FACTORS INFLUENCING GIRLS’ PERFORMANCE IN PHYSICS IN NATIONAL SCHOOLS IN NAIROBI AND KIAMBU COUNTIES, KENYA

By

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MAY, 2014

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Factors influencing girls' performance

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DECLARATION

I hereby declare that this thesis represents my own work and has not been previously submitted to any university or any other institution for award of degree, diploma or any other qualification.

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DEDICATION

This thesis is dedicated to the families of students of Alliance High School who missed my educational services while thesis was being developed.
ACKNOWLEDGEMENT

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ABSTRACT

This study was designed to investigate factors that influence girls' enrolment and performance in physics in five (28%) 'traditional' national schools in Kenya. Meaningful learning of physics is the hallmark of a technologically competent workforce in science, technology and engineering. However, there is a lower performance index and enrolment of girls opting to study physics at KCSE. Specifically, the factors of attitudes of students, learners' ability and teacher characteristics were found to affect enrolment and performance of girls in physics. Three theories that influence the understanding of the issues in this study include Bloom’s Theory of Affect, Bruner’s Theory of Constructivism and Kneller’s Progressive Theory. Despite intervention measures by the Ministry of Education to alleviate girls’ polarization in enrolment and performance in physics, the MOEST, 2006 module report upholds that there are negative influences in the teaching and learning of science. A wide range of literature review on girls’ enrolment and performance in physics nationally and in sub county schools showed low enrolment and poor performance at KCSE. However, no research was evident on factors that influence girls’ performance in physics in Kenya national schools. The study used a survey design among five national schools in Nairobi and Kiambu counties; form two class was chosen as the target population as well as teachers of science and mathematics in the five schools. Purposive and simple random sampling was used in the study. A random sample of two hundred and twenty eight form two students was selected from the five schools. From each school a sample of forty five students was selected using a simple random sampling method. Questionnaires were used to collect data for both teacher and student factors. In addition, an Achievement Test was used to isolate areas of misconceptions that account for poor performance of girls compared to boys. The data was analysed using both descriptive and inferential statistics. Statistical Package for Social Sciences (SPSS) was used in data analysis. Means, frequency distributions and percentages, histograms, and pie charts were determined. Likert Scale was used to measure attitudes affecting performance of physics among all the targeted girls’ schools and the teachers. The study showed students’ attitude, learner’s ability and teacher characteristics, affected girls’ enrolment and performance in physics in national schools. The girls had better positive attitudes and performance in learner abilities in physics than the boys. The results also showed that teachers of physics in girls’ national schools are effective and efficient in instructional designs. The findings of this study may be used to foster positive attitudes towards physics. The methods of physics instruction among girls may also be impacted by constructivism approaches as the results show strong preference to physics practical work.
# LIST OF ABBREVIATIONS AND ACRONYMS

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<tr>
<td>KCPE</td>
<td>Kenya Certificate of Primary Education</td>
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<tr>
<td>KCSE</td>
<td>Kenya Certificate of Secondary Education</td>
</tr>
<tr>
<td>KICD</td>
<td>Kenya Institute of Curriculum Development</td>
</tr>
<tr>
<td>KNEC</td>
<td>Kenya National Examinations Council</td>
</tr>
<tr>
<td>LAT</td>
<td>Learner Achievement Test</td>
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<td>MDGs</td>
<td>Millennium Development Goals</td>
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<td>MOEST</td>
<td>Ministry of Education, Science and Technology</td>
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<td>PSE</td>
<td>Physics Self-Efficacy</td>
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<td>PSQ</td>
<td>Physics Student Questionnaire</td>
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<tr>
<td>SE</td>
<td>Self-Efficacy</td>
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<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
</tr>
<tr>
<td>TQ</td>
<td>Teacher Questionnaire</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
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<td>USA</td>
<td>United States of America</td>
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CHAPTER ONE: INTRODUCTION

1.1 Introduction

Physics education is an important part of the foundation for many occupations (VanGorden and Slater, 1998) and consequently, the issue of enrolment and performance of girls in physics has been a subject of discussion and research globally (Farmer, 1993). The United Kingdom (UK), Dainton report of 1968 established that the number of boys studying physical science subjects beyond compulsory period far outweighed the number of girls. Likewise Kenya National Examinations Council (KNEC) reports of 2004 to 2010 attest this similarity as shown in Figure 1.1.

![Graph showing candidature in physics from 2004 to 2010 for males and females.]

Figure 1.1: National KCSE candidature in physics (2004-2010)
Source: KNEC, 2004 – 2010 Reports
Figure 1.1 shows KNEC physics enrolment of female and male candidates in national examinations during 2004 - 2010. The trend of females being outnumbered by males is evident, almost in the ratio 1:2. This is in spite of an overall trend of KCSE physics enrollment being below forty one percent (41%) nationally.

The current high school curriculum in Kenya puts emphasis on science subjects and yet students’ performance in the science subjects in national examinations has been consistently poor over the years (Madera, 2001). Despite equal education opportunities, there is growing evidence since 1990’s that boys have continued to perform better than girls in physics (Elimu, 2007). However, there is no evidence to suggest that girls and boys have any significant inherent differences in ability (Bennett, 2003). A review of literature by Zhu (2007) shows that Self-Efficacy (SE) is a successful predictor of students’ course-taking although many other factors which are contextual variables have been reported to have influence on Physics Self-Efficacy (PSE).

1.1 Background to the problem

The American Institute of Physics reported that in the 1986-87 year, eighteen percent (18%) of American high schools rarely or never taught physics (Neuschatz and Covalt, 1988). In United States of America (USA) fewer students enroll in physics than in other high school science courses (Farmer, 1993). Likewise science educators in Australia have watched with growing concern the steady decline in the proportion of high school students choosing
senior science courses (Lyons, 2005). If physics enrolments are not adequate, severe shortages of engineers and scientists would be experienced, limiting competitiveness in global science and technology for the 21st century (Van Gorden and Slater, 1988). Duckworth and Ormerod (1975) found physics generally to be preferred and more widely chosen by boys than girls. This outcome is despite the parity in educational resources between girls and boys in world powers like, USA whose future economic competitiveness, hinges on strong science education (Hakim, 2007). Studies by Hart and Cottle (1993) and Alters (1995) indicate that college success for virtually all science, computing, engineering, and premedical majors depend partly on good performance in physics.

Developing countries, such as Kenya, face common problems in science performance emanating from rapidly increasing populations of students in schools, critical shortage of trained teachers as well as lack of materials and facilities for teaching science (Comber and Keeves, 1973). Twoli (1986) established that boys in Kenya, outperformed girls in the physical science domain. Elimu News (2007) also reports the same situation of boys outperforming girls at both KCPE and KCSE in science and physics respectively.

Figure 1.2 shows physics performance of female and male candidates in KCSE during 2004 - 2010.
Figure 1.2: National average marks in KCSE physics (2004-2010)
Source: KNEC, 2004 – 2010 Reports

The trend of females underperforming males in physics in KCSE is evident. This is in spite of an overall trend of KCSE physics performance being below forty three percent (43%) nationally. The reasons for differential enrolment and performance of girls in physics as compared to boys emanate from negative influences in learning science, which are is suggested to arise from the students’ attitudes, socialization and instruction of physics (MOEST Science Module, 2001). Table 1.1 shows percentage enrolment (% E) and performance (% P) from at least grade B- in physics from selected national schools in KCSE from 2005 – 2007.
Table 1.1: Enrolment and performance in KCSE physics (2005-2007)

<table>
<thead>
<tr>
<th>National school</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
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<tr>
<td></td>
<td>% E</td>
<td>% P</td>
<td>% E</td>
</tr>
<tr>
<td>Alliance Girls High School</td>
<td>64</td>
<td>66</td>
<td>72</td>
</tr>
<tr>
<td>Kenya High School (Girls)</td>
<td>56</td>
<td>94</td>
<td>66</td>
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<tr>
<td>Starehe Boys Centre</td>
<td>100</td>
<td>75</td>
<td>93</td>
</tr>
<tr>
<td>Mangu High School (Boys)</td>
<td>85</td>
<td>75</td>
<td>97</td>
</tr>
<tr>
<td>Maseno School (Boys)</td>
<td>86</td>
<td>80</td>
<td>83</td>
</tr>
<tr>
<td>Alliance High School (Boys)</td>
<td>98</td>
<td>87</td>
<td>99</td>
</tr>
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</table>

Source: KNEC, 2005 – 2007 Reports

Grade B- is the minimum benchmark credit in KCSE that signifies good performance in physics (KNEC Confidential, 2011). Observations from table 1.1 show that the higher the enrolment (% E) in physics the better the performances of physics (% P) at KCSE in selected national schools.

It is also observed that some students in the selected national schools underperform below grade B- in KCSE physics despite the subject being optional. This underperformance may suggest candidates' inability to display:
• adequate knowledge, facts, principles and laws that will make them understand the working of the physical world
• the appropriate problem-solving skills in physics to enable them cope with everyday problems
• an ability to analyze common situations, make hypotheses, design and perform experiments to test their hypotheses and to come up with appropriate conclusions
• an ability to make basic calculations to solve standard physics problems
• some appreciation of the importance of physics in society and its application in common everyday situation
• some ability to recognize relations between physical variables

(KNEC Confidential, 2011).

Notably, both the trends of enrolment and performance in physics in national girls’ schools are lower than in boys’ schools. Thus the low trends and the persistent disparity between girls and boys in KCSE physics are worrying. Based on the above background this study investigated factors that influence girls’ enrolment and performance in physics in Kenya national schools.

1.2 Statement of the problem

The problems of education are of a general philosophical character and one cannot criticize existing educational policies or suggest new ones without considering such general philosophical problems such as the nature of a
person, society, and education as a social process (Kneller, 1971). Kenya’s industrial development as outlined in national goals of education and objectives of KCSE physics syllabus (KIE Secondary Syllabus, 2002) pinpoint instruction in physics to be a pivotal contribution and a vehicle to the realization of the elements of the Kenya Vision 2030. The Vision recognizes the process of emergence of the knowledge economy and scientific progress as always associated with increase in science-related and technology-related activities. Thus creation, adaptation and use of knowledge for rapid economic growth hinges on promoting science, technology and innovation. One strategy to promote physics instruction is to enhance both enrollment and performance in physics at KSCE in order to increase the current transition in science from secondary education to university (Kenya Vision 2030, 2007)). Although the Kenya Government has formulated policies to industrialize the country by 2030, the teaching of physics, which is singularly important in the industrialization of Kenya, is not given special attention in the high school curriculum. Foremost, physics is regarded as an optional subject in high school curriculum, a level where it should have been compulsory (MOE Records). Enrolment and performance of girls opting to study physics at KCSE is lower than that of the boys (KNEC Reports, 2005- 2012) and this has serious repercussions for the career options available to women (Sells, 1973). This scenario contravenes the Millennium Development Goals (MDG) which targets elimination of gender disparities in science, technology and innovation (Juma and Cheong, 2005). An average of just 20 and 8 per cent boys and girls respectively enroll in the physics course in high schools in Kenya (KNEC
Report, 2007). Thus, the persistence of fewer girls opting to study physics is worrying and requires investigation especially in the national schools. This study investigated factors affecting girls’ enrolment and performance in physics in Kenyan national schools to establish facts and reasons for their poor enrolment and performance in physics.

1.3 The purpose of the study

Major factors that influence physics enrolment and performance are either school or student based influences (VanGorden and Slater, 1998). Zhu (2007) in China schools reported that girls had lower physics self-efficacy (PSE) than boys and educators had long been concerned about how to promote girls’ PSE and then to increase their physics course studying. This concern has given rise to numerous attempts to improve girls’ PSE through collegiate interventions. The purpose of this study was to identify major factors that influence high school physics enrolment and performance in girls’ national schools in Kenya and suggest possible solutions to the challenges encountered in physics instruction.

1.4 Objectives of the study

The main objective of the study was to investigate factors that influence girls’ enrolment and performance in physics in Kenya national schools.

The specific objectives of this study were:
a) To find out the attitudes of girls towards the learning of physics and how this relates to enrolment.

b) To evaluate learner abilities of girls as compared to boys in physics performance.

c) To find out teacher characteristics that influence girls' enrolment.

d) To find out teacher characteristics that influence girls' performance in physics.

1.5 Research questions

Most research questions can be considered from philosophical, social and scientific view and none of the approaches individually presents a solution to most problems (Enger and Ross 2000). This research attempted to provide answers to the following research questions:

a) Do girls' attitudes as compared to boys' attitudes towards the learning of physics affect their enrolment and performance in Kenya national schools?

b) Do learner abilities affect girls' performance in physics in Kenya national schools?

c) What professional teacher characteristics influence performance in physics among girls in Kenya national schools?

d) What professional teacher characteristics influence enrolment of girls in physics?
1.6 Justification for the study

Female students have lower PSE than male students and this difference is not evident until late adolescence (Kahle and Meece, 1994). Thus early and appropriate interventions aiming at improving girls' PSE is essential since it is critical to their participation in physics (Leslie, McClure and Oaxaca, 1998). This study targeted form two girls, in order to find out factors in:

- attitudes of girls towards physics
- learning abilities and
- instruction of physics among girls.

These factors may influence enrolment and performance in physics at Kenya Certificate of Secondary Education (KCSE).

1.7 Theoretical framework

The three theories that influence the understanding of the theoretical issues in this study include Bloom’s Theory of Affect, Brunner’s Theory of Constructivism and Kneller’s Progressive Theory. Bloom’s theory also known as Bloom’s Taxonomy of Instructional Objectives as quoted by Tsuma (1998) states three independent variables: the cognitive, the affective and the psychomotor entry characteristics of learners during instruction, account for most of the variance in the achievement of learning. According to this theory, the learner should benefit from development of knowledge and intellect (Cognitive Domain); attitude and beliefs (Affective
Domain); and the ability to put physical and bodily skills into effect - to act (Psychomotor Domain) (Eisner, 2000). Bloom's theory provides a basis for ideas which have been developed for instructional curriculum around the world and has an excellent structure for planning, designing, assessing and evaluating training and learning effectiveness (Eisner, 2000).

Krathwhol and Anderson (2001) stated that Bloom's theory was useful in developing a system of categories of learning behaviour that assist in the design and assessment of educational learning. In Kenya, girls' national schools admit girls with very high cognitive abilities following their high entry KCPE scores. The instructional and co-curricular resources are relatively available in national schools and therefore engage girls in their psychomotor skills during physics instruction. This study adapted Bloom's Theory of Affect due to an interface of elements that make up the theory.

Brunner's Theory of Constructivism, also known as the discovery method, is an accepted instructional technique based on the notion that learning takes place through classification and schema formation (Gallenstein, 2004). In this theory it is believed that learners construct new ideas or concepts based upon existing knowledge.

The process of learning is active and involves transformation of information, deriving meaning from experience, forming hypotheses and decision making (Cherry, 2004). This theory advocates learning by discovery method where learners take a more active role in their learning process by answering a series of questions or solving problems designed to introduce a general concept (Mayer, 2003).
In Brunner's theory the process of knowledge construction by learners is more important than the evaluation of what has been learned. Therefore there is emphasis on knowledge construction during the learning process and opportunities are provided for learners to construct new knowledge and new meanings from authentic experiences (Cherry, 2004).

Brunner's Theory of Constructivism befits this study since KCSE physics curriculum has a bias towards a practical approach. Brunner's view has been appreciated in the world and embraced in Kenya for physics instruction, the capacity of students constructing knowledge in physics is assessed at KCSE. The specific learner abilities under investigation are easily observed through the discovery method of instruction for easy differentiation among the students under study. Both Bloom's Theory of Affect and Brunner's Theory of Constructivism put the learning environment into context in terms of content, methodology and technique which is discovery method of teaching (Mayer, 2003). Bruner's Theory of Constructivism is a means that mediates Bloom's Theory of Affect during physics instruction. These two theories can account for differential enrolment and performance between girls and boys in physics.

Kneller (1971) expounds the progressive theory of education which is based on social change and the findings of the behavioural sciences. This theory lays emphasis on change and novelty. The progressive theory is in line with the Kenya's Ministry of Education (MOE) regulation and policy which allows for the choice of at least two sciences at KCSE and paves way for some students to abandon the study of physics beyond Form Two and enrolment in the subject at KCSE. This study also adapted the progressive theory in order to
investigate the impact of the policies and social factors affecting implementation of the KCSE curriculum on enrolment and performance of girls in physics.

1.8 Conceptual framework

Students' own interest, their previous experiences, social cultural influences, learning resources, and the teacher interplay to influence learning of science. The theoretical issues within this thesis raise the questions of the nature of relationship between these factors affecting instruction in physics and the resulting girls' enrolment and performance in physics at KCSE. These factors modify attitudes and abilities of learners besides teacher characteristics and affect enrolment and performance in physics at KCSE in Kenya national schools. Thus the factors of attitude, learner ability and teacher characteristics which are independent variables, may affect girls' instruction in physics (an intervening variable) hence influencing their enrolment and performance and in KCSE physics. Figure 1.3 shows a summary of these variables.
1.8.1 Attitudes of girls towards physics

Studies have shown that Self Efficacy (SE) is a major predictor of girls’ course choice, academic achievement and career interest (Britner and Pajares, 2001). Lower girls’ enrolment and performance are partly caused by negative influences in learning science (MOEST Science Module, 2001). If girls do not overcome the challenges to enroll in science and mathematics courses, the
female pool of potential professional scientists and engineers will not increase effectively (Tsuma, 1998).

Studies done by O’Brien (2002), show that boys are more likely to take all the three core science courses (biology, chemistry, and physics) and enroll in advanced placement physics approximately three times as often as do the girls. Since attainment is a product of learning and learning is influenced by opportunity and effort (Elliot, 2000), girls need to have positive attitudes in order to perform well and enroll in physics courses at high school. Thus this study examines attitudes of girls’ towards physics instruction.

1.8.2 Learner abilities

Learner abilities comprising mathematical ability, spatial ability, concept development and laboratory practice during physics instruction are expected to affect girls’ performance in physics. Peltzer (1988) showed four general intellectual abilities most important in physics achievement as the ability to reason in terms of visual images (visualization or spatial ability), mathematical insight, the ability to evaluate the logic of arguments, and the ability to carry out problem solving in a productive way. Although visual spatial ability is now recognized as an important aspect of thought and accordingly as an important factor in learning, lack of this ability not only hinders a person’s vocational pursuits but also his or her creative thinking potential (Paivio, 1970) and (Holliday, 1975).
1.8.3 Teacher characteristics

Teacher characteristics definitely influence instruction of girls in physics, for effective instruction is mediated by the teacher (Danielson, 2007). The teacher’s role is essential and affects students more than any other group (Shaw, 1950; Lord, 1985) found out that the teacher, being trained in instruction, enhances visual-spatial aptitudes through the teaching of physics. Thus the influence of a teacher in girls’ enrolment and performance in physics is critical and essential.

1.9 Significance of the study

This study provided factors affecting girls’ enrolment and performance in physics at KCSE in Kenya national schools. The results and recommendations of this research should be useful in policy making besides being a document for further research. The results of this study could be used in improving the administration and instruction of physics in high schools. Following these findings, physics teachers might acquire new knowledge; develop new attitudes, skills, valuations, teaching and learning experiences. They might reorganize and present these learning experiences in a manner to raise the interest of the girls in learning physics. They might also be able to use friendly approaches in instruction in physics as a result of this study. The results of this study might provide insights and enlighten education stakeholders on factors that influence enrolment and performance of girls in physics. This might
enable them to guide girls to improve their learning abilities and their attitudes towards of physics. The factors that positively affect enrolment and performance in physics education are key in raising parity between girls and boys in physics.

1.10 Basic assumptions of the study

National schools are assumed to adhere to the use of a common teaching syllabus provided by the Kenya Institute of Education (K.I.E). These schools have ample basic instructional resources for helping students perform well in KCSE. Thus instruction in physics is experience-based, spiral, using a practical approach, and learning from known to unknown. The students who choose physics at the end of Form Two also enroll for KCSE physics.

1.11 Scope and limitation of the study

1.11.1 Scope of the study

This study sought to identify the major factors that influence girls’ enrolment and performance in physics in national schools in Kenya. Eighteen (18) traditional national schools in Kenya had an operational Form Two class when this study was conducted. The study was limited to five (5) national schools located in the Nairobi and Kiambu counties.
Three thousands two hundred and forty (3240) form two (2) students were targeted in the selected national schools inclusive of both boys and girls. These traditional national schools that have been well established and have ample facilities and learning resources hence they could give credible results to the study.

1.11.2 Limitations of the study

The study was limited by time for data collection. This was delimited by the researcher sending questionnaires to respondents in person and receiving responses within a fortnight. Clarifications were sought and made by telephone to respondents on some open ended items in the questionnaires.
1.12 Definition of terms as used in this study

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievement</td>
<td>A measurement of what a person knows and can do after training, i.e. measurement of human capital.</td>
</tr>
<tr>
<td>Adolescence</td>
<td>The period between puberty and adulthood</td>
</tr>
<tr>
<td>Affective</td>
<td>Feelings, emotions and behaviour, i.e. attitudes</td>
</tr>
<tr>
<td>Attitude</td>
<td>This refers to students’ positive or negative mental inclination to the study of physics. This is also how one feels about physics; the interest or lack of it in studying physics.</td>
</tr>
<tr>
<td>Compulsory</td>
<td>KCSE Curriculum subject required by regulation or closed to choice</td>
</tr>
<tr>
<td>National schools</td>
<td>Centres of educational excellence as well as integration that have students’ admission of diverse socio-cultural, economic background and evenly spread out to cover all regions of Kenya</td>
</tr>
<tr>
<td>Optional</td>
<td>KCSE Curriculum subject open to choice</td>
</tr>
<tr>
<td>Performance</td>
<td>The accomplishment of a given task measured against preset known standards of accuracy, competence, completeness, and speed</td>
</tr>
</tbody>
</table>
Science
A process of arriving at a solution to a problem or understand an event in nature that involves testing possible solutions.

Scientific method
A way of gaining information (facts) about the world by forming possible solutions to questions followed by rigorous testing to determine if the proposed solutions are valid (meaningful, convincing, sound, satisfactory, confirmed by others).

Science process skills
These are the empirical skills which are used in the scientific method or investigation. They include observation, interpretation, inferences etc.

Self-efficacy
The beliefs about one’s capabilities to accomplish a given task.

Spatial ability
The skill to reason in terms of visual images (visualization), analyze, comprehend and express imaginative signs and shapes.

The Kenya Vision 2030
A vehicle for accelerating transformation of Kenya into a rapidly industrializing middle income nation by the year 2030.

Visual spatial
The ability to form and control a mental image.
CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The purpose of this chapter is to examine the literature on girls' enrolment and performance in physics in high schools covering attitudes, learners' ability, and teachers' characteristics in the learning of physics. It is, therefore, imperative to review the available literature in physics and science education in general so as to acquire insight in the area and highlight gaps the study sets out in learning of physics among girls in Kenya national schools.

2.2 The nature and image of science

It is increasingly important that the nature and ways of science be understood and how actions of society affect living things (Enger and Ross 2000). Studies done by O'Brien (2002), show that boys are more likely to take all the three core science courses (biology, chemistry, and physics) and enroll in advanced placement physics approximately three times as often as do the girls. An earlier study by Duckworth and Ormerod, (1975) found physics to be preferred and more widely chosen by boys than girls. However, students' enrolment in physics is inhibited by conflicts with other courses, extracurricular activities and fear of failure (Crawley and Black, 1992). This
trend of low enrolment in physics is also observed in Kenya following KNEC 2006 and 2007 Reports.

Science is perceived as masculine from the way it is presented (Bennett, 2003). Kelly (1985) identified four senses in which science could be considered to be masculine. First, the majority of those who choose to study it are male, so that it is seen as a predominantly male area of academic activity. Second, it is mode of instruction suits more the interest and motivation of boys. Third, behaviours in science classes are such that boys and girls act out characteristic gender roles. Finally Kelly (1985) suggested that because it has been socially constructed in a parochial male-dominated society, science is itself inherently masculine. However, this suggestions do not rule that female are incompetent in studying science for milestone scientific works have been achieved by females like Madame Mary Curie and Florence Bacon (Tillery, 2007) in the history of science.

The experimental nature of science fosters teamwork and manipulative skills of objects as well as promoting observational, deductive and evaluative skills (Wan and Van, 2006). Science derives its power and authority from its empirical method; a method that comprises a sure and reliable inference from observation and experiment. This authority is from the senses and experiences from which scientific knowledge is constructed (Stanesby, 1985). It is the nature of science therefore to look for more new knowledge, through two processes referred to as deductive and inductive reasoning (MOEST Science Module, 2001). These skills sit well within the KCSE physics course and are essential in the learning and teaching of physics, especially in field trips,
practical and project work, (KIE Secondary Syllabus, 2002). Teaching to understand science follows Bacon’s view of understanding nature from consulting nature and not the writings of Aristotle (Stanesby, 1985).

Scientific methods and values include seeking to answer questions using some kind of evidence, recognizing the importance of rechecking data, and understanding that scientific knowledge and theories change over time as more information is gathered (Rezba, 1999). Science contributes its unique skills, with its emphasis on hypothesizing, manipulating the physical world and reasoning from data (Padilla, 1990).

Scientific investigation in Figure 2.1 includes proposing an explanation for the observation made, use of explanations to make predictions, testing of predictions by doing an experiment by making multiple observations, modification of explanation if need be, and drawing conclusion(s).
2.3 Attitudes towards learning physics

A study in Texas by Crawley and Black (1992) discovered that students in Texas had enrolment intentions that were determined by their attitude towards enrolment and their degree of perceived behavioral control. In Australia, low intrinsic value of school science and erosion of its strategic value contribute to the reluctance of students to choose physical science courses in the senior school (Lyons, 2005). Bennett (2003) in the UK found evidence to suggest that boys generally had a more positive attitude to science than girls, and the masculine image of science has a strongly alienating effect on girls. Likewise,
in Kenya, MOEST Science Module, (2001) reported a biased attitude in science lessons where teachers and pupils expect boys to be more participative, and achieve better than girls. No wonder one of the general objectives of instruction of physics in KCSE curriculum is to foster a positive attitude towards physics among both boys and girls (KIE Secondary Syllabus, 2002).

In the same context girls have been made to believe that science is meant for boys resulting in lower participation of girls in science (MOEST Science Module, 2001). Because of being dominant in class, boys are known to volunteer easily to do assignments as found in Kenya by Tsuma, (1998) and Wanjama, Muraya and Gichaga, (2006). It is important that both girls and boys get access to science education for competition in educational opportunities; since attainment is a product of learning and learning is influenced by opportunity and effort (Elliot, 2000). Disparities in enrolment and performance between girls and boys are partly caused by negative influences in learning science (MOEST Science Module, 2001).

All these studies on attitude of students towards physics in Kenya were limited in sample and cannot be extended to find out attitude of girls towards physics in Kenya national schools and show clearly how attitudes are underpinning the performance of physics in Kenya. This study examines the attainment of the objective given just an average of eight per cent (8%) of the girls enroll to do KCSE physics annually (KNEC 2006 and 2007 Reports). This study sought to establish the girls’ attitudes towards physics in Kenya national schools.
2.4 Learner abilities in physics education

After 1950 there has been a great effort of researchers dealing with science education on determining the factors affecting the achievement in science courses (Delialioglu and Askar, 1999). Many students especially from Western Europe and the United States of America (USA) have shown that there are differences between boys and girls in the level of achievement in science (Shaycoft, 1963). This could be due to the fact that most classroom activities are organized to accommodate male learning styles (Ong, 1981). In Kenya, girls always achieve lower scores in science than boys (MOEST Science Module, 2001). Researchers have shown that intellectual factors played an important role in physics achievement (Delialioglu and Askar, 1999). Efumbi (2002) researched on learner abilities, in operations, spatial ability, concept development and laboratory practice and found no significant difference between achieving in physical science for boys and girls in Busia District of Kenya. However, these findings were from schools with inadequate learning resources (Chiriswa, 2002). In this study performance of girls in physics in Kenyan national schools is assessed since the schools have sufficient instructional resources. It is expected that since national schools take the best performing students at KCPE, the schools should handle effectively any subject.
2.4.1 Mathematical ability

KCSE Physics course is rich in mathematical operations, has high level of abstraction and is often symbolic (KIE Secondary Education Syllabus, 2002). The many abstract concepts that KCSE physics embodies were also cited by Madera (2001). Pallrand and Seeber (1984) investigated the relationship between mathematical skills of students and achievement in physics and confirmed findings of earlier studies of a significant correlation between mathematics skills and physics. Griffith (1985) found that mathematical skills can serve as a predictor for physics courses. Delialioglu and Askar (1999) found mathematical skill as a factor influencing the success in learning and achievement in physics skills. Serbin (1972) in the USA found girls typically do well academically in comparison with boys although large numbers of girls avoid both mathematics and science courses in the later years of high school. Hughes and Hughes (1959) in UK had found girls superior than boys in verbal ability; they read more and wrote more while boys were superior to girls in mathematical and mechanical ability. Glennon and Callaghan (1968) in the USA found boys achieved higher scores than girls in tests dealing with mathematical reasoning. From junior high school and beyond, boys surpassed girls in studies involving science (Suydam and Riedesel, 1969).
2.4.2 Spatial ability

Spatial thinking appears to be central to many scientific domains thus measures of spatial ability are correlated with success in physics (Kozhernikov, Motes, Hergarty, 2007) and Sorby (2001). Siemankowski and MacKnight (1971) found that science students who were mostly physics majors possessed more highly developed visualization skills than non-science students. Pallrand and Seeber (1984) investigated and found spatial aptitudes in successful students of physics. According to Lord (1985) and Brinkmann (1966) visual-spatial ability is an important cognitive operation for success in science and it is helpful and can be enhanced in physics through instruction and practice. However, spatial ability is also an innate phenomenon (McFie, 1973). A number of studies in the 1960s showed that students who did well in physical science subjects also scored highly on tests of spatial ability and boys tended to obtain higher scores than girls on such tests (Bennet, 2003).

Maccoby and Jacklin (1975) in the UK undertook an extensive review of studies on spatial ability, concluding that after the age of 12, where boys obtained higher mean scores than girls in tests on spatial ability. However, a reworking of the data by Hyde (1981) showed that sex differences accounted for only a very small percentage of the variance in the scores, and Whyte (1996) showed that girls who had followed a six-month programme of activities aimed at improving spatial ability performed as well as boys. Harding (1986) showed that there is no significant inherent difference in the ability between boys and girls in physical science performance.
Performance in tests of visual-spatial ability correlates with mathematical ability and achievement test scores according to Fennema, (1977). Many researchers have suggested that genetic or other physiological factors contribute to the sex difference in visual-spatial skill (Stafford, (1961), Broverman, Klaiber, Kobayashi, and Vogel, (1968), Hartlage, (1970), Bock and Kolakowski., (1973) and Wittig, (1976). Sherman (1967) proposed that environmental factors, specifically the differential play experiences of boys and girls, may provide differential amounts of practice in visual-spatial skills.

Different rates of play with sex-typed toys, such as blocks and models, which require the use of these skills, might result in the development, over time, of a practice deficit in girls, who have less exposure to this type of play material. According to Pallrand and Seeber., (1984) visual-spatial ability influences course selection in physics. This spatial skill helps one to identify forms from the patterns and vice versa and the ability to see relationships and patterns and solve critical problems in the complex real world (MOEST Science Module, 2001). KCSE physics course deals with content that requires both large-scale and small-scale spatial abilities (KIE Secondary Education Syllabus, 2002); thus many concepts in the course are abstract, often symbolic and involve laboratory skills.
2.4.3 Concept development

One of the ways for concept development is by the principle of concept mapping. The principle of a concept map is that it provides a visual means of showing connections and relationships between a hierarchy of ideas ranging from the very concrete to the abstract (Bennett, 2003). Concept maps can be used in such a way as asking respondents to modify their maps at a number of points during a period of instruction as a means of establishing how their thinking is developing. Strategies for helping bring about change are in two key phases; the first of these involves gathering information about students’ current thinking (elicitation) and the second involves presenting students with some form of stimulus or new idea which challenges the current thinking, resulting in students reformulating their ideas, (Bennett, 2003). This study focuses on how concepts are developed during physics instruction as this relates to performance in the subject. Misconception in physics is generally articulated as a common cause of poor performance in physics at KCSE (KNEC Reports 2004 – 2010).

2.4.4 Laboratory practice

According to KIE Secondary Education Syllabus (2002), KCSE physics course is rich in abstraction and involves laboratory skills. Thus the processes and skills approach to practical work dominates much of practical work (Bennett, 2003).
One outcome of the practical work in science lessons is the rise in investigations as a means of developing procedural understanding- the abilities to carry out the processes of scientific enquiry such as:

- hypothesizing
- observing
- classifying
- measuring
- communicating
- inferring and

In Busia district of Kenya, Efumbi (2002) found that there was a positive relationship between students' achievement in chemistry and use of practical in laboratory approach in teaching. Use of laboratory approach in physics instruction is only assumed to be taking place given that national schools are well endowed with laboratories unlike district schools. Thus there is need to establish the use of laboratory approach in physics instruction and how enrolment and performance in physics is affected.

2.5 Teacher characteristics

Duckworth and Ormerod (1975) reviewed research regarding the influence of science teachers on students' attitudes toward science in Britain and America. The British and American studies showed conflicting results of science teacher influence (British - teacher not influential; American - teacher influential).
However, studies by (Kahn and Weiss, 1973, and Ramsey and Howe, 1969 a and b) concluded that the role of the teacher is important in the development of students’ affective behavior over education. Sobolewski (1993) reviewed data from New York state and found out that majority of students enrolling in physics had a positive view of the teacher – the teacher is liked by the student, and the student thinks the teacher has a good reputation. Further students who know the teacher are likely to enrol in physics than those who do not. The results were consistent with Sobolewski (1993) who found out that the experience of the teacher was a latent variable influencing physics enrolments. Studies on the efficiency, style, and personality of science teachers and how these teacher factors affect attitudes of students toward science and performance in physics in national schools in Kenya is yet to be done. Although The Kenya National Examinations Council publishes national data on enrolment and performance of girls at KCSE, a wide gap exist between influence of teacher characteristics versus girls’ enrollment and performance in physics in national schools in Kenya; hence this study was set out to find out the impact of teacher characteristics on girls’ enrollment and performance in physics in national schools in Kenya. The problem of enrolment and performance in physics among girls in Kenya is worsened by the rapidly increasing population of students in schools, critical shortage of trained teachers as well as lack of materials and facilities for teaching science. However, the literature review available on girls’ enrolment and performance in physics is from western countries. In Kenya no research has been done to show the relationship between influence of girls’ attitude,
learner abilities and teacher characteristics on enrolment and performance in physics. The importance of a positive attitude and learner ability in physics instruction besides strong teacher factors that influence enrolment and performance of girls in physics is what led to this survey study in five national schools in Kenya.
CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter describes the methodology of the study by considering:

- Study area
- Research design
- Target population
- Sample size
- Sampling procedure
- Instruments for data collection
- Administration of research instruments
- Pilot study
- Data collection procedures and analysis.

The first section consists of the description of the research samples including method of its selection. The second section describes the research instruments that were used to collect data. The third section describes the methods and techniques in collecting data on enrolment and performance in physics in Kenya national schools, while the fourth section describes the methods used in the data analysis process.
3.2 Study area

At present (2013), Kenya has a total of forty eight (48) national schools, out of which thirty (30) are newly upgraded. All the national schools in Kenya are boarding. The researcher showed interest in finding out factors influencing girls’ enrolment and performance in physics in the traditional national schools in the two counties. Both Nairobi and Kiambu counties have twelve (12) of the traditional national schools, half for girls. Nairobi and Kiambu counties neighbor one another and exhibit similar socio economic characteristics that influence instruction. Three girls’ and two boys’ schools were sampled from the two counties. Since this study concerned girls’ enrolment and performance in physics, more of girls had to be sampled. The boys were included in the sample for comparison. All the five schools selected are the oldest national schools in Nairobi and Kiambu counties, well equipped in instructional resources and admit students with comparable entry behavior. This study involved form two students in the sampled schools since choice to study physics for KCSE is recommended at the end of the form two coursework (MOE Reports, 2010).
3.3 Research design

The research used the descriptive survey design. The process of the research is shown in figure 3.1 in sequence of events from:

- the problem statement
- sampling process
- data collection procedure
- piloting of instruments for data analysis and presentation and finally
- summary, conclusion and recommendations.
Statement of the problem

Population of National Schools in Nairobi and Kiambu
Sample-Form two

Data Collection Procedures
- Students’ Questionnaires
- Teachers’ Questionnaires
- Head of Department Checklist
- Achievement Test

Data analysis
- Percentages
- Means
- Frequencies
- t-test

Checking quality of data collection, coding and editing

Data Presentation
- Tables
- Pie charts
- Histograms

Summary, Conclusions and Recommendations

Figure 3.1: Steps of the process of the study
3.4 Target population

Two hundred and twenty eight (20%) students, thirty nine (39) teachers and twenty five (25) heads sciences and mathematics departments in the five sampled schools were targeted for the investigation. The 'traditional' national schools have an average population of ninety (90) heads of sciences and mathematics departments, one hundred and forty four (144) physics and mathematics teachers and three thousands two hundred and forty (3240) form two students (MOE Reports, 2010). The form two students were picked for the research because they have as yet to choose exam subjects.

3.5 Sample size

According to Gatara, (2010), a simple random sample is central in probability sampling in that it is based on the basis that every element in a population has a chance of being included in the sample. Five (5) national schools comprising two (2) boys’ schools and three (3) girls’ schools were therefore picked out of the twelve (12) national schools in Nairobi and Kiambu counties. To be specific, twenty five (25) heads of departments of sciences and mathematics besides subject heads of: physics, chemistry and biology were sampled. In addition thirty nine (39) teachers of sciences, mathematics and an average of forty six (46) Form Two physics students from each school, culminating to a total of two hundred and twenty eight (228) students were purposively sampled from the five (5) national schools to participate in the study. Common
science process skills exist in the instruction of biology, chemistry, physics and mathematics and many physics teachers are either majors, minor or regular trained instructors of other science or mathematic subjects. Their views for physics instruction were essential and valid in this study.

3.6 Sampling procedure

Purposive and random sampling was used in the study. Five national schools, i.e. three girls’ and two boys’ were picked and the target population consisted of two hundred and twenty eight (228) form two students. In each of the schools sampled, the heads of science, physics, chemistry, biology and mathematics departments were interviewed on professional teacher characteristics in line with the research questions in the study. The reason for involving five levels of school leadership in the school is because the five levels of leadership influence the enrolment and performance in physics. Table 3.2 summarizes sample size tabulation. The schools were coded P, Q, R, S, and T for purposes of confidentiality.
Table 3.2: Sampling grid

<table>
<thead>
<tr>
<th>National School</th>
<th>Number of students</th>
<th>Number of students sampled</th>
<th>Number of teachers of physics and mathematics</th>
<th>Number of departmental heads of sciences and mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>P (Boys)</td>
<td>220</td>
<td>44</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>Q (Girls)</td>
<td>215</td>
<td>43</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>R (Boys)</td>
<td>265</td>
<td>53</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>S (Girls)</td>
<td>220</td>
<td>44</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>T (Girls)</td>
<td>220</td>
<td>44</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1140</td>
<td>228</td>
<td>39</td>
<td>25</td>
</tr>
</tbody>
</table>

**KEY**
P is national boys’ school in Kiambu County
Q and T are national girls’ school in Kiambu County
R is national boys’ school in Nairobi County
S is national girls’ school in Nairobi County
3.7 Instruments for data collection

Four instruments (Physics Student Questionnaire (PSQ), Teacher Questionnaire (TQ), Head of Department Checklist (HDC) and Learner Achievement Test (LAT) were used during the study.

3.7.1 Physics student questionnaire

PSQ was administered to 228 Form Two students in three girls’ and two boys’ national schools in Nairobi and Kiambu counties of Kenya. Students were asked to respond to a 5-point Likert Scale ranging from strongly disagree (SD) to strongly agree (SA) during data collection of student factors in questionnaires. Some statements were written in the tense describing the statement as being a positive factor and others in the tense considering the statement as not being a factor influencing physics enrolment and performance. The PSQ (Appendix 1) sought to obtain information on the following student factors:

- attitude towards physics
- learning of physics
- level of difficulty of physics
- peer influence and
- career aspirations
3.7.2 Teacher questionnaire

Teachers were asked to respond to a 5-point Likert scales ranging from strongly disagree to strongly agree. Physics Teacher Questionnaire (PTQ) (Appendix 2) sought to gather information on the following teacher characteristics:

- professional qualification
- years of teaching
- preparedness
- teaching methods
- approach to teaching
- lesson strategies and
- evaluation practices

3.7.3 Head of department checklist

The Head of Department Checklist (HDC) (Appendix 3) targeted physics, chemistry, biology, sciences and mathematics heads in five national schools. The composition of this heads of department was because both science and mathematics subjects have common process skills and reasoning. The checklist was used to collect data concerning management of physics instructional resources. Thus the checklist was used to obtain data on instructional process in terms of:

- use of current lesson plans
• use of current schemes of work
• motivation of learners
• students' attitudes towards physics

3.7.4 Learner achievement test

An achievement test to distinguish content difficulty was used to assess practical procedures, abilities in operations, spatial and concept development in physics among form two students in the five national schools. Basic questions of form two content from former KCSE question papers were compiled and further standardized to assess the above mentioned learner abilities. These questions formed The Learner Achievement Test (LAT), (Appendix 4) and were administered to one hundred and thirty girls (130) and ninety seven (97) boys. There was consensus by supervisors and the teachers from the sampled schools on the content, cognitive level, skill, quantity of questions in the LAT and time for students doing the test in order to perform t-test on the results.

3.8 Pilot study

Piloting was necessary to ensure that all questions mean the same to all respondents (Bell, 1987). The reason for piloting the instruments was to determine their reliability and validity indices. The instruments PSQ, TQ and LAT were piloted. Piloting of the three instruments on their effectiveness was
done with forty four (44) form two boys at one of the national schools in Nairobi which was not part of the schools in the study.

3.8.1 Validity of research instruments

Validity is a measure of the degree to which a research instrument measures what it is supposed to measure. The pilot phase was to help in establishing of the validity of these instruments.

3.8.2 Reliability of research instruments

Reliability is a measure of the degree to which a research instrument yields consistency. Reliability of Teacher Questionnaire (TQ), Physics Student Questionnaire (PSQ) and Learner Achievement Test (LAT) were ascertained during the pilot phase of the study using split half method. The respondents were grouped into two halves and scores from the two groups correlated after administering the instruments. The correlation was calculated using the Pearson product–moment correlation formula:

\[ r_{xy} = \frac{N \sum XY - \sum X \sum Y}{\sqrt{(N \sum X^2 - (\sum X)^2)(N \sum Y^2 - (\sum Y)^2)}} \]

Where \( r_{xy} \) is the reliability coefficient
- \( N \) is the number of respondents in one group
- \( \sum x \) is sum of scores by respondents in one group
- \( \sum y \) is the sum of scores by respondents in the second group

44
For the PSQ the value of $r_{xy}$ was obtained for all students besides that for boys and girls alone. However the three instruments PSQ, TQ and LAT gave an index of at least 0.7 which was considered acceptable.

3.9 Administration of research instruments

Questionnaires PSQ and TQ were administered to the sampled students and teachers respectively. The student questionnaire dealt on instruction and attitude towards physics. The teacher questionnaire dealt on personal, professional characteristics and teaching and learning conditions. Data was obtained by administering questionnaires PSQ, TQ and HDC to sampled students and physics teachers in the schools. More information was also obtained from comments of heads of departments of sciences and mathematics. LAT was administered by the regular physics teacher of the sampled form two classes under the guidance of the researcher.

3.10 Data collection procedures and analysis

Four instruments were used during the study. These instruments mainly sought information on:

- attitudes
- learner abilities and
- teacher characteristics that influence girls’ enrolment and performance in Kenya national schools.
The four instruments (PSQ, TQ, HDC and LAT) were administered in three girls’ and two boys’ national schools in Nairobi and Kiambu counties of Kenya. The administration was done in the seventh week of third term of 2011. Collection of data and its analysis are critical processes. Most data included:

- attitudes of students towards physics
- peer influence
- career aspirations
- teacher characteristics and
- learning abilities of girls in physics.

Other data included:

- number of students enrolment in physics over time (2004-2010)
- physics performance at KCSE over time (2004-2010)
- number of Physics teachers
- qualification and sex of teachers over the period (2004-2010) and
- enrolment of boys or girls in physics.

The data was analysed using both descriptive and inferential statistics. Statistical Package for Social Sciences (SPSS) was used in data analysis. Descriptive statistics using means, frequency distributions and percentages, histograms, and pie charts were determined. Likert Scale was used to measure attitudes affecting performance and enrolment of physics among all the targeted girls’ schools and the teachers.

Data from heads of department checklist was used to supplement teacher characteristics that influence enrolment and performance of physics among
girls in Kenya national schools. A t-test was used to compare learner abilities in performance in LAT in physics between schools P (boys) and Q (girls) then schools R (boys) and S (girls) and lastly schools (P+R) boys and schools (Q+S) girls.
4.0: Introduction

The purpose of the study was to investigate factors that influence girls’ enrolment and performance in physics in Kenya national schools. In this study, physics student questionnaire (PSQ), Teacher questionnaire (TQ), head of department checklist (HDC) and the learner achievement test (LAT) were used to solicit information on attitudes, learner abilities and teacher characteristics that influence girls’ performance and enrolment in Kenya national schools. The population of Form Two students in the eighteen (18) national schools is about three thousands and six hundred (3600). Five (5) schools out of the eighteen (18) national schools from Nairobi and Kiambu counties were picked. Two hundred and twenty eight (228) students comprising one hundred and twenty one (131) girls and ninety seven (97) boys were sampled for the study.

4.1 Attitudes of girls towards enrolment in physics

This research addressed attitude of girls in national schools in Kenya, as compared to boys’ towards the learning of physics and how it affects their enrolment and performance. Students were asked to respond to a 5- point Likert Scale ranging from strongly disagree (SD) to strongly agree (SA). The PSQ (Appendix 1) sought to obtain information on student factors. Positive statements or questions were coded as: Strongly Agree (SA) 5 points, Agree (A) 4 points, Neutral (N) 3 points, Disagree (D) 2 points and Strongly
Disagree (SD) 1 point. Negative statements were coded as: Strongly Agree (SA) 1 point, Agree (A) 2 points, Neutral (N) 3 points, Disagree (D) 4 points and Strongly Disagree (SD) 5 points. An average of 4 and 5 in statements or questions was taken as positive attitude while 1 and 2 was taken as negative attitude. The means of each the statements or questions were computed hence the overall means for all the students, girls and boys were computed as 4.03, 4.06 and 4.00 respectively as indicated in table 4.1.
Table 4.1: Analysis of the Likert scale of means of attitudes

<table>
<thead>
<tr>
<th>N</th>
<th>Statement</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Overall</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls N=136</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Boys N=98</td>
</tr>
<tr>
<td>1</td>
<td>I am interested in physics</td>
<td>4.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.53</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.76</td>
</tr>
<tr>
<td>2</td>
<td>If I enroll in physics, my mean grade will be lower at KCSE</td>
<td>4.49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.59</td>
</tr>
<tr>
<td>3</td>
<td>My parents and immediate relatives want me to study physics</td>
<td>2.51</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.47</td>
</tr>
<tr>
<td>4</td>
<td>My friends are influencing me to enroll in physics for KCSE</td>
<td>3.94</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.88</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.01</td>
</tr>
<tr>
<td>5</td>
<td>I will need physics for college or university admission</td>
<td>4.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.79</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.59</td>
</tr>
<tr>
<td>6</td>
<td>Physics is applicable in everyday life</td>
<td>4.72</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.61</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.82</td>
</tr>
<tr>
<td>7</td>
<td>I fear many assignments in physics</td>
<td>4.19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.89</td>
</tr>
<tr>
<td>8</td>
<td>Physics is too difficult for me</td>
<td>4.31</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.26</td>
</tr>
<tr>
<td>9</td>
<td>I have enough time to study physics</td>
<td>4.18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.15</td>
</tr>
<tr>
<td>10</td>
<td>I often play with physics related objects</td>
<td>3.99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.99</td>
</tr>
<tr>
<td>12</td>
<td>I can’t enroll in physics because I don’t perform well in the prerequisites</td>
<td>4.29</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.09</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.48</td>
</tr>
<tr>
<td>13</td>
<td>I will enroll in physics because I enjoy studying physics</td>
<td>3.35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.46</td>
</tr>
<tr>
<td>14</td>
<td>My physics teacher motivates me in physics</td>
<td>4.11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.37</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.86</td>
</tr>
<tr>
<td>15</td>
<td>My physics teacher helps me develop confidence to perform well in physics</td>
<td>4.16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.87</td>
</tr>
<tr>
<td>16</td>
<td>My physics teacher helps me develop proficiency in layout of work in physics</td>
<td>4.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.93</td>
</tr>
<tr>
<td>17</td>
<td>My physics teacher allows me participate in asking and answering questions during physics lessons</td>
<td>4.40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.57</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.22</td>
</tr>
<tr>
<td>18</td>
<td>We often work in smaller groups during physics lessons</td>
<td>2.72</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.64</td>
</tr>
<tr>
<td>19</td>
<td>We do not do continuous assessment tests and assignments in physics very often</td>
<td>4.29</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.51</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.07</td>
</tr>
<tr>
<td></td>
<td>Overall mean</td>
<td>4.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.06</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.00</td>
</tr>
</tbody>
</table>
The overall attitude mean is 4.03. This shows a positive attitude towards physics among students in national schools. When the attitude is isolated according to gender, the attitude of girls, of 4.06 is higher than that of the boys, 4.00. However the difference in the levels of attitudes is not significant as shown by t-test. This shows that the high level of attitudes between girls and boys likely affects the learning of physics equally.

4.2 Girls’ reasons for enrolling in physics

Some structured questions were included in student questionnaires to find out reasons that influence enrolment of girls in physics at KCSE. Girls were strongly influenced in enrolment and performance in physics by:

- having an interest in physics
- seeing the applications of physics in future
- being allowed to participate during instruction.

These results are in line with the findings of Crawley and Black (1992). The teacher characteristics in girls’ national schools in Kenya compare with the results of studies done at Kansas, USA on factors influencing enrolment in physics whereby majority of student enrolling in physics had a positive view of the teacher; the teacher was liked by the students, and the students thought the teacher had good reputation (VanGorden and Slater, 1998).

Other reasons that positively influenced girls in physics included the girls having had enough time to study physics on their own, often having played with physics related objects, and enjoying physics lessons.
The negative influences that inhibited enrolment and performance of girls in physics included:

- fear of lowering girls’ mean grade at KCSE when physics grade is included (4.40)
- too much assignments in physics (4.49)
- physics being too difficult (4.38) and
- poor performance in prerequisites such as English and Mathematics (4.09).

Performance in physics in coursework (9%) was the least significant factor in influencing enrolment of girls in KCSE physics. Other factors (as in Figure 4.1) influencing enrolment of girls in physics at KCSE included: careers that require physics enrolment (45%), interest in physics (25%) and other reasons (20%).

Figure 4.1: Reasons for girls opting to enroll in physics at KCSE
The most significant reason for majority of the girls to enroll in physics at K.C.S.E. is for career choice which was rated highest at 46% as shown in figure 4.1. This reason was found to influence enrolment in physics in a study conducted in Texas by Crawley and Black (1992).

4.3 Reasons that influence girls’ enrolment in physics at KCSE

A range of factors that influence enrolment were explored.

Figure 4.2 shows the most significant reason for girls enrolling in physics at KCSE was found to be mastery of concepts in physics (understand how physics works in their environment) (62%).
Figure 4.2 Reasons that influence girls’ enrolment in physics at KCSE

Other reasons for girls enrolling in physics included:

- laboratory practice (29%)
- school policy (28%)
- good performance in physics (20%).
- good teaching (9%)

However, laboratory practice (29 %), being hands on is motivating in the instruction of physics and influences enrolment of girls.
4.4 Learner abilities that girls rely on to enroll and perform well in physics

Following grading measure by KNEC of a student passing in physics practical in order to score at least B- grade (KNEC Confidential, 2011), many girls decline enrolling in physics at KCSE for fear of failing to attain distinction grades, should they panic and perform poorly in physics practical. A checklist was included in the student questionnaires on abilities one hundred and one girls (131) rely on to enroll and perform well in physics. The factors that were investigated included:

- cognitive work
- practical work in physics
- operations in physics

A reasonable percentage of the girls relied on at least good performance in cognitive work (70%), operations in physics (67%) and practical work (59%) to enroll and perform well in physics as illustrated in figure 4.3.
among girls and boys were measured by administration of Learner Achievement Test (LAT) having questions that require

The responses from the students were marked and the results for both girls and boys were analysed and compared using percentage means as in Figure 4.4 and t-test as in Table 4.2.
Figure 4.4: Mean scores of learner abilities

According to MOEST Science module (2001) girls underperform in science than boys. This is similar with the national performance in KCSE physics as earlier depicted in figure 1.2. However in this study, figure 4.4 shows a reverse view in physics performance as the girls national schools outperformed the boys in national schools, almost all the skills that were evaluated by the LAT. Only in the descriptive ability is where the girls underperformed the boys.

Table 4.2 shows lower standard deviations of girls to boys of (1.84:2.08), (2.35:2.61), (0.84:0.96) and (1.76:2.03) in mathematical, spatial, descriptive and concept development skills respectively in the LAT among the girls.
This suggests homogeneity in performance among girls than boys whose range of marks might be higher. Generally performance of girls showed better in learner abilities when compared to boys.

Table 4.2: Means, standard deviations and t-test at α level on learner abilities

<table>
<thead>
<tr>
<th>Learner ability</th>
<th>School</th>
<th>Percentage Mean</th>
<th>Standard deviation</th>
<th>t-value</th>
<th>df</th>
<th>Significance (2 tailed) level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mathematical</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>33</td>
<td>2.04</td>
<td>2.118</td>
<td>85</td>
<td>0.037</td>
</tr>
<tr>
<td></td>
<td>Q</td>
<td>40</td>
<td>1.98</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>39</td>
<td>2.06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>33</td>
<td>1.58</td>
<td>2.331</td>
<td>94</td>
<td>0.022</td>
</tr>
<tr>
<td></td>
<td>(Q+S)</td>
<td>38</td>
<td>1.84</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(P+R)</td>
<td>36</td>
<td>2.08</td>
<td>0.069</td>
<td>181</td>
<td>0.945</td>
</tr>
<tr>
<td></td>
<td>(Q+S+T)</td>
<td>39</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Spatial</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>6</td>
<td>0.70</td>
<td>0.978</td>
<td>85</td>
<td>0.331</td>
</tr>
<tr>
<td></td>
<td>Q</td>
<td>8</td>
<td>0.73</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>9</td>
<td>0.84</td>
<td>1.121</td>
<td>94</td>
<td>0.265</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>12</td>
<td>0.76</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Q+S)</td>
<td>10</td>
<td>2.35</td>
<td>1.046</td>
<td>181</td>
<td>0.297</td>
</tr>
<tr>
<td></td>
<td>(P+R)</td>
<td>8</td>
<td>2.61</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Q+S+T)</td>
<td>13</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

58
### Table 4.2, continued

<table>
<thead>
<tr>
<th>Learner ability</th>
<th>School</th>
<th>Percentage Mean</th>
<th>Standard deviation</th>
<th>t-value</th>
<th>df</th>
<th>Significance (2 tailed) level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptive</td>
<td>P (44 boys)</td>
<td>18</td>
<td>0.88</td>
<td>1.378</td>
<td>85</td>
<td>0.172</td>
</tr>
<tr>
<td></td>
<td>Q (43 girls)</td>
<td>14</td>
<td>0.83</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R (53 boys)</td>
<td>18</td>
<td>0.88</td>
<td>1.182</td>
<td>94</td>
<td>0.241</td>
</tr>
<tr>
<td></td>
<td>S (43 girls)</td>
<td>14</td>
<td>0.83</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Q+S) (86 girls)</td>
<td>14</td>
<td>0.84</td>
<td>0.240</td>
<td>181</td>
<td>0.811</td>
</tr>
<tr>
<td></td>
<td>(P+R) (97 boys)</td>
<td>18</td>
<td>0.96</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Q+S+T) (130 girls)</td>
<td>25</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Concept</td>
<td>P (44 boys)</td>
<td>36</td>
<td>2.11</td>
<td>3.871</td>
<td>85</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Q (43 girls)</td>
<td>52</td>
<td>1.78</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R (53 boys)</td>
<td>45</td>
<td>1.88</td>
<td>2.953</td>
<td>94</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>S (43 girls)</td>
<td>56</td>
<td>1.73</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Q+S) (86 girls)</td>
<td>54</td>
<td>1.76</td>
<td>4.677</td>
<td>181</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>(P+R) (97 boys)</td>
<td>40</td>
<td>2.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Q+S+T) (130 girls)</td>
<td>53</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

In Table 4.2, it is observed that there is significant difference between girls and boys in concept development in national schools in Kenya. The other area where there is some significance is in mathematical ability in physics where there are mixed results. Thus, the premise that learner abilities do not influence girls' performance in physics in national schools in Kenya can be discarded. This may hold for high ability girls like those that join national schools.
4.6: Influence of teacher characteristics on enrolment and performance in physics

Thirty nine (39) teachers responded to the Teachers Questionnaire (TQ) with a 5-point Likert Scale ranging from strongly disagree (SD) to strongly agree (SA). The TQ (Appendix 3) was administered to obtain information on teacher instructional factors that influence enrolment and performance of girls in physics. The results were coded, analysed and was used to evaluate the teachers influence on enrolment and performance of girls in physics. Table 4.3 shows analysis of teacher characteristics which affect enrolment and performance of girls in physics.
Table 4.3: Effect of teacher characteristics in physics instruction

<table>
<thead>
<tr>
<th>Question number</th>
<th>Statement</th>
<th>Mean in girls schools (N=17)</th>
<th>Mean in boys schools (N=22)</th>
<th>Mean of all teachers (N=39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1B</td>
<td>I am always punctual for my lessons</td>
<td>4.35</td>
<td>4.36</td>
<td>4.43</td>
</tr>
<tr>
<td>2B</td>
<td>I am bothered by low tests scores from students</td>
<td>4.29</td>
<td>4.59</td>
<td>4.48</td>
</tr>
<tr>
<td>3B</td>
<td>I always revise tests done</td>
<td>4.29</td>
<td>4.55</td>
<td>4.43</td>
</tr>
<tr>
<td>4B</td>
<td>I always attend to students who make mistakes during lessons</td>
<td>3.59</td>
<td>4.18</td>
<td>4.15</td>
</tr>
<tr>
<td>5B</td>
<td>I always give written assignments to students</td>
<td>3.88</td>
<td>4.14</td>
<td>4.12</td>
</tr>
<tr>
<td>6B</td>
<td>I always mark the assignments I give</td>
<td>3.52</td>
<td>3.95</td>
<td>3.92</td>
</tr>
<tr>
<td>7B</td>
<td>I am bothered by students who don’t do their assignments</td>
<td>4.29</td>
<td>4.59</td>
<td>4.49</td>
</tr>
<tr>
<td>8B</td>
<td>Students sleep during my lessons</td>
<td>3.52</td>
<td>3.27</td>
<td>3.25</td>
</tr>
<tr>
<td>9B</td>
<td>Students actively participate in class discussions</td>
<td>4.17</td>
<td>4.41</td>
<td>4.35</td>
</tr>
<tr>
<td>10B</td>
<td>Parents and fellow teachers talk positively about physics and its performance.</td>
<td>3.82</td>
<td>3.73</td>
<td>3.82</td>
</tr>
<tr>
<td>7C</td>
<td>The students our school admits are too poor to pass well in physics?</td>
<td>4.88</td>
<td>4.59</td>
<td>4.69</td>
</tr>
<tr>
<td>8C</td>
<td>Our students are lazy.</td>
<td>3.76</td>
<td>3.82</td>
<td>3.76</td>
</tr>
<tr>
<td>9C</td>
<td>If our school admitted better students the physics results would improve.</td>
<td>2.76</td>
<td>2.60</td>
<td>2.87</td>
</tr>
<tr>
<td>10C</td>
<td>The major reasons why physics is performed the way it is, is the quality of the students we admit.</td>
<td>3.05</td>
<td>3.19</td>
<td>3.15</td>
</tr>
<tr>
<td>12C</td>
<td>My daily work does not allow me to attend to slow learners.</td>
<td>2.88</td>
<td>3.18</td>
<td>2.84</td>
</tr>
<tr>
<td>14C</td>
<td>Frequent evaluation improves performance.</td>
<td>4.41</td>
<td>4.52</td>
<td>4.48</td>
</tr>
<tr>
<td>15C</td>
<td>The physics syllabus is too wide to complete in the time given</td>
<td>3.70</td>
<td>3.67</td>
<td>3.66</td>
</tr>
<tr>
<td>16C</td>
<td>I rejoice when I complete the syllabus on time</td>
<td>4.37</td>
<td>4.14</td>
<td>4.34</td>
</tr>
<tr>
<td>17C</td>
<td>To me completing the syllabus is a big achievement</td>
<td>4.00</td>
<td>3.86</td>
<td>4.10</td>
</tr>
<tr>
<td><strong>Mean of means</strong></td>
<td></td>
<td>3.87</td>
<td>3.97</td>
<td>3.96</td>
</tr>
</tbody>
</table>
Table 4.3 shows the overall means of teacher factors in girls’ (3.97) and boys’ (3.96) in national schools respectively. The means indicate that the teachers have commitment to duty, efficiency and a good attitude towards instruction in physics. These results support the studies reviewed in Duckworth and Ormeorod (1975) in which the role of the teacher is an important factor in students’ attitudes towards science; described a good teacher as one who considers all learners equally.

A checklist (HDC) concerning physics instruction and teacher characteristics was also used among twenty five (25) heads of departments of sciences and mathematics. A number of teacher instructional and related factors were also examined and the results analysed and recorded as in Table 4.4.
Table 4.4: Instructional factors that influence enrolment and performance

<table>
<thead>
<tr>
<th>Instructional factor</th>
<th>Measure present in percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of current instruction syllabuses</td>
<td>98</td>
</tr>
<tr>
<td>Use of current schemes of work</td>
<td>90</td>
</tr>
<tr>
<td>Guidance to students in physics enrolment</td>
<td>80</td>
</tr>
<tr>
<td>Mark books updated</td>
<td>78</td>
</tr>
<tr>
<td>Remedial lessons</td>
<td>70</td>
</tr>
<tr>
<td>Use of current lesson plans</td>
<td>50</td>
</tr>
<tr>
<td>Use of team teaching</td>
<td>32</td>
</tr>
</tbody>
</table>

Use of current instructional syllabuses ninety eight per cent (98%) and schemes of work ninety per cent (90%) were dominant professional teacher characteristics that influences enrolment and performance in physics among girls. Guiding girls in enrolling in physics was eighty per cent (80%). This guidance enhances enrolment in physics at KCSE. Use of remedial lessons was prevalent seventy per cent (70%). This prevalence warrants investigation to establish the reason for high dependency on remedial instruction and time in national schools. But one reason might be to do with assurance of content understanding. However, use of current lesson plans fifty per cent (50%), show effectiveness and efficiency is compromised by as half of the teachers as they lacked instructional lesson plans which are critical documents for instruction (Danielson, 2007). The absence lesson planning takes for granted
the questions of what, why and how to teach content (MOEST Science Module, 2001). Thus instruction without lesson planning is less effective and controls both enrolment and performance. Use of team teaching thirty two per cent (32%) was less common and unpopular in national schools. This was least embraced and limits stimuli variation in instruction of physics.

Generally half of the teachers were found effective and efficient in physics instruction. These results are in agreement with Kahn and Weiss, (1973), and Ramsey and Howe, 1969(a) and (b) who concluded that efficiency of science teachers affected attitudes of students towards science and is important in development of students’ affective behaviour.

4.6.1 Use of laboratory experiments in physics instruction

Heads of Department Checklist (HDC) was also used to obtain rate of use of laboratory during science instruction on a scale ranging from weekly to annually. The findings are summarized in figure 4.5.
Figure 4.5: Use of laboratory experiments, during physics instruction

Figure 4.5 shows almost 68% of physics instructions in national schools use laboratory experiments and demonstration methods weekly. This method of instruction in physics of using practical is most favourable for girls to develop science process skills through constructivism and is more effective (MOEST Science Module, 2001). This approach of teaching was also recommended by Robinson (1991), as the most suitable method for girls when learning science. Because of this method, a wider range of girls are attracted and enroll in KCSE physics.
4.6.3 Teaching experience

Experience is important in any profession and so is in teaching and particularly teaching science. Teachers of science were asked to record their teaching experience in years. Figure 4.6 shows percentage of teachers experience in teaching physics in girls’ national schools in Kenya.

![Figure 4.6 Teachers' instructional experience](image)

**Figure 4.6 Teachers' instructional experience**

About 60% of the science teachers in the sampled national schools had 11 to 15 years of teaching experience. This means that in national schools, a majority of the teachers have adequate teaching experience. This experience ensures quality instruction and guarantees good performances in physics. Pupils taught by teachers with many years of experience performed better than pupils taught...
by newly employed teachers (KNEC Poster, 2010). These findings of this study are also consistent with Sobolewski (1993); the experience of the teacher influences physics enrolment.

4.6.4 Teaching load of physics teachers in national schools

The teaching load was measured in hours per week. Figure 4.7 shows 20% of teachers of science in national schools have standard teaching load of 19 hours per week as recommended by the Ministry of Education in Kenya. However majority of teachers of physics in nationals schools (74%) have lower teaching loads, between 14 to 16 hours. This should guarantee room for quality instruction, remedial lessons and other duties that can yield good performance in physics.

![Pie chart showing teaching load distribution in national schools](image)

Figure 4.7: Teaching load in national schools
4.6.5 Challenges faced by teachers of physics

Figure 4.8 shows instructional challenges in national schools which include low attitude, large classes, and lack of instructional equipment were below 30%. This finding confirms the ample instructional resources for physics being available in national schools. It can be said from the data that teachers of physics have no serious challenges.

Figure 4.8: Challenges faced by teachers of physics

Schools set their own policies on subject choices and about the management of science subjects following guidelines from the Ministry of Education, Science and Technology in Kenya. Figure 4.9 shows that the policy of all sciences being compulsory (49%) is not applicable to all national schools. A high percentage (51%) of the schools have physics as an optional subject.
Figure 4.9: Science policy in national schools

Generally, there is no uniform policy that controls enrolment and performance of students in physics in national schools. Thus students in national schools have the choice to enroll in physics at KCSE or opt for other sciences. The physics teacher in this case is limited in challenging the status quo.
CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of the findings

The government of Kenya has formulated policies to industrialize the country by 2030. However, low enrolment and performance index of girls opting to study physics can be a setback. This deficit can have serious implications for the career options available to women given that an average of just 8 per cent girls enroll in the physics course in high schools in Kenya (KNEC Report, 2007). Thus, the persistence of less girls opting to study physics is worrying and calls for further investigation, especially when it comes to the cream of the girls in the national schools. This study was set to investigate factors affecting girls' enrolment and performance of physics in Kenyan National Schools. The main objective of the study was to investigate the factors that influence girls' enrolment and performance in physics in national schools in Kenya. The study was set to find out:

- the attitudes of girls as compared to the attitudes of boys towards the learning of physics,
- the effect of learner abilities of girls' performance in physics,
- teachers' characteristics that influence girls' enrolment
- characteristics that influence girls' performance in physics.

70
The following were the main findings of the study:

a) The attitude of girls towards studying physics in national schools in Kenya is better (4.06) and was slightly higher than that of the boys (4.00). This is the main reason why girls opt to enroll to study physics at KCSE. The attitude is influenced by the life around the girls, career related factors such as studying engineering and technological courses at tertiary levels.

b) Girls in national schools are good in physics when it comes to developing and applying key abilities like mathematical, spatial and concept development.

c) Instructional modes that benefitted girls most in national schools were remedial teaching, present in seventy per cent (70%) measure, which is used to clarify some difficult concepts, and team teaching in fifty per cent (50%) measure.

d) The attitude scale shows that teachers of physics in the national girls' schools are positive when it comes to commitment of instruction of physics. Teachers go a long way to ensure that girls like and understand the study of physics.

e) The workload of physics teachers in national girls' schools is modest. This allows teachers to invest more time to guide girls in physics content.

5.2 Conclusion

The investigation in this study established the relationship between instruction of physics among girls versus their enrolment and performance in reference to Kneller's progressive theory, Brunner's constructivism theory and Bloom's
instructional theory. Upholding Kneller's progressive theory girls are influenced to enroll for physics so long as Brunner's constructive theory and Bloom's instructional theory are used during physics instruction. Applying Brunner's constructive theory and Bloom's instructional theory in physics instruction guarantees good performance in physics.

The results show that enrolment and performance of girls in physics in national schools in Kenya are influenced by attitude, learner abilities and teacher characteristics. The research showed a positive attitude towards physics among girls in national schools. However, low enrolment in physics at KCSE is affected by the less negative attitude and low performance of girls. Girls can be 'delicate' and a 'small' attribute can lift or derail a girl from studying physics. That is why teachers of physics have to go an extra mile in preparation, instruction and assessment, in school physics.

5.3 Recommendations

This investigation shows that enrolment and performance in physics is affected by several factors that are either learner or teacher oriented related.

5.3.1 Recommendations for action

In order to increase enrolment and performance in physics among girls, the following recommendations are necessary for action:
a) University enrolment

Girls need to understand that to enroll in physics at the university one should have enrolled and performed well in physics in high school. However, teachers of physics and counselors need to reinforce this by highlighting the importance of physics in careers.

b) Teachers' influence

A physics teacher is central in instruction. To reduce talent pool shortages in scientific careers the influence of the teacher should be addressed by:

i) Considering individualization of learners when the teacher's personality is marched by befitting instructional methods for example allowing instruction from derived from the learners environment and world of view.

ii) Teachers' using demonstrations and laboratory activities that are attractive and effective in physics instruction, for example hosting physics practical regularly

iii) Boosting enrolment and interest of girls in physics through enhanced physics teacher personality

5.3.2 Suggestions for further research

This study used a survey design to collect data from schools mostly in Nairobi and its environs. This may have its own limitations and that is why I suggest the following:
a) A different method of study

A similar study using experimental design can show more details on the factors affecting enrolment and performance of physics in Kenyan national schools.

b) Change of study area

Although, this study dealt with national schools from Nairobi and Kiambu counties; similar studies in rural schools can be useful for comparison.

c) Studying factors affecting performance of boys in physics

A false perception that boys are better in physics performance has been faulted in this study. Thus, detailed factors affecting performance of boys in physics need to be investigated.

d) Study in other science subjects:

The focus on this study was physics. A study in other science subjects, such as chemistry and biology will be useful for comparison.
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Appendix 1: Physics Student Questionnaire (PSQ)

I am kindly asking for your assistance in finding out the factors influencing enrolment and performance in physics among students in Kenya National Schools. Please provide your information as honest and accurate as possible in your answers. The information you give will be treated very confidentially between you and me. Thank you for your help.

General information

Questionnaire code number

Sex (MALE or FEMALE) please tick(✓)

Instructions

Read through the instructions very carefully and answer the questions that follow.

1. For the Yes/No or boxed questions (SA, A, N, D, SD) indicate your choice by ticks in the appropriate place/boxes. Be as honest and sincere as possible.
2. The questions with spaces to be filled should be answered in the spaces provided below/next to the statement
3. The information you will give will help improve physics performance and enrolment in your school if the results will be complete and trustworthy
4. Your cooperation is needed in this inquiry and therefore do all you can to ensure it is a success.
5. The information you will give is for the purpose of research only
6. Make just one choice for every statement

SA stands for STRONGLY AGREE
A stands for AGREE
N Stands for NEUTRAL or NOT SURE
D stands for DISAGREE
SD stands for STRONGLY DISAGREE
1. I am interested in physics.

2. If I enroll in physics, my mean grade will be lower at KCSE.

3. My parents and immediate relatives want me to study physics.

4. My friends are influencing me to enroll in physics for KCSE.

5. I will need physics for university admission.

6. Physics is applicable in everyday life

7. I fear too many assignments in physics.

8. Physics is too difficult for me.
9. I have enough time to study physics.

   SA   A   N   D   SD

10. I often play with physics related objects.

   SA   A   N   D   SD

11. Please tick your performance in the last physics examinations.

   Excellent  76 - 100
   Very good   61 - 75
   Good        45 - 60
   Average     35 - 45
   Below average  0 - 35

12. I can’t enroll in physics because I don’t perform well in the prerequisites.

   SA   A   N   D   SD

13. I will enroll in physics because I enjoy studying physics.

   SA   A   N   D   SD


   SA   A   N   D   SD

15. My physics teacher helps me develop confidence to perform well in physics.

   SA   A   N   D   SD

SA  A  N  D  SD

17. My physics teacher allows me to participate in asking and answering questions during physics lessons.

SA  A  N  D  SD

18. We often work in smaller groups during physics lessons.

SA  A  N  D  SD

19. We do not do continuous assessment tests and assignments in physics very often.

SA  A  N  D  SD

20. Do you wish to enroll in physics at KCSE? YES/NO (please tick your response) Give reason(s) for your response in question 27
Factor(s) that may determine your **choice/enrolment** of physics for KCSE are listed in the table below. Please tick the measure of each factor that influences you to choose physics.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Less Significant Reason</th>
<th>Significant Reason</th>
<th>Most Significant Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>School policy that mandated you</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good teacher of physics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good understanding of concepts/laws/use of laws of physics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory Practice is interesting (Experiments/Practical)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strong school tradition/history of good performance in physics</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thank you for your cooperation
Appendix 2: Teacher Questionnaire (TQ)

Instructions
Kindly assist me in finding out the factors influencing performance and enrolment in physics among students in Kenya national schools. Please give as honest information as possible. The information you give will be treated very confidentially between you and me. Thank you for your help.

General information
Code of school

Sex (MALE or FEMALE) please tick(✓)
Teaching subjects: 1. ____________ 2. ____________

Instructions
1. Please read through the instructions very carefully first before you start answering the questions.
2. For the Yes/No or boxed questions (SA, A, N, D, SD) indicate your choice by ticks in the appropriate place/boxes. Be as honest and sincere as possible.
3. The questions with spaces to be filled should be answered in the spaces provided below/next to the statement
4. The information you will give will help improve physics performance and enrolment in your school if the results will be complete and trustworthy
5. Your cooperation is needed in this inquiry and therefore do all you can to ensure it is a success.
6. The information you will give is for the purpose of research only
7. Make just one choice for every statement
   SA  stands for STRONGLY AGREE
   A   stands for AGREE
   N   Stands for NEUTRAL or NOT SURE
   D   stands for DISAGREE
   SD  stands for STRONGLY DISAGREE

(Please write or tick appropriate responses for the following questions)
Section A.
1. Please name your main subject of teaching

2. What is your professional qualification? (Please tick one)
(a) Graduate teacher
(b) Diploma

3. How many years of work experience do you have? (Please tick one)
(a) 0-5
(b) 5-10
(c) 11-15
(d) 16-20
(e) Over 20

Section B. (Please tick an appropriate response)
1. I am always punctual for my lessons.

2. I am bothered by low tests scores from students.

3. I always revise tests done.

4. I always attend to students who make mistakes during lessons.

5. I always give written assignments to students.

6. I always mark the assignments I give to my classes.
7. I am bothered by students who don’t do their assignments.

8. Students sleep during my lessons.

9. Students actively participate in class discussions.


Section C.

1. When did you last undergo in-service training in your subject?

2. When did inspectors surprise you last?

3. Do you have a scheme of work? YES/ NO (please tick one)

4. How many lessons do you have in a week?

5. Are you comfortable with your workload? (YES/NO) (please tick one)

6. Does the size of your class hinder you from being effective in teaching physics/mathematics? Yes No 

7. The students our school admits are too poor to pass well in physics

8. Our students are lazy

90
9. If our school admitted better students the physics results would improve

   SA   A   N   D   SD

10. The major reasons why physics is performed the way it is, is the quality of the students we admit.

   SA   A   N   D   SD

11. I have problems in the teaching

   Yes   No

Give a reason or reasons for your response in 11.

12. My daily work does not allow me to attend to slow learners in physics

   SA   A   N   D   SD

13. How frequently do you evaluate your students?

<table>
<thead>
<tr>
<th>Daily</th>
<th>Weekly</th>
<th>Every fortnight</th>
<th>Monthly</th>
<th>Every term</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

14. Frequent evaluation improves performance in physics

   SA   A   N   D   SD

15. The physics syllabus is too wide to complete in the time given.

   SA   A   N   D   SD

16. I rejoice when I complete the physics syllabus on time

   SA   A   N   D   SD

17. To me completing the syllabus is a big achievement

   SA   A   N   D   SD

   Thank you for your cooperation
Appendix 3: Head of Department Checklist (HDC)

Kindly help me in finding out the factors influencing performance and enrolment in physics among students in Kenyan national schools. Kindly provide your information as honest and as accurate as possible. The information you give will be treated very confidentially between you and me. Thank you for your kind assistance.

General information

Head of Science/Physics/Chemistry/Biology/Mathematics (Please tick) (√)
Female ___ Male __________
Code of the school ________________________________

Instructions

1. Please allow me a few minutes for an interview with you concerning a study of enrolment and performance in physics at KCSE in your school.

2. For responses of Yes/No or boxed questions I will indicate your choice by ticking (√) in the appropriate place/boxes.

3. Be as honest and sincere as possible.

4. The questions with spaces to be filled should be answered in the spaces provided below/next to the statement.

5. The information you will give will help improve physics enrolment and performance in your school if the results will be complete and trustworthy.

6. Your cooperation is needed in this inquiry and therefore do all you can to ensure it is a success.

7. The information you will give is for the purpose of research only.
Teaching syllabus is current and used in my subject

1. Teaching schemes of work are current and used in my subject

2. Teaching lesson plans are current and used in my subject

3. Mark books are used and updated in my subject

4. Team teaching is rarely used in your department

5. Teachers in your department offer remedial lessons?

7. Rate of laboratory experiments done in your department:

Weekly  Monthly  Termly  Annually  Rarely
8. Do you offer guidance to your students on subject choice?

Yes ☐ No ☐

9. Performance of your department in your school:

Satisfactory ☐ Not satisfactory ☐

Give a reason for your response ___________________________________________________________________

10. What is your school's subject policy?

___________________________________________________________________________

11. The frequency of testing in your department (Please tick)

<table>
<thead>
<tr>
<th>Daily</th>
<th>Weekly</th>
<th>Every fortnight</th>
<th>Monthly</th>
<th>Every term</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments
Performance in physics at KCSE depends on the measures of abilities/skills/endowment students demonstrate in both learning and assessment. Please suggest the measure of strength students rely on that makes them enjoy learning and performing well in physics.

<table>
<thead>
<tr>
<th>By what measure do the following factors influence performance and enrolment in physics.</th>
<th>Very Good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good knowledge of laws, theories, numerical work/ solving problems/calculations / drawing of neat diagrams, cognitive work.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy in measurements during practical work/ Good manipulative skills in physics and lay out of work</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selection/manipulation/assembling/dismantling/setting up apparatus for experiments in the laboratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analysis of data using calculators and mathematics tables/ graph work/interpretation of graph work/ inferences/ derivation of hypotheses - mathematical ability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### School physics enrolment and performance mean at KCSE

<table>
<thead>
<tr>
<th>YEAR</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>KCSE</td>
<td>Mean</td>
<td>Entry</td>
<td>Mean</td>
<td>Entry</td>
<td>Mean</td>
</tr>
<tr>
<td>Physics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thank you for your cooperation
Appendix 4: Learner Achievement Test (LAT)

I am kindly asking for your assistance in finding out the factors influencing performance and enrolment in physics in among students in Kenya national schools. Please give as honest information as possible. The information you give will be treated very confidentially between you and me. Thank you for your help.

General information
Code of school ________________________________
Sex (male or female) please tick
Name of student (optional) __________ Age _______ Years

Instructions
1. Please read through the questions very carefully first before you start answering the questions.
2. Show ALL your working if possible
3. The bracket () after the marks is for official use

Answer all the questions in this section in the sections provided

Process skills, concept development, practical procedures, mathematical skills and spatial abilities in physics

1. Figure 1 shows how magnets are stored in pairs with keepers at the ends.

Explain how this method of storing magnets helps in retaining magnetism longer
B1
Magnetic induction on the keepers reduces end repulsion forming closed magnetic loops.

2. When thirty drops of a liquid were released from a burette, the liquid level changed from the 25 ml mark to the 40 ml mark. Determine the volume of each drop.
(1 mark) A1

\[
\frac{(40-25)}{30} = 0.5 \text{ cm}^3
\]

3. A measuring cylinder contained 19.0 cm\(^3\) of water. After some iron nails of mass 48g were submerged into water, the total volume was 25.0 cm\(^3\). Determine the density of iron.
(2 marks) A1 C\(_3\)1

\[
\rho = \frac{m}{V} = \frac{48}{25-19} = 8 \text{ g/cm}^3
\]

4. (a) A uniform metre rule pivoted at the 30 cm mark, was balanced by weight of 2 N suspended from the 5 cm mark. Determine the mass of the metre rule.
(Take \(g = 10 \text{ N/kg}\)) (2 marks) C\(_2\)

\[
2 \times 25 = W \times 20; \quad \text{Thus} \quad W = 2.5 \text{ N} \quad \text{Hence} \quad m = 0.25 \text{ kg}
\]

5. Figure 2 shows a device for closing a steam outlet.

Figure 2

The area of the piston is 4.0x10\(^{-4}\) m\(^2\) and the pressure of the steam in the boiler is 2.0x10\(^5\) Nm\(^{-2}\). Determine the weight \(W\) that will just hold the bar in the horizontal position shown.
(2 marks) C\(_2\) 1A\(_1\)1
2 × 10^5 x 4.0 × 10^{-4} x 15 = w x 60

\[ W = 20N \]

6. Figure 3 shows a ray of light incident on a convex mirror.

![Figure 3](image)

Using a suitable construction on the same diagram, determine the radius of curvature of the mirror.

\[ 3.3 \times 2 = 6.6 \text{ cm} \]

7. A truck driver views through a side mirror of focal length 50cm a 5m Nissan moving at a speed of 72km/hr on a straight path behind. Determine the apparent speed of the Nissan as viewed in the side mirror.

\[ 72 \text{ km/h} = \frac{72000 \text{ m}}{3600 \text{ s}} = 20 \text{ m/s} \]

\[ \frac{1}{f} = \frac{1}{u} + \frac{1}{v} \]

\[ \frac{1}{0.5} = \frac{1}{20} + \frac{1}{v} \text{ hence } v = \frac{20}{39} \text{ and } m = \frac{1}{39} \]

New speed = \( \frac{1}{39} \times 20 \text{ m/s} = 0.5128 \text{ m/s} \)

Or \( \frac{1}{39} \times 72 \text{ km/h} = 1.846 \text{ km/h} \)
Figure 4 shows a U-shaped iron core with a current carrying coil wound around its arms. A cardboard is placed on the core and iron fillings sprinkled on top.

Figure 4

8. Sketch on the cardboard in figure b the magnetic field pattern as viewed from the top.

Figure 5 shows a ray of light incidence on a convex mirror at its pole O.

Figure 5

9. (a) Describe a procedure that can be used to cause the reflected ray to be rotated through an angle of 60°.

(b) Rotating the mirror about the principle axis through an angle of 30°.
(b) The centre of curvature and the principal focus of a concave mirror are C and F respectively. An object is moved from C to F. Describe the movement of the image.

The image moves from C to infinity

10 (a) Distinguish between longitudinal and transverse waves

In longitudinal waves, particles are displaced in the same direction as the wave motion while in transverse waves, particles are displaced at right angles to the direction of the wave motion.

Figure 9 shows a wave profile drawn using an RF scale of 1/1000.

![Figure 9](image)

b) Determine:
   i) The frequency of the wave

   \[ f = \frac{1}{T} = \frac{1}{0.4} = 2.5 \text{ Hz} \]

   (2 marks) C1

   ii) The velocity of the wave

   \[ v = fA = 2.5 \times 5.3 \times 2 = 26.5 \text{ m/s} \]

   (3 marks) C1

11. A thin copper wire was made into a spiral spring then stretched by loading it with increasing forces and the new length of the spring measured. The results obtained are shown in the table below.

<table>
<thead>
<tr>
<th>Force x 10^2 (N)</th>
<th>0.0</th>
<th>5.0</th>
<th>10.0</th>
<th>15.0</th>
<th>20.0</th>
<th>25.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of spring (cm)</td>
<td>20.0</td>
<td>20.6</td>
<td>21.2</td>
<td>21.8</td>
<td>22.4</td>
<td>24.2</td>
</tr>
<tr>
<td>Extension (mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a) Complete the table above

(1 mark) A1
(b) State with a reason what is observed on the length of the wire when all the weights are removed.

Wire becomes longer than 20 because of plastic deformation since elastic limit has been exceeded.

(c) On a grid provided draw a graph of Extension against Force.
(d) Describe the graph drawn in (c) (2 marks) D₂₁ D₃₁
Extension is directly proportional to force until a force of 1500N is exceeded or an extension of 18mm.

(g) Show that the work done on the spring during when in it is perfectly elastic is directly proportional to the square of its extension. (4 marks) C₁₁ A₂₁ B₄₁

\[ W = F \cdot s = \text{area under the Hooke's Law graph} \]
\[ W = \frac{1}{2} F e \text{ but } f = ke \text{ therefore } W = \frac{1}{2} ke^2 \]
Thus work is directly proportional to \( e^2 \)

Thank you for your cooperation

KEY
A-Mathematical ability- \( A₁ \) is numerical computation, \( A₂ \) is non-numerical computation and \( A₃ \) is geometrical work

B-Spatial ability- \( B₁ \) involves complicated, multi-step manipulations of information through visualization. \( B₂ \) involves mental rotation- ability to rapidly and accurately rotate 2D or 3D figures. \( B₃ \) involves relative velocity and distance judgment. \( B₄ \) involves horizontal or vertical transfer of knowledge in or across subject(s)/discipline(s)

C-Concept development- \( C₁ \) is good understanding of concepts, \( C₂ \) is application of concepts and \( C₃ \) means rational concepts

D-Descriptive ability- \( D₁ \) is English language skills, \( D₂ \) is logical order of ideas and \( D₃ \) is good comprehensive work
Appendix 5: National schools that were used in the research period

The original Kenya national schools were eighteen and located in Central, Nairobi, Rift valley and Nyanza provinces of Kenya. The schools used in the study from Nairobi and Kiambu counties were:

Alliance Girls High School- Kiambu county
Alliance High School- Kiambu county
Kenya High School- Nairobi county
Limuru Girls High School- Kiambu county and
Nairobi School- Nairobi county

Source (MOE, 2010)
Appendix 6: Research permit and letter of authorization

CONDITIONS:

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

GPK(6555)301/14/2011

(CONDITIONS—see back page)

PAGE 2

THIS IS TO CERTIFY THAT:

Prof./Dr. Mr./Ms./M.S. Institution

Jairus Simokha Akweya of (Address) Kenyatta University

P.O.Box 43844-00100, Nairobi

has been permitted to conduct research in

Kilifi

Location

Province

Central and Nairobi

District

on the topic: Factors influencing girls enrollment and performance in physics in National Schools in Nairobi Cosmopolitan, Kenya.


Applicant's Signature

National Secretary for Science & Technology

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Research Permit No. HCST/RCD/14/012/733

Date of issue 22nd June, 2012

Fee received KSH. 1,000
RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on "Factors influencing girls' enrolment and performance in physics in National schools in Nairobi Cosmopolitan, Kenya," I am pleased to inform you that you have been authorized to undertake research in Kiambu District and Nairobi Province for a period ending 31st July, 2012.

You are advised to report to the Provincial Commissioner and the Provincial Director of Education, Nairobi Province, the District Commissioner and the District Education Officer, Kiambu District before embarking on the research project.

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

Said Hussein
FOR: SECRETARY/CEO

Copy to:

The Provincial Commissioner
The Provincial Director of Education
Nairobi Province.

The District Commissioner
The District Education Officer
Kiambu District.
Appendix 7: In-set map of National Schools: P, Q, R, S and T, in Nairobi and Kiambu counties in Kenya

R: F Scale: 1:120 000

KEY

P and R National Boys’ High School
Q, S and T National Girls’ High School