INTEGRATION OF INVESTIGATIVE SCIENCE PROCESS SKILL TEACHING STRATEGY ON STUDENTS’ ACHIEVEMENT, PROBLEM SOLVING, MOTIVATION AT SECONDARY SCHOOL PHYSICS EMBU COUNTY, KENYA

BY
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OCTOBER, 2020
DECLARATION

This research thesis is my original work and it has not been previously submitted or published in any other form or a degree, diploma or other award in any university.

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DEDICATION

This thesis is dedicated to my wife Lucy Njoki and to our children Immaculate Mwende, Wendo, Mumbi, Makena, Mutugi and my parents Francis Njoka and Silveria Njura.
ACKNOWLEDGEMENT

Glory and honor to almighty God his mercy and grace are sufficient in our lives. I am wholly indebted to my supervisors Prof Nicholas Twoli and Dr. Waweru Gichuhi for their unreserved commitment and constructive comments that contributed towards making this work a success.

I greatly thank all the Principals and teachers in the schools where I carried out this research for their cooperation and assistance. Special regards to my wife, Lucy Njoki and our children for their invaluable prayers and encouragements to complete this work.

I also wish to thank Kenyatta University for giving me the opportunity to study at the University. I salute all others who helped me in one way or the other during my research period. Finally to all researchers who have gone before me for their exemplarily works.
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<th>Description</th>
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<tbody>
<tr>
<td>ANCOVA</td>
<td>Analysis of Covariance</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Analysis of Variance</td>
</tr>
<tr>
<td>FAWE</td>
<td>Forum for African Women Educationists</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GOK</td>
<td>Government of Kenya</td>
</tr>
<tr>
<td>ISPS</td>
<td>Investigative Science Process Skill</td>
</tr>
<tr>
<td>KCPE</td>
<td>Kenya Certificate of Primary Education</td>
</tr>
<tr>
<td>KCSE</td>
<td>Kenya Certificate of Secondary Education</td>
</tr>
<tr>
<td>KIE</td>
<td>Kenya Institute of Education</td>
</tr>
<tr>
<td>KNEC</td>
<td>Kenya National Examinations Council</td>
</tr>
<tr>
<td>LTM</td>
<td>Long Term Memory</td>
</tr>
<tr>
<td>PAT</td>
<td>Physics Achievement Test</td>
</tr>
<tr>
<td>SMASSE</td>
<td>Strengthening of Mathematics and Science in Secondary Education</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
</tr>
<tr>
<td>STE</td>
<td>Science and Technology Education</td>
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ABSTRACT

One of the challenges facing Kenya in the teaching of Physics in secondary schools is how to make learners acquire knowledge, build up capacity for critical thinking in solving problems in any situation and make an effort to enable them understand the application of content in real life situations and careers. Based on this challenge, the present study was designed to determine the effect of investigative science process skill teaching strategy on students’ achievement, problem solving and motivation in Physics. The study was guided by the following objectives; To determine students achievement in school physics when using investigative science process skill (ISPS) teaching strategy, To determine problem solving abilities of learners in physics when using ISPS teaching strategy, To establish if ISPS have any effects on students motivation towards physics compared to conventional teaching strategies, to find out gender difference in achievement among the students taught through ISPS teaching strategy in physics, to establish if there is any difference in achievement among the students taught through ISPS teaching strategy based on school category. Theoretical framework of the study was based on constructivist theories of learning. Quasi-Experimental design was used. The research was carried out in eight schools in Embu County. Stratified random sampling technique was used to select participating schools, then simple random sampling was used to select and assign participating schools in experimental and control group. The sample was form three students. Research instrument used was: Students motivation scale (SMS), Physics Achievement Test (PAT) on the topic of Electricity (II) and an observation schedule was also administered to determine achievement as well as understanding of the topic “(Electricity)”. The research instrument was pilot-tested for validity and reliability. The reliability coefficient was calculated using Kuder-Richardson (KR-Formula20). A coefficient value of 0.768 was considered suitable for reliability of the instrument. Data was analysed using the analysis of variance (ANOVA) and chi-square and t-test. Hypotheses was tested at alpha (α) value of 0.05 level of significance using a computer Statistical Package for Social Sciences (SPSS) for Windows. The findings of the study demonstrated that ISPS enhanced academic achievement, problem solving and motivation in learning. It is hoped that the results of the study provide useful information to Physics teachers, curriculum developers, Quality Assurance and standards officer (QASO) and teacher-trainers.
CHAPTER ONE
INTRODUCTION

1.0 Introduction
This chapter covers background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, research hypotheses and significance of the study, scope of the study, limitations of the study, assumptions of the study, theoretical framework, conceptual framework and definition of terms.

1.1 Background of the Study
Science has been viewed as a tool that can assist growth in many countries. It plays central and leading tasks in spearheading industrial progress, innovation, promoting national wealth, getting better health and accelerating development (Vadya, 2003). Among the science Physics is regarded as a basic subject (Wambugu and Chengeiywo, 2008).

It imbues learners with orderly thinking and stores the theories essential for accepting the technicalities of how the things people rely on, work. It provides students with logical problem solving and skills which are significant for many sciences. The knowledge and skill to do something correct is indebted to science particularly physics owing to its importance on addressing phenomena relating the interaction of matter and power. This relation is imperative for a scientific call for altering society (Zhaoyao, 2002).

Physics continues to influence application in medicine (X-rays, Computerised Tomography Scan, Ultra-sound echo Freeman (2012) is based on Physics principles.
Currently, wide variety of treatment techniques made possible by the discovery of radioactivity. Continuing research into challenges posed by diseases such as cancer, Ebola and HIV/AIDS, require the development of high precision equipment employing Physics principles. Information Communication and Technology (ICT) is as a result of discovery of the Transistor, computers and mobile phones show indispensability of Physics. Electromagnetism is vital in the generation of electricity, optical and satellite communication, portable electronics, radio and radar perception which all creation of physics are making our world a better place to live (Campell, 2006).

However, there is a problem in Physics education in that enrolment in Physics courses at all levels is low in many countries such as Kenya, Nigeria, Uganda, Tanzania and Rwanda (Wambugu, 2008). The reasons vary from poor preparation, poor mathematics, and inadequate teacher qualification as well as below pedagogical content (Semala, 2010). A lot of students believe Physics is difficult, abstract and tiresome (Wambugu, 2008). Students differ in what they know for example prior knowledge, some study to memorise the material, others to develop an understanding of it and others to get good grades or marks. Therefore, learning strategies should entail as to how students learn what they learn or reorganise what they already know (Bennett, 2003).

Students’ learning difficulties can often be attributed to ineffective or inappropriate cognitive processes (Stanley, 2000). Physics concepts should consists of learning investigational methods and practices of scientific facts and correct theories within a given area (Wheeler, 2000). However, approaches to learning are associated with
learning outcomes (Rennie, 2003). Thus science education aims at preparing students so that they can be able to think innovatively, investigate, evaluate, experiment and are committed to pursuing the study of science then the focus should be on teaching for conceptualizing rather than memorizing science content (Barchok, 2006).

The 2009 situational analysis conducted by Centre for Mathematics, Science and Technology Education in Africa (CEMASTE) revealed that learners are involved in learning of mathematics and science when there is deliberate effort to make them understand the applicability of the content in real life situations and careers.

Okere (2004) posits that interests in learning improve by gender when there is maximum collaboration among teachers and adequate opportunities for learners to interact in groups. Students (boys and girls) study physics in form one and two. The students’ usually choose the science subjects they will study in form three. Many students do not select Physics at the end of form two; the national enrolment shows that Physics has the least enrolment of all subject. According to statistics compiled by (Elimu, 2007) the same trend is similar for African countries.

Teachers who have a teaching experience of five years from first posting and above agreed that some topics are difficult to teach and learn, such as, fluid flow, waves (II) (reflection, refraction, and interference), electrostatics (II) especially splitting of flame by charging because students cannot see the charges, refraction of light (equations are too many especially where there is multiple medium), current and electricity (II), current flow in a circuit has too many equations. Some of the reasons
advanced are that most of the concepts are abstract difficult and irrelevant. Students’ misconceptions may provide the pointers to the underlying problems and these are the issues the proposed study seeks to address. During the release of 2003 K.C.S.E results, the then minister for education noted that,

Poor performance in these subjects, Mathematics and Sciences remain a matter of concern to my Ministry. I appeal to all secondary school teachers, parents and other leaders to make deliberate efforts to improve the delivery of quality performance in these key subjects. (Aduda, 2003 p. 2).

Available statistics show that students’ achievement in science and mathematics is low nationally. Table 1.1 provides information on national performance of KCSE candidates in Mathematics and Science subjects for the period from 2006 to 2012.

Table 1.1: National KCSE Percentage Scores in Mathematics and Sciences (2006-2012)

<table>
<thead>
<tr>
<th>Year</th>
<th>Mathematics</th>
<th>Physics</th>
<th>Chemistry</th>
<th>Biology</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>19.04</td>
<td>40.32</td>
<td>24.91</td>
<td>27.45</td>
</tr>
<tr>
<td>2007</td>
<td>19.73</td>
<td>41.31</td>
<td>25.39</td>
<td>41.95</td>
</tr>
<tr>
<td>2008</td>
<td>21.30</td>
<td>36.21</td>
<td>22.74</td>
<td>30.34</td>
</tr>
<tr>
<td>2009</td>
<td>21.13</td>
<td>31.31</td>
<td>19.12</td>
<td>27.15</td>
</tr>
<tr>
<td>2011</td>
<td>22.16</td>
<td>32.62</td>
<td>23.66</td>
<td>28.62</td>
</tr>
<tr>
<td>2012</td>
<td>21.23</td>
<td>32.71</td>
<td>20.06</td>
<td>28.89</td>
</tr>
</tbody>
</table>


The result in this Table 1.1 is a pointer that all is not well as all the mean scores are below fifty percentage mark. Despite poor performance in chemistry most secondary schools have made it compulsory leaving biology and physics as optional subjects
(Changeiywo, 2000). This further explains why students choose biology as opposed to physics.

Moreover physics being a subject that is directly related to mathematics it is evident from the national KCSE results may influence physics performance. In Kenya it has been noted that many students do not select physics when given an option (physics chemistry and biology) this especially applies to girls (Aduda, 2003). Students in Kenya have also been noted to perform poorly generally in sciences (Changeiywo, 2000). This explains why Physics is not popular compared to other sciences in Kenya. Moreover, the performance of Physics is low unlike that of Biology and Chemistry in Embu County (Table 1.3). Recent findings which show that beliefs and attitudes about ability and effort are related to gender differences in academic achievement particularly in sciences and mathematics (Wachanga, 2004).

Students who have negative typecast imagery of scientists, science and mathematics in society are easily unenthusiastic from pursuing scientific disciplines and generally perform poorly in science subjects. The teacher should therefore ensure that the pedagogy employed is one which enables students to formulate tentative explanations to assist in sense making and often test them as instruction unfolds in order not to affect student’s interest (Mills, 2000).

On the nature of skills learned by students, it emerged that only less than 10% of observed lessons promoted investigative skills and problem solving (Okere, 2004). These are some of skills that students require to build up in order to see possibilities that others lack Craft (2005) the significant method involved in the learning of new
ideas Changeiywo (2000) the option to make relations with concepts that are not familiar. Moreover, it requires cognitive and innovative thinking skills, in other words different idea Schunk (2000) and thoughts Craft (2005) and also assess (Desarrollo, 2007). Process skills training in science instruction has gained importance because it advocates for student-centred practical activities. It also encourages development of creative talent, innovativeness and nurtures positive attitude to science as it involves learners in activities they perceive to be relevant to their environment and their world in general Coi, Wenderoth, Cunninghamham and Dirks (2010) consider science process skills as the underling skills leading to problem-solving which requires that students apply what they have learned to a variety of settings and situations in their day to day lives (Pravica, 2005).

The relatively poor performance in KCSE in public schools shows that the government is pumping millions of Kenyan shillings into education but students’ achievement is very low. This is bad news for the country where up to fifteen percent of GDP is used in education (ministry of education, 2012). Moreover, if the country expects to achieve vision 2030, history and social sciences will not take us there as observed by World Bank.

The World Bank is perturbed over the quality of graduates that Kenyan universities and colleges are producing in its September 2015 report, Keny’s Education Achievement and Challenges, the enrolment in critical science disciplines such as agriculture, engineering, computer science, ICT, medicine and veterinarian science is very low and growing at a very low pace as most students opt for humanities, social sciences and arts. Moreover the education system is not producing graduates with the knowledge, skills and competencies crucial for securing vision 2030. In addition Kenya’s education could surpass its performance by increasing the knowledge and skills of Kenyans for inclusive and sustainable development. (Ouma, 2015, p 11).
The setting of schooling on how well students study and teachers instruct is still comparatively unfamiliar. Contemporary educators understand that for daily living it is at least important to learn science process skills as principals and facts of science (content). Practical actions in physics give opportunities for students to really do science as opposed to leaning regarding science. Practical activities can be taken as an approach to be used to instruct students on process skills as it makes the duty of a teacher (teaching) more authentic to the students as opposed to nonfigurative or hypothetical presentation of facts, main beliefs and laws of subject matters (Madera, 2001), sensible Moreover work should engage the students in hands-on activities, using varieties of instructional/equipment to make the lesson abode.

Science process skills are the bases for scientific investigation plus the increase of intellectual skills and attitudes that are needed to gain knowledge of concepts. Teachers act discriminately encouraging and offering more opportunities to high performing students. In turn high performing students become more responsive and dominate class discussions. Teachers are in a position to determine student’s problems, the scale deficiency, or identify problems based upon students ’teachers’ own evaluation or feedback from (KNEC, 2013). Based on this challenge in teaching and learning of Physics, many students choose biology and chemistry at the end of form two as indicated in Table 1.2 in Embu County.
Table 1.2: Enrolment in Science Subjects in Form Three in Embu County.

<table>
<thead>
<tr>
<th>School name in Embu County</th>
<th>Enrolment of Biology</th>
<th>Enrolment of Chemistry</th>
<th>Enrolment of Physics</th>
<th>Total no per Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>141</td>
<td>141</td>
<td>30</td>
<td>141</td>
</tr>
<tr>
<td>SB</td>
<td>146</td>
<td>162</td>
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<tr>
<td>N</td>
<td>103</td>
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<td>5</td>
<td>103</td>
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<tr>
<td>SG</td>
<td>130</td>
<td>130</td>
<td>36</td>
<td>130</td>
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<tr>
<td>NG</td>
<td>143</td>
<td>143</td>
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<td>137</td>
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<tr>
<td>KB</td>
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<td>25</td>
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<tr>
<td>ED</td>
<td>33</td>
<td>40</td>
<td>7</td>
<td>40</td>
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<tr>
<td>KB</td>
<td>104</td>
<td>104</td>
<td>34</td>
<td>104</td>
</tr>
<tr>
<td>TG</td>
<td>69</td>
<td>69</td>
<td>5</td>
<td>69</td>
</tr>
</tbody>
</table>

**Source:** County Education Office (2013). Embu County Evaluation Mocks form three October / November 2013.

In Embu County, Physics is the least chosen subject compared to Biology and Chemistry as shown in table 1.2. Reasons advanced are, shortage of trained teachers which has caused many schools to accept untrained teachers who are not aware of modern trends in teaching Physics (Wachanga, 2002) and the content in secondary school Physics syllabus shows that there are many topics where resources to teach the subject are not available and the students are left to make meaning on what is being taught (Wachanga, 2004). Moreover Physics is considered abstract, difficult and boring.

Steady decline in academic achievement scores in sciences and mathematics of high school students has caused a deep concern in many African countries (Ogunniyi, 2002). According to Tsuma (2000), the main serious predicament in Africa today is the decline on the quality of teaching/learning of mathematics and science. In Kenya
for instance, the KNEC reports KNEC (2013) indicate that the performance of Physics at KCSE rank is low compared to other subjects despite numerous curricular changes (Changeiywo, 2002).

Science process skill of investigation is very important for technological development and the understanding of scientific concepts, scientific knowledge and particularly Physics knowledge is fundamental in food production, industrial growth, economic growth and healthcare facilities among other socio-economic needs (Changeiywo, 2000; Okere, 2004). All these can only be achieved if students acquire the skill of investigation. It is therefore important to establish the students’ level of performance on this skill.

In secondary schools, students’ performance in Physics practical is quite low and this directly contributes to the overall poor performance in Physics in KCSE (KNEC, 2013). In Physics practical’s, students are expected to make correct observations, readings, recording evaluation and interpretation and all these skills are subsumed (that is to place under another as belonging to it) in the science process skill of investigation. KNEC (2013) however, does not specify which aspects of the science process skill of investigating are contributing to students’ low performance in Physics practical in KCSE. The study therefore aimed at investigating how students performed on the skill of science process skill of investigation on the topic “Electricity (II) in Physics.”

The main reason of scientific investigation was to build up explanations of normal phenomena in a systematic and inventive process. Learners were to access, create,
practice and transfer information using appropriate technologies (Wan and Van, 2006). Within the use of logic and consent, scientific investigations involve the test of anticipated explanation connecting the use of conventional techniques and procedures and typically require substantial creativity (Zhu, 2007). It is widely acknowledged that education, especially Physics education is very significant in once life in and after school.

Okere (2004) views the process of learning something as being able to comprehend what the information is all about. Teachers should therefore help the students understand the nature of the physical world they live in using the appropriate knowledge and simple scientific language. According to Cherrholmes (2001) greater symmetry is needed for the students to learn, express and gain the confidence to explore, experiment, discuss, interpret, evaluate, present and take responsibility. Therefore, teachers should help Physics students to move beyond reliance upon positivistic knowledge received from authority to experiment, critical reflection and judgement. Moreover the content in secondary schools shows that there are many topics where resources to teach the subject is not available and the students are left to speculate (Ndirangu, 2000).

Science process skill of investigation unlike other process skills subsumes other science process skills, like observing, evaluating, reading, interpreting and recording. It then follows that any science practical activity which requires students to apply the above science process skill is basically testing the students’ ability on the science process skill of investigation (Bailey and Millar, 2000). According to KNEC (2013) major area of difficulty experienced by many students is with use of
circuit diagrams as conveyors of precise information. It is therefore of interest to see how students fare on in a practical activity which utilizes circuit diagrams.

1.2 Statement of the Problem

The place of work has changed on in various ways and so it follows that methods of imparting skills ought to be reviewed. Stokking (2000) contends that knowledge of Physics is crucial in several professions and for trade and industry development, however in Kenya, data illustrate that there is a gap as science classes are expected to nurture skills of identifying and solving real world problems in student’s. Moreover, performance is poor at KCSE level in Embu County.

Curriculum developers and employers for a long period have spoken about the developing gap between the knowledge and skills students ought to obtain in school and being competent in life after school. In order to resolve the problem facing the world today, the future of education and teaching lies in finding and promoting inventive ways of imparting skills and attitudes that promote ingenious thinking and problem-solving as a substitute of the recent pedagogies that edge on rote learning (Changeiywo, 2000). There are indications that the skill of scientific investigations is receiving least attention in Kenyan secondary schools and public universities.

Findings of a survey on training needs of teachers Okere (2004) shows that teachers rarely provide learners with opportunities to solve non-familiar problems. This state of affairs is also reflected in examination performance where real world problems or questions in science and mathematics are avoided by most candidates (KNEC, 2013). Therefore, the goal should be to integrate process skill based learning in
teaching and learning. Further, Harlen (2004) noted that there is a growing gap between integration of communication and collaboration skills in teaching and learning which are meant to enhance the attainment of three key skills in science namely; process skills; critical thinking and reasoning skills. The current study was designed to fill this knowledge gap. Students’ performance in KCSE mathematics, physics, chemistry and biology in Kenya generally and in Embu County in particular is below average compared to other subjects.

In reaction to such poor performance in mathematics and science the government of Kenya has tried to resolve the situation by in servicing teachers with recent methodologies of teaching science and mathematics which are student-centred through SMASSE projects, offering monetary support to students and re-evaluation of syllabus. Despite these efforts, there is little impact on mathematics and physics performance in Embu County as shown in Table 1.3. This is evident from result of KCSE for the years 2007 to 2013.

**Table 1.3: Performance and Enrolment in Mathematics and Science Subjects in the years 2007-2013 in Embu County**

<table>
<thead>
<tr>
<th>Year</th>
<th>Mathematics Enrol</th>
<th>M/S</th>
<th>Biology Enrol</th>
<th>M/S</th>
<th>Chemistry Enrol</th>
<th>M/S</th>
<th>Physics Enrol</th>
<th>M/S</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>4392</td>
<td>2.048</td>
<td>4162</td>
<td>4.163</td>
<td>2500</td>
<td>3.961</td>
<td>829</td>
<td>3.811</td>
</tr>
<tr>
<td>2008</td>
<td>4367</td>
<td>2.177</td>
<td>4132</td>
<td>4.574</td>
<td>2611</td>
<td>4.45</td>
<td>857</td>
<td>4.444</td>
</tr>
<tr>
<td>2009</td>
<td>4098</td>
<td>2.709</td>
<td>2813</td>
<td>4.791</td>
<td>2400</td>
<td>4.624</td>
<td>991</td>
<td>4.38</td>
</tr>
<tr>
<td>2010</td>
<td>3935</td>
<td>2.678</td>
<td>3373</td>
<td>5.086</td>
<td>3498</td>
<td>4.462</td>
<td>1053</td>
<td>4.313</td>
</tr>
<tr>
<td>2011</td>
<td>4317</td>
<td>2.759</td>
<td>3110</td>
<td>5.103</td>
<td>3060</td>
<td>4.34</td>
<td>1032</td>
<td>4.322</td>
</tr>
<tr>
<td>2012</td>
<td>4364</td>
<td>2.821</td>
<td>3224</td>
<td>4.403</td>
<td>3169</td>
<td>3.718</td>
<td>1173</td>
<td>3.699</td>
</tr>
<tr>
<td>2013</td>
<td>4390</td>
<td>3.021</td>
<td>3310</td>
<td>4.502</td>
<td>3259</td>
<td>3.818</td>
<td>1214</td>
<td>3.799</td>
</tr>
</tbody>
</table>

**Source:** County Education Office (2013). 2013 (KCSE) Result Analysis. Sub-county Education Office: CEO.
Among the sciences, physics is the least chosen by students after form two as shown in Table 1.3. The mean score of mathematics is the lowest compared to chemistry, biology and physics implying that performance in mathematics is directly proportional to that of physics, as most concepts, laws and principles in physics are normally expressed in mathematics. This means that there must be factors which have not been addressed as far as students’ performance in physics is concerned. It is due to this low performance that this study of investigative science process skill teaching strategy on students’ achievement, problem solving and motivation in secondary school physics in Embu County, Kenya was carried out.

1.3 Purpose of the Study
The study is intended to investigate the effects of integration of investigative science process skill teaching strategy on students’ achievement and the resulting problem solving abilities and motivation towards learning of Electricity (II) in selected secondary schools in Embu County, Kenya.

1.4 Objectives of the Study
The objectives of the study were:

a) To determine the gain in students achievement in school physics (Electricity II) when using Investigative Science Process Skills teaching strategy.

b) To determine the gain in problem solving abilities of learners in physics (Electricity II) when using Investigative Science Process Skills teaching strategy.
c) To establish effect of Investigative Science Process Skills on students’ motivation towards Electricity (II) compared to conventional teaching strategies.

d) To determine gender differences in achievement among the students taught through Investigative Science Process Skills teaching strategy in the topic “Electricity (II).”

e) To establish if there is any difference in achievement among the students taught through Investigative Science Process Skills teaching strategy based on the school category.

1.5 Research Questions

a) How does use of Investigative Science Process Skills Teaching Strategy affect students’ achievement in Electricity (II) as compared to conventional teaching strategies?

b) How does use of Investigative Science Process Skills Teaching Strategy affect students’ problem solving abilities towards learning Electricity (II) as compared to conventional teaching strategies?

c) How does Investigative Science Process Skills affect students’ motivation towards learning Electricity (II) as a topic compared to conventional teaching strategies?

d) How does gender difference affect achievement among the students taught through Investigative Science Process Skills Teaching Strategies?

e) How does difference in achievement affect students taught through Investigative Science Process Skills teaching strategy based on the school category?
1.5.1 Research Hypotheses

The study was guided by the following null hypotheses:

Ho1: There is no significant difference between student’s achievement scores in Electricity (II) of students who are exposed to Investigative Science Process Skills (ISPS) teaching strategy and those taught using conventional methods.

Ho2: There is no significant difference in problem solving abilities towards learning Electricity (II) between students who are exposed to Investigative Science Process Skills (ISPS) teaching strategy and those taught using conventional methods.

Ho3: There is no significant difference in level of motivation towards Electricity (II) a topic in physics among students who are exposed to Investigative Science Process Skills (ISPS) teaching strategy and those taught using conventional methods.

Ho4: There is no significant difference in achievement scores in physics test between boys and girls who are exposed to Investigative Science Process Skills (ISPS) teaching strategy.

Ho5: There is no significant difference in achievement scores between students who are exposed to Investigative Science Process Skills (ISPS) teaching strategy based on their school category.

1.6 Significance of the Study

According to Harlen (2004), the use of appropriate teaching method(s) by science teachers should play a key role in helping students develop their ideas and process skills such as experimenting, investigating, observing, hypothesizing, predicting, drawing conclusions and communicating. ISPS lead to acquisition of problem
solving, achievement and motivation in physics. This can ensure that the number of students taking science courses at the universities increases if teachers employ effective and efficient teaching methods which facilitate students learning of science by promoting cognitive and effective characteristics of the learner. This need is expected to be met by use of ISPS teaching strategy in this study. Physics is an important subject for school leavers for making career choices at the universities and middle level colleges. Good results are ideal in the present world for one to fit in technological advancement (Harsten, 2005).

Teaching investigative science process skill is important for transferability of learning. That is once a skill has been acquired, it may be transferred to a new area of application (Okere, 2004). The investigative science process skill teaching approach enhances the idea of “science for all” in that skills acquired are not forgotten easily and that the students will use such skills later in life. Moreover, it enhances pupils’ attitude towards learning science. It is believed to be flexible, makes the knowledge more relevant to the pupils. The results of this study will be used for further research on inventive teaching strategies in Physics education. The findings will play an important role in formulation of policies and strategies aimed at reversing the negative trends in Physics education; particularly the issue of under achievement. The positive effect of ISPS teaching strategy on students’ achievement in this study will help in sensitizing policy makers and curriculum developers to formulate relevant policies that advocate teaching strategies that promote meaningful learning.
1.7 **Scope of the Study**

The proposed study involved form 3 students selected randomly from secondary schools in Embu County. The county has numerous categories of schools, that is, National schools, Extra County schools and Sub-County school. Eight schools were selected four boys only and four girl’s schools. Form 3 students were chosen because the topic involving Electricity (II) was taught in this class according to secondary syllabus KIE (2007) and that Form 3 students could express their scientific ideas in written form (Githua, 2002). This topic Electricity (II) was chosen because students’ performance in this area has been poor in Physics KCSE exam paper 3 KNEC (2014). The study focused on county secondary schools. In addition students admitted to these schools had almost the same entry behaviour County Education Office (2011) thus providing a basis for generalization of the results.

1.8 **Limitations of the Study**

The study focused on Form three students drawn from eight randomly selected county schools in Embu County. Conclusions were confined to form 3 students enrolled in these schools in Embu County. In addition this study was conducted within a specified time frame and resources of the researcher. Therefore, only identified variables (achievement, problem solving abilities and motivation levels) of sampled schools were studied.

The topic, covered in the study was presented in the approved KIE New Syllabus (2007) therefore the generalization of the results was limited to this topic and not Physics as a subject.
1.9 Assumptions of the Study
The study assumed that:

a). The study was not to be interrupted by administrative constrains (like students unrest) or non-attendance of some students in schools.

b). The schools included in this study sample were to provide a good classroom environment for the learners.

c). The teachers involved in the study were trained teachers, having a minimum of five years of experience.

d) ISPS has an input on students learning of physics in Embu County.

1.10 Theoretical Framework
The theoretical framework of this study is on social constructivist theory of learning. Constructivists’ theory who view learners as constructors of meaning from input by processing it through existing cognitive structures and then retaining it in long-term memory (Orora, Wachanga and Keraro, 2005). In this sense, learning is viewed as an activity which involves constructing meaning through a social process where students interact with one another as well. This objective is achieved in a physics lesson through class experiments where students work in groups of four or five students (Okere, 2004). Consequently teaching must put in consideration what is in learner’s mental experiences. According to constructivist school of thought, knowledge is not transmitted into the student, instead students build meaning from their interactions with one another (Pravica, 2005). Constructivists’ theorists assent that individuals actively develop knowledge they possess. This development of knowledge is a lifelong process requiring significant mental engagement in learners (Brook and Brook, 1996). Constructivists do centre on the
following: They support and believe in varied viewpoints, they employ major sources beside scheming, inductive and objective resources, give confidence to students in prior knowledge as they construct new meaning and they let students’ reactions towards lessons as well as alter the teaching approach used

Individuals learn through a continuous process of modifying and interpreting their own experiences.

In their point of view the instructor provides leaners with experience that let them to calculate and control objects, they reconstruct meaning further from students’ inquest and discussions.

Students should be given opportunities to alter concepts, prove laws, observe and draw conclusions (Driver and Oldham, 2004). Constructivists teaching take into account what students come in with initially at the beginning of instruction. This makes the learners to practice and rebuild new experiences as they go up the academic ladder. Researchers have investigated many teaching pedagogies from constructivist teaching/learning arrangement (Brown, 2001 and Campell 2006). In restructuring their leaning Students’ information is clarified and exchanged all the way during dialogue and learners can expand technical facts. Learners are set for a chance to experiment their facts and their experiences with cognitive disagreement. They connect and get solutions to their problems.

Research studies made known that constructivist teaching strategies are of use not only in attainment but also help learners build their views about science and enlarge their thinking ability. Carey et al., (2007) portends that prior to the constructivist
theory, teaching methods included scientific inquiry; most learners viewed science as a way of accepting facts about the world and promotion of conceptual change. The science syllabus in high school need to practice strategies that are rich in variables and conditions which can be designed into numerous teaching methods to improve structural knowledge by a process (Ausubel, 2000). An ordinary aspect of constructivist learning, which create opportunity for students’ learning and understanding. Although different teaching approaches are being employed, students continue to hold their wrong conception that is why the current study is designed aiming to resolve the outcome of ISPS on student’s achievement problem solving abilities and motivation.

1.1 Conceptual Framework

Constructivists state that the instructor needs to guide the learners in an attempt to provide an environment conducive for students to construct meaning at individual and group level (Duit and Treagust, 2003). Knowledge is actively built by the students in collaboration with his/her world (Piaget, 1950). This intern brings about self-directed learning and ultimately facilitate the construction of new knowledge (Piaget, 1972). It should, however be noted that there is dispute about which of the activities in a physics lesson contribute to scientific achievement are skills which ones are processes.

To overcome this difficulty it is convenient to refer to all those activities that contribute to scientific learning as process-skills (Okere, 2004). The use of investigative science process skill is linked to constructivist teaching because it involves activities that define the teacher as a facilitator and enables students to
construct meaning that leads to scientific learning. Moreover ISPS is a hands-on explorations that fuel the construction process, letting them discover by themselves, thus students come to make sense of their experience, gradually optimizing their interaction with the world. When you investigate, you gather information about a problem. Knowledge is not merely a commodity to be transmitted, encoded and reapplied but a personal experience to be constructed making the study to hold the view of knowledge construction as demanded by constructivist theorist. It involves using your senses and planning. The difference between experimenting and investigating is that in the former the ideas to be tested and the equipment to be used are provided; while in the latter the student has to think of the apparatus as well as the procedure to be used (Changeiywo, 2002). It is therefore significant that a study that involves students in investigative science process skill is likely to lead to meaningful learning as well as scientific achievement compared to conventional methods of learning. The link between the independent variable, intervening variables and dependent variables is diagrammatically represented in figure 1.1.

**Figure 1.1: Conceptual framework**

**Source:** (Fairbrother, 2000).
Scientific Learning is subjective to factors such as, teacher-methodology, learner’s prior knowledge, resources available, individual differences and classroom environment. The factors are interconnected to facilitate the teaching/learning procedure, which eventually influences the students’ achievement and motivation in Physics. Teacher training and experience determine how effective a teacher is. The study will involve qualified Physics teachers with a minimum of five years teaching experience. It is assumed that these teachers will therefore teach in comparable ways (Fraenkel and Wallen, 2000).

1.12 Definition of Terms

**Achievement** - refers to students performance in Physics Achievement Test (PAT)

**Constructivism** – theories developed in which learners are seen as constructing new meaning from input by processing it through existing cognitive structures and then retaining it in the long term memory either individually or socially.

**Conventional teaching strategy** – in this study it refers to instructional strategy where the teacher dominates during learning process with minimal learners talk and activity. The instruction is teacher and text book centered.

**Electricity** - refers to the flowing motion of electric charge.

**Extra County Schools**- Public schools within the county allowed admitting students from other counties (previously known as provincial schools).

**Gender**- gender refers to the difference between boys and girls in Social-cultural aspects rather than physical difference only consequently resulting in society assigning different roles to boys and girls.
**Investigative** - sometimes you may have ideas why something happens or predict a relationship between two variables. When you test your ideas, you are investigating.

**Investigative Science Process Skill Teaching Strategy (ISPS)** – a method of teaching where learning is seen as involving change in learners, conceptions and self-discoveries. This occurs when learners interact with apparatus through internal reflection.

**Motivation** – it is the effort which the learners put into learning as a result of their need or desire to learn. In this study motivation refers to students’ effort put in as a consequence of their desire to learn Physics as a subject. MTC will be measured along four dimensions: perceived confidence, perceived choice, and perceived pressure/tension in this study.

**Performance** - refers to the overall grades a student attains after a prolonged period of instruction.

**Physics** - Branch of science that deals with matter in relation to energy.

**Problem–Solving** – Application of scientific knowledge, concepts, principle strategies in an attempt to get a solution to a problem.

**Science**- is the system of thinking about the universe through data collected by observation and controlled experimentation. It is also a body of knowledge about the universe.

**Science process skill** – refers to all those activities that contribute to scientific learning.
CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction
This chapter covers a review of literature relevant to the study. Academic achievement gains from integration of ISPS in teaching of Physics, Gains in problem solving abilities from integration of ISPS in teaching of physics, Effects of achievement/evaluation on scientific investigations, ISPS teaching Physics for discovery learning, Effect of integration of ISPS in teaching on academic achievement by gender and enhancement of science process skills in learning of physics, gender and learning physics, teaching for development of favourable attitudes, attitude and achievement in physics learning, Effect of integration of ISPS in teaching and motivation towards learning of physics, motivational factors in learning of physics, goal orientation and engagement in physics, values and interests, belief in self; motivation for Physics learning, foundations of constructivism theory on learning of physics, and finally a summary of literature review - gaps.

2.2 Academic Achievement Gains from Integration of ISPS in Teaching of Physics
Meaningful learning takes place as soon as students can bear in mind and make meaning of structural knowledge and are capable of applying what they have well-read (Anderson and Krathwohl, 2001; Bransford., 2000). The capacity to relate information to a new state of affairs is determined by the extent to which students study Physics all through insight. To structure knowledge in Physics, lessons and
teaching/learning activities need to be organised in such a way that students are inquisitive, the context is meaningful and of interest to the students. According to Wachanga and Mwangi (2004) learning occur when students look for information and relate it to pertinent existing new facts and principles in their cognitive formation. Noteworthy knowledge occurs progressively over time (Shuell, 2004). According to Hodson (2003), knowledge in a skill rich setting is significant if education is lively (controlling) productive, introspective intended and genuine (multifaceted and appropriate and helpful, concerted and chatty). Knowledge is significant, improved and liable to reassign to new situations especially in real-life (Hodson, 2003). Students, who have not acquired significant learning, learn by rote (Novak and Gowin, 2002). The main restrictions of rote knowledge are pitiable retention and repossess of new ideas, possible meddling in later learning of connected concepts and failure to use the new information to solve innovative problems. Wachanga and Mwangi (2004) assert that achievement in significant learning depends on three factors (Osborne, 2002).

The context measures the degree of cognitive strategy employment independently from knowledge acquisition, the context permits the students to construct concepts through his/her own cognitive efforts and employ this knowledge in proposing solutions and making decisions. The context is in built on new knowledge. If these factors are not met then memorization takes over. Learner skill–building for significant knowledge is a difficult process (Bransford, Brown and Cocking, 2000). It requires a rational endeavour or action connecting diverse learner–centred actions. To be precise, past knowledge is vital in knowledge–building processes. Students construct their logical knowledge in Physics ahead of what they previously
recognize and accept as true. Students articulate new technical information by modifying and enlightening their present skills in Physics and adding up innovative concepts to previous ones. Learners moreover, construe data based on their potential and environments (Oyoo, 2007). For instance, learners who do not have hypothetical framework towards making-measurement, or tasks on how to evaluate, interpret, predict, and expected observation and analysis of what they do in experiment / practical work (Hodson, 2003).

An important goal of education is the development of learners who can be responsible for not only employing their existing knowledge but for creating new knowledge so as to do away with miss- conceptions that might hinder their capacity to find out new things (Brandsford et al., 2000). Ndirangu, Kathuri and Mungai (2003) indicate that denotation is a mixture of reflection, language, understanding and interaction. The function of common experiences is essential in knowledge building and its growth (Anderson and Krathwohl, 2001). Student knowledge can be facilitated by others and can lead to the processing of information insides ones head before making generalization regarding the trend of data, making conclusions from observations or using experience and acquired knowledge (Song and Keller, 2001). In cooperation, student-teacher relations are crucial for significant learning which can be improved by cognitive kit as science process skills. In addition, valuable learning needs students to be able to manipulate their own learning in expression and self-evaluation (Brandsford et al., 2000).

A major impediment to students’ relations to various principles of human learning, which include the necessity of having a logical relationship between the objectives
of instruction, content to be taught, the practice and application exercises is what is used to develop learning and the evaluation methods used to assess mastery (Salim, Puteh and Daud, 2011). The operational remembrance is often loaded with inward bound information in the course of experiments. Moreover, differences in assignments and assessment procedures will produce differences in students study patterns and differences in what students’ learn and retain.

In science education, instruction involves conceptual change rather than infusion of information into a vacuum (Sadiq, 2003). This is due to prior knowledge that student brings to a learning situation and this prior knowledge establishes a framework within which new input is interpreted. When this knowledge brought to new learning situation is accurate, the results of learning are authentic. However, if prior knowledge includes misconceptions the results may be distortion or rejection of the new learning (Kim and chin, 2011).

In order for students to construct new meaning in Physics learning, they should then include science process skills to enable them adapt to inventiveness, problem solving, introspective thinking and creativity which are vital ingredients for logical and scientific growth of any country. Science process skills when learnt in the minds of students, helps students in construction of knowledge both in laboratories, social environs and classrooms. Science process skills are inseparable in practice as they form conceptual understanding involved in learning (meaningful) and applications in sciences and mathematics (Okere, 2004).
Rational model, according to Nersessian (2003), happens mostly when learners get significant learning. This is only likely to happen when the misconceptions are well anchored in the student’s personal experience and are not resistant to change. Knowledge of laws, theory and facts is nonetheless complicated (Juma and Cheong, 2005). In order to fill the knowledge gap of imaginative learning so that students can visualize the ideas and hence have a better understanding (Wheeler, 2000) the evidence is obtained from an investigation of the performance on the skill by high school students, A-level and first year Bachelor of Education.

According to Okere (2004) Physics students for example 90 pupils out of 146 tested were unable to carry out an experiment on internal resistance of a cell. The low performance on the skill of the design of scientific investigations is partly due to the lack of practice on the skills of investigation. Moreover, science process skills approach enhance “science for all”, pupils attitudes towards learning of Physics and above all it is more flexible, and makes the knowledge more relevant to the pupils as it is more of hands on activity and it is hence motivating (Ndirangu et al., 2003).

Even though, numerous problems continue to confront attainment of projected education goals as envisaged in the vision 2030 development strategic plan. One of the notable challenges is the poor performance in science examinations. Students are reported to have poor mastery of the content; poor scientific language; poor understanding of concepts and inability to relate Physics knowledge to real life situation (KNEC, 2013). Various modern approaches are adept to deal with the dilemma. In spite of the implementation of these diverse approaches to learners, achievement at KCSE examinations is nevertheless poor. Science process skill
knowledge is a necessary component in various pedagogical models to facilitate meaningful Physics learning. The use of investigative science process skill teaching strategy in this study intends to facilitate meaningful learning, peer interactions and assist students to comprehend the contents of Physics in order to fill this gap.

2.3 Gains in Problem Solving Abilities from Integration of ISPS in Teaching

There is no creativity in rote knowledge, there is merely lifting and duplicating what the instructor says (Wasanga, 2009). Failure to adequately impart science process skills is a pointer to weaknesses in instructional strategies used by teachers. It could also be an indicator of ignoring science process skills during implementation of the curriculum. Teaching of physics concepts must consider the fact that students are not inert vessels into which information is poured relatively, they are dynamic participants in the learning process, come from varied backgrounds and that they do not all learn in the same way.

Hence, teaching should not be considered a linear process with one-way delivery of content and concepts (Wambugu and Chengeiywo, 2008). Novel inventive instruction approaches such as ISPS are being employed to improve achievement, problem solving and motivation among Physics students. There is limited information on its effects (KNEC 2005, 2007, 2009, 2011, 2012, & 2013). A good teaching strategy promotes development of both cognitive as well as effective characteristics of learners. The present study is designed to determine the effect of investigative science process skill teaching strategy on secondary school students’ achievement, problem solving and motivation towards Physics learning.
On average students perform poorly in science subjects as compared to social science subjects. A close analysis of questions performed poorly by the candidates show that students have glaring weaknesses in answering questions. Weaknesses noted include poor interpretation of questions, poor scientific language, poor understanding of Physics concepts and inability to relate Physics knowledge to real life situation (KNEC, 2004; 2007 and 2011). These weaknesses are most likely derived from poor teaching/learning strategies employed. Duffy and Jonassen (2008) assert that teachers should develop in the process of knowledge construction to enable them to learn meaningfully. Knowledge is taken to be an active constructive, cumulative, self-regulated and goal-oriented process in which the learner plays a critical role (Trowbridge, Bybee, and Powell, 2004).

Teaching should involve advancement of instructional methods that hold learners enthusiastically in the course of knowledge acquisition. Investigative science process skill teaching strategy proposed in the present study is one way towards this end. Instruction has frequently focused more on transmission of information than on knowledge construction (Zohar and Duri, 2003). Students frequently would like to know the right answer (Bennett, 2003). It is therefore important to have student-centred learning environments that give confidence, motivate students to build up and set up a broad array of practical and meta-cognitive facts as well as broader variety of cognitive process at school (Anderman and Young, 2000). Research on both efficient and cognitive aspects of the learners in relation to teaching and learning strategies (Okere, 2004), schools will have to engage students with strategies that will enable every learner to harness their potential through activities inclined towards equipping students with investigative skills and that can help
learners in life (Young, 2000). Much of the research that has been carried in Kenya as related to teaching/learning process centred on the cognitive aspect of the learners in terms of achievements; instructional methods used by teachers; motivation towards science and mathematics as well as factors that affect science performance (Kiboss, 2003; Okere, 2004; and Changeiywo, 2000). None of these studies sought to determine the effect of teaching strategy with an aim of promoting construction of new knowledge learning.

Salleh (2004) labels Physics as difficult, uninteresting, and have remained so for many decades. Such perceptions appear universal. Somehow the traditional system of Physics education has not been able to overcome this problem. Millirun (2007) notes that if we endow ‘our’ students with skills such investigations, data presentation and evaluation of experimental results, significant thoughts and ingenuity they will be better prepared in future. This can only be achieved by teaching of Physics in secondary schools. Physics endeavours to appreciate the daily occurrences of phenomena like eclipses, lightening, mirages and laws governing their formation. By conception of these laws, we can better interact with and harness our environment.

Pravica (2005) portends, there are certain skills involved in a class investigation that students must have first, reformulating general statement that are testable; second, criticizing given experimental procedures and suggesting improvement that could be made to them; and third, devising, and describing the sequences of investigations (Oyoo, 2007). It is important to note that the first and second skills fall into the sensitivity of creativity (Salleh, 2004). Moreover, in the course of scientific
investigations students’ knowledge and understanding of concepts in physics are made clear as explanations are made during group discussions and presentations of data. Omosewo (2000) adds that, most of practical work in physics involves measurements or observation Manoah, Indoshi and Othuon (2011) point out that, poor performance in Physics is due to factors such as teachers not using student-centred approaches, lack of experiments, practical’s, trained teachers and lack of resources that could have brought about problems in learning of Physics in secondary schools.

Many teachers point out that low achievement could be as a result of negative attitudes by the learners as well as omitted linkage between primary and secondary (Mohan, 2007). Whereas school environments that are focused on demonstrating high ability and competing for grades can increase the academic performance of some students, research suggests that many young people experience diminished motivation under these conditions. Motivation focus about procedures that explain objective directed activity (Pintrich, Marx and Boyle, 2000). Moreover incentives also explains mental action such as assignment engagement such as interpretation, data presentation, activity choice, which is subsumed in the science process skill of investigation (Millar, 2004).

Students can be helped to understand Physics concepts, principles and laws in order to equip them with necessary skills for job opportunities in future through implicit teaching of science process skills that help students acquire a reputation of these skills and thereby augmenting their content, acquisition in the process ( Salleh, 2004). In Physics investigation science process skill is an indispensable tool of
helping student’s achievement and motivation. According to Monoah, Indoshi and Othuon (2011), there are fifteen process skills. These are: discussing, planning, recording, presenting, applying, classifying, evaluating, experimenting, hypothesizing, inferring, interpreting, investigating, observing, predicting and questioning. In secondary schools teaching science process-skill is based on the notion of transferability of learning. That is once the skill has been acquired it may be transferred to new areas of application. Secondly, the process-skill based approach enhances the idea of “science for all”. In particular it is believed that pupils do not forget the skills they have acquired very easily. Thus they will use such skills later in life even if they do not proceed to learn science to higher levels of education (Stokking, 2000).

The third argument in favour of process-skill based approach in the teaching is that it enhances pupil’s attitude and motivation towards learning of Physics. Many pupils shy away from Physics because of the content approach which they believe makes the learning more difficult. Fourthly, it is believed that the process skill approach is more flexible, makes the knowledge more relevant to the pupils and it is hence motivating. It is upon these reasons that the present study is designed.

A study by Okere (2004) portends that, there exists a relationship between three elements of science and scientific investigation illustrated in the figure below.
Organizing data by human mind goes beyond the empirical observation of events phenomena. It involves identification of patterns and relationships, Okere (2004) views the process of learning as being able to comprehend what the information is all about. Teachers should therefore help the students understand the nature of the physical world they live in using the appropriate knowledge and simple scientific languages.

Reasons advanced to poor performance in science especially Physics is failure by the teachers to use strategies that captivate learners during instruction. Brown (2001) portends that quest for better teaching strategies have been going on for a long time. According to Kiboss (2003) nearly all the teaching strategies practiced in Kenya schools are mostly expository and facts orient making students to be passive.

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**Figure 2.1: Relationship between Three Elements of Science and Scientific Investigation**

*Source: Okere (2004)*

Investigation of phenomena in nature
- Events
- Objects
- Relationships

Scientific motivation attitudes and processes
- Motivation and attitudes
- - Intense curiosity
- - Humility processes

Scientific products
- Facts (factual data)
- Concepts
- General factors
- Principles
- Theories
- Laws

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Kochhar (2000) argues that the best curriculum and the most ideal syllabus remain boring if not converted into exciting and interesting by the right teaching methods. As a result, there is need to improve the teaching of Physics subject. The research finding in Kenya indicate that gender difference in Physics achievement begin to appear in lower classes and increase in higher levels in college and universities (Okeke, 2007). This gender differences is attributed to the interaction of factors within the school environment. Eshiwani (1995) argues that science and mathematics in classroom has been depicted as masculine subject where the link between science, classroom and its relevance outside is lacking.

Practical in Physics involve teachers’ demonstrations in class experiments hence it is teacher centred while class investigations are students centred and are better than teacher demonstrations because pupils develop manipulation skills (Okere, 2004). During class investigations pupils are divided into groups, and are given clear instructions. These instructions should be in a worksheet and should be clarified orally with the help of a chalkboard. Instructions are given at the beginning of the investigation but if the teacher finds out that a point which has been misunderstood by pupils he can call attention and give new instructions.

Wachanga (2002) demonstrated that the class investigation method can be improved by incorporating co-operative learning in it. In this strategy, the students groups are constituted in such a way that they meet the elements of co-operative learning, which includes group heterogeneity – group should be limited to four or five people and be heterogeneous as possible (males and females with different abilities), group goals and positive independence. A single goal (e.g. grade) must be established.
Each member must achieve the objectives or make specific contributions for the group to attain the reward and promote interaction made necessary by positive interdependence. Students must be shown how to help one another to achieve the goal. Techniques such as peer tutoring, challenging one another, reasoning and mutual encouragement are examples.

Individual accountability - Each member must make significant contribution to a goal. Interpersonal skills – positive interaction cannot occur without effective face to face interactions. Students must be keen at skills such as leadership, decision making, clear communication and conflict management. Group cohesion and productivity are not forth coming if individuals are stubborn. Equal opportunities for awareness – given the above conditions all students must be allowed to contribute in their own way. This is done through comparable class group competitions. Team competition – competition can be effective if it involves well matched competitors, this is done without norm referencing, and is not used too frequently. Okere (2004) found out that students’ motivation and achievement are enhanced when cooperative learning is introduced in Physics class investigation. The study intends to determine the effects of investigative science process skills teaching strategy as a method of instruction in Physics education.

2.3.1 Effects of Achievement/ Evaluation on Scientific Investigations

Process skill of investigation largely depends on the ability to analyse, interpret and evaluate the readings obtained from an experiment. According to Millar (2003), evaluation is the process of judging the activity that has been done and deciding whether or not it was done fairly. In physics education, the activities that require
evaluation include statements of the problem, which is judging whether or not a problem is expressed in such a way that it is testable (Bailey and Millar, 2000). The next level of evaluation is about criticizing experimental procedures and suggesting improvements that could be made to such procedures. The task involves identifying the variables to be controlled in order to make the results of the scientific investigation fairer (Okere, 2004).

As students become more conversant with the evaluation process they make judgement about the reliability of the experimental results (Black, 2004). The ability of students to evaluate their readings will make them reason logically about the dependent, independent and control variable in any experimental set up. In KCSE, students are always required to evaluate their readings hence, if the students have good ability to evaluate their readings in an experiment the performance, of students in Physics will improve. According to KNEC (2012) students’ poor performance in Physics is attributed to students’ in ability to evaluate their readings correctly. Okere (2004) investigated on the use of result from an experiment by A-level students on performance of charcoal cooker. A housewife bought two types of charcoal cookers A and B. She wanted to find out which of the two cookers would cook fish faster. He found out that only twelve students out of 146 could evaluate the results from the experiment while 55 students were unable to do any evaluation. This implies that, students carry out experiments in the labs but they are never made to become sensitive to their experimental results. For the school system to produce innovative students, the scientific creative skills especially the evaluation of experimental data has to be emphasized (Wollman, 2002).
This study will investigate if form three Physics students are able to evaluate their readings. Osborne (2002) indicates that Physics encourages the formation of scientific attitudes relevant to developing society. Wachanga (2002) contends that knowledge of science occupies a central position among traditional science subjects. Physics knowledge has been used to solve problems affecting communities in Kenya. A nation will hardly develop simply by sending students to school but rather providing meaningful and relevant education that is translated to problem solving which in turn translates into national development; through Science and Technology education (STE); which is regarded as a vehicle for economic and social development in country (Shuell, 2004). Based on this premise, the government of Kenya has put in place policies on education and training for its citizens to ensure overall success in its development strategies (Republic of Kenya, 2005).

Some of the developments in Physics education taking place currently in Africa as well as in the international world which can affect the teaching/learning of Physics in Kenya include one process versus content approach to the teaching of Physics. That is a knowledge based curriculum has little relevance, because of the explosion in information and the ease with which it can be accessed. On the other hand, the process skill alternative focuses on qualities of science education, which will be of value when the facts are out of date or have been forgotten.

Okere (2002) portends that, the main reason in favour of teaching science process skills is based on the notion of transferability of learning. Once a skill has been acquired it may be transferred to new areas of application. For example, if a student has acquired the skill of prediction. Through training in Physics, one would expect
such as a student to apply this skill in another subject like Chemistry. Moreover, pupils do not forget the skills they have acquired very easily. Therefore they are expected to use the skills later in life even if they do not proceed to learn science beyond secondary school level. In Kenya, majority of form four students do not go on with education to higher levels. Instead, they end up in tertiary institutions and in the informal sector. It is therefore important to equip the pupils with the proper resources which in this case are the process skills which will enable them earn a living after leaving school. However, it has been found that the science process skills are not receiving adequate attention in the Kenyan secondary schools (Okere, 2002). The concern here is not why we carry out assessment in Physics but rather what science process-skills and abilities should be assessed in order to meet selection for access to higher education, entry into employment, a means of defining the concept and orientation of the curriculum and the maintenance of educational standards. The science examinations are usually used to assess content, process skills or practical abilities. Science process skills are divided between those that are cognitive in nature and those that relate to practical activities (Kim and chin, 2011).

2.3.2 ISPS Teaching Physics for Discovery Learning

Osborne (2002) found that much learning that is noteworthy is built all the way through discoveries that take place during investigation stirred by inquisitiveness. Proper learning involves figuring out how to use prior knowledge or what students already know in order to go beyond what they by now think (Sadiq, 2003). Moreover, cognitive theorists argue that discovery learning leads to problem solving skills, an increase in students’ confidence about their learning abilities and an ability to adapt in real world. They emphasize on actions that give confidence to students to
look for, discover, evaluate or else enthusiastically process input more readily than react to it besides strengthening their weaknesses. They further explain that foundations of learning science are quite applicable in line with one of the objectives of teaching science, which is to guide the students to discover knowledge and analyse situations. Well laid, concepts so formed can be applied to discover new meanings and knowledge (Wheeler, 2000). As such the leaner discovers the intended content on his/her own, as he or she discovers several facts and concepts from the environment in his day-to-day living. Okere (2004) agrees with him and points out that those ideas are quite applicable in science education in line with one of the objectives of teaching science, which is to guide the students to discover knowledge and analyse situations (Roth & Roy Chondhury, 2001). Discovery involves leaners at some point in discussions (Marx et al., 2004). A discussion is a purposeful conversation proceeding towards a certain goal. For a discussion to be meaningful, the participants need a sufficient background to know what they are talking about and facts to base their arguments on (National Research Council, 2005).

Based on these observations, it is imperative that Physics teachers in Kenya lay emphasis on learner-centred teaching methods that will involve students actively in the learning process. These methods are expected to enhance students understanding in learning. Students in Kenya have been noted to have poor conceptualizing of concepts, a situation that has led to their underachievement in national examinations (KNEC, 2012). ISPS teaching strategy proposed in this study is expected to involve students actively in the process of learning and thus enhancing discovery learning.
2.3.3 Enhancement of Science Process in Learning of Physics

The teaching of science process skills in Physics is likely to make changes in the role of learning in normal classroom environment as students participate in construction of knowledge both in laboratories social environs and classrooms. Science process skills are undividable within training from the theoretical perception implicated in knowledge and application in sciences and mathematics.

A paradigm shift from a teacher – centred, directed in structural emphasis to where students are more actively involved in the learning experiences could lead to better achievement. Talisayon (2006) provides the intellectual groundwork in scientific benchmark inquiries and deductive or Piagetian concrete operational reasoning according to (Ellam, 2002). Science process skills are attributed to hypothetical – deductive way of thinking or Piagets’s prescribed functioning logic (Juma and cheong, 2005). The process skills will activate and build up students’ intelligence of reliability inside personal erudition, increasing the permanency of their knowledge experiences, in addition to educating them about research methods above and beyond thinking skills that are used to get information. They are suitable for all discipline fields, as they indicate on the right view of scientific reasoning when solving problems and planning experiments. It is supplementary significant designed for the students to study how to relate science process skills to reality learning, concepts generalization, theories and principles in Physics curriculum.

Therefore, it is essential for learners to single out practice of science process skills for these skills are valuable in learning/ teaching of mathematics and sciences. The science process skills ought to be integrated in secondary school education
programs. Science – A process Approach (SAPA) developed by the American Association for the Advancement of science was developed between 1963 and 1974. In this method, teaching of science process skills is purposeful on basic and secondary school science curricular (Preece and Brotherton, 2008). They encouraged research based science to permit students create and find answers to their problems, have critical thoughts, deciding and finding answers to their inquisitiveness, rather than having the students learn by rote the concepts (Schunk and Ertmer, 2000).

Science process skills lay the framework of research based laboratory applications in the studies carried out for the efficacy of laboratory applications, it was found that the students could not use the science process skills during laboratory applications which resulted in failure of acquiring meaningful learning experiences (Nkapa, 2000). In science education teachers have the duty of facilitating the necessary learning environment such as active participating in meaningful learning, developing science process skills, taking responsibility of their own learning through interactive scientific research. Science process skills do help students and teachers to run the research correctly, to connect the research question hypothesis and findings with the daily life, and also to uncover the previous knowledge of students (Shuell, 2004).

Teachers and students-teachers should acquire student-teachers and high school students once imparted with these skills help to grow up as the future scientists. The shift from the teacher – centred method of teaching science to child-centred activities which are encouraged and developed in the child gives confidence for inquiry, an attempt to make students fully aware as well as understand the ways
science work as they are being equipped and prepared for their possible careers in science and technology (Akinbobula, 2006). It is worth noting that for science teaching to be meaningful and relevant, it must adequately reflect on the nature of science. Science process skills are rational, bodily abilities and competent tools in study of mathematics and sciences, as well as community growth (Nwosu and Okeke, 2003). Process skills are cognitive as well as psychomotor skills that can be engaged in problem solving. They are used in problem-identification, objective inquiry, data gathering, interpretations and communication. Science process skills approach methods of teaching do faster desire for investigation and scheming skills in students and deter rote learning, encourages students to be actively involved in learning process a condition which makes it superior to others (Akinbobola, 2008). Furthermore its use increases the intransience of knowledge and development along with solving problems, thinking critically and making decisions. Hence there is need to find, teach science process skills and find out their effects on students achievement in Physics.

Various methods of investigating the connection amid real and internal mental processes that equate learning with learned attainment and determine “success” also by means of short-answer questions (Wayne and Youngs, 2003). None of the studies over explanation on the level or the type of knowledge, rote memorization and recall to be measured (Singh, Granville and Dika, 2002). However, assumptions can be drawn that these studies measure examination preparation strategies instead of new knowledge acquired based on fact (Novak at el., 2002). Nkapa (2000) further notes that there is a problem due to poor retention and retrieval of new ideas, major limitation imposed by such isolated propositions are poor retention and retrieval of
new ideas, conclusion from learning of related concepts and in ability to use the new ideas to solve societal problems. Therefore classroom practices require better evaluation methods that are helpful to the students (Ellis, Copper and Sawyer, 2000). Process skill teaching has a unique application in the teaching/ learning process. It provides students with an opportunity to carry out an investigation to solve problems (Okere, 2004). This kind of learning is likely to be made possible by use of ISPS. The ISPS proposed in this study is therefore expected to assist both the learner and the teacher in Physics learning as the thinking process is made enhanced in learning.

2.4 Effect of Integration of ISPS in Teaching on Academic Achievement by Gender.

According to Eshiwani (1995) girls under achieve in science and mathematics at secondary level. Under performance of girls in sciences is partly due to teacher bias (Trowbridge, Bybee and Power, 2004). Teachers give additional to consideration to boys as they appear rather difficult to manage than girls who appear to have a good behaviour. As a result girls receive less attention, less help and fewer challenges. According to Changeiywo (2002) in developing countries, girls have less access to education than boys. Similarly enrolment of girls is lower than that of boys in Kenya at KCSE level (KNEC, 2012). Partinson (2008) asserts that there is gender imbalance in sciences where more boys take science subjects than girls. Similarly Kelly (2001) noted under-participation of girls in science. In most countries both developed and developing countries the participation level for females in science beyond the age at which the study of science is compulsory are lower than those for male. The gender difference tends to be very large for Physics, either somewhat small for Chemistry and either slight or non-existent for Biology.
The research has shown that once students are free to choose females and male’s participation is quite different in the study of science. Partinson (2008) points out that many theories have been presented to explain these gender imbalances in sciences from biological and genetic effects to peer group pressure. Kiboss (2003) reports that in terms of the ability to apply Physics concepts the differences favouring males was small at age of eleven and largest at age of fifteen. In Physics, smaller inconsistent differences in favour of males were found while in Biology there was no consistence pattern. Differences in performance on practical skills were also heterogeneous, with males consistently performing better than females when handling certain instruments and females consistently performing better than males on tests involving observations skills.

In Thailand, Science is compulsory for virtually all students throughout secondary school and it has the smallest science – related gender difference. Young (2000) report that girls out do boys in chemistry and as well as boys in Physics. They proposed that in addition to the mandatory nature of Science curriculum in Thailand, cultural influences that associate Physics, with women works and the predominance of women among physical science teachers, have a positive influence on girls’ achievement in the physical science. Rennie (2003) suggest that boys and girls are more likely to perform equally in science when cultural norms and values reflect a society in which women traditionally have played an important economic role.

Tsuma (2000) points out that there is need to devise mathematics and science curriculum that are accessible to girls, where they will feel less strange, hence perform like male counterparts. He further points out that teachers should come up
with instruction techniques that involve students, which will encourage and excite young women to study science. This study is designed in an attempt to eliminate these shortcomings by ensuring full participation of boys and girls in ISPS teaching strategy. Thus find out gender difference in achievement among students taught through ISPS.

2.4.1 Teaching for Developing of Favourable Attitudes

The amount of learning in the science classroom has been found to relate positively to the initial interest and attitudes, that child will bring into the classroom. Carin, Bass and Contant (2001) argued that the feelings of the students about science might be more important to their achievement in science than any other variables. Moreover, attitude and behaviour of the teacher might have a strong influence on development of attitudes and values towards science by their students. Teachers of science, in contrast with teachers of mathematics have generally recognized that teaching for development of favourable attitudes is an important part of their work (SMASSE, 2005). Wachanga and Mwangi (2004) reports that social background, aptitude, socializing, experiences, home activities, gender roles, ideology, views concerning the role of science and stereotyping of science subject, and occupation together give rise to specific science-related belief and attitudes: one’s belief on an object determines the attitude; belief on the perceived laziness (or difficulty) of science has been found to determine attitude toward science and science achievement (Danton, 2003).

Generally a positive attitude among the students is an important goal of science education in many jurisdictions of the major goals of education reveals unanimity of
opinion that development of scientific literacy includes development of positive attitudes towards science (Lederman, 2004). This development of positive attitude towards science is a critical component of science instructions (Gardner, 2000). It is judged imperatively that students develop favourable orientation be maintained (Anderman and Machr, 2006). It is believed that ISPS strategy investigated develop attitudes that fosters achievement and problem solving among physics learning.

2.5 Attitude and Achievement in Physics Learning

Instructors world over suggest that students’ attitudes toward the subjects they study impact on their achievement in those subjects. In a cognitive research to determine the relations between attitude and performance Wilison (2006) concludes that attitude has a self-effacing effect afterwards on achievement for school students. However, recent investigations have been evasive with reverence to the correlation linking attitude and achievement in science courses. For instance, Wilson, Hughes, Alberto and Waugh (2006) found no relationship involving students’ attitudes and their later attainment in a college Physics course. Likewise, Nicoll, Nakhleh and Francisco (2001) portend that learner attitudes in relation to mathematics capability and relation to a specific course did not guess achievement in Physics. However, Freedman (2000) established that attitude was absolutely and fairly related to performance for secondary school. Similarly, Harden (2002) established that attitudes regarding Physics are a superior predictor of performance for college Physics students than cognitive factors like admittance examination scores and mathematics qualifications. Koballa (2005) adds that there are insufficient valid and reliable measures of attitude (Gongolin and Swartsz, 2000).
Research regarding relationship of attitude towards science with achievement consists of studies that have examined the attitude of students from various perspectives (Cannon and Simpson, 2002). Attitudes associated with science appear to be affecting student’s participation in science as a subject Koballa, Crawley and Shrigley (2005) as well as performance (Weiss, 2001). An international assessment of nine and thirteen year old students in 20 countries by International Assessment of Education Progress (IAEP) revealed that positive attitudes influence students’ performance by the majority of thirteen year old students. In fifteen countries in Korea there was a notable exception, only a quarter of the top-performing students exhibited positive attitudes. Ha Ubler and Huffmann (2002) portends that attitudes towards Biology in schools directly or indirectly influence students’ performance in Biology. He argued that students with positive attitudes towards Biology are expected to be interested in doing Biology and science – like activities.

Students’ attitudes have been reported as a major predictor of students’ performance in science subjects (Akubuiro and Joshua, 2004). All these researchers found out in their different studies that students with positive attitudes towards a school subject perform better in that subject than students with negative attitudes towards that subject. When an individual has an interest or positive mind attitude towards any object, he/she behaves favourably towards that object, and vice versa.
2.6 Effect of Integration of ISPS in teaching and Motivation towards Learning of Physics

Githua (2002) defines motivation as effort in which learners put into learning as a result of their need or desire to gain knowledge. The expression motivation to study is defined by Georgouli (2002) as the state or measure of being meaningful. An interesting classroom environment is very important in ensuring successful and fruitful learning which in itself requires creativity in designing teaching strategists. A student who is intrinsically motivated undertakes an activity for its own sake, for the enjoyment it provides, the learning it permits or the feelings of accomplishment it evokes (Lepper, 2000). On the other hand, learner’s who are extrinsically motivated student carry out assignments’ so as to get reward or to avoid punishment from teachers (Wachanga, 2002). These findings suggest that when teachers capitalize on existing intrinsic motivation, there are several potential benefits. That it is important that teachers try to convince their students that learning rather than grades or the purpose of academic work. This can be done by emphasizing the interest value and practice importance of the material that the students are studying and by de-emphasizing grades and other rewards that is intrinsic motivation should be emphasized.

2.6.1 Motivational Factors in Learning of Physics

Learning is not only supported but also enhanced through positive affective factors such as interest, motivation, attitude, belief; self-confidence and self-efficacy, students’ belief in their own abilities and the value they attribute to their learning tasks are significant predictors of their final success.
A student is more likely to desire to learn when they appreciate the value of the classroom. Activities and when they believe that they will succeed if they apply reasonable efforts (Brophy, 2002). In addition, motivational belief can influence the process of learning and conceptual changes (Song and Keller, 2001). This motivation is usually context specific and relies strongly on the classroom situation. Students need to believe that they are capable of performing a task, that they have some control over the tasks and that the task is achievable.

The beliefs the teachers themselves have about teaching and learning and the nature of the expectations they hold for students also exert a powerful influence. Sigh, Granville and Dika (2002) pointed out that to every large degree; students expect to learn if their teachers expect them to learn. That it is important for teachers to communicate positive expectations to their students; that they can learn the material presented to them. Some of the strategies and factors that may be employed to motivate students and stimulate them to learn include; first teachers providing a supportive environment and establishing a trusting bond since motivation is natured by the teachers in every learning situation. Secondly the teachers should cater levels of activity to students level teachers should try and difficulty nor too easy (Wasanga, 2009). Thirdly teachers should help students recognize links between effort and outcomes. Learning is a long term plan of effort and investment. Fourthly the teachers should breakdown learning steps into digestible pieces and the teachers should minimize students’ performance anxiety during learning activities.
2.6.2 Goal-orientation and Engagement in Physics
Students who have purposed to achieve a specific goal can’t easily allow motivational setback, such as tediousness, dullness, distractions and gradually more complicated errands to thwart them from finishing their obligatory school work (Wambugu and Changeiywo, 2000). Students who engage in activity do them with a better understanding whereas learners with an aggressive ‘goal achieve more superficial learning. The level of engagement determines the probability that conceptual change will occur.

The nature of the tasks also influences the students’ goal orientation. Errands that are significant, demanding and connected to life outside school provide strong motivational goals. Unrestricted classroom tasks too can also facilitate mental connection as well as idea alteration (Pintrich, Marx and Boyle, 2000). Where they are offered choice and some control over learning they are also likely to be goal-oriented and hence more likely to learn (Ndirangu, 2000). Students must find satisfaction in learning based on the understanding that the goals are useful to them or, less community, based on the pure enjoyment of exposing new things.

2.6.3 Values and Interests
Value and interest are said to be intrinsic, that is, they are characteristic of the person not the task. A student’s personal interest will influence their selective attention: their effort level, their willingness to persist with a task and their final acquisition of knowledge (Keller, 2000). Learners who are engrossed in class material search for more information, connect in more ways, and employ critical thinking and exhibit
innovative methods. Sinatra and Pintrich (2003) suggest that the value of a student place on tasks or topic will affect their choice to become engaged support their learning by increasing attention and persistence and activated prior knowledge.

2.6.4 Belief in Self

Students’ interest can be influenced by motivational texture of the classroom context such as challenge, choice, novelty, fantasy and surprise all of these aspects need to be kept within the capabilities of the students (Keller, 2000). Belief in self is said to be situation-specific, not general self- concepts (Pintrich et al, 2000). A student who lacks self-esteem as relates to learning of science and insight can feel endangered by the disagreement of the abstract challenge, although this also means that, they are less likely to retain their own prior conceptions. Conversely students with high self-esteem have more belief in their own judgement are more likely to retain their own development conceptions. Several scholars have identified various motivational factors that influence learning outcomes. In this study the indicators of motivation have been used to develop the students` motivational scale items.

2.6.5 Motivation for Physics Learning

Students’ incentive affects significant Physics learning; specifically if incentives are directly linked to higher level of thinking (Hart, 2000). Most of research literature indicates notable relationships between learner’s motivational viewpoints and their mental processes (Pinrich et al., 2000). A range of factors that have an effect on learners intrinsic motivation to involve students in classroom tasks considering their welfare, wants, goal and viewpoint regarding their potential and expectations that improve their self-worth (Schunk and Ertmer 2000).
If students believe in their own capability towards a task, they can use high order thinking. Furthermore, achievement develops motivation. Marzano (2001) ascertains that learners motivation depends on three factors: first is the feeling of worth (for instance a student feels it is essential to learn facts on gas laws); second is the observation of efficiency and third is one’s emotive positive reply to the information component. The following conditions must be satisfied for an activity to qualify to be intrinsically motivating (Hodson, 2003):

It has a suitable degree of confront, important and genuine task for learners, learners offer opportunity for educational criticism and recommendation, the task is devoid of previous obstacles as well as constraints. Students perform in their own free will, and

Point of reference in appraisal is not based on contest neither on comparison but on individual evaluation in learning of physics.

Ausubel 2000) too points that the possible meaning of the material itself insignificant knowledge, is that learners enthusiasm can be interfered by the responses of others (for instance Physics teacher and students), and by remuneration; gifts, and punishment (Hodson, 2003). It is assumed that a stable classroom environment is necessary for intellectual growth. Introduction of the expression of investigation is alleged to improve learners’ motivation for Physics learning. The idea of “attention” is extremely outstanding factor about students’ motivation: Students frequently lack curiosity in studying Physics (Osborne, 2000).

Okere (2004) portends that frequently, secondary level students think that Physics is too conceptual (Gabel, 2000). However, Physics can be interesting and exciting for
students (Vadya, 2003). Research has also emphasised on the role of enthusiastic Physics teacher students’ enthusiasm in Physics Wachanga (2004) found that students’ interest is absolutely correlating with recall, concentration, thoughtful, deep cognitive commitment and individual interest linked to a Physics task or topic. It is a very stable trait but it can also change. While in the context of learning (e.g. a particular learning environment and the Physics teacher) affects students situational interest, it can develop into an individual interest if the students receive enough support. More student-centred strategies with many students discussions in experiments are needed to engage students in meaningful learning Aksela (2005) small-group investigatory strategies can motivate students to learn science. Real-world problems motivate and help to encourage transfer of knowledge and skills, by encouraging students to apply their knowledge. Hence need to embark on ISPS to enhance problem solving and motivation towards physics learning.

2.7 Foundations of Constructivism Theory in Learning of Physics

The recent changes in teaching and learning practices have had their roots in two broad theoretical developments. The first development, in the field of psychology, has been the work of behaviourism in favour of a movement broadly referred to as cognitive psychology. Behaviourism is based on the foundation that it is pointless to posit about the works of the brain, as we can merely learn the actions of people and how they respond to stimuli (Schultz and Schultz, 2002). The result of this idea is that there is an inflection on strategies such as recurrence that support ‘parrot’ approach to learning rather than advanced order cognitive processes. The cognitive psychology faction rejects this principle, in its place surmises that a person’s reaction to stimulus is personal and depends on the person’s cognitive condition and
on the intellectual processes taking place. The significant effect of the cognitive situation is that rather than being apprehensive with the learner’s cognitive goings-on and the mental models that they form (Piaget, 1950).

This further results in hands-on investigations that fuel practical process by letting them learn things by themselves. ISPS is a strategy that view students as constructors of their own cognitive tool as well as of their external realities as it is self-directed learning and ultimately facilitate the construction of new knowledge moreover, learners come to make sense of their experience, gradually optimizing their interactions with the world (Piaget, 1972).

This advancement alone, however, did not oblige prevalent changes in instruction methods to occur. There is a propensity to take for granted that though learners enthusiastically form a rational replica of the information they obtain, there is yet some impartiality ‘correct’ rational model for any given area of facts that students have to acquire. Therefore the focus continual to be scheming a single chain of influential actions, with the rationale changing from reinforcing to ‘correct’ responses to stimuli, to ‘transferring’ the ‘correct’ mental model to the student (Okere, 2004). The second growth, which is more theoretical shift than a new group in psychology, has been the steady negative response of the postulation that there is some acceptable knowledge interpretation. The unconventional view, termed constructivist, is the view that rather than there being a single correct mental model of knowledge, the range of information representations that persons build may be in the same way suitable. The focus of teaching then becomes one of guiding the learner as they construct on and adjust their existing rational models that are a focus
on knowledge building rather knowledge transmission. (McInerney and McInerney, 2000; Slavin 2000).

There are three broad main beliefs that jointly describe the constructivist view of learning. The primary principle is that each being forms their own image of knowledge, construction on their own personal experiences, and accordingly that there is no particular ‘correct’ illustration of knowledge. This principle was expressed by Kant in his critique of pure reason and later adopted.

The second principle, more often than not credited to Piaget, is that people learn all through active investigation and that learning occurs when the learner’s investigation uncovers an inconsistency between their current information interpretation and their experience. Piaget labels the state that the learner is in when they have uncovered such an inconsistency as a state of disequilibrium. The process of altering the knowledge illustration to slot in the know-how is called modification. (McInerney and McInerney, 2000; Slavin, 2000). Bruner was the first to adopt a comprehensive theory of teaching based on this principle, in his invention learning theory. (Bruner, 1999; Vander Zanden and Pace, 1999).

The third principle, usually ascribed to Vadya (2003) is that learning occurs within a social context and that a relation flanked by learners and their peers is a necessary part of the learning process. Vadya (2003) describes those capabilities that are away from the learner on their own, but are able to be passed out with the support of more well-informed peers, as capabilities in the zone of proximal growth (Dixon-Krauss, 2001; McInerney and McInerney, 2000; Slavin, 2000).
2.7.1 Constructivist Theories and Learning

In the opinion of constructivist, learning is a practical course in which the learner is developing an inner illustration of knowledge an individual understanding of know-how. This inner knowledge illustration is constantly open to change, its arrangement and connecting the fundamental challenge of constructivism is in its changing the focus of control over learning from the teacher to the student. Educational technologists, with their foundations are in argument to which other knowledge structures are attached. Knowledge is an active course in which importance is accomplished on the foundation of understanding. This view of knowledge does not necessarily reject the existence of the real world, and agrees that reality places constrains on the concepts that are, but contends that all we know of the world are human interpretations of our experience of the world. Behavioural psychology, have sought to design programs in such a way that students would be enticed to achieve pre-specified objectives.

Constructivists have said that this violates both what we know now about the nature of learning situated, interactive and about the nature of knowledge (perspective, conventional, tentative and evolutionary). They have claimed that objectives should be negotiated with students based on their own felt needs, that programmed activities should emerge from within the contexts of their lived worlds that students work together with peers in the social construction of personally significant meaning and that evolution should be a personalized on goings, shared analysis of progress (Okeke, 2007).
Agreeing with this view of knowledge, learning to happen and transfer to environments beyond the school or training classroom. Learning through cognitive apprenticeship, mirroring the co-operation of real world problem solving, and using the tools available in problem solving situations is important. How effective or instrumental the learner’s knowledge structure is in facilitating thinking in the content fields is the measure of learning (Orodho, 2003).

2.7.2 Implication of Constructive Theories in Teachings/Learning Process

The study of human cognition has many precise applications for educational practice and scientific use. The following are five general educational applications of constructive theory that should be well thought-out when designing lessons: First, if learning depends on how information is mentally processed, then students’ cognitive processes should be a major concern to educators. Students’ learning difficulties can often be attributed to ineffective or inappropriate cognitive processes. For example, learning disabled children process information less effectively than non-disabled children (Salleh, 2004). Teachers must become aware of not only what students learn but also of how they attempt to learn it. Second, educators must consider students’ levels of cognitive development when planning topics and networks of instruction. For example explanations based on concrete operational logic are unlikely to be effective ways of presenting ideas to preoperational kindergarteners. Concrete operational elementary school children have difficulties in understanding abstract ideas that do not lie in with their own experiences. These students will learn more effectively if the same information is presented through investigative hands on actives. Even high school and college students, who have not completed the formal operational stage, will need concrete experiences prior to
presenting abstract material. Third students organize the information they learn. Teachers can help students’ learn by presenting organized information through discovery by helping students see how one thing relates to another through practical work. Fourth, new information is most likely acquired when students can associate or prove laws they have learnt through what they already know/learnt in theory.

It is until then that learning is likely to be slow and in effective. Fifth, Sinatra and Pintrich (2003) have argued from an operant conditioning perspective that students must actively respond if they are to learn. Cognitivists, however emphasize mental activity combined with physical ones. If students control their own cognitive process, it is ultimately the students themselves who decide what information will be learned, and how. This is the basis under which the current study is designed. ISPS teaching strategy is likely to result in meaningful learning as it underlines the importance of mental activity combined with a physical one which hence is expected to promote the understanding of the students. This is the basis upon which this study is based.

2.8 Summary of the Literature Review (Gaps)
In all the literature reviewed there is near consensus on the need to transform and modernize the way we are teaching the next generation locally not much has been done in terms of concretizing this desire in the classroom and school environment. Okere (2004) pointed that quest for better teaching strategies have been going on for a long time and in order to fill the gap of academic achievement gains from integration of ISPS in teaching of physics. According to Kiboss (2003) nearly all the teaching strategies practised in Kenyan schools are mostly expository and facts
orient making students to be passive. Moreover students’ motivation and achievement are enhanced when co-operative learning is introduced in physics class experiments (Wachanga and Mwangi, 2004). Discovery learning leads to problem solving skills, an increase in students’ confidence in their learning abilities and about an ability to adapt in real world (Sadiq, 2003). Investigative science process skill may eliminate limitation caused by poor retention and retrieval of new ideas, individual inferences in subsequent learning of related content and ability to use new ideas to solve society problems. Teaching requires that teachers to use methods that are unique to the content being taught. The learner is central to learning thus teachers need to involve them actively in their own learning and make connections between what they learn and what they already know. The major task confronting teachers, then is to find ways of bridging the gap between what students already know and what they are expected to learn by addressing, academic achievement gains from integration of ISPS in teaching, gains in problem solving abilities from integration of ISPS in teaching, effect of integration of ISPS in teaching and motivation towards leaning of physics, effect of integration of ISPS in teaching on academic achievement by gender and by school category. Thus, the effects of ISPS teaching strategy on students achievement, problem solving and motivation in secondary school physics in Embu County, Kenya which has not previously been used is aimed at filling this knowledge gap.
CHAPTER THREE
RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction
In this chapter, a description of the research design is given. The target population, sampling procedures, sample size and the data collection instruments that were used in this study are also specified. The chapter sums up with data collection procedures as well as statistical methods that were employed in data analysis.

3.1.2 Location
The study was conducted in secondary schools in Embu County. Embu County is about 155 kilometres from Nairobi city centre. The county was selected because of its performance in KCSE physics which has persistently recorded a low mean score over the years. The county had many boys and girls secondary schools as well as co-education schools with a large number of trained teachers in all subject areas.

3.2 Research Design
The study adapted a non-equivalent Solomon- Four Group Quasi-Experimental research design. Non-equivalent groups were used because classes in secondary schools once constituted existed as intact groups. The school authorities do not normally allow such classes to be broken up and reconstituted for research purposes. Thus it was possible to assign class randomly as required in true experimental designs. The schools selected were however assigned to the treatment and control conditions as intact groups. The quasi-experimental design was deemed appropriate for the study because it would allow for assessment of effects of integration of ISPS
in teaching on achievement, problem solving abilities and motivation towards physics learning.

The research design was represented as follows:

<table>
<thead>
<tr>
<th>Group</th>
<th>Treatment</th>
<th>Pre-test 1</th>
<th>Post-test 1</th>
<th>Pre-test 2</th>
<th>Post-test 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>(E1)</td>
<td>O1</td>
<td>X</td>
<td>O2</td>
<td></td>
</tr>
<tr>
<td>Group II</td>
<td>(C1)</td>
<td>O3</td>
<td>X</td>
<td>O4</td>
<td></td>
</tr>
<tr>
<td>Group III</td>
<td>(E2)</td>
<td>X</td>
<td>O5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group IV</td>
<td>(C2)</td>
<td>X</td>
<td>O6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 3.1: Solomon-four Group, Non Equivalent Control Group Design

Source: (Borg and Gall, 1989).

Where O1 and O3 were pre-tests
O2 O4 O5 and O6 were post-tests.

X was the treatment where students would be taught by use of ISPS

- - - - Indicates non-equivalent groups

☑️ Represented no treatment to the groups

C1 Control 1

C2 Control 2

Group I was the experimental group which received pre-test, treatment and the post test.
Group II was the control group which received a pre-test followed by no- treatment and finally a post test.
Group III was the group that would receive treatment and a post test. It would not be pre tested.
Group IV was the group that would receive post-test only.

Solomon Four control group Quasi-Experimental designs was deemed appropriate for this study because it was considered vigorous for both Experimental and Quasi-experimental studies (Borg and Gall 1989). The design helped the researcher achieve four purposes: to assess the effect of the experimental treatment relative to the control condition, to assess the interaction between pre-test and treatment (x), to assess the effect of the pre-test relative to the post-test and; to assess the homogeneity of the groups before administration of treatment.

Quasi-experimental research design procedure controlled all major threats to internal validity except those associated with interaction of: selection and history, selection and maturation. Selection and instrumentation (Cook and Campbell, 2000: Mugenda and Mugenda, 2003)

To control for interaction between selection and maturation the schools were randomly assigned, to the control and treatment groups. The conditions under which the instruments was administered would also be kept as similar as much as possible across the schools to control for interaction between selection and instrument. The teachers to give the intervention were trained on how to administer the treatment. They used a schemes of work for eight weeks then administered a post test.

An instructional guidelines (appendix A) for teachers in the study based on the physics syllabus (2002) was constructed and used to train teachers on how to use the schemes of work and to give the treatment. The manual was used by the teachers’ in the experimental groups to ensure that there was uniformity in exposure of students to interventions. All the teachers involved in the study adopted a common schemes
of work on the topic of “Electricity (II)”; this ensured that the intended content was covered uniformly for all groups involved in the study.

3.3 Target Population

The target population was secondary school students in Embu County and accessible population was all form three physics students. The students were selected because the topic of electricity (II) was taught at this level. In year 2016 total schools established with classes running from form one to form four were 180 where 2 were national schools, 18 boys only, 17 girl’s only and 143 co-educational schools. Form 3 students tally to about 4180 students. Eight teachers from the eight schools each with five years of teaching experience participated in the study. The County was chosen because of its poor performance in K.C.S.E. results in Physics and low enrolment in physics as a subject compared to Biology and chemistry.

3.4 Sampling Techniques and Sample Size

The research used stratified random sampling to select the eight schools that participated in the study four of which were girls’ while the other four were boys’ schools. Simple random sampling technique was used to group four schools to experimental and four others to control groups. Where schools had more than one stream all participated but simple random sampling was done to select one stream for data analysis. The selection of four boys and four girls schools was deemed necessary to avoid excessive stratification that could result in complexities stemming out of logistics involved in handling many schools, types especially in a quasi-experimental design. The success of experimental and quasi-experimental designs normally relied on stringent control of extraneous variables.
(Fraenkel and Wallen, 2000). A challenge that could be minimized by reducing variation in characteristics of groups involved. A total of 320 students from eight schools participated in the study as shown in the population grid below:

<table>
<thead>
<tr>
<th>Group</th>
<th>Group type</th>
<th>Boys</th>
<th>Girls</th>
<th>Number of Respondents Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Experimental</td>
<td>40</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>II</td>
<td>Control</td>
<td>40</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>III</td>
<td>Experimental</td>
<td>40</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>IV</td>
<td>Control</td>
<td>40</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>160</td>
<td>160</td>
<td>320</td>
</tr>
</tbody>
</table>

3.5 Research Instruments

The research used a number of instruments, including Physics Achievement Test (PAT), observation schedule, motivation scale and interview schedule.

Physics Achievement Test (PAT), Observation schedule, motivation scale

3.5.1 Physics Achievement Test

To determine academic achievement gains from integration of ISPS, effect of integration of ISPS in teaching on academic achievement by gender. Physics Achievement Test (PAT) was developed for the research on the topic of Electricity (II) from Physics syllabus and contained two tests, a pre-test and a post-test. The purpose was to provide a common measure to assess students' performance in the control and experimental groups.
3.5.2 Observation Schedule

Observation schedule was used to observe lessons on the topic Electricity (II) to provide data on teacher and student activities during instruction processes. It had two sections which provided data on the teachers and students activities respectively. Observation method was used because certain types of information could best be obtained through direct examination by the researcher. The data obtained from observation was very reliable because it was first-hand information (Meredith, 2007). In this study physics lessons were observed to get first-hand information on the arrangements of how the gains in problem solving abilities from integration of ISPS in teaching and how students’ process skills are enhanced while in the laboratory. The observation was about planning an investigation, data analysis, synthesis and conclusion. The observation was done using a constructed schedule.

3.5.3 Motivation Scale

A motivation scale which was a written list of questions which are related to the subject was introduced to both control and experimental groups in the eighth week of teaching. The questions were given to both the experimental group and the control group. The required information could be extracted from the answers given by the respondents (Mugenda and Mugenda, 2003). Use of questions could reach a large number of people who were able to read and write independently (Orodho, 2003). For the purpose of this study, the researcher constructed a motivation scale to facilitate data collection.
3.6 Piloting Study

Okere (2000) observes that piloting is important as it helps identify misunderstanding, ambiguities, and inadequate items. The study carried out piloting of instruments using two secondary schools with same characteristics as sample schools in Kirinyaga County.

3.6.1 Validity

Validity of the instruments was improved using a judgment by experts. Face validity of PAT was achieved by presenting the items to specialists in the Department of Educational Communication and Technology. The items showed a relationship between the construct and predicted outcome. On content validity of PAT, the test items were taken to physics teachers in secondary schools in the study to judge the extent to which the test items represents a representative sample of the entire content that the test is designed to measure.

3.6.2 Reliability

Reliability is a measure of the extent to which a research instrument yields consistent results after repeated trials (Borg and Gall, 1986). The instruments were pilot tested in two schools that would not form part of the study. Reliability coefficient was determined using Kunder-Richardson (KR – Formula 20) estimates. KR – Formula 20 as an estimate of reliability was appropriate because it required less time since it would be administered once and it would provide the mean of all possible split half coefficients (Gay, 2003; Wiersma and Jurs, 2005). The KR-Formula 20 was adapted from (Sattler, 1988):
Where:

\[ r_{tt} = \left( \frac{n}{n-1} \right) \left[ \frac{s^2 - \sum pq}{s^2} \right] \]

\[ r_{tt} \] = reliability estimate

\[ n \] = number of items on the test

\[ s^2 \] = variance of the total test

\[ p \] = proportion of the respondents getting the item correct

\[ q \] = proportion of the respondents getting the item incorrect

\[ \sum pq \] = sum of the product p and q for each item

A reliability coefficient of at least 0.7 would be considered sufficient and acceptable and was used in the study (Mugenda & Mugenda, 2003).

**Calculation of the Reliability Coefficient**

\[ r_{tt} = \left( \frac{n}{n-1} \right) \left[ \frac{s^2 - \sum pq}{s^2} \right] \]

Where:

\[ r_{tt} \] = reliability estimate

\[ n \] = number of items on the test

\[ s^2 \] = variance of the total test

\[ p \] = proportion of the respondents getting the item correct

\[ q \] = proportion of the respondents getting the item incorrect

\[ \sum pq \] = sum of the product p and q for each item
School A with 13 Physics students (pre test – post test)

<table>
<thead>
<tr>
<th>$X$</th>
<th>$f$</th>
<th>$Fx$</th>
<th>$d = \dot{x} - x$</th>
<th>$d^2$</th>
<th>$fd^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>1</td>
<td>20</td>
<td>-4</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>30</td>
<td>-14</td>
<td>196</td>
<td>592</td>
</tr>
<tr>
<td>19</td>
<td>2</td>
<td>38</td>
<td>-22</td>
<td>484</td>
<td>968</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>14</td>
<td>-3</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>25</td>
<td>1</td>
<td>25</td>
<td>-8</td>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>9</td>
<td>-7</td>
<td>49</td>
<td>49</td>
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<tr>
<td>21</td>
<td>1</td>
<td>21</td>
<td>-5</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>23</td>
<td>1</td>
<td>23</td>
<td>-7</td>
<td>49</td>
<td>49</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>18</td>
<td>-2</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

$\sum f = 13$  $\sum fx = 214$  $\sum fd^2 = 1767$

Mean = 16.46  
Variance = 135.92

<table>
<thead>
<tr>
<th>$P$</th>
<th>$Q$</th>
<th>$Pq$</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>20</td>
<td>400</td>
</tr>
<tr>
<td>16</td>
<td>24</td>
<td>384</td>
</tr>
<tr>
<td>15</td>
<td>25</td>
<td>375</td>
</tr>
<tr>
<td>19</td>
<td>21</td>
<td>399</td>
</tr>
<tr>
<td>7</td>
<td>33</td>
<td>231</td>
</tr>
<tr>
<td>25</td>
<td>15</td>
<td>375</td>
</tr>
<tr>
<td>15</td>
<td>25</td>
<td>375</td>
</tr>
<tr>
<td>17</td>
<td>21</td>
<td>399</td>
</tr>
<tr>
<td>9</td>
<td>31</td>
<td>279</td>
</tr>
<tr>
<td>7</td>
<td>33</td>
<td>231</td>
</tr>
<tr>
<td>21</td>
<td>19</td>
<td>399</td>
</tr>
<tr>
<td>23</td>
<td>17</td>
<td>391</td>
</tr>
<tr>
<td>18</td>
<td>22</td>
<td>396</td>
</tr>
</tbody>
</table>

$\sum pq = 4634$
\[ n = 40 \]
\[ r_{tt} = 0.768 \]
\[ r_{tt} = 0.8 \]

### 3.7 Data Collection Techniques

A research permit was obtained from National Council of Science Technology and Innovation (NACOSTI) and also a letter from District Educational Officer (DEO). In order to conduct research in the sample schools, the teachers were trained for one week on how to use ISPS. This enabled them to master the skills of using ISPS as a teacher’s strategy. After this period a PAT and MSQ pre-test was administered to experimental group 1 and control group 2. This was followed by the exposure of ISPS. At the treatment period, the researcher assisted Physics teachers in sample schools to administer PAT post-test to all four groups followed by administration of MSQ. The researcher then scored and code collected data for analysis.

### 3.8 Data Analysis

The data was scored, coded and organized the data for analysis. Data was analyzed using both descriptive and inferential statistics. Raw data was analyzed using means, standard deviation and percentages so as to meaningfully describe the distribution of the measurements. Inferential statistics dealt with analysis, interpretation and decisions on the bases of the results (Changeiyyo, 2002). Quantitative methods of data analysis involving the use of Analysis of variance (ANOVA) and t-test was used to list statistical significant difference within and among means in the posttest
scores for the group exposed to ISPS and those exposed to regular teaching methods. When dealing with 2 means, a t-test was used because of its superior power of detecting the difference between 2 means. On the conceptualization of the topics on physics electricity (2) and also between the pre-tested groups and those not exposed to pretest. Hypothesis which was tested using the measures of central tendency. Computations were conducted using Statistical Package for Social Sciences (SPSS) version 18 for windows.
### Table 3. 2: Summary of Statistical Analysis

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Independent Variable</th>
<th>Dependent Variable</th>
<th>Statistical Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ho1: There is no significant difference between students achievement scores in Electricity (ii) of students who are exposed to Investigative Science Process Skills (ISPS) teaching strategy and those that are taught using conventional methods.</td>
<td>- ISPS teaching strategy - Conventional teaching methods</td>
<td>- Students achievement in Physics (PAT)</td>
<td>T–test</td>
</tr>
<tr>
<td>Ho2: There is no significant difference in problem solving abilities towards learning electricity (ii) between students who are exposed to Investigative Science Process Skills (ISPS) teaching strategy and those that are taught using conventional methods.</td>
<td>- ISPS teaching strategy - Conventional teaching methods</td>
<td>Learners problem solving abilities</td>
<td>Chi-Square t-test</td>
</tr>
<tr>
<td>Ho3: There is no significant difference in level of motivation towards electricity (ii) a topic in physics among boys and girls who are exposed to Investigative Science Process Skills (ISPS) teaching strategy and those that are taught using conventional methods.</td>
<td>ISPS teaching strategy Gender of the learners.</td>
<td>Motivation towards Physics</td>
<td>ANOVA t-test</td>
</tr>
<tr>
<td>Ho4: There is no significant difference in achievement scores in physics test between boys and girls who are exposed to Investigative Science Process Skills (ISPS) teaching strategy.</td>
<td>- ISPS teaching strategy - Gender of the learners.</td>
<td>Students achievement in Physics (PAT)</td>
<td>t-test F-values</td>
</tr>
<tr>
<td>Ho5: There is no significant difference in achievement scores between students who are exposed to Investigative Science Process Skills (ISPS) teaching strategy based on their school category.</td>
<td>- ISPS teaching strategy - Regular teaching methods - School category</td>
<td>Students achievement in Physics (PAT)</td>
<td>ANOVA t-test</td>
</tr>
</tbody>
</table>
3.9 Logistical and Ethical consideration

The names of the schools used was coded to hide their identity. The research permit was obtained from National Commission for Science, Technology and Innovation. The findings of this research would be beneficial to the society. Methodology used in this research was selected on the basis of research objectives and interpreted in accordance with general methodological standards. Subject’s responses to the motivation scale was treated with utmost confidentiality and data collected according to accepted standards hence a true report of the finding was published.
CHAPTER FOUR
DATA ANALYSIS, PRESENTATION AND DISCUSSION

4.1 Introduction

This chapter presents the result of the findings of the study guided by the set objectives. The objectives of the study were; to determine students’ achievement in school physics (Electricity II) when using Investigative Science Process Skills teaching strategy; to determine the problem solving abilities of learners in physics (Electricity II) when using investigative Science Process Skills teaching strategy; to establish if Investigative Science Process Skills have any effects on students’ motivation towards Electricity II, compared to conventional teaching strategies; to find out gender differences in achievement among the students taught through Investigative Science Process Skills teaching strategy in the topic “Electricity II”; and to establish if there is any differences in achievement among the students taught through Investigative Science Process Skills teaching strategy based on the school category.

Based on the set objectives the following research hypotheses were generated and formed the null hypothesis of the study;

Ho1: There is no significant difference between student’s achievement scores in electricity (II) of student who are exposed to investigative Science Process Skills (ISPS) teaching strategy and those taught using conventional methods.
Ho2: There is no significant difference in problem solving abilities towards learning Electricity (II) between student who are exposed to investigative Science Process Skills (ISPS) teaching strategy and those taught using conventional methods.

Ho3: There is no significant difference in level of motivation towards Electricity (II) a topic in physics among student who are exposed to investigative Science Process Skills (ISPS) teaching strategy and those taught using conventional methods.

Ho4: There is no significant difference in achievement scores in physics test between boys and girls who are exposed to investigative Science Process Skills (ISPS) teaching strategy.

Ho5: There is no significant difference in achievement scores between students who are exposed to investigative Science Process Skills (ISPS) teaching strategy based on their school types.

The study used quasi experimental approach where four boys’ schools and four girls’ schools were randomly selected and purposefully sampled. Two boys and two girls’ schools were randomly assigned as experimental groups while the other two boys and two girls’ schools were the control group. Each research objective guided the compilation of data and each related data for each objective were analyzed separately.
4.1.1 Normality Test

A plot of homogeneity of the average of student pre-test and the post test score for all learners studied showed deviations from the zero mark of the line of best fit not crossing probability lines (P < 0.05; thus homogeneity was accepted at 95% probabilities Figure 4.1(b).

Figure 4.1a: Normality Test for the Pre-test Results
4.2 To Determine Students’ Achievement in School Physics (Electricity II) when using Investigative Science Process Skills Teaching Strategy

Students’ achievement in the selected schools was determined when using Physics achievement test. The achievement in school physics (Electricity II) was recorded in four schools used as experimental and four schools as control group. To establish the effect of the use of ISPS, a pre-test was conducted in the schools. The resulting score
from the students in the control was 18.05 ± 0.28 and in the experimental group was 18.24 ± 0.28 out of 40. Using two sample t-test, students’ achievement in the control and experimental group of schools in Physics (Electricity II) before the experiment (pre-test) were not significantly different (t = 0.49, P = 0.623).

Table 4.1: Mean Achievement of the Students in Physics (Electricity II) (Pre-test)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard error (SE)</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>18.05a</td>
<td>0.28</td>
<td>13.0</td>
<td>22.0</td>
</tr>
<tr>
<td>Experimental</td>
<td>18.24a</td>
<td>0.28</td>
<td>13.0</td>
<td>22.0</td>
</tr>
<tr>
<td>t-test</td>
<td>0.49</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-value</td>
<td>0.623</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mean values in the same column denoted by similar letters are not significantly different at P ≤ 0.05. Means separated using Tukeys HSD test.

Students’ achievements in pre-test and after the test were presented in figure 4.2a and 4.2b respectively.
In this study, same students who were given pre-test were subjected to a post-test to establish the effect of the use of ISPS. The resulting post-test score from the students in the control was $18.10 \pm 0.26$ (mean ± standard error) and the score for the experimental group was $28.83 \pm 0.28$. Using two sample t-test, these achievements in the control and experimental group of schools in Physics (Electricity II) after the experiment (post-test) were significantly different ($t = 28.06$, $P = 0.0001$).

**Table 4.2: Mean Achievement of the Students in Physics (Electricity II) after using ISPS (Post-test)**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard error (SE)</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>18.10a</td>
<td>0.26</td>
<td>13.0</td>
<td>22.0</td>
</tr>
<tr>
<td>Experimental</td>
<td>28b</td>
<td>0.28</td>
<td>23.0</td>
<td>34.0</td>
</tr>
<tr>
<td>t-test</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-value</td>
<td>0.0001*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mean values in the same column denoted by similar letters are not significantly different at $P \leq 0.05$. *significant difference in the means
Figure 4.2b: Post-test Mean Achievements of the Students in Physics Electricity II

Students’ achievements before the experiment (pre-test) were compared to their achievements after the use of ISPS (post-test). Mean score post-test (mean 23.59 ± 0.46) was significantly higher than the students’ mean score pre-test (mean 18.15± 0.20), t = 11.73, P = 0.0001. This showed that Investigative Science Process Skills teaching strategy (ISPS) resulted into a significant improvement of the individual students score in Physics (Electricity II) teaching.

Table 4.3: Mean Achievement of the Students in Physics (Electricity II) before (pre-test) and after test (Post-test)

<table>
<thead>
<tr>
<th></th>
<th>Mean score</th>
<th>Standard error (SE)</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>18.15a</td>
<td>0.20</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>Post test</td>
<td>23.59b</td>
<td>0.46</td>
<td>13</td>
<td>34</td>
</tr>
<tr>
<td>t-test</td>
<td>11.73</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-value</td>
<td>0.0001*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

80
Mean values in the same column denoted by similar letters are not significantly different at $P \leq 0.05$. *significant difference in the means

**Figure 4.3:** Mean Achievement of the Students in Physics Electricity II before Pre-test and after Post-test

When related to the first null hypothesis of the study which was stated as follows:

**Ho1:** There is no significant difference between achievement scores in Electricity (II) of students who are exposed to Investigative Science Process Skills (ISPS) teaching strategy and those taught using conventional methods.

In testing this hypothesis, using t-test, the result showed that Science Process Skills teaching strategy (ISPS) significantly improved individual students score in Physics (Electricity II) learning ($t = 11.73, P = 0.0001$). The null hypothesis is therefore rejected; “There is a significant difference between achievement scores in Electricity (II) of students who are exposed to Investigative Science Process Skills (ISPS) teaching strategy from those taught using conventional methods. The result of the study shows that ISPS teaching strategy indeed affect students’ achievement as
compared to conventional methods. This gives the answer to the first research question.

ISPS as an instructional strategy influences learners understanding of concepts as significant learning takes place as students make meaning of structural knowledge and are able to apply what they have well –read. The results are in line with the argument of Wachanga and Mwangi (2004) that significant learning occur when students look for information and relate it to new facts and principles in their cognition. Students are able to articulate new information by modifying and enlightening their present skills in physics and adding up innovative concepts to previous ones (Oyoo, 2007). The findings are in line with results of Okere, ((2002) who views that in an evaluation exercise groups in the experimental groups after the intervention always attained better scores in subjects tested than the control groups. This also improves the retention rate of leaners and creates interest in the learning process.

In testing this hypothesis, using t-test, the result showed that Science Process Skills teaching strategy (ISPS) significantly improved individual students score in Physics (Electricity II) learning (t = 11.73, P = 0.0001). Therefore, “There is a significant difference between achievement scores in Electricity (II) of students who are exposed to Investigative Science Process Skills (ISPS) teaching strategy from those taught using conventional methods.
4.3 To Determine the Problem Solving Abilities of Learners in Physics (Electricity II) When Using Investigative Science Process Skills Teaching Strategy

4.3.1 Students Problem Solving Ability

The data collected on problem learners’ solving ability was first subjected to Cronbach’s Alpha reliability test to establish the reliability of the data. The result gave a reliability of $r = 0.965$. Which is a reliability coefficient of 96.5% which is above the 70.0% reliability test limit. Therefore information received by the questionnaire was reliable. In determining the problem solving abilities of the learners in physics (Electricity II) when using ISPS teaching strategy, learners views on 30 items were tested in a scale of 1 – 5 (1-undecided, 2-disagree, 3-strongly disagree, 4-agree, 5-strongly agree). The mean responses on the items as indicated by the control group and the experimental group were established.

When ISPS teaching strategy was used, the learners agreed (mean response 3.79) that they find physics quite easy to understand. They noted physics lessons to be very interesting (mean response 3.76), find fun in learning physics (mean response 3.49), enjoy learning physics (mean response 3.66) and they find physics lessons pleasing. Table 4.4.
Table 4.4: Mean Response on the Problem Solving Abilities of the Students

<table>
<thead>
<tr>
<th>Activity</th>
<th>Mean response</th>
<th>Standard error</th>
<th>t-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Find physics quite easy to understand</td>
<td>1.78</td>
<td>0.09</td>
<td>14.33</td>
<td>0.001*</td>
</tr>
<tr>
<td>Control group</td>
<td>1.78</td>
<td>0.09</td>
<td>14.33</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.79</td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics lessons are very interesting</td>
<td>1.91</td>
<td>0.09</td>
<td>12.81</td>
<td>0.001*</td>
</tr>
<tr>
<td>Control</td>
<td>1.91</td>
<td>0.09</td>
<td>12.81</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.76</td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning physics is fun</td>
<td>1.82</td>
<td>0.09</td>
<td>11.44</td>
<td>0.001*</td>
</tr>
<tr>
<td>Control</td>
<td>1.82</td>
<td>0.09</td>
<td>11.44</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.49</td>
<td>0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning physics is enjoyable</td>
<td>1.89</td>
<td>0.09</td>
<td>12.50</td>
<td>0.001*</td>
</tr>
<tr>
<td>Control</td>
<td>1.89</td>
<td>0.09</td>
<td>12.50</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.66</td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics lessons are pleasing</td>
<td>1.75</td>
<td>0.08</td>
<td>11.58</td>
<td>0.001*</td>
</tr>
<tr>
<td>Control</td>
<td>1.75</td>
<td>0.08</td>
<td>11.58</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.41</td>
<td>0.12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Response scale (1-undecided, 2-disagree, 3-strong disagree, 4-agree, 5-strongly agree)
*indicate a significant variation in the control and the experimental group when tested at P≤ 0.05

Experimental result showed that students were able to easily carry out calculations in physics (mean response 3.53), considered physics as their favorable subject (mean response 3.46) and they liked to discuss physics problems with other students (mean response 3.98). The students did not find physics terms very abstract (mean response 2.67). These were significant improvements from the control group where the
students did not perform well in physics (mean response 1.80) and did not consider physics as their favorite subject. (Table 4.5).

Table 4.5: Mean Response of the Students Opinion on Physics

<table>
<thead>
<tr>
<th>Activity</th>
<th>Mean response</th>
<th>Standard error</th>
<th>t-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I find physics terms very abstract</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control group</td>
<td>1.71</td>
<td>0.07</td>
<td>6.81</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>2.67</td>
<td>0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I perform well in physics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>1.80</td>
<td>0.07</td>
<td>10.81</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.22</td>
<td>0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calculation in physics are very easy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>1.91</td>
<td>0.08</td>
<td>11.47</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.53</td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Like discussing physics problems with other students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>1.97</td>
<td>0.08</td>
<td>13.85</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.98</td>
<td>0.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics is my favorable subject</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>2.00</td>
<td>0.08</td>
<td>11.08</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.46</td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Response scale (1-undecided, 2-disagree, 3-strong disagree, 4-agree, 5-strongly agree)

*indicate a significant variation in the control and the experimental group when tested at P≤ 0.05

In the experimental group, in a scale of 1 – 5, the learners were always eager to respond physics (mean response 3.50), they always did physics assignment (mean response 3.94) and always try to answer questions during physics lessons (mean
response 3.91). They did not indicate that they easily remember what they learn in physics. Table 4.6.

Table 4.6: Mean Response of the Students on Learning Physics

<table>
<thead>
<tr>
<th>Activity</th>
<th>Mean response</th>
<th>Standard error</th>
<th>t-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am always eager to learn physics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>1.91</td>
<td>0.09</td>
<td>10.65</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.50</td>
<td>0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning Physics is exciting</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>1.87</td>
<td>0.09</td>
<td>11.85</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.57</td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Always do Physics assignments</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>2.01</td>
<td>0.11</td>
<td>13.22</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.94</td>
<td>0.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easily remember what I learn in Physics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>1.80</td>
<td>0.07</td>
<td>10.41</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.19</td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I always try to answer questions during physics lesson</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>1.87</td>
<td>0.10</td>
<td>14.32</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.91</td>
<td>0.10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Response scale (1-undecided, 2-disagree, 3-strong disagree, 4-agree, 5-strongly agree)

*indicate a significant variation in the control and the experimental group when tested at P≤ 0.05

Student who were taken through ISPS teaching accepted that, what they learnt in physics were important (mean response 4.46) and they always try to get good marks in physics (mean response 4.47). They however, noted that physics lessons are
challenging (mean response 3.57). These group appreciated that they do not understand everything that their physics teacher teaches. Table 4.7.

Table 4.7: Mean Response of the Students on Understanding Physics

<table>
<thead>
<tr>
<th>Activity</th>
<th>Mean response</th>
<th>Standard error</th>
<th>t-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I understand everything that my physics teacher teaches</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>1.80</td>
<td>0.07</td>
<td>8.70</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>2.85</td>
<td>0.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What I learn in physics is important</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>2.16</td>
<td>0.13</td>
<td>15.83</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>4.46</td>
<td>0.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I always try to get good marks in physics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>2.22</td>
<td>0.12</td>
<td>16.05</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>4.47</td>
<td>0.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics lessons are challenging</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>1.96</td>
<td>0.12</td>
<td>10.02</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.57</td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Response scale (1-undecided, 2-disagree, 3-strong disagree, 4-agree, 5-strongly agree)

*indicate a significant variation in the control and the experimental group when tested at $P \leq 0.05$

4.3.2 Overall Score of the Achievements of the Students

An average score was computed to establish the overall score of the students in the tested items by the control group of students and the experimental group. The mean
score therefore was $1.923 \pm 0.053$ for the control and $3.627 \pm 0.041$ (mean ± standard error) for the experimental group. In the scale given $1 – 5$ therefore, it implied that control group disagreed on the items tested while the experimental group agreed on the items tested. Using a two sample t-test, comparison of the response therefore showed that there was a significant difference in problem solving abilities of learners when using ISPS ($t = 25.39$, $P = 0.0001$).

**Ho2**: There is no significant difference in problem solving abilities towards learning Electricity (II) between students who are exposed to ISPS teaching strategy and those taught using conventional methods. Based on the findings in this objective, there was a significant difference in problem solving abilities of the two groups ($t = 25.39$, $P = 0.0001$). The research therefore fails to accept the null hypothesis and adopts an alternative hypothesis, “There is a significant difference in problem solving abilities towards learning Electricity (II) between students who are exposed to ISPS teaching strategy and those taught using conventional methods”.

The results showed that (ISPS) enables students’ ability to solve problems compared to those taught using conventional methods of teaching. The finding were in agreement with Okere, (2004) who opines that teaching should be for retention, valid, reliable and objective to enable leaners to solve problems both in class and outside the class. Duffy and Jonassen, (2008) asserts that teachers should develop the process of knowledge construction to enable meaningful learning by solving their problems as well as those of the society at large. The finding are in agreement with the finding of Wasanga, (2009) who says imparting science process skills is one way to equipping learners with skills to solve problems. Novel inventive
instruction approaches such as ISPS could be employed to improve problem solving in physics.

4.4 To Establish if Investigative Science Process Skills have any Effects on students’ Motivation towards Electricity II Compared to Conventional Teaching Strategies

Using chi-square test, Investigative Science Process Skills were found to have positive effects on the students’ motivation towards Electricity II, (P < 0.05). When ISPS is used, majority of the students in the experimental group (30.7%) have self-confidence regarding physics studies. 37.8% felt that physics lessons are well organized, 36.2% were of the opinion that learning physics is rewarding whereas 37.0% see the teaching methods used by their teachers are enjoyable. 45.7% of the students in experimental group applied physics knowledge in other subjects whereas only 11.2% of the control group do apply physics knowledge. Table 4.8.
Table 4.8: Students’ Motivation towards Electricity II

<table>
<thead>
<tr>
<th>Activity</th>
<th>Control</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>U (%)</td>
<td>D (%)</td>
<td>SD (%)</td>
<td>A (%)</td>
<td>SA (%)</td>
<td>$\chi^2$-value</td>
<td>P-value</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Find physics quite easy to understand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control group</td>
<td>55 (47.4%)</td>
<td>43 (37.1%)</td>
<td>7 (6.0%)</td>
<td>11 (9.5%)</td>
<td>0 (0.0%)</td>
<td>121.327</td>
<td>0.001*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>13 (10.2%)</td>
<td>7 (5.5%)</td>
<td>15 (11.8%)</td>
<td>51 (40.2%)</td>
<td>41 (32.3%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics lessons are very interesting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>46 (39.7%)</td>
<td>47 (40.5%)</td>
<td>12 (10.3%)</td>
<td>9 (7.8%)</td>
<td>2 (1.7%)</td>
<td>112.790</td>
<td>0.001*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>14 (11.0%)</td>
<td>6 (4.7%)</td>
<td>16 (12.6%)</td>
<td>52 (40.9%)</td>
<td>39 (30.7%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning physics is fun</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>51 (44.0%)</td>
<td>45 (38.8%)</td>
<td>11 (9.5%)</td>
<td>8 (6.9%)</td>
<td>1 (0.9%)</td>
<td>89.248</td>
<td>0.001*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>16 (12.6%)</td>
<td>17 (13.4%)</td>
<td>13 (10.2%)</td>
<td>51 (40.2%)</td>
<td>30 (23.6%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning physics is enjoyable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>44 (37.9%)</td>
<td>53 (45.7%)</td>
<td>9 (7.8%)</td>
<td>8 (6.9%)</td>
<td>2 (1.7%)</td>
<td>105.639</td>
<td>0.001*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>13 (10.2%)</td>
<td>12 (9.4%)</td>
<td>15 (11.8%)</td>
<td>52 (40.9%)</td>
<td>35 (27.6%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics lessons are pleasing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>52 (44.8%)</td>
<td>51 (44.0%)</td>
<td>4 (3.4%)</td>
<td>8 (6.9%)</td>
<td>1 (0.9%)</td>
<td>96.929</td>
<td>0.001*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>19 (15.0%)</td>
<td>15 (11.8%)</td>
<td>11 (8.7%)</td>
<td>59 (46.5%)</td>
<td>23 (18.1%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*indicate a significant variation in the control and the experimental group when tested at $P \leq 0.05$

Group where ISPS was used performed well in physics (36.2%), find calculation in physics are very easy (30.7%), like discussing physics problems with other students (45.7%) and they take physics as their favorite subjects (34.6%). The attitudes between the control and the experimental groups was significant at $P \leq 0.05$. 
Table 4.9: Students’ Behavior towards Physics

<table>
<thead>
<tr>
<th>Activity</th>
<th>U</th>
<th>D</th>
<th>SD</th>
<th>A</th>
<th>SA</th>
<th>$\chi^2$-value</th>
<th>P-value</th>
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<td>I find physics terms very abstract</td>
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</table>

*indicate a significant variation in the control and the experimental group when tested at $P \leq 0.05$

In the experimental group, the students were always eager to learn physics as agreed by 33.9%. They noted that learning Physics is exciting (38.6%) and they always do physics (assignments (46.5%). Most of these students (29.1%) easily remember what they learnt in physics and 42.5% of them always try to answer questions during physics lessons. The findings showed there was a significant difference in the experimental group from the control group of students.
Table 4.10: Students’ Behavior towards Physics

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<th>Activity</th>
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<th>SA</th>
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<th>P-value</th>
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<td>(22.0%)</td>
<td>(29.1%)</td>
<td>(16.5%)</td>
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<tr>
<td><strong>I always try to answer questions during physics lesson</strong></td>
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<td>(14.7%)</td>
<td>(0.9%)</td>
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</tr>
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<td>(4.7%)</td>
<td>(10.2%)</td>
<td>(8.7%)</td>
<td>(42.5%)</td>
<td>(33.9%)</td>
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<td></td>
</tr>
</tbody>
</table>

*indicate a significant variation in the control and the experimental group when tested at $P \leq 0.05$

As opposed to the control group, the experimental group did not agree (21.3%) that they understand everything that was taught. The experimental group (59.8%) realized that what they learn in physics is important. 37.0% of them always try to get good grades in physics. However, 37.0% noted that physics lessons were challenging whereas only 10.3% of the control group noted these challenges. 21.3% of the experimental group found learning physics to be stimulating while only 5.2%
of the control group found learning physics stimulating. These results showed there was a significant difference in the experimental group from the control group of students \( (P < 0.05) \).

Table 4.11: Students’ Understanding towards Physics

<table>
<thead>
<tr>
<th>Activity</th>
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</thead>
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<td>I understand everything that my physics teacher teaches</td>
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<td>40 (34.5%)</td>
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<td>27 (21.3%)</td>
<td>11 (8.7%)</td>
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<tr>
<td>What I learn in physics is important</td>
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</tr>
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<td>42 (33.1%)</td>
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<td>8 (6.9%)</td>
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<td>34 (26.8%)</td>
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<tr>
<td>Learning physics is stimulating</td>
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</table>

*indicate a significant variation in the control and the experimental group when tested at \( P \leq 0.05 \)

Majority of the students in the experimental group (30.7%) had self-confidence regarding physics studies. 37.8% felt that physics lessons were well organized, 36.2% were of the opinion that learning physics was rewarding whereas 37.0% see
the teaching methods used by their teachers were enjoyable. 45.7% of the students in experimental group applied physics knowledge in other subjects whereas only 11.2% of the control group do apply physics knowledge.

Table 4.12: Students’ Views on Physics Lessons

<table>
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<tr>
<th>Activity</th>
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<th>SA</th>
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<td></td>
<td>(46.6%)</td>
<td>(27.6%)</td>
<td>(9.5%)</td>
<td>(11.2%)</td>
<td>(5.2%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>14</td>
<td>12</td>
<td>20</td>
<td>46</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(11.0%)</td>
<td>(9.4%)</td>
<td>(15.7%)</td>
<td>(36.2%)</td>
<td>(27.6%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The teaching method used by my physics teacher is enjoyable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>47</td>
<td>41</td>
<td>13</td>
<td>8</td>
<td>7</td>
<td>111.281</td>
<td>0.001*</td>
</tr>
<tr>
<td></td>
<td>(40.5%)</td>
<td>(35.3%)</td>
<td>(11.2%)</td>
<td>(6.9%)</td>
<td>(6.0%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>7</td>
<td>7</td>
<td>20</td>
<td>47</td>
<td>46</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.5%)</td>
<td>(5.5%)</td>
<td>(15.7%)</td>
<td>(37.0%)</td>
<td>(36.2%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I apply physics knowledge in other subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>47</td>
<td>42</td>
<td>11</td>
<td>13</td>
<td>3</td>
<td>106.725</td>
<td>0.001*</td>
</tr>
<tr>
<td></td>
<td>(40.5%)</td>
<td>(36.2%)</td>
<td>(9.5%)</td>
<td>(11.2%)</td>
<td>(2.6%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>11</td>
<td>8</td>
<td>9</td>
<td>58</td>
<td>41</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(8.7%)</td>
<td>(6.3%)</td>
<td>(7.1%)</td>
<td>(45.7%)</td>
<td>(32.3%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* indicate a significant variation in the control and the experimental group when tested at $P \leq 0.05$
Table 4.13: Student’s Behavior on Physics Lessons

<table>
<thead>
<tr>
<th>Activity</th>
<th>U</th>
<th>D</th>
<th>SD</th>
<th>A</th>
<th>SA</th>
<th>χ²-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have self-confidence regarding physics studies</td>
<td>55</td>
<td>42</td>
<td>11</td>
<td>6</td>
<td>2</td>
<td>134.07</td>
<td>0.001*</td>
</tr>
<tr>
<td>Control</td>
<td>(47.4%)</td>
<td>(36.2%)</td>
<td>(9.5%)</td>
<td>(5.2%)</td>
<td>(1.7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>12</td>
<td>5</td>
<td>12</td>
<td>39</td>
<td>59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(9.4%)</td>
<td>(9.4%)</td>
<td>(30.7%)</td>
<td>(46.5%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| *indicate a significant variation in the control and the experimental group when tested at P ≤ 0.05

| Physics lessons are well organized             | 55   | 40   | 7   | 11  | 3   | 100.937  | 0.001*  |
| Control                                       | (47.4%) | (34.5%) | (9.5%) | (2.6%) |       |          |         |
| Experimental                                  | 7    | 17   | 30  | 48  | 25  |          |         |
| (5.5%)                                        | (13.4%) |       | (23.6%) | (37.8%) | (19.7%) |          |         |

| Learning physics is rewarding                  | 54   | 32   | 11  | 13  | 6   | 73.856   | 0.001*  |
| Control                                       | (46.6%) | (27.6%) | (9.5%) | (11.2%) | (5.2%) |          |         |
| Experimental                                  | 14   | 12   | 20  | 46  | 35  |          |         |
| (11.0%)                                       | (9.4%) |       | (15.7%) | (36.2%) | (27.6%) |          |         |

| The teaching method used by my physics teacher is enjoyable | 47   | 41   | 13  | 8   | 7   | 111.281  | 0.001*  |
| Control                                       | (40.5%) | (35.3%) | (11.2%) | (6.9%) | (6.0%) |          |         |
| Experimental                                  | 7    | 7    | 20  | 47  | 46  |          |         |
| (5.5%)                                       | (5.5%) |       | (15.7%) | (37.0%) | (36.2%) |          |         |

| I apply physics knowledge in other subjects   | 47   | 42   | 11  | 13  | 3   | 106.725  | 0.001*  |
| Control                                       | (40.5%) | (36.2%) | (9.5%) | (11.2%) | (2.6%) |          |         |
| Experimental                                  | 11   | 8    | 9   | 58  | 41  |          |         |
| (8.7%)                                       | (6.3%) |       | (7.1%) | (45.7%) | (32.3%) |          |         |
Majority, 39.4% of the students in the experimental group always participated in physics lessons. 52.0% were always attentive in physics lessons and 46.5% of the students in this group cooperated with other students during physics lessons. It was established that, the students were not interested in becoming a physics teacher while 6.3% of the students in the experimental group and none of the students in the control group would have liked to become physics teacher. Concerning courses related to physics, 55.1% of the students in experimental group strongly agreed and stated that they would have liked to pursue courses related to physics.

Table 4.14: Students’ Participation in Physics Lessons

<table>
<thead>
<tr>
<th>Activity</th>
<th>U</th>
<th>D</th>
<th>SD</th>
<th>A</th>
<th>SA</th>
<th>$\chi^2$-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I always participate in physics lessons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>49</td>
<td>47</td>
<td>6</td>
<td>12</td>
<td>2</td>
<td>95.821</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>8</td>
<td>21</td>
<td>10</td>
<td>50</td>
<td>38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am always attentive in physics lessons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>48</td>
<td>49</td>
<td>3</td>
<td>14</td>
<td>2</td>
<td>114.474</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>7</td>
<td>13</td>
<td>9</td>
<td>66</td>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I cooperate with other students during physics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>46</td>
<td>45</td>
<td>9</td>
<td>14</td>
<td>2</td>
<td>143.826</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>8</td>
<td>2</td>
<td>4</td>
<td>59</td>
<td>54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would like to be a physics teacher</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>36</td>
<td>42</td>
<td>37</td>
<td>0</td>
<td>1</td>
<td>48.891</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>7</td>
<td>27</td>
<td>80</td>
<td>8</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would like to pursue a course relate to physics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>42</td>
<td>45</td>
<td>15</td>
<td>8</td>
<td>6</td>
<td>120.467</td>
<td>0.001*</td>
</tr>
<tr>
<td>Experimental</td>
<td>6</td>
<td>6</td>
<td>19</td>
<td>26</td>
<td>70</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*indicate a significant variation in the control and the experimental group when tested at $P \leq 0.05$
 Majority, 39.4% of the students in the experimental group always participated in physics lessons. 52.0% were always attentive during physics lessons and 46.5% of the students in this group cooperated with other students during physics lessons. It was established that, the students were less interested in becoming physic teachers, 6.3% of the students in the experimental group and none of the students in the control group would have liked to become physics teachers. Concerning courses related to physics, 55.1% of the students in experimental group strongly agreed and stated that they would have liked to pursue courses related to physics.

**Observation of Physics Lessons**

An observation was made for the control and experimental group of students. The experimental group, the learners used their five senses, used numbers to describe an object e.g. using a ruler, a voltmeter, an ammeter and micrometer screw gauge. They were able to make assumptions on what would happen if they carried out an activity, how they would find out what would happen and what they would do to find out what happens. They strongly wondered what would happen if they carried out an activity, able to predict and to question what they had to do to find out if they are right or wrong. They asked what materials they needed and what steps were to be taken. The experimental groups were strong at sharing ideas through talking and listening, drawing, labeling graphs and acting things out.

Observation on teaching in the experimental group showed that the teacher was adequate in planning e.g. teaching plan clearly related to the intended learning outcomes. The teachers’ knowledge in subject matter was up to date. The teacher made use of current research where appropriate. The content was at appropriate level
for students and the teaching methods were appropriate for the intended learning outcomes. Structures e.g. the structure of session was clearly set out for students. Students were actively engaged with the material. On presentations, it was observed that there was appropriate use of audio visual and other technology aids. The teacher could be heard from the back of the room and pronunciation was clear.

It was observed that the lesson was student centered, interesting inquiry based learning and the teacher was simply the guide. For the Control group of students were not able to use numbers to describe an object e.g. using a ruler, a voltmeter, an ammeter and micrometer screw gauge. They were not able to predict what was going to happen, how they would find out what would happen and what they were going to do to find out the mistakes. Not able to find what materials they would need and the steps they would take. They were not able to share ideas through talking and listening drawing and labeling graphs.

Observed teaching among the control group showed that, the teacher was not planning satisfactorily. The teaching method was not appropriate for the intended learning outcome. It was observed that, the structure of the session was not clearly set out to students, and the students were not actively engaged with the material. Presentation was not appropriate as there wasn’t any use of audio visual and other aids. The teacher could hardly be heard at the back room and pronunciation was not satisfactorily clear.

It was noted that the teacher dominated the lesson and students were passive. The lesson was teacher centered.
**Ho3:** There is no significant difference in motivation towards Electricity (II) a topic in physics among students who are exposed to ISPS teaching strategy and those taught using conventional methods. The findings in this objective revealed that in all the thirty items, students taught using ISPS were motivated than those taught using conventional methods (P < 0.05). The hypothesis was rejected and adopted the alternative hypothesis that, “There is a significant difference in motivation towards Electricity (II) a topic in physics among students who are exposed to ISPS teaching strategy and those taught using conventional methods”.

### 4.5 Gender Differences in Achievement among the Students Taught Through Investigative Science Process Skills Teaching Strategy in the Topic “Electricity II”

Both male and female students were used in this study. In the pre-test achievement the average achievement score by the male was 17.91 ± 0.38 (mean ± Standard error) while that of the female was 18.23 ± 0.23 (mean ± Standard error). To establish the variation in achievement of the students by gender of the students, a two sample t-test was used. The result of the study showed that there was no significant difference in the achievement by gender during pre-test. However, in the post-test results, female students achieved a mean of 25.54 with a standard error of 0.49, while the male students achieved a mean of 17.84 with a standard error of 0.34. This showed that there was a significant effect of gender (t = 12.90, P = 0.0001) on post-test students’ achievement. When considering male achievement before and after the experiment, the result indicated that there was no significant change in male achievement after using ISPS teaching strategy (t = 0.14, P=893). However, Post-test achievement by the female students (mean 25.54) was significantly higher (t = 13.55, P = 0.0001) after
using ISPS teaching strategy than pre-test achievements by the female students (mean 18.23). This indicated that, use of ISPS teaching mainly improved the performance of the female students in physics. Table 4.15.

Table 4.15: Differences in Achievement among the Students’ by Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Pre-test</th>
<th>Post test</th>
<th>T-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>17.91 ± 0.38a</td>
<td>17.84 ± 0.34a</td>
<td>0.14</td>
<td>0.893</td>
</tr>
<tr>
<td>Female</td>
<td>18.23 ± 0.23a</td>
<td>25.54 ± 0.49b</td>
<td>13.55</td>
<td>0.0001*</td>
</tr>
<tr>
<td>T-value</td>
<td>0.72</td>
<td>12.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-value</td>
<td>0.475</td>
<td>0.0001*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mean values in similar column denoted by the lower case are not significantly different at P ≤ 0.05,

Mean values in similar row denoted by same upper case as superscript are not significantly different at P ≤ 0.05, Means separated using Tukeys HSD test. * Indicate a significant p-value

H04: There is no significant difference in achievement scores in physics test between boys and girls who are exposed to Investigative Science Process Skills (ISPS) teaching strategy.

In this objective, the findings showed that there was a significant difference in students achievements in physics by gender (t = 12.90, P = 0.0001) and female achievements were better than the male achievements after using ISPS. The researcher therefore fails to accept the null hypothesis and adopts the alternative hypothesis “There is a significant difference in achievement scores in physics test
between boys and girls who are exposed to Investigative Science Process Skills (ISPS) teaching strategy.

4.6 To Establish if there is Any Difference in Achievement among the Students Taught through Investigative Science Process Skills Teaching Strategy Based on the School Category

4.6.1 Comparison of the Student’s Achievements in the Four Categories

The schools were in four categories based on (1) gender of the students (2) County and National schools categories. Boys (E1) and (C1), 2. (E2) and (C2), 3. Girls (E1) and (C1), 4. (E2) and (C2).

In these categories, achievements, of student’s both control and treatment was recorded. Category 1 had a mean achievement in physics score of 22.71 ± 0.55; category 2 had a mean achievement score of 24.34 ± 0.64; category 3 had 24.58 ± 0.73 while category 4 had a mean achievement of 24.30 ± 0.66. Students’ achievements in physics were compared in the four categories using one way Analysis of variance (One-Way ANOVA). The result showed that implementation of Investigative Science Process Skills teaching (ISPS) in schools was effective and resulted in uniform achievement in the schools regardless of the set school categories since there was no significant difference in the students’ achievements in the four school categories (F = 1.806, P = 0.146). This result therefore indicate that Investigative Science Process Skills teaching strategy can effectively be used to improve Physics teaching in the schools.
Table 4.16a: Achievements of the Students in the School Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Mean ± SE</th>
<th>F-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>22.711 ± 0.545a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>24.337 ± 0.638a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>24.575 ± 0.734a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>24.298 ± 0.656a</td>
<td>1.806</td>
<td>0.146</td>
</tr>
</tbody>
</table>

Mean values in similar column denoted by same letter are not significantly different at \( P \leq 0.05 \).

Table 4.16b: ANOVA Table Showing Variations in Achievements in the Four School Categories

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>193.281</td>
<td>3</td>
<td>64.427</td>
<td>1.806</td>
<td>0.146</td>
</tr>
<tr>
<td>Within Groups</td>
<td>12200.153</td>
<td>342</td>
<td>35.673</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>12393.434</td>
<td>345</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\textbf{Ho5}: There is no significant difference in achievement scores between students who are exposed to Investigative Science Process Skills (ISPS) teaching strategy based on their school category.

The findings in this objective showed that there was no significant difference in achievement scores between students who are exposed to ISPS based on the school category (\( F = 1.806, P = 0.146 \)). The researcher therefore accepts the Null hypothesis.
**Figure 4.4:** Flow Diagram Showing Summary of Chapter Four; Comparison between ISPS Teaching Strategy and Conventional Teaching Methods in Physics and Students’ Achievements.
CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction.
This chapter presents the summary of main outcomes resulting from the data analysis of the five objectives that guided the study, conclusions in respect to secondary schools physics. Recommendations are also drawn for all stakeholders involved in Kenya secondary schools education with partiality on effective teaching strategies to advance on physics teaching/learning skills and achievement in physics. Lastly the chapter winds up by citing the possible areas of further research in relation to ISPS.

5.2 Summary of the Findings
The summary of the study indicated that there was a significant difference between achievement scores in the topic of electricity (II) of students, who were exposed to investigative science process skills (ISPS) teaching strategy and those taught using conventional methods. This implied that (ISPS) is more effective than conventional teaching approaches in improving students learning in electricity (II) in physics. The finding of the study indicated that use of (ISPS) teaching mainly improved the performance of the female students in physics. Thus the findings showed that there was a significant difference in students’ achievement in physics by gender and female achievements were better than the male achievements after using (ISPS). Therefore there is a significant difference in achievement scores in physics test between boys and girls who are exposed to (ISPS) teaching strategy.
Based on the finding of the study there was significant difference in problem solving towards leaning of physics of the two groups (t=25.39, p=0.0001). Therefore the researcher accepts the alternative hypothesis that there is a significant difference in problem solving towards learning electricity (II) between students who are exposed to ISPS teaching strategy and those taught using conventional methods.

Moreover, the findings of the study revealed that in all the thirty items, students taught using ISPS were motivated than those taught using conventional methods (p<0.05). There is a significant difference in motivation towards electricity (II) a topic in physics among students who are exposed to ISPS teaching strategy and those taught using conventional methods.

However, the study finding show that there was no significant difference in achievement scores between students who are exposed to ISPS based on the school category (F=1.806, P=0.146).

The findings also showed a big difference in mean gains existing between learners exposed to ISPS (treatment) E1 and E2 on PAT test compared to moderate learning mean gains realized by those not exposed to treatment. This implied that ISPS positively enhanced learners achievement, problem solving and motivation per student and by gender than those not exposed ISPS.

The results indicated that ISPS gave students mastery of the concepts and process skills during the processes of learning.
The observed scores were higher in experimental groups than control groups an indicator that ISPS is a strong base for collaborative meaningful learning in physics lessons as it laid emphasis on hands on activities, inquiry based learning, student centered as the role of the teacher was to facilitate learning process. Unlike conventional methods that are teacher centered promoting rote learning.

5.3 Conclusions

Use of ISPS enhanced the acquisition of science process skills and subsequent improvement in physics than use of conventional teaching methods. This is evident by the significantly high mean scores in PAT attained by the experimental groups than those in the control groups.

Findings of the study demonstrated that ISPS enhanced problem solving, academic achievement and motivation in learning of Electricity (II) a topic in physics. Therefore students stand to benefit more in learning of physics when exposed to ISPS than conventional methods.

Results of the study indicated that ISPS is beneficial in improving students’ mean scores in PAT, test. Use of ISPS can be used to master concepts, acquire process skills in physics and ultimate higher academic achievement.

A result showed that male and female students exposed to ISPS, females performed better than males in achievement test. This implies that the ISPS was effective to learners irrespective of school category in learning. When students were taught Electricity (II) a topic physics with ISPS, the students felt motivated and found the learning process interesting.
Findings of the study demonstrated that ISPS enhanced problem solving, motivation, and academic achievement girls performed better than boys in learning of physics. Therefore ISPS benefited girls more than boys.

Results of the study indicated that ISPS enhanced learners/learners and teachers-learners interactions during learning experiences in Electricity (II) a topic in physics than conventional methods

5.4 Study Implications

The study indicated that ISPS enhanced meaningful learning in Electricity (II) a topic in physics proving that ISPS is an effective in learning/teaching physics. Therefore physics teachers can incorporate the use of ISPS in teaching physics to improve achievement; problem solving and motivation especially from form ones. The ISPS can be flowed up the levels to form four and finally higher mean scores in KCSE examinations as the basis entry point to majority of courses at colleges and universities. Integrating science process skills in teaching and learning physics as building chips can enhance learner’s critical thinking and logical reasoning master the concepts towards attainment of physics competency in high schools unlike conventional pedagogies which can propagate rote learning when note checked.

Teachers should be sensitized on the benefits of integrating science process skills in teaching and learning physics. Teacher Training Colleges, Universities, and in-service Teaching fraternity should emphasis on ISPS in teaching especially in lesson preparation and presentations in class. Use of ISPS resulted in higher students’ achievement and acquisition of science process skills thus should be used in science
(physics chemistry and biology) teaching at secondary school level. When the approach is implemented in secondary school, acquisition of skills will be guaranteed and likely to improve and performance at KCSE exams would be better.

Teachers need to make use of more investigative skills approaches that actively involve learners in the teaching-learning process to ensure effective acquisition of skills and concepts. The use of conventional methods, for example, notes writing and lecture method may not adequately realize meaningful learning in physics. Teacher training institutions should emphasize the use of ISPS as an effective approach in teaching and learning of physics for higher gain in KCSE.

5.5 Recommendations
Based on the results of this study, ISPS lead to acquisition of problem solving abilities, achievement and motivation in physics in secondary schools in Embu County. It was therefore recommended that:-

a) Physics teachers ought to incorporate use of ISPS as way of enhancing learning amongst the students particularly in form three. This would guarantee a solid foundation of problem solving not only in Physics but also mathematically related subjects like chemistry and Mathematics, in secondary school, colleges and Universities.

b) Physics teachers should assimilate ISPS in teaching Physics and improve achievement. If physics teacher accepts ISPS in teaching they might improve performance of physics in KCSE, increase the number of students taking
physics and consequently the number of students taking science related courses would increase.

c) The contents of ISPS should be adopted as a teaching strategy within the regular in-servicing course for teachers for example in SMASSE.

5.6 Suggestions for further studies

Based on findings of the study, the following areas had been identified for further research.

a) A study should also be carried out to investigate the effects of ISPS on students’ Problem solving, Achievement and motivation toward other areas of sciences and mathematics

b) Studies involving other classes should be carried out to determine the effects of ISPS across different classes in secondary schools. Such studies could give insight on the benefits of ISPS for students at different levels learning.

c) Studies should be done to determine the views of physics teachers on use of ISPS

d) Studies to be done to assess the facilities available in Kenyan secondary schools for proper implementation of ISPS in secondary schools.

e) A study should also be carried out to investigate the effects of ISPS on students’ achievement, problem solving and motivation towards other physics topics in other forms.
REFERENCES


The module proceeded as follows:

**Step one:** Before the student arrived, the teacher had to set out the material and equipment following an agreed standard layout on the table. The teacher greeted the students and explained in general terms that a practical investigation is to follow. The tester used the student’s first name in conversation. But this was not recorded and the tester did not know the students’ identity. Once seated, the student was introduced to the problem and the equipment. The teacher then handed the students the question paper. Students were helped in reading this paper where necessary. The tester then invited each student to ask any question to clarify the task before being told to go ahead. Each student was asked to state in his or her words what the problem is all about.

**Step Two:** Test began. The tester watched what is done as the student carried out the investigation and filled the effect list as the experiment proceeded. The tester had to record each action undertaken by the student as it took place and decided when one trial was completed and another one started. Occasionally, students asked for advice or approvals during the investigation process but were told, “You are told what to do.” The tester intervenes only if safety is threatened.

**Step Three:** This is when students had completed the task. The students writing the result of their investigation on their paper, or finishing their written account of what
they had done would signify this. The tester then marked students work and checked all questions required by the check list. The final question was put to the students along lines, “would you do the same experiment in the same way if you could begin again?” The response to this opportunity to reflect critically on what had been done was noted. After completing one investigation, the student would be required to tackle the second problem. Testing student on one problem, experiment took about 20 minutes.
QUESTION ONE : PRE-TEST

Answer all the questions in the spaces provided

1. You are provided with the following apparatus: one ammeter, two dry cells, one switch, six connecting wires, one variable resistor (r) and two bulbs rated 2w and 5w.

The aim of the experiment is to investigate which of the two bulbs provided has a higher electrical resistance. Proceed as follows:

a) Draw a well-labelled diagram which can be used to carry out the investigation. (5 mks)

2. You are provided with the following apparatus: two dry cells, a switch, three bulbs, connecting wires and an ammeter.

a) Connect up a series circuit including two cells, a switch, an ammeter and two bulbs.

i) Draw the circuit diagram using the proper symbols for the above set up. (5 mks)

ii) Read and record the ammeter reading. (3 mks)

b) Add a third bulb in parallel with one of the first two bulbs.

i) Draw the circuit diagram for the set up. (5 mks)

ii) Read and record the ammeter reading. (3 mks)
3. The circuit shown above is set up on the bench. You are also given two metres labelled x and y.

a) Choose which meter will measure electric current and tick the box below. (2 mk)

Metre X □ Metre Y □

b) Connect the ammeter in the circuit and record the current reading. (4 mks)

(When you have done this, ask the supervisor to check your circuit)

c) Choose which meter will measure voltage and tick the box below. (2 mks)

Metre X □ Metre Y □

d) Connect the meter bulb, measure and record the voltage across bulb A. (2 mks)

You are provided with bulbs A and B: measure and record the voltage across bulb A. (3 mks)

4. You are provided with bulbs A and B, connecting wires, switch and one dry cell. Connect them as shown below.

![Circuit Diagram]

a) Close the switch and compare the brightness of bulbs A and B. Explain your answer. (6 mks)
QUESTION TWO: POST-TEST

2.a You are provided with the following apparatus.

- 2 dry cells
- A cell holder
- Voltmeter (0-5 v)
- An ammeter (0-1 A)
- A resistance wire mounted on a millimetre scale
- 6 connecting wires
- Micrometer screw gauge (shared)

i) Connect the circuit as shown by figure 1 below fig 1

![Figure 1](image)

Record the EMF (E) of the cells when the switch K is open.

E = ........................................................... (1 mk)

ii) Disconnect the voltmeter and connect the circuit as shown by fig 2 below.(4mks)

b) Adjust the length $L$ of the wire to 0.1m, close the switch K and read the values of current and record on the table 1 below.(5mks)

<table>
<thead>
<tr>
<th>Length L(m)</th>
<th>0.1</th>
<th>0.2</th>
<th>0.3</th>
<th>0.4</th>
<th>0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current I(A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\frac{L}{I}
\]
TABLE 1

i) Repeat the procedure in (c) above for the other values of length L given in the table above.

(5 marks)

ii) Calculate the values of \( \frac{1}{\text{Current}} \) and record in the table above.

(4 mark)

c) On the grid provided plot a graph of \( \frac{1}{\text{Axis}} \) against L (x-axis) (6 marks)

d) Determine the gradient of the graph.

(4 marks)

e) i) Measure the diameter of the wire at three different points.

\[ d_1 \text{.................................................} \text{(mm)} \quad d_2 \text{..................} \text{(mm)} \quad d_3 \text{.........} \text{(mm)} \]

(2mks)
Average diameter, \( d = \frac{d_1 + d_2 + d_3}{3} \)
\[ d = \text{mm} \quad (2\text{mks}) \]

ii) Determine the cross-section areas (A) of the wire. \quad (3\text{ marks})

f) From the equation \( I = \frac{KL + Q}{AE} \)

Determine:

i) The value of K \quad (2\text{ mark})

ii) The value of Q \quad (2\text{ mark})
APPENDIX B

Motivation towards Physics Learning (MTPS) SCALE.

Instructions

The MTPS scale contains a large number of statements. It is not A TEST. The information obtained will be used for research, which aims at improving the learning of Physics in schools. Only the researcher will have an access to the information about your responses

THERE ARE NO RIGHT OR WRONG ANSWERS. What is required is your personal Feelings OR Opinions ON EACH STATEMENT OR QUESTION. Please answer ALL Questions as quickly as you can.

NO NAMES ARE REQUIRED

Use a pencil to fill the Questionnaire. If you change your opinion on any statement or Question, clearly erase the response before making the necessary adjustment.

SECTION A:

SEX

Male ☐  Female ☐

AGE: (Years) ________________

For the following section, please indicate the extent to which you agree with the statement in each of the following questions. Indicate whether you strongly Agree, Agree, Uncertain, Disagree or Strongly Disagree by CIRCLING the letters that best describe your level of agreement
<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I find physics quite easy to understand</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>2.</td>
<td>Physics lessons are very interesting</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>3.</td>
<td>Learning physics is fun</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>4.</td>
<td>Learning physics is enjoyable</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>5.</td>
<td>Physics lessons are pleasing</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>6.</td>
<td>I find physics terms very abstract</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>7.</td>
<td>I perform well in physics</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>8.</td>
<td>Calculations in physics are very easy</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>9.</td>
<td>I like discussing physics problems with other students</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>10.</td>
<td>Physics is my favourite subject</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>11.</td>
<td>I am always eager to learn physics</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>12.</td>
<td>Learning physics is exciting</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>13.</td>
<td>I always do physics assignments</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>15.</td>
<td>I always try to answer questions during physics lessons</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>16.</td>
<td>I understand everything that my physics teacher teaches</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>17.</td>
<td>What I learn in physics is important</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>18.</td>
<td>I always try to get good marks in physics</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>19.</td>
<td>Physics lessons are challenging</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>20.</td>
<td>Learning physics is stimulating</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>21.</td>
<td>I have self-confidence regarding physics studies</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>22.</td>
<td>Physics lessons are well organized</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>23.</td>
<td>Learning physics is rewarding</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>24.</td>
<td>The teaching method used by my physics teacher is enjoyable</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>25.</td>
<td>I apply physics knowledge in other subjects</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>26.</td>
<td>I always participate in physics lessons</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>27.</td>
<td>I am always attentive in physics lessons</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>28.</td>
<td>I cooperate with other students during physics experiments</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>29.</td>
<td>I would like to be a physics teacher</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
<tr>
<td>30.</td>
<td>I would like to pursue a course related to physics</td>
<td>SA</td>
<td>A</td>
<td>SD</td>
<td>D</td>
</tr>
</tbody>
</table>
APPENDIX C

PART A

PHYSICS OBSERVATION SCHEDULE

School   Class   Date   Time

The researcher observed, learner’s psychological behavioral reactions reflecting the assessed aspect of investigative abilities, data collection, data presentation/applying, conclusion and in varying in Physics classes. The teaching was normally conducted by the teacher while the researcher check-listed any psychological behavioral reaction from the learners.

Observations.

<table>
<thead>
<tr>
<th>Science Process Skills</th>
<th>Description</th>
<th>Strong</th>
<th>Weak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observing Qualities</td>
<td>Using the five senses. Notice the difference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measuring Quantities</td>
<td>Using numbers to describe an object e.g. using a ruler, a voltmeter, an ammeter, micrometer screw gauge.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inference</td>
<td>What are your assumptions?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predicting</td>
<td>What’s going to happen If I do this will happen How will we find out what will happen? What are we going to do to find out what happens?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimenting</td>
<td>I wonder what will happen if we do this? I predict that this will happen. What do I have to do to find out if I’m right or wrong? What materials will I need? What steps will I take (Procedure) what needs?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communicating</td>
<td>Sharing ideas through talking and listening drawing and labeling graphs and acting things out.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PART B

OBSERVATION OF TEACHING

<table>
<thead>
<tr>
<th>Name of the Teacher</th>
<th>Satisfactory</th>
<th>Not satisfactory</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Planning e.g. Teaching plan clearly related to the intended learning outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Knowledge of subject matter e.g. content is up to date</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Embedding research e.g. makes use of current research, where appropriate.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Level e.g. content is at appropriate level for students.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Teaching methods. e.g. methods are appropriate for the intended learning outcomes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Structure: e.g. the structure of the session is clearly set out to students.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Student involvement. E.g. the students are actively engaged with the material.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Presentation: e.g. There is appropriate use of audio visual and other technology aids. The lecturer/teaching fellow can be heard at the back room and pronunciation is clear.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Observer Name:.................................................................
Signature:.............................................................................
Role:.....................................................................................
Date:....................................................................................
Observers Comments:............................................................
APPENDIX D

MAP OF EMBU COUNTY, KENYA
APPENDIX E:

RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MR. NAZARIO MBOGO NJOKA
of KENYATTA UNIVERSITY, 92-60103
RUNYENJES, has been permitted to
conduct research in Embu County

on the topic: EFFECTS OF
INVESTIGATIVE SCIENCE PROCESS SKILL
TEACHING STRATEGY OF STUDENTS
ACHIEVEMENTS PROBLEM SOLVING AND
MOTIVATION IN SECONDARY SCHOOL
LEVEL PHYSICS IN EMBU COUNTY KENYA

for the period ending:
17th January, 2019

Permit No : NACOSTI/P/18/44643/20801
Date Of Issue : 18th January, 2018
Fee Recieved : Ksh 2000

Applicant’s
Signature

Director General
National Commission for Science,
Technology & Innovation
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Serial No.A 17160
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