

Four factors, happy (0.748), want to apply my knowledge to solve problems (0.659),excited (0.648) and interested in Physics course (0.400) correlate high with component 1. Happy correlates least with all other component and hence was extracted to represent all others. Of the four factors correlating highly with component two, doubting my ability to learn Physics was extracted to represent others and feeling confident about Physics was extracted among the two highly correlated with component three.

Table: 4.79
Factor Matrix for Item 6 Students' Questionnaire

	Component		
	1	**2**	**3**
FCPC	.502	.593	-.237
FEPC	.071	.777	-.056
DALP	-.561	.205	.526
WSPP	.476	-.155	.439
H	.733	-.037	.343
E	.341	.152	.601
FWT	-.694	.413	-.081
F	-.577	.146	.009
UH	-.572	.182	.526
IP	.670	.427	.005

Extraction Method: Principal Component Analysis

a. 3 components extracted.

Factor 1 is a bipolar factor with four variables with a negative sign and five variables with a positive sign as shown in table 4.79. It is interesting to note that the variables "feeling eager to learn the physics" is not associated with the positive sign variables.

Table: 4.80
Rotated Component Matrix for Item 6 of the Students' Motivation Questionnaire

	Component		
	1	**2**	**3**
FCPC	.090	-.276	.759
FEPC	-.093	.192	.752
DALP	-.020	.791	-.085
WSPP	.659	-.074	-.048
H	.748	-.264	.164
E	.648	.231	.165
FWT	-.579	.547	.156
F	-.400	.436	-.064
UH	-.025	.790	-.110
IP	.400	-.284	.625

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization

a. Rotation converged in 5 iterations.

The rotated component matrix helps one to determine what the component represents. The first component is most highly correlated with happiness and the second component is highly correlated with doubting ability. Component three is highly correlated with feel confident about Physics course. The three variables describe the motivation created while students learn in groups.

Table: 4.81
Component Score Coefficient Matrix For Item 6 of SMQ

	Component		
	1	2	3
FCPC	-.075	-.086	.464
FEPC	-.084	.145	.510
DALP	.155	.443	.004
WSPP	.366	.086	-.098
H	.359	.010	.018
E	.401	.274	.063
FWT	-.235	.209	.194
F	-.135	.165	.027
UH	.155	.440	-.012
IP	.113	-.037	.347

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization

Component Scores

4.10.7: Summary and Discussion of Results

This study had two objectives and one research question. Independent test and ANOVA were used to test the hypothesis one and two while factor analysis was used to extract the underlying factors that accounted for the variables in each of the six items of the questionnaire to explain students' motivation orientation after having been exposed to the science process skills advance organizer.

The first hypothesis was to determine the effect of science process skills advance organizer on students' performance of electric circuits. The results indicated an improvement of the scores from the pretest scores for both boys and girls. The boys mean score of 5.467 at Pretest improved to 6.933 at post-test, an increase of 26.82%. The girls pretest scores improved from 4.462 at pretest to 5.026 at post-test, an increase of 12.64%. The results agree with Mayer (1977) who reported a series of studies supporting the positive but conditional effects of advance organizers. In this study the condition that might have contributed to the low results improvement might have been the lack of pre-requisite skills by both learners and teachers in the implementation of the advance organizer exposure despite the teachers having been trained before the experiment.

The second hypothesis was to determine the influence of the science process skills advance organizer by gender. The results indicated that both boys' and girls' performance was positively influenced by the Science Process Skills advance organizer but the effect was more pronounced on girls treated with the science process advance organizer than the girls not treated. Pearce, Rene'e Deanna (1997), in a study to explore the relationship between gender, learning orientation, self-confidence and achievement in high school Physics students stated that gender was not significant in predicting learning orientation or achievement.

The research question tried to determine whether the science process skills advance organizer had positive factors influencing students' motivation towards electric circuits in Physics. Students showed a dislike of the lesson where the teacher was dominant in the lesson and strongly indicated that the science process skills advance organizer gave them confidence, happiness, stimulation, and a desire to learn the physics course while engaging themselves in experimental activities and group collaborations. Item three of the questionnaire had the following factors as students' feelings towards doing the experiment themselves. Feeling confident 24.872%, applying learnt knowledge to solve practical problems, 16.17% and feeling eager to learn the Physics course, 13.551%. Students also said the exposed science process skills advanced organizer was useful, interesting and rewarding and made them eager to learn the physics course. From the findings, students are more inclined in participating in Physics lessons. Anusak H. (2006) in a PhD thesis states that instructors' beliefs influence teachings strategies whereas student's beliefs, goals and motivation influence learning strategies.

CHAPTER FIVE

SUMMARY, CONCLUSIONSAND RECOMMENDATIONS

5.1 Introduction

This chapter summarizes the major findings of the study, outlines the conclusions, gives the implications of the findings and suggests recommendations and areas of further investigations.

5.2 Summary of the findings

5.2.1 Research Hypothesis 1

There is no statistically significant difference exposed to science process skills advance organizer and those taught using conventional methods.

The analysis of the experiment group posttest and the control group posttest showed a significant difference in favor of the experiment group. The boys exposed to the science process skills advance organizer had their results more significant than the girls exposed in the same group.

5.2.2 Research Hypothesis 2

There is no statistically significant influence of science process skills advance organizer on performance of electric circuits in physics based on gender.

The girls exposed to the science process skills advance organizer had results significantly different from the girls not exposed. The results of the boys exposed to the advance organizer were not significantly different from the results of the boys not exposed to the advance organizer.

5.2.3 Research Hypothesis 3

There are no factors explaining students' motivation on electric current circuit on having been exposed to science process skills advance organizer.

Factor analysis tables, 4.33, 4.42, 4.52, 4.61, 4.70 and 4.79 indicate that students were able to describe their level of motivation on electric current circuit having been exposed to science process skills advance organizer. On the teacher domination in a physics lesson, the students' description with five solutions accounted for 66.352% with boring taking 16.002%. Students described working through an experiment as stressful (30.687%), an indication of less exposure to experimental activities in Physics lessons. A feeling of being confident in engaging in experiments was also expressed (24.872%). Students felt stimulated (26.229%) with the ability to make positive conclusions from science process skills advance organizer activities. Students found it useful (20.454%) to have been exposed to advance organizer activities before the Physics lesson, an indication of ability to connect the activities with the concepts being taught in the classroom. Working in groups during exposure of the science process skills advance organizer made the students happy (20.864%), an indication of students developing confidence in the learning of Physics.

5.2.4 Research Question

Are students motivated to learn electric circuit when exposed to Science Process skills advance organizer before the actual lesson?

The responses from all the six items of the questionnaire indicated that the students were motivated by the science process skills advance organizer towards learning electric circuits in physics. Students described science process skills as stimulating, useful, created confidence and made them happy.

Factor analysis was used to extract the underlying dimensions explaining the students' feeling status on each of the six statements in the SMQ. The successive factors extracted in factor analysis are not of equal strength and each successive factor account for less and less variance (Kenneth S.B et.al, 2014).The first extracted factor in each of the six statements strongly supported the use of science process skills advance organizer as a good strategy of teaching electric circuits in physics. The results indicated a positive change towards physics and the lesson. They were motivated towards physics. Ben Van Dusen (2014) in a PhD thesis stated 'Rather than viewing motivation as a property of the student, or viewing students as inherently interested or disinterested in physics, the theoretical perspective on motivation and identity helps examine features of the learning environments that determine how students' experience themselves through physics class.' The first factor for each of the statements in the SMQ are as follows: Boring (16.002%), Too stressful (30.68%), Feeling confident about the physics course (24.872%), Stimulating (26.9%), Usefulness (20.454%), and Happiness (20.864%).The student's motivation questionnaires were analyzed using the factor analysis to extract the most dominant responses for each of the six items.

5.3 Conclusions

From the findings of the study, Science process skills advance organizer has an effect in the learning of Physics and is gender dependent. Science process skills advance organizer motivates students towards learning of physics. The study findings indicates that science process skills advance organizer can motivate students towards learning physics and can improve on the teaching methods if teachers are inducted on their uses and can construct relevant advance organizers. Lack of teachers experience in administering experimental research in education was a challenge and needs to be addressed so that progressive teaching methods of Physics can be adopted to promote and motivate students towards learning Physics. The results of this study agree with Owoeye (2016) that advanced organizer teaching strategy significantly influences students' academic performance in Biology in senior secondary schools.

5.4 Recommendations

The following recommendations arise from this study;

i. Introduction of Science process skills Advance organizers to enhance the teaching and learning of Physics in Laikipia Central Sub County and to a large extent in Laikipia County and other counties in Kenya.

ii. Teachers are encouraged to be inducted in constructing relevant science process skills advance organizers for different topics in Physics.

iii. The Kenya Institute of Curriculum Development introduce seminars and workshops to help the teachers realize the power they have in shaping students' motivation through the construction of relevant science process skills advance organizers for effective teaching of physics in schools.

5.4.1 Policy Recommendation

Experts in science education and other subjects be encouraged for more research to identify effects of science process skills advance organizers for motivation of students in various subjects and topics of interest for better facilitation of learning and improvement of performance in physics and other subjects.

5.4.2 Recommendations for Further Research

Based on the findings of this study, the researcher recommends further investigation on:-

i) Science process skills advance organizer on other topics in Physics taught and examined the end of Secondary Education.
ii) How trainee teachers and those already in the field can be inducted on how to construct relevant and usable science process skills advance organizers for teaching physics.
iii) Further research is done to investigate the motivation orientation of students in physics.

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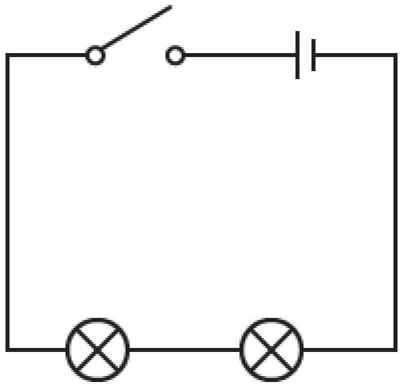
APPENDICES

Appendix I: Teacher Guide to Student Activities

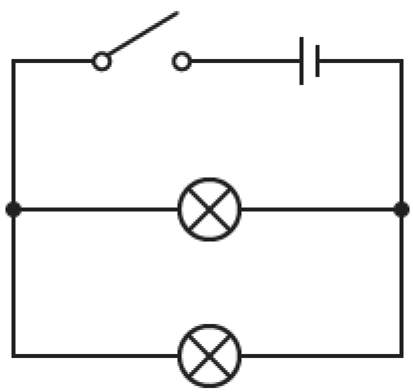
Topic	Exp.	Description	Activity	Science process skill(s)
Current Electricity	1	Circuit components	Identify and name circuit components e.g. switches, cells, resistors, connecting wires, ammeters, voltmeters etc.	1. Observing 2. Reading meter scales 3. Identify positive and negative cell terminals.
	2	Cell arrangements	1. Series 2. Parallel 3. In opposition	1. Record voltage reading for 1cell, 2 cells, 3 cells, 4 cells when connected in series and repeat when connected in parallel. 2. Record voltage for cells connected in opposition. 3. Communicate results of 1 & 2.
	3	Resistor arrangements	1. Series 2. Parallel	1. Read current through resistors connected in series and voltage across each resistor-comment on the differences when resistors are (a) of same value and (b) of different value.

				2. Repeat 1 when resistors are connected in parallel. 3. Predict current passing through resistors in parallel when values are in ratios of 1:2, 1:3 and 1:4.
			3.	
	4	Ohm's Law	1. Take current reading for up to five cells connected in series, Record corresponding voltages. 2. Draw a graph of voltage against current. 3. Find the slope of the graph.	1. Relationship of voltage and current. 2. Choosing correct graph scales.

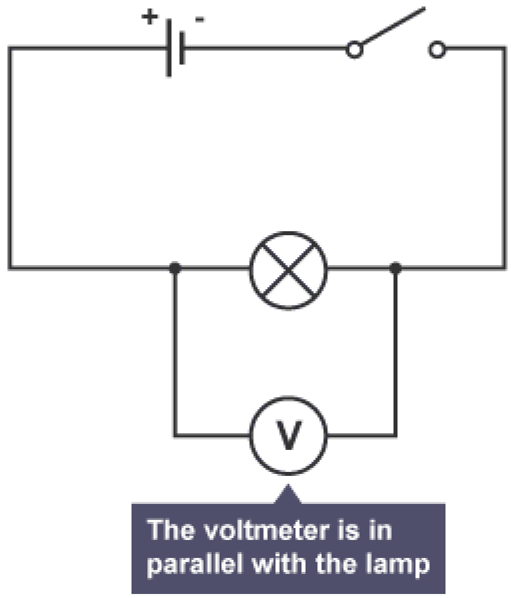
Diagrams For Students To Conceptualise Electrical Circuits And Component Arrangements

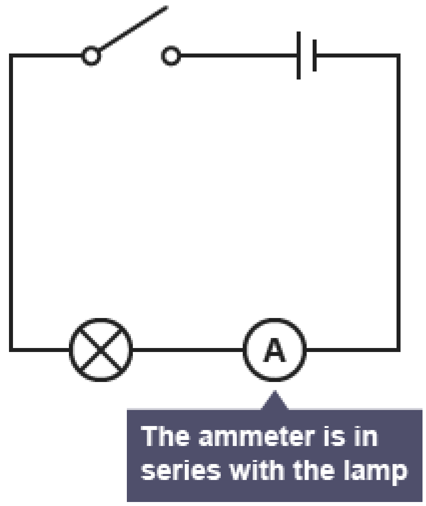


Two lamps connected in series with an open switch and a cell

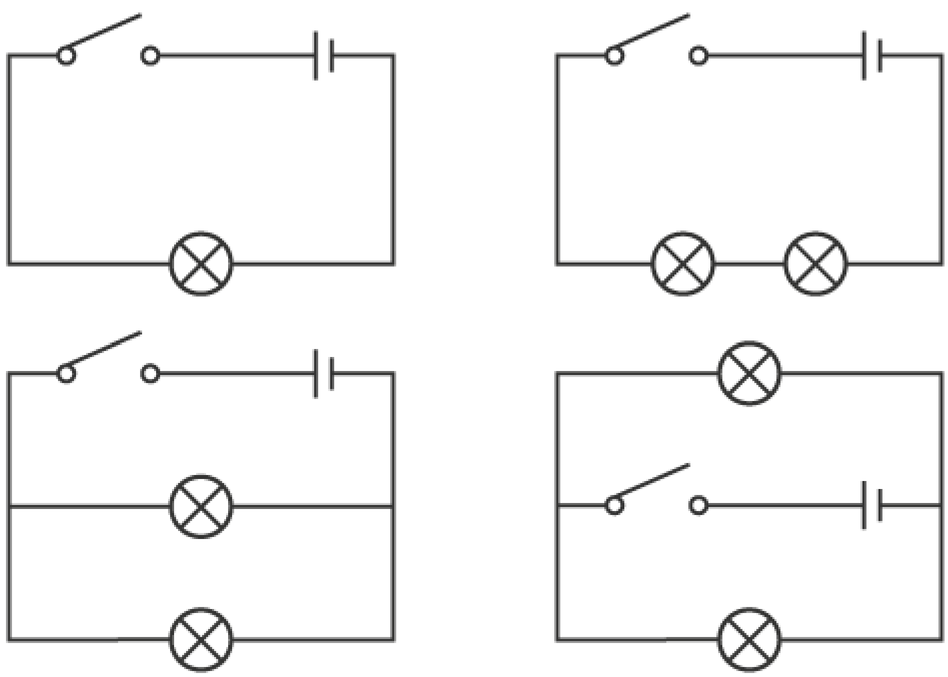


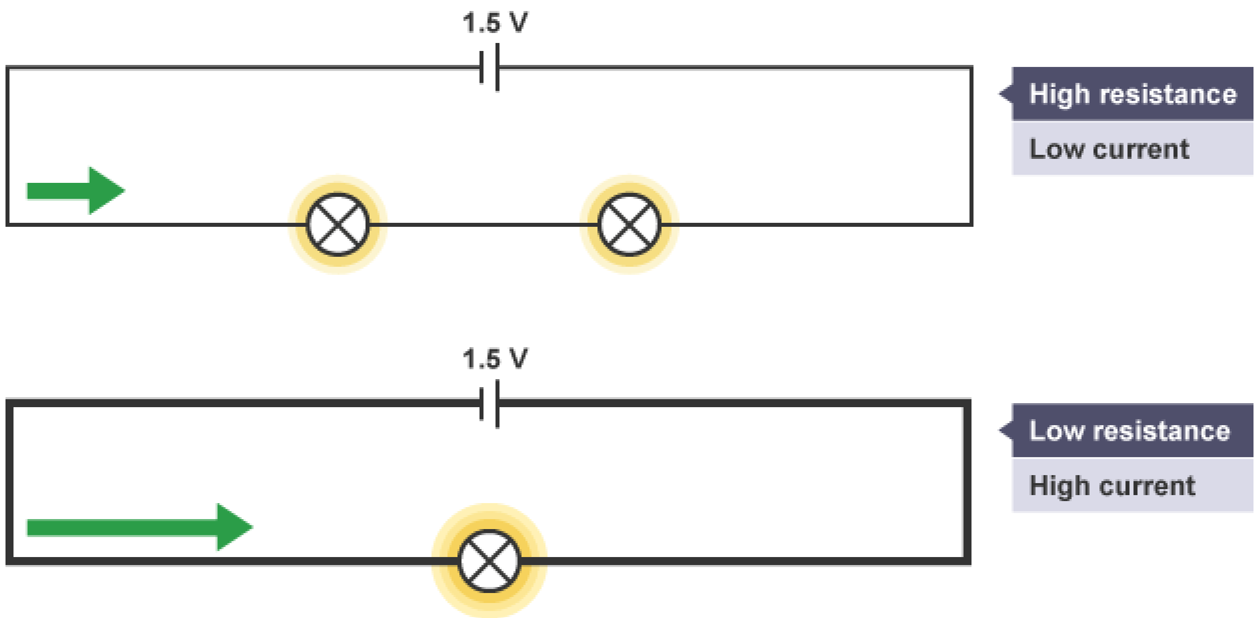
Two lamps connected in parallel with an open switch and a cell



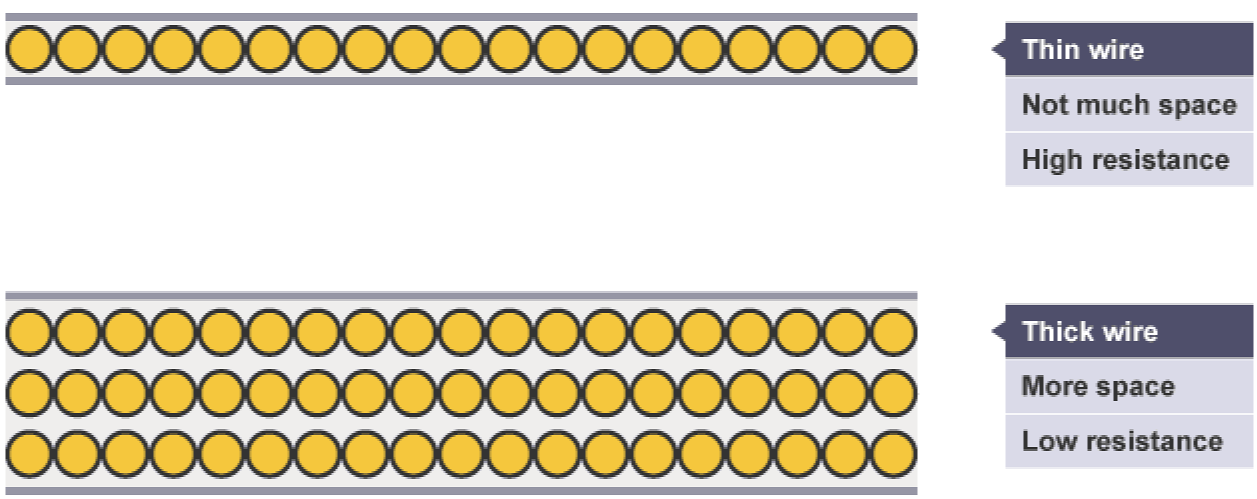


Which of the circuits here are connected in series, and which are connected in parallel?





Circuit with a cell, switch, lamp and ammeter connected in series



Cross-sections of thin and thick wires

Appendix II: Physics Achievement Test (PAT)

SCHOOL: _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

CLASS: _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ __

(Tick appropriately)

GENDER: MALE ☐

FEMALE ☐

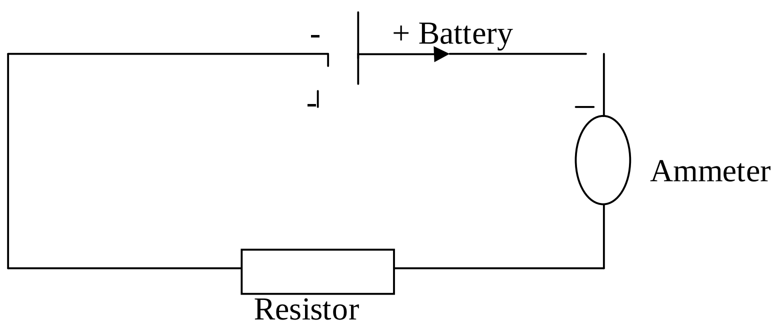
<u>INSTRUCTIONS</u>

This paper consists of three questions

Answer all questions by circling the correct answer

Read all questions carefully to ensure that you understand it before selecting your choice

1. Study the circuit diagram below and answer questions 1-3



Which of the following statements is true?

A. The amount of current flowing in the circuit is not affected by the power of the battery

B. As the power of the battery decreases, the amount of current flowing reduces.

C. The amount of the current flowing increases as the power of the battery reduces

D. None of the above

2. What would happen to the current flowing if the terminal of the battery is reversed?

A. The current would cease flowing

B. The same amount of current would flow in the opposite direction

C. The same amount of current would flow in the same direction

D. A smaller current would flow in the circuit

3. Which one of the following statement is **NOT** true?

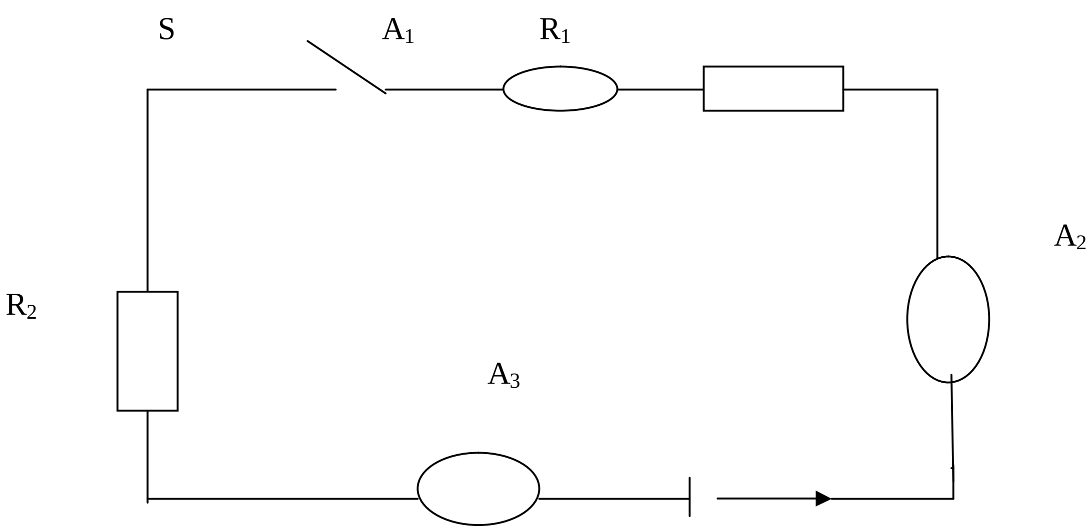
A. A higher resistor value reduces the amount of current flowing in the circuit

B. The resistor in the circuit offers a resistance of current flow

C. The resistor in the circuit stops current flowing in the circuit

The resistor in the circuit does not affect the current flowing in the circuit

4. Use the diagram below to answer questions 4-5



A_1 and A_2 are identical ammeters

R_1 is greater than R_2

What happens when the switch S, is closed

A. All ammeters give the same reading

B. The ammeter readings in A_1 and A_2 are the same but different from A_3

C. All ammeters give different readings

D. The reading on ammeters A_3 is higher than that of A_2

5. Which one of the following is **<u>NOT</u>** true?

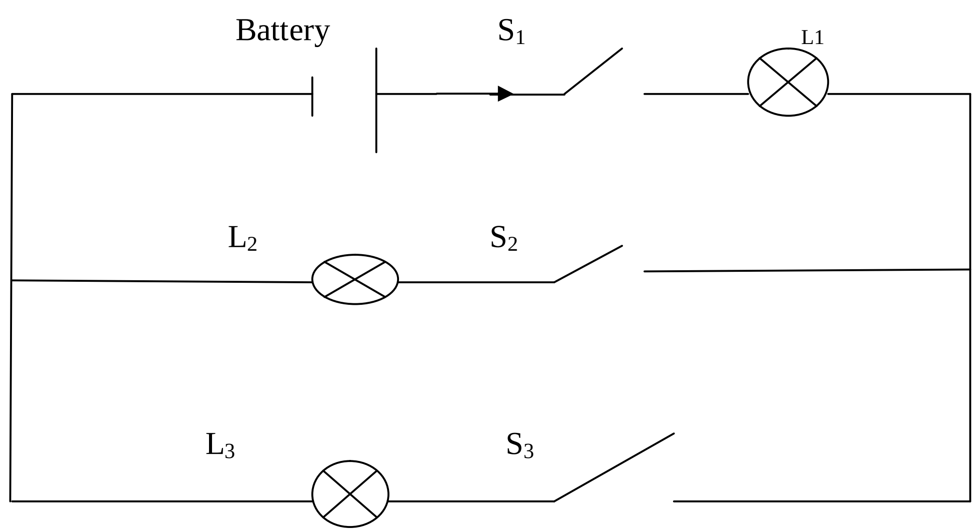
A. The energy required to drive current through R_1 is greater than that required to drive current.

B. The same energy is required to drive current through R_1 and R_2.

C. Negligible energy is required to drive current through the copper wires compared to that required to drive current through R_1 andR_2.

D. The energy of the battery would last longer if R_1 was removed from the circuit.

6. Study the diagram below and answer questions 6-8



S_1, S_2, and S_3 are identical switches

L_1, L_2, and L_3 are identical bulbs

What will happen when S_2 andS_3 are closed?

A. Bulb L_2 and L_3 light but L_1 does not.

B. Bulb L_1 lights dimly compared to L_2 andL_3

C. Bulb L_1 lights but not L_2 and L_3

D. No bulb lights

7. What would be observed if all switches S_1, S_2, and S_3 are closed?

A. All bulbs would light equally

B. Bulb L_2 and L_3 would light equally Bulb L_1 would not be brighter than L_2 and L_3?

C. Bulb L_1 lights dimly compared to L_2 andL_3

D. The brightness of L_2 and L_3 would be different

8. Switches S_1 and S_2 are closed and S_3 left open. Which one of the following statements is **<u>NOT</u>** true?

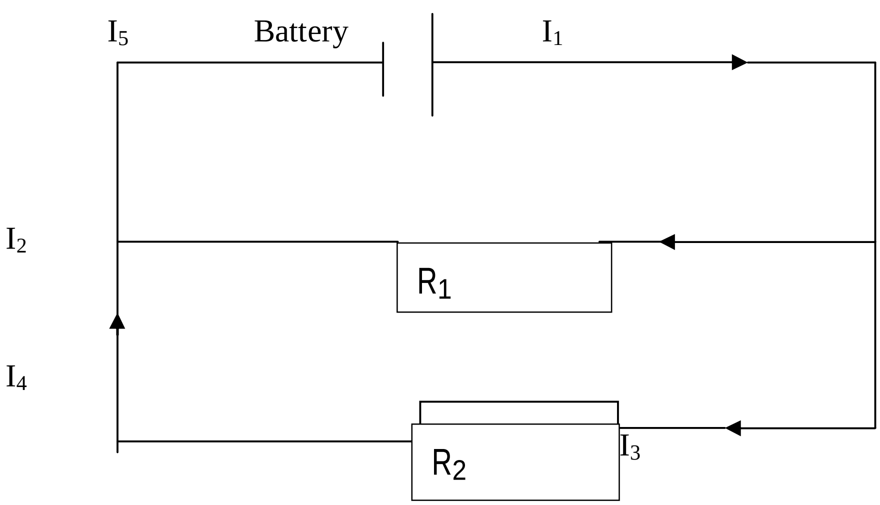
A. Bulb L_2 would not light

B. The brightness of bulb L_1 would be greater than that of L_3

C. Both bulbs L_1 and L_3 would light with the same brightness

D. The same current would flow through bulbs L_1 and L_3

In the circuit diagram below resistor R_1 is greater than R_2. Use the diagram to answer questions 9-11.



9. Which one of the following expressions about the current in the circuit is true?

A. $I_1 = I_2 + I_3 + I_4$

B. $I_1 = I_5$

C. $I_5 = I_1 + I_2 + I_3 + I_4$

D. $I_5 = I_1 + I_3 + I_4$

10. Which one of the following statements is true?

A. $I_1 = I_3$

B. I_2 is greater than I_3

C. I_3 is greater than I_2

D. None of the above

11. Which one of the following expressions is **NOT** true?

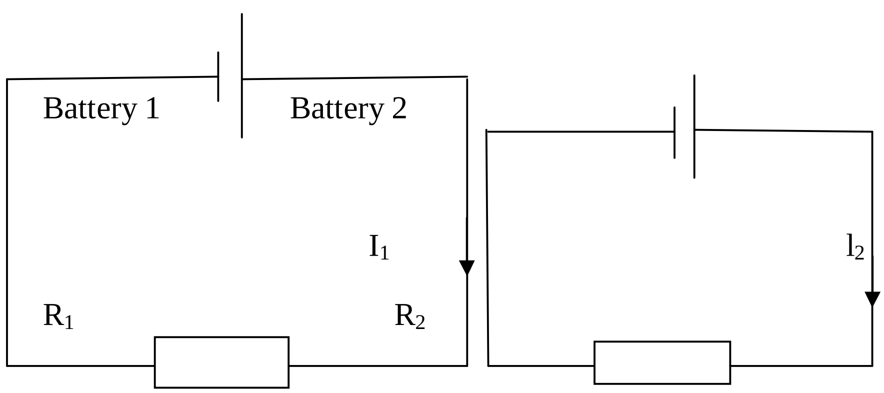
A. $I_1 = I_2 + I3$

B. $I_3 = I_4$

C. $I_2 + I_4 = I_5$

D. $I_1 + I_2 = I_5$

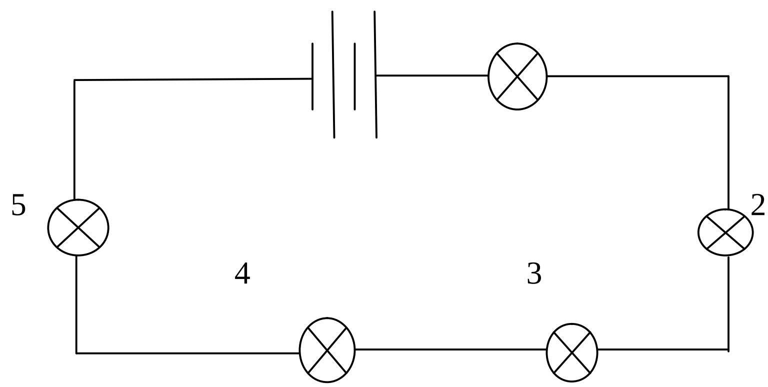
12. In the circuit diagrams below, battery 1 has 1.5 volts while battery 2 has 1.0 volts. R_1 and R_2 are equal.



Which of the following statements is true?

A. I_1 is equal to I_2
B. I_1 is greater than I_2
C. I_2 is greater than I_1
D. None of the above

13.

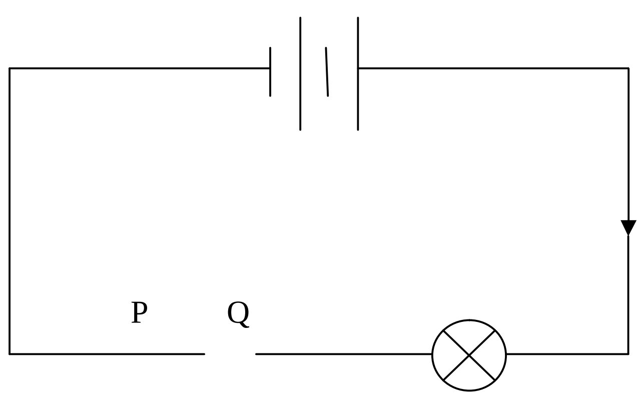


The diagram above shows five identical bulbs and a battery connected in a circuit. Which of the following statements is true?

A. Bulb 5 is dimmer than bulb 1 because energy of the battery decreases as current flows from bulb 5
B. Bulb 5 is dimmer than bulb 1 because the current decreases as it flows from bulb 1 to bulb 5
C. Bulb 5 and 1 are equal in brightness because the same current flows through the bulbs
D. Bulb 5 and bulb 1 are equally bright because they are connected next to the battery and will therefore be brighter than bulbs 2, 3 and 4

14. A student set up the following circuit to investigate flow of current in different materials.

Battery



Bulb (used as indicator)

He connected different test materials to close gap PQ. He found that the bulb lit very brightly, dimly, very dimly, and of with different materials. The reason for this is that:-

A. Some materials consume more electric current than others before it reaches the bulb.

B. Some materials offer more resistance to current flow than others.

C. Some materials have fewer atoms to carry current than others.

D. Some materials have less power to push current than others.

15. Which of the following statements is NOT true of electric flow?

A. A very little electrical energy is required for electric current flow through a conducting copper wire.

B. Very high electrical energy is required to push current through a high resistor wire.

C. Wires of different cross-sectional areas offer different resistance to flow of electric current.

D. The cross-sectional area of conducting wire has no effect on resistance to flow of electric current.

Appendix III: Form Two Enrolment In Laikipia Central Sub-County 2016

S/No.	School Category	Zone	Boys	Girls	Total
1	Public Day	A	85	-	85
2	Public Day	A	36	39	75
3	Public Day	B	112	-	112
4	Public Day	B	16	42	58
5	Public Boarding	C	62	39	101
6	Public Day	B	90	64	154
7	Public Day	C	24	16	40
8	Public Boarding	B	-	34	34
9	Public Day	C	27	19	46
10	Public Day	B	52	34	86
11	Public Day	A	11	11	22
12	Public Boarding	B	58	-	58
13	Private	C	19	6	25
14	Public Day	A	-	45	45
15	Public Day	A	35	27	62
16	Public Day	C	12	14	26
17	Public Day	A	5	11	16
18	Public Day	A	3	3	6
19	Public Day	A	14	11	25
20	Public Day	C	9	11	20
21	Public Day	B	44	42	86
22	Public Day	A	8	12	20

Appendix IV: Physics Achievement Test Results

Questions	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	SEX
	1	1	1	0	0	1	0	1			1	0	1	1	0	1
	0	1	1	0	1	0	0	1			1	0	0	1	1	1
	1	1	1	0	0	1	0	1			0	0	0	1	0	1
	1	1	1	0	1	1	0	1			0	0	1	1	1	1
	1	1	0	0	0	1	0	0			1	1	1	0	0	1
	0	0	0	0	0	0	0	1			0	0	0	0	0	1
	0	1	0	0	1	1	0	0			0	1	0	0	1	1
	0	1	0	1	1	0	0	0			0	1	0	1	0	1
	0	0	1	0	1	0	0	0			0	0	0	0	0	1
	1	1	0	1	0	1	1	1			0	0	0	0	0	1
	1	0	1	0	0	0	1	1			0	0	0	0	0	1
	0	0	1	0	0	0	1	0			0	1	0	0	0	1
	0	0	1	0	1	1	0	1			0	0	0	0	0	1
	0	0	0	1	0	0	0	0			0	0	0	0	0	1
	0	1	0	1	0	1	0	1			0	0	0	1	0	1
	0	0	1	0	1	1	0	1			0	0	1	0	1	1
	0	0	1	0	0	1	0	0			0	0	0	1	0	1
	0	1	0	1	0	0	0	1			0	1	0	0	0	1
	1	1	1	0	0	0	0	1			0	0	0	1	0	0
	1	1	1	0	0	0	0	1			1	0	0	0	0	0
	1	1	1	1	0	1	1	1			0	0	0	0	1	0
	1	1	0	1	0	0	0	0			1	0	0	1	1	0

	1	1	1	0	0	0	0	0			0	1	0	1	0	0
	0	0	0	0	0	1	0	0			0	1	0	1	0	0
	0	0	0	0	0	1	0	1			0	1	1	0	0	0
	1	1	1	0	1	0	0	0			0	0	0	0	0	0
	1	1	0	1	1	0	0	0			0	0	0	0	0	0
	0	1	0	1	0	1	0	1			1	1	1	1	0	0
	0	0	1	0	0	0	0	0			1	0	1	0	0	0
	0	0	0	1	0	0	0	0			1	1	0	1	0	0
	0	1	0	1	1	0	0	0			0	0	0	1	1	0
	1	0	1	0	0	0	1	0			0	0	0	1	0	0
	1	1	0	0	0	0	0	1			0	0	1	0	0	0
	1	1	0	1	0	0	0	0			0	0	1	1	0	0
	0	1	1	1	0	0	0	1			1	0	0	0	0	0
	1	1	0	0	1	1	1	1			0	0	0	0	0	0
	0	1	0	0	1	0	1	0			1	0	0	0	0	0
	0	0	0	1	0	0	0	0			0	0	0	0	1	0
	0	0	1	0	0	0	1	1			1	0	1	0	0	0
	1	1	1	0	1	0	0	0			0	0	1	1	1	0
Total(1)	**18**	**25**	**20**	**14**	**13**	**15**	**8**	**20**	**0**	**0**	**11**	**10**	**11**	**17**	**9**	**18**
Total(0)	**22**	**15**	**20**	**26**	**27**	**25**	**32**	**20**	**0**	**0**	**29**	**30**	**29**	**23**	**31**	**22**

Appendix V: Student Motivation Questionaire (SMQ)

School;_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ __ __

Class; _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ __ __

Gender; _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ __ __

Age; _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ __ __

Admission No ; _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ __ __

The purpose of this Questionnaire is to find out what you think about the Physics course. Please indicate what you think about each item. Information given in this questionnaire will be treated confidentially for research purposes only. Please feel free to ask for any clarifications if need be.

<u>Instructions</u>

1. Read the items carefully and try to understand before choosing what truly agrees with your thoughts.
2. Circle the letter that corresponds to how you really feel toward the physics course.
3. The choices are strongly Agree (SA), Agree (A), Disagree (D), Strongly Disagree (SD) and Undecided (U).
4. If you change your mind about an answer, you may close it neatly and circle another.

Example:

A student who strongly agrees with the following statement would answer as follows:

Performing the Physics experiment in the group was stimulating.

SD D U A SA

ITEMS

1. Learning the Physics course by the teacher explain everything was (tick appropriately)

SNO.	Variable	Strongly Disagree (SD)	Disagree (D)	Undecided (U)	Agree (A)	Strongly Agree (SA)
1.	Fun					
2.	Satisfying					
3.	Informative					
4.	Useful					
5.	Boring					
6.	Frustrating					
7.	Hard					
8.	Challenging					
9.	Too demanding					
10.	Too stressful					

2. Learning the Physics course by working through an experiment was (tick appropriately)

SNO.	Variable	Strongly Disagree (SD)	Disagree (D)	Undecided (U)	Agree (A)	Strongly Agree (SA)
1.	Stimulating					
2.	Rewarding					
3.	Time wasting					
4.	Hard					
5.	Too stressful					
6.	Satisfying					
7.	Informative					
8.	Fun					
9.	Challenging					
10.	Boring					

3. Learning the Physics course by doing the experiment myself made me (tick appropriately)

SNO.	Variable	Strongly Disagree (SD)	Disagree (D)	Undecided (U)	Agree (A)	Strongly Agree (SA)
1.	Feel confident about the Physics course					
2.	Feel eager to learn the Physics course					
3.	Doubt my ability to learn Physics					
4.	Want to apply my knowledge to solve practical problems					
5.	Happy					
6.	Excited					
7.	Feel as if I was wasting time					
8.	Frustrated					
9.	Unhappy					
10.	Interested in Physics					

4. Drawing conclusions of the experiments done by me was (tick appropriately)

SNO.	**Variable**	**Strongly Disagree (SD)**	**Disagree (D)**	**Undecided (U)**	**Agree (A)**	**Strongly Agree (SA)**
1.	Stimulating					
2.	Rewarding					
3.	Time wasting					
4.	Boring					
5.	Useful					
6.	Well Organized					
7.	Frustrating					
8.	Fun					
9.	Interesting					
10.	Hard					

5. The practical lessons that I was exposed to before Physics lessons were (tick appropriately)

SNO.	Variable	Strongly Disagree (SD)	Disagree (D)	Undecided (U)	Agree (A)	Strongly Agree (SA)
1.	Stimulating					
2.	Rewarding					
3.	Time wasting					
4.	Fearful					
5.	Useful					
6.	Interesting					
7.	Not enjoyable					
8.	Doubtful					
9.	Embarrassing					

6. Learning Physics through experiments in groups and applying the knowledge to real life situation made me (tick appropriately)

SNO.	Variable	Strongly Disagree (SD)	Disagree (D)	Undecided (U)	Agree (A)	Strongly Agree (SA)
1.	Feel confident about the Physics course					
2.	Feel eager to learn the Physics course					
3.	Doubt my ability to learn Physics					
4.	Want to apply my knowledge to solve practical problems					
5.	Happy					
6.	Excited					
7.	Feel as if I was wasting time					
8.	Frustrated					
9.	Unhappy					
10.	Interested in Physics course					

Appendix VI: Students Responses To Student' Motivation Questionnaire

Table 1: For statement 1: Learning physics course by the teacher explaining everything was;

Variables	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Fun	15	6	5	24	27	77
Satisfying	3	6	6	34	28	77
Informative	6	7	9	33	21	76
Useful	4	1	4	23	45	77
Boring	49	13	5	5	4	76
Frustrating	28	23	14	7	5	77
Hard	27	20	11	16	3	77
Challenging	24	16	8	15	14	77
Too demanding	20	9	9	25	12	75
Too stressful	42	17	5	7	6	77

Table 2: For statement 2: Learning Physics course by working through an experiment was;

Variables	**Strongly Disagree**	**Disagree**	**Undecided**	**Agree**	**Strongly Agree**	**Total**
Simulating	12	4	7	26	29	78
Rewarding	3	8	5	36	23	75
Time wasting	49	18	6	1	2	76
Hard	36	22	7	9	4	78
Too stressful	42	17	8	3	8	78
Satisfying	12	5	7	26	26	76
Informative	4	5	5	30	30	74
Fun	6	8	2	29	32	77
Challenging	18	24	4	18	9	73
Boring	56	14	4	2	2	78

Table 3: For statement 3: Learning the Physics course by doing the experiment myself made me;

Variables	**Strongly Disagree**	**Disagree**	**Undecided**	**Agree**	**Strongly Agree**	**Total**
Feel confident about the Physics course	5	5	0	17	49	76
Feel eager to learn the Physics course	16	10	3	20	26	75
Doubt my ability to learn Physics	28	15	11	8	11	73
Want to apply my Knowledge to solve practical problems	5	3	4	31	31	74
Happy	8	0	3	23	40	74
Excited	9	4	2	34	21	70
Feel as if I was wasting time	51	13	5	8	0	77
Frustrated	30	22	12	10	2	76
Unhappy	44	16	4	5	6	75
Interested in Physics	12	0	3	26	33	74

Table 4: For statement 4: Drawing conclusions of the experiments done by me was;

Variables	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Stimulating	13	8	4	26	26	77
Rewarding	7	8	7	26	30	78
Time wasting	50	15	4	4	4	77
Boring	50	1	5	2	3	61
Useful	3	3	1	27	43	77
Well Organized	3	1	5	30	39	78
Frustrating	32	15	8	15	6	76
Fun	11	4	5	29	28	77
Interesting	2	3	2	27	43	77
Hard	38	21	7	6	6	78

Table 5: For statement 5: The practical lessons that I was exposed to before Physics lessons were;

Variables	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Stimulating	14	9	11	18	26	78
Rewarding	5	7	8	28	29	77
Time wasting	56	14	1	2	5	78
Fearful	36	19	6	12	5	78
Useful	4	0	3	25	46	78
Interesting	3	1	3	36	34	77
Not Enjoyable	46	17	8	3	3	77
Doubtful	32	19	13	11	2	77
Embarrassing	41	15	11	4	7	78

Table 6: For statement 6: Learning Physics through experiments in groups and applying the knowledge to real Life situation made me;

Variables	**Strongly Disagree**	**Disagree**	**Undecided**	**Agree**	**Strongly Agree**	**Total**
Feel confident about the Physics course	7	1	5	20	44	77
Feel eager to learn the Physics course	18	8	5	19	27	77
Doubt my ability to learn Physics	31	14	13	6	9	73
Want to apply my Knowledge to solve practical problems	4	1	6	28	38	77
Happy	5	1	3	38	28	75
Excited	6	5	5	28	28	72
Feel as if I was wasting time	51	12	5	4	1	73
Frustrated	37	23	10	4	3	77
Unhappy	46	21	6	4	1	78
Interested in Physics	5	2	3	21	47	78

Appendix VII: Summary of T-test analysis

Table1: T-test Result for Hypothesis 1

The findings of the Solomon four group design

Test	Number	Comparison	Mean	Sd	Mean Different	T-Value	P-Value	Remark
1	54	Group 1pretest	4.74	2.030	-2.601	-7.421	0.000	Entry point different
	79	Group2pretest	7.34	1.954				
2	54	Group 1pretest	4.74	2.030	-0.815	-2.123	0.036	Significant
	54	Group1posttest	5.56	1.959				
3	54	Group posttest1	5.56	1.959	-1.938	-6.166	0.000	Significant
	79	Group 2 posttest	7.49	1.648				
4	54	Group 1 posttest	5.56	1.959	1.500	2.903	0.005	Significant
	18	Group 3 posttest	4.06	1.697				
5	79	Group 2 posttest	7.49	1.648	2.769	8.423	0.000	Significant
	40	Group 4 posttest	4.73	1.783				
6	79	Group 2 pretest	7.34	1.954	2.617	7.102	0.000	Significant
	40	Group 4 posttest	4.73	1.783				

Appendix VIII: T-test Result for Hypothesis 2

Table 6.2: T-test Result for Hypothesis 2

Test No.	N		Comparison	Mean		Sd		mean diff.		T -Value		P-Value	
	F	M		F	M	F	M	F	M	F	M	F	M
1	39		Group 1 Pre test	4.46		1.790		-.564		-1.442		.153	
	39		Group 1 post test	5.03		1.662							
2	39	15	Group 1 post test	5.03	6.93	1.662	2.052	2.151	.800	-6.186	-1.398	.000	.167
	34	45	Group 2 post test	7.18	7.73	1.242	1.876						
3	39	15	Group 1 post test	5.03	6.93	1.662	2.052	1.526	2.719	1.743	3.855	.089	.001
	4	14	Group 3 post test	3.50	4.21	1.732	1.718						
4		15	Group 1 post test		6.93		2.052		2.267		3.108		.004
		18	Group 4 post test		4.67		2.114						
5		45	Group 2 post test		7.73		1.876		3.519		6.247		.000
		14	Group 3 post test		4.21		1.718						
6		14	Group 3 post test		4.21		1.718		-.452		-.650		.521
		18	Group 4 post test		4.67		2.114						

Appendix IX: SPSS Output for Reliability of Physics Achievement Test and Students' Motivation Questionnaire

(a) **Scale: ALL VARIABLES OF PHYSICS ACHIEVEMENT TEST**

Case Processing Summary

		N	**%**
Cases	Valid	2	4.8
	Excluded[a]	40	95.2
	Total	42	100.0

a. List wise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
.944	.951	11

Item Statistics

	Mean	Std. Deviation	N
Q1	20.000	2.8284	2
Q2	20.000	7.0711	2
Q4	20.000	8.4853	2
Q5	20.000	9.8995	2
Q6	20.000	7.0711	2
Q7	20.000	16.9706	2
Q11	20.000	12.7279	2
Q12	20.000	14.1421	2
Q13	20.000	12.7279	2
Q14	20.000	4.2426	2
Q15	20.000	15.5563	2

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Q1	200.000	8978.000	1.000	.	.945
Q2	200.000	10952.000	-1.000	.	.979
Q4	200.000	7938.000	1.000	.	.932
Q5	200.000	7688.000	1.000	.	.930
Q6	200.000	8192.000	1.000	.	.935

Q7	200.000	6498.000	1.000	.	.930
Q11	200.000	7200.000	1.000	.	.928
Q12	200.000	6962.000	1.000	.	.928
Q13	200.000	7200.000	1.000	.	.928
Q14	200.000	8712.000	1.000	.	.941
Q15	200.000	6728.000	1.000	.	.928

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
220.000	9522.000	97.5807	11

(c) Scale: Item Variables For The Students' Motivation Questionnaire

Case Processing Summary

Variables		N	%
Cases	Valid	5	100.0
	Excluded[a]	0	.0
	Total	5	100.0

a. List wise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.727	.799	17

Item Statistics

Variables	Mean	Std. Deviation	N
Fun	15.40	10.065	5
Satisfying	15.40	14.450	5
Informative	15.20	11.628	5
Useful	15.40	18.716	5
Boring	15.20	19.241	5
Frustrating	15.40	9.965	5
Hard	15.40	9.072	5
Challenging	15.40	5.727	5
Too Demanding	15.00	7.176	5
Too Stressful	15.40	15.630	5
Fcpc	15.20	19.905	5
Fepc	15.00	8.888	5
Dalp	14.60	7.893	5
Interesting	15.40	17.925	5
Not Enjoyable	15.40	18.036	5
Doubtful	15.40	11.104	5
Embarassing	15.60	14.792	5

Item-Total Statistics

Variables	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Fun	244.40	8962.800	.572	.	.698
Satisfying	244.40	9753.300	.067	.	.739
Informative	244.60	9862.300	.068	.	.735
Useful	244.40	9384.800	.116	.	.743
Boring	244.60	7940.300	.538	.	.686
Frustrating	244.40	9884.800	.086	.	.732
Hard	244.40	9550.800	.294	.	.718
Challenging	244.40	9182.800	.856	.	.699
Too Demanding	244.80	9214.200	.645	.	.702
Too Stressful	244.40	8320.800	.557	.	.687
FCPC	244.60	9226.300	.139	.	.742
FEPC	244.80	8935.700	.678	.	.694
DALP	245.20	9280.700	.534	.	.706

Interesting	244.40	9374.300	.132	.	.739
Not Enjoyable	244.40	8457.800	.413	.	.704
Doubtful	244.40	9462.800	.263	.	.720
Embarrassing	244.20	8728.200	.437	.	.702

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
259.80	10154.700	100.771	17

Appendix X: Field Data

S.No.	Group	Pre Test	Gender	Post Test	Treatment	Method
i.	Exp.1	4	M	8	SPSAO	1
ii.	Exp.1	5	M	6	SPSAO	1
iii.	Exp.1	4	M	8	SPSAO	1
iv.	Exp.1	8	M	5	SPSAO	1
v.	Exp.1	8	M	6	SPSAO	1
vi.	Exp.1	4	M	8	SPSAO	1
vii.	Exp.1	6	M	7	SPSAO	1
viii.	Exp.1	8	M	9	SPSAO	1
ix.	Exp.1	3	M	3	SPSAO	1
x.	Exp.1	4	M	7	SPSAO	1
xi.	Exp.1	11	M	9	SPSAO	1
xii.	Exp.1	5	M	10	SPSAO	1
xiii.	Exp.1	7	M	8	SPSAO	1
xiv.	Exp.1	3	M	7	SPSAO	1
xv.	Exp.1	2	M	3	SPSAO	1
xvi.	Exp.1	7	F	6	SPSAO	1
xvii.	Exp.1	3	F	7	SPSAO	1
xviii.	Exp.1	6	F	7	SPSAO	1

xix.	Exp.1	2	F	7	SPSAO	1
xx.	Exp.1	2	F	3	SPSAO	1
xxi.	Exp.1	4	F	4	SPSAO	1
xxii.	Exp.1	4	F	6	SPSAO	1
xxiii.	Exp.1	7	F	4	SPSAO	1
xxiv.	Exp.1	3	F	7	SPSAO	1
xxv.	Exp.1	3	F	4	SPSAO	1
xxvi.	Exp.1	6	F	7	SPSAO	1
xxvii.	Exp.1	1	F	6	SPSAO	1
xxviii.	Exp.1	5	F	4	SPSAO	1
xxix.	Exp.1	2	F	4	SPSAO	1
xxx.	Exp.1	2	F	2	SPSAO	1
xxxi.	Exp.1	4	F	3	SPSAO	1
xxxii.	Exp.1	4	F	4	SPSAO	1
xxxiii.	Exp.1	5	F	5	SPSAO	1
xxxiv.	Exp.1	6	F	7	SPSAO	1
xxxv.	Exp.1	5	F	5	SPSAO	1
xxxvi.	Exp.1	6	F	7	SPSAO	1
xxxvii.	Exp.1	7	F	4	SPSAO	1
xxxviii.	Exp.1	3	F	3	SPSAO	1
xxxix.	Exp.1	3	F	5	SPSAO	1
xl.	Exp.1	4	F	5	SPSAO	1

xli.	Exp.1	6	F	4	SPSAO	1
xlii.	Exp.1	4	F	7	SPSAO	1
xliii.	Exp.1	7	F	8	SPSAO	1
xliv.	Exp.1	5	F	6	SPSAO	1
xlv.	Exp.1	6	F	5	SPSAO	1
xlvi.	Exp.1	6	F	2	SPSAO	1
xlvii.	Exp.1	4	F	6	SPSAO	1
xlviii.	Exp.1	2	F	4	SPSAO	1
xlix.	Exp.1	5	F	6	SPSAO	1
l.	Exp.1	7	F	3	SPSAO	1
li.	Exp.1	6	F	7	SPSAO	1
lii.	Exp.1	1	F	2	SPSAO	1
liii.	Exp.1	6	F	6	SPSAO	1
liv.	Exp.1	5	F	4	SPSAO	1
lv.	Control 1	9	M	8	RTM	2
lvi.	Control 1	11	M	7	RTM	2
lvii.	Control 1	7	M	10	RTM	2
lviii.	Control 1	9	M	8	RTM	2
lix.	Control 1	8	M	7	RTM	2
lx.	Control 1	8	M	8	RTM	2
lxi.	Control 1	6	M	8	RTM	2
lxii.	Control 1	9	M	10	RTM	2

lxiii.	Control 1	9	M	10	RTM	2
lxiv.	Control 1	9	M	7	RTM	2
lxv.	Control 1	7	M	9	RTM	2
lxvi.	Control 1	8	M	10	RTM	2
lxvii.	Control 1	10	M	6	RTM	2
lxviii.	Control 1	7	M	4	RTM	2
lxix.	Control 1	10	M	10	RTM	2
lxx.	Control 1	5	M	7	RTM	2
lxxi.	Control 1	8	M	8	RTM	2
lxxii.	Control 1	8	M	4	RTM	2
lxxiii.	Control 1	8	M	11	RTM	2
lxxiv.	Control 1	8	M	6	RTM	2
lxxv.	Control 1	9	M	5	RTM	2
lxxvi.	Control 1	9	M	9	RTM	2
lxxvii.	Control 1	6	M	10	RTM	2
lxxviii.	Control 1	12	M	10	RTM	2
lxxix.	Control 1	12	M	7	RTM	2
lxxx.	Control 1	7	M	7	RTM	2
lxxxi.	Control 1	7	M	7	RTM	2
lxxxii.	Control 1	5	M	7	RTM	2
lxxxiii.	Control 1	8	M	10	RTM	2
lxxxiv.	Control 1	10	M	6	RTM	2

lxxxv.	Control 1	7	M	8	RTM	2
lxxxvi.	Control 1	7	M	7	RTM	2
xxxvii.	Control 1	5	M	5	RTM	2
xxxviii.	Control 1	8	M	10	RTM	2
lxxxix.	Control 1	7	M	8	RTM	2
xc.	Control 1	7	M	7	RTM	2
xci.	Control 1	8	M	10	RTM	2
xcii.	Control 1	8	M	8	RTM	2
xciii.	Control 1	11	M	10	RTM	2
xciv.	Control 1	8	M	8	RTM	2
xcv.	Control 1	10	M	9	RTM	2
xcvi.	Control 1	6	M	7	RTM	2
xcvii.	Control 1	8	M	4	RTM	2
xcviii.	Control 1	7	M	6	RTM	2
xcix.	Control 1	8	M	5	RTM	2
c.	Control 1	8	F	9	RTM	2
ci.	Control 1	8	F	6	RTM	2
cii.	Control 1	7	F	9	RTM	2
ciii.	Control 1	6	F	8	RTM	2
civ.	Control 1	4	F	8	RTM	2
cv.	Control 1	4	F	8	RTM	2
cvi.	Control 1	4	F	8	RTM	2

cvii.	Control 1	8	F	6	RTM	2
cviii.	Control 1	5	F	5	RTM	2
cix.	Control 1	4	F	4	RTM	2
cx.	Control 1	4	F	9	RTM	2
cxi.	Control 1	4	F	7	RTM	2
cxii.	Control 1	7	F	9	RTM	2
cxiii.	Control 1	6	F	6	RTM	2
cxiv.	Control 1	5	F	7	RTM	2
cxv.	Control 1	6	F	7	RTM	2
cxvi.	Control 1	5	F	6	RTM	2
cxvii.	Control 1	7	F	6	RTM	2
cxviii.	Control 1	5	F	6	RTM	2
cxix.	Control 1	4	F	7	RTM	2
cxx.	Control 1	4	F	8	RTM	2
cxxi.	Control 1	9	F	7	RTM	2
cxxii.	Control 1	10	F	8	RTM	2
cxxiii.	Control 1	8	F	9	RTM	2
cxxiv.	Control 1	7	F	6	RTM	2
cxxv.	Control 1	7	F	7	RTM	2
cxxvi.	Control 1	9	F	8	RTM	2
cxxvii.	Control 1	5	F	7	RTM	2
cxxviii.	Control 1	6	F	8	RTM	2

cxxix.	Control 1	6	F	7	RTM	2
cxxx.	Control 1	8	F	6	RTM	2
cxxxi.	Control 1	9	F	8	RTM	2
cxxxii.	Control 1	10	F	8	RTM	2
cxxxiii.	Control 1	7	F	6	RTM	2
cxxxiv.	Exp.2		M	2	SPSAO	2
cxxxv.	Exp.2		M	3	SPSAO	1
cxxxvi.	Exp.2		M	4	SPSAO	1
cxxxvii.	Exp.2		M	6	SPSAO	1
cxxxviii.	Exp.2		M	3	SPSAO	1
cxxxix.	Exp.2		M	7	SPSAO	1
cxl.	Exp.2		M	6	SPSAO	1
cxli.	Exp.2		M	4	SPSAO	1
cxlii.	Exp.2		M	4	SPSAO	1
cxliii.	Exp.2		M	6	SPSAO	1
cxliv.	Exp.2		M	2	SPSAO	1
cxlv.	Exp.2		M	4	SPSAO	1
cxlvi.	Exp.2		M	6	SPSAO	1
cxlvii.	Exp.2		M	2	SPSAO	1
cxlviii.	Exp.2		F	5	SPSAO	1
cxlix.	Exp.2		F	2	SPSAO	1
cl.	Exp.2		F	5	SPSAO	1

cli.	Exp.2		F	2	SPSAO	1
clii.	Control 2		M	8	RTM	2
cliii.	Control 2		M	7	RTM	2
cliv.	Control 2		M	6	RTM	2
clv.	Control 2		M	8	RTM	2
clvi.	Control 2		M	6	RTM	2
clvii.	Control 2		M	1	RTM	2
clviii.	Control 2		M	5	RTM	2
clix.	Control 2		M	5	RTM	2
clx.	Control 2		M	2	RTM	2
clxi.	Control 2		M	6	RTM	2
clxii.	Control 2		M	4	RTM	2
clxiii.	Control 2		M	3	RTM	2
clxiv.	Control 2		M	4	RTM	2
clxv.	Control 2		M	1	RTM	2
clxvi.	Control 2		M	5	RTM	2
clxvii.	Control 2		M	6	RTM	2
clxviii.	Control 2		M	3	RTM	2
clxix.	Control 2		M	4	RTM	2
clxx.	Control 2		F	5	RTM	2
clxxi.	Control 2		F	5	RTM	2
clxxii.	Control 2		F	8	RTM	2

clxxiii.	Control 2		F	6	RTM	2
clxxiv.	Control 2		F	5	RTM	2
clxxv.	Control 2		F	3	RTM	2
clxxvi.	Control 2		F	4	RTM	2
clxxvii.	Control 2		F	4	RTM	2
lxxviii.	Control 2		F	4	RTM	2
clxxix.	Control 2		F	8	RTM	2
clxxx.	Control 2		F	3	RTM	2
clxxxi.	Control 2		F	4	RTM	2
clxxxii.	Control 2		F	5	RTM	2
lxxxiii.	Control 2		F	4	RTM	2
lxxxiv.	Control 2		F	4	RTM	2
clxxxv.	Control 2		F	5	RTM	2
lxxxvi.	Control 2		F	5	RTM	2
xxxvii.	Control 2		F	6	RTM	2
xxxviii.	Control 2		F	4	RTM	2
lxxxix.	Control 2		F	2	RTM	2
cxc.	Control 2		F	4	RTM	2
cxci.	Control 2		F	7	RTM	2

Key: RTM-REGULAR TEACHING METHOD, SPSAO- THE INDEPENDENT VARIABLE, PRETEST AND POSTTEST MARKED OUT OF 15.

Appendixes XI : Letter of Introduction

INSTITUTE OF POSTGRADUATE STUDIES & RESEARCH

Private Bag-20157 **Tel: 0773265999**
Kabarak, Kenya
Email:directorpostgraduate@kabarak.ac.ke **www.kabarak.ac.ke**

31st March 2016

Ministry of Education, Science and Technology
National Commission for Science, Technology and Innovation.
9th Floor, Utalii House,
P.O Box 30623-00100.
NAIROBI

Dear Sir/Madam

SUBJECT: RESEARCH BY GDE/M/1191/09/12- JOSEPHAT K. KIGO

The above named is a Doctoral student at Kabarak University in the School of Education. He is carrying out a research entitled "Effect of Science Process Skills Advance Organizer on Students' Gender, Motivation and Performance in Electric Circuits in Secondary School Physics in Laikipia Central District: Laikipia County"

The information obtained in the course of this research will be used for academic purposes only and will be treated with utmost confidentiality.

Please provide the necessary assistance

Thank you.

Yours Faithfully,

KABARAK UNIVERSITY POSTGRADUATE STUDIES & RESEARCH DEPT 31 MAR 2016 PRIVATE BAG - 20157, KABARAK

DR. BETTY JERUTO TIKOKO
DIRECTOR POSTGRADUATE STUDIES & RESEARCH

Kabarak University Moral Code
As members of Kabarak University family, we purpose at all times and in all places, to set apart in one's heart, Jesus as Lord. (1Peter 3:15)

Appendix XII: Permit

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471, 2241349,3310571,2219420
Fax:+254-20-318245,318249
Email:dg@nacosti.go.ke
Website: www.nacosti.go.ke
when replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref. No.

NACOSTI/P/16/14258/11136

Date:

11th May, 2016

Josephat Kariru Kigo
Kabarak University
Private Bag - 20157
KABARAK.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Effect of science process skill advance organizer on students gender motivation and performance in electric circuits in secondary school physics in Laikipia Central District Laikipia County,"*** I am pleased to inform you that you have been authorized to undertake research in **Laikipia County** for the period ending **10th May, 2017.**

You are advised to report to **the County Commissioner and the County Director of Education, Laikipia County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. STEPHEN K. KIBIRU, PhD.
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Laikipia County.

The County Director of Education
Laikipia County.

CONDITIONS

1. You must report to the County Commissioner and the County 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) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 9109

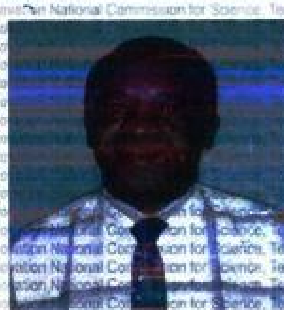
CONDITIONS: see back page

THIS IS TO CERTIFY THAT:
MR. JOSEPHAT KARIRU KIGO
of KABARAK UNIVERSITY, 12250-20100 NAKURU,has been permitted to conduct research in Laikipia County

on the topic: *EFFECT OF SCIENCE PROCESS SKILL ADVANCE ORGANIZER ON STUDENTS GENDER MOTIVATION AND PERFORMANCE IN ELECTRIC CIRCUITS IN SECONDARY SCHOOL PHYSICS IN LAIKIPIA CENTRAL DISTRICT LAIKIPIA COUNTY*

for the period ending:
10th May,2017

Permit No. : NACOSTI/P/16/14258/11136
Date Of Issue : 11th May,2016
Fee Recieved :Ksh 2000



....
Applicant's Signature

....
Director General
National Commission for Science, Technology & Innovation

Appendix XIII: County Authority

THE PRESIDENY
MINISTRY OF INTERIOR & CO-ORDINATION OF NATIONAL GOVERNMENT

When replying please quote
Fax: 062-2031874
E-MAIL: *cclaikipiacounty@yahoo.com*

COUNTY COMMISSIONER
LAIKIPIA COUNTY
P.O. BOX 11-10400
NANYUKI

Ref No.

CC.ED.12/4 VOL.1/(71)

16TH May, 2016

Deputy County Commissioner,
LAIKIPIA CENTRAL.

RE: RESEARCH AUTHORIZATION - JOSEPHHAT KARIRU KIGO

This is to inform you that the above named person has the authority of the National Council for Science, Technology and Innovation to conduct research ***"Effect of science process skill advance organizer on students gender motivation and performance in electric circuits in secondary school physics"*** in Laikipia Central for the period ending 10th May 2017.
This is to inform you that this office has no objection for him to undertake research.

Kindly accord him the necessary support.

COUNTY COMMISSIONER
LAIKIPIA

A O. OKELLO
COUNTY COMMISSIONER
LAIKIPIA

cc

JOSEPHAT KARIRU KIGO

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

STATE DEPARTMENT OF EDUCATION

Telegrams: "Education" LKP.
Telephone: 062-31518, 31519
Email:laikipiacountydirector@yahoo.com

County Director of Education,
Laikipia County,
P.O. Box 253.
NANYUKI.

When replying please quote:
Ref: LPA/C/A/58 VOL. 1

16TH MAY, 2016

Josephat Kariru Kigo,
Kabarak University,
Private Bag – 20157,
KABARAK.

RE: RESEARCH AUTHORIZATION
JOSEPHAT KARIRU KIGO

The National Commission for Science, Technology and Innovation letter ref. No. NACOSTI/P/16/14258/11136 dated 11th May, 2016 refers.

Following your application for authority to carry out research on **"Effect of science process skill advance organizer on student's gender motivation and performance in electric circuits in secondary school physics in Laikipia Central District, Laikipia County,"** I am pleased to inform you that you have been authorized to undertake research in **Laikipia County** for a period ending **10th May, 2017.**

Give a copy of your research to this office after completion of your work.

Noordin Mohamed
FOR: COUNTY DIRECTOR OF EDUCATION,
LAIKIPIA COUNTY.

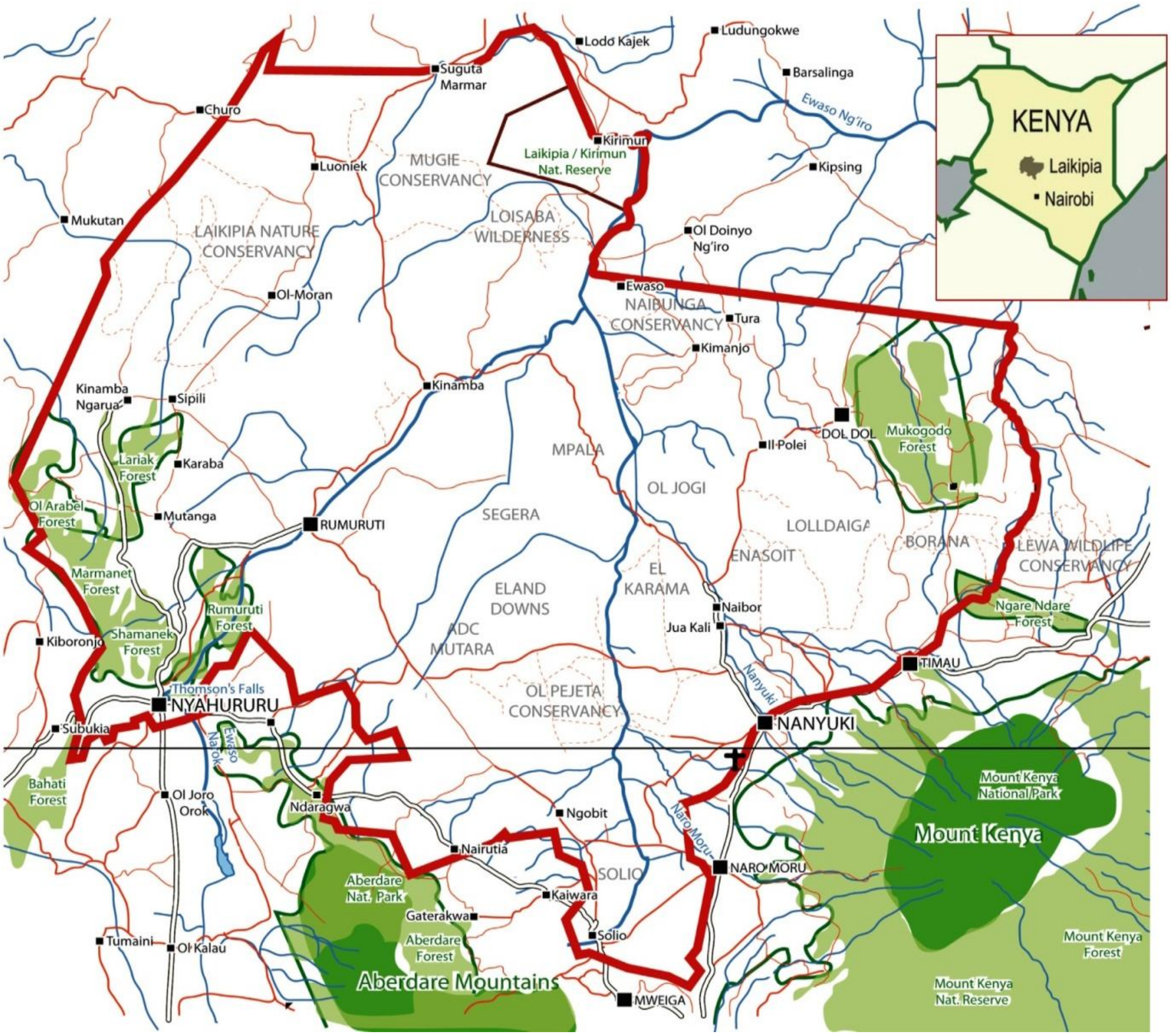
COUNTY DIRECTOR OF EDUCATION LAIKIPIA

CC.
National Commission for Science,
Technology and Innovation,
NAIROBI.

The County Commissioner
LAIKIPIA COUNTY,

ISO 9001:2008 CERTIFIED

Appendix XIV: Laikipia-Map



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