INFLUENCE OF TEACHER INSTRUCTIONAL PRACTICES ON STUDENTS’ ENGAGEMENT IN LEARNING PHYSICS IN CO-EDUCATIONAL SECONDARY SCHOOLS OF MURANG’A COUNTY, KENYA

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November 2015
DECLARATION

I declare that this thesis is my original work and has not been presented in any other university/institution for consideration of any certification. This thesis has been complemented by referenced sources duly acknowledged. Where text, data (including spoken words), graphics, pictures or tables have been borrowed from other sources, including the internet, these are specifically accredited and references cited using current APA system and in accordance with anti-plagiarism regulations.

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This Thesis has been submitted with our approval as University supervisors.

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DEDICATION

To my wife Evangeline, my children and their spouses and grand children who encouraged and provided me with unwavering support during the work on this project. Your love has been amazing and I could not expect more.

Special dedication to my late parents – Muchoki and Wangui who would have overjoyed with successful completion of this work.
ACKNOWLEDGMENT

I thank the Almighty God for being gracious and merciful towards me as I carried out this project. He gave me the strength and the necessary perceptions throughout this study. He also gave me a team of people who supported me with very open hearts, and to whom I feel greatly indebted. However, due to limited space, may I single out the following persons and institutions for their special contribution to this study.

Firstly, I would like to express my deep gratitude to my supervisors Prof. Nicholas W. Twoli and Prof. John N. Maundu for their relentless efforts in mentoring and supervising me throughout this study. Their tremendous support, close guidance and professional suggestions and comments made on my work provided pillars for my growth as a scholar.

In addition, I am thankful to the faculty members of the Educational Communication and Technology (ECT) Department at Kenyatta University (KU) and the members of Department of Curriculum and Leadership (CL) at Syracuse University (SU) for their collective efforts and expert suggestions that helped to shape this work. In particular am indebted to Prof. Henry Ayot, Dr. Sophia Ndethiu, Prof. Jeff Rozelle, Prof. John Tillotson and the late Dr. Ndichu Gitau for their comments on my work at the proposal stage. In addition am indebted to Dr. Mueni Kiio, Dr. Samson Ondigi, Dr. Bernard Mugo and Dr. Florence Miima for their encouragement and morale support that they extended to me.

Likewise, I would like to appreciate the support-staff in the Department of ECT in KU and the Department of CL in SU. They were all very kind to me in accessing relevant resources that were within their charge.

Moreover, am greatly indebted to the teachers and students who participated in this study. They took time away from their busy school programs in order to give me their attention as I collected the study data. To them all, together with their school principals, I say Thank you.

Furthermore, I sincerely thank KU for the generous sponsorship extended to me in this study. The University paid tuition fees for my study and supported me with a paid study leave for a one year sandwich professional development program at the SU. In this regard, I would like to thank the partnership project between KU and SU, under the leadership of Prof. Agnes Gathumbi in KU and Prof. Joanna Masingila in SU for granting me the scholarship for my study program at SU. The program at SU was critical in enhancing my professional capacities as a scholar.
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ABBREVIATIONS AND ACRONYMS

AAUW: American Association of University Women
Bio: Biology
Chem: Chemistry
CPCE: Create Participatory Classroom Environment
ESUA: Encouraging Social Understanding and Activism
FCTSD: Fostering Critical Thinking Skills and Disposition
FPC: Feminist Pedagogical Components
INSET: In-Service Education and Training
KCSE: Kenya Certificate of Secondary Education
KNEC: Kenya National Examinations Council
Lab: Laboratory
NAEP: National Assessment of Education Progress
Phy: Physics
Sci: Science
SMASSE: Strengthening of Mathematics and Science in Secondary Education
VLV: Validate Learners’ Voices
ABSTRACT

Gender equity in enrolment and achievement in secondary school physics remains a matter of pedagogic concern. Studies carried out elsewhere in the world clearly document a myriad of reasons to account for the disparity. This study purposed to investigate how teacher instructional practices influence boys’ and girls’ engagement in learning of physics in Kenyan co-educational secondary schools. It was guided by feminist pedagogical theory, which is predicated on four learner-centred pedagogy components: creating participatory learning environments, validating learners’ ideas and experiences; encouraging social understanding and inspiring application of learned insights in the larger world; and fostering critical thinking and disposition. It applied an exploratory study design to identify nature of instructional practices; to determine underpinnings for the instructional practices; to establish teachers’ experiences; and to investigate students’ perceptions of frequency of gender inclusive practices in the teaching of physics. Data were collected from 14 out of 19 physics teachers and 191 out of 258 students in 14 co-educational schools in Murang’a County. The data were gathered using classroom observation schedule; survey questionnaire for students; and interview protocol for teachers. Qualitative data were analysed through the method of constant comparison. For the quantitative data, mean scale ratings of perceived frequency of gender inclusive instructional practices were computed and t-test applied to evaluate significance of difference between the boys’ and girls’ perceptions. Data analysis revealed that teaching of physics in the schools was mostly through expository methods. The teachers applied these methods in disregard of their high professional qualifications; with low achievement expectations for their learners, and more particularly for the girls and; in excuse of inadequate resources. The gap between teaching qualifications and practices in the classroom was further supported by teachers’ feeling that they had a high teaching workload and that the syllabus was overloaded. The study further revealed that both the boys and the girls perceived that there was low frequency of gender inclusive instructional practices. Difference in the boys’ and girl’ perceptions were statistically significant at $\alpha = 0.05$ for majority of the questionnaire items. Findings of the study would help teachers to reflect about their pedagogical practices for the benefit of the students. Furthermore, the findings would be useful in review of gender-equity training in teacher education programs. In addition, the findings would be valuable to all stakeholders concerned with promoting gender equity and addressing issues of excellence in the teaching and learning of physics.
CHAPTER ONE:
INTRODUCTION AND BACKGROUND TO THE STUDY

1.1. Preamble

Gender equity in physics education as defined in terms of enrolment and achievement at the secondary school level remains a mirage for many, even the developed countries. This constitutes a double-layered gender problem of access to and quality of physics education. A substantial body of research shows that in post-compulsory (Form 2 in the Kenyan system) level for the physics education, male students outnumber female students and also the male students outperform the female students on achievement tests in the subject (Lee, & Burkam, 1996; Stokking, 2000; Kahle, 2004; Lorenzo., Crouch, & Mazur, 2006; National Science Foundation, 2010; Oyoo, 2011). Such differences have been attributed to gender stereotypes and lack of role models, unresponsive curriculum and school environments (Brotman & Moore, 2008). This study explored how instructional practices of physics teachers support or constrain the gender parity in participation in co-educational secondary schools (schools in which boys and girls receive instruction together) physics classes.

This chapter provides a background of the problem, statement of the problem and the purpose and objectives of the study. Further, it discusses the theoretical and conceptual frameworks for the study, and explains the significance, scope and
limitations of the study, concluding with the chapter summary and definition to terms used in the study.

1.2. Background to the Problem

The global community, as well as the Kenyan community, envisages equitable participation of females and males in all spheres of human endeavours. Indeed, the United Nations (2008) notes that in adopting the Millennium Declaration in the year 2000, the international community pledged to “spare no effort to free our fellow men, women and children from the abject and dehumanizing conditions of extreme poverty (p. 3).” Education is a strong agent in the realization of this vision, and more particularly in promoting gender parity. The third Millennium Development Goal posits this focus even more explicitly, “Promote gender equality and empower women: Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015” (United Nations, 2008, p. 16).

Teachers’ instructional practices therefore, at all levels of learning need to be configured to stimulate the gender parity in learning of high school physics, where females have been heavily under-represented and generally underperforming. The implication of this gap is worrisome in today’s society where there is wide application of physics knowledge in many career fields of engineering and technology. This study was motivated by the need to contribute towards
improving the classroom climate (Rolin, 2008) particularly that encountered by female learners in secondary school physics and subsequently addressing their underrepresentation and underachievement as illustrated in the following section.

1.1.1. The Uptake of Physics Education.

The under-representation of females in physics education exists in countries across the world. The National Science Foundation (2010) in the USA and Sainsbury (2007) in the United Kingdom clearly document the underrepresentation of women in science coursework and careers. This underrepresentation commences at the post-compulsory level of science education. For instance in USA where physics is an elective subject in high schools, Campbell, Voelkl and Donahue (2000) observe that only 14 per cent of the 17-year olds (the high school final year students) were reported in the 1996 NAEP to have been taking physics. This was quite a small percentage as compared to the 94 per cent and the 56 per cent that were reported to have taken or were taking biology and chemistry respectively. This situation is illustrated in Table 1.1 of the percentage of 17-year olds who were reported in the 1996 National Assessment for Educational Progress (NAEP) to have taken or were taking each of the science subjects.
Table 1.1: Percentage of 17-Year-olds Reporting in 1996 NAEP to Have Taken or Taking Each of the Science Subjects

<table>
<thead>
<tr>
<th></th>
<th>Biology</th>
<th>Chemistry</th>
<th>Physics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female Students</td>
<td>95%</td>
<td>58%</td>
<td>12%</td>
</tr>
<tr>
<td>Male Students</td>
<td>92%</td>
<td>53%</td>
<td>16%</td>
</tr>
<tr>
<td>Combined male and female students</td>
<td>94%</td>
<td>56%</td>
<td>14%</td>
</tr>
</tbody>
</table>

Source: Campbell et al. (2000)

It is important to note that many high schools in the USA offer science within the four years of study in a predetermined order: earth sciences, biology, chemistry and physics, and only those students that persist in their choice encounter physics in the fourth year (the 12th grade) (Stokking, 2000). Campbell et al. (2000) further noted that the parity in uptake was in favour of the female students in biology and chemistry, while it was in favour of male students in physics. Kahle (2004) also notes this status of low uptake of physics among girls by referring to the course-taking data from the 1999 NAEP in the USA, which showed that of the 17-year-old girls, a mere 16 per cent were taking physics while 60 per cent, about four times as much were taking chemistry.

In the UK, another key player among the industrialized countries, Hampden-Thompson, Lubben and Bennett (2011) observe that in the year 2010 the percentage of students opting for sciences beyond the post-compulsory (post-16) schooling level was quite low. Among the sciences, Hampden-Thompson et al.
further note that the uptake of physics was the lowest at 3.6 per cent as compared to 6.8 per cent and 5.2 per cent for biology and chemistry respectively.

In comparison between the male and female students' uptake of chemistry and physics, Hampden-Thompson et al. (2011) report higher levels of uptake of chemistry in female only schools when compared with male only or co-educational schools. In the case of physics uptake, Hampden-Thompson et al. found higher levels of the uptake among male only and co-educational schools when compared with female only schools.

In Sweden, Viefers, Christie and Ferdos (2006) note that despite overt attempt at equalizing opportunities for women, physics at the university level remained a male stronghold, meanwhile the other natural science subjects were attracting an increasing number of women. The difference in the male and female students' interest toward physics becomes important at the beginning of first grade in secondary school education. At higher general secondary education, the gender disparity is very explicit with more than 50% of male students compared to almost 15 per cent of female students choosing to study physics (Stokking, 2000).

Nigeria (Erinosho, 1997); South Africa (Rowena, 1997) are also reported to have quite a low take-up of physics, and a heavy under-representation of girls in physics.

In the Kenyan context, the uptake of physics at the upper secondary education obtains a similar pattern to that of the countries discussed above. This is illustrated in Table 1.2, which presents national data on percentage of students, actual numbers in brackets, enrolled in the KCSE science subjects in the years 2007 to 2010.

Table 1.2: Percentage Enrolment (actual numbers in brackets) of Female and Male Students in the Year 2007 to 2010 KCSE

<table>
<thead>
<tr>
<th>KCSE Year</th>
<th>Student Sex</th>
<th>Biology</th>
<th>Physics</th>
<th>Chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>Female (F)</td>
<td>94.8 (119521)</td>
<td>19.1 (23953)</td>
<td>98.3 (123903)</td>
</tr>
<tr>
<td></td>
<td>Male (M)</td>
<td>86.0 (128943)</td>
<td>40.0 (60042)</td>
<td>97.4 (146062)</td>
</tr>
<tr>
<td></td>
<td>M + F students</td>
<td>90.0 (248464)</td>
<td>30.4 (83997)</td>
<td>97.8 (269969)</td>
</tr>
<tr>
<td>2008</td>
<td>F</td>
<td>94.8 (132151)</td>
<td>19.1 (26151)</td>
<td>98.5 (137244)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>85.8 (142067)</td>
<td>40.5 (67086)</td>
<td>97.8 (161857)</td>
</tr>
<tr>
<td></td>
<td>M + F students</td>
<td>89.9 (274218)</td>
<td>30.7 (93237)</td>
<td>98.1 (298101)</td>
</tr>
<tr>
<td>2009</td>
<td>F</td>
<td>94.4 (143359)</td>
<td>19.2 (29233)</td>
<td>98.6 (149755)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>85.2 (155943)</td>
<td>40.9 (74955)</td>
<td>97.9 (179167)</td>
</tr>
<tr>
<td></td>
<td>M + F students</td>
<td>89.3 (299302)</td>
<td>31.1 (104188)</td>
<td>98.2 (328922)</td>
</tr>
<tr>
<td>2010</td>
<td>F</td>
<td>94.2 (148729)</td>
<td>19.0 (29964)</td>
<td>98.7 (155725)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>84.8 (166334)</td>
<td>40.4 (79108)</td>
<td>97.8 (191653)</td>
</tr>
<tr>
<td></td>
<td>M + F students</td>
<td>89.0 (315063)</td>
<td>30.8 (109072)</td>
<td>98.2 (347378)</td>
</tr>
</tbody>
</table>

Source: KNEC (2009, 2011)

Table 1.2 shows that there is a low uptake of physics as compared to the other science subjects. In the year 2007, only 30.4% of the students sat for the KCSE
physics examination in the year 2007, which is quite small compared to 90% and
97.8% of the students that sat for the biology and chemistry examinations
respectively. The same pattern is seen in the KCSE data of the years 2008, 2009
and 2010 as shown in the Table 1.2.

The data in Table 1.2 reveal that students’ access to physics education at post-
compulsory schooling (beyond the Form 2 level) of secondary school level in
Kenya is an issue that ought to raise genuine concern. This low uptake reflects the
preference of physics among the students since MOEST (2000) guides that
students elect at least two of their preferred science subjects at the end of their
Form 2 (10th grade in a system of 12 years), the second year of four year schooling
in the Kenyan system of secondary education. At the end of the four years, the
students sit for a national examination in their preferred subjects for the award of
Kenya Certificate of Secondary Education (KCSE).

Even though the standards of KCSE do not discriminate between boys and girls,
the enrolment for girls is much lower than that of the boys in all the years under
review. A paltry 19.0% of the girls registered for the year 2007 KCSE physics
examination as compared to a registration of 40.0% for boys. The enrolment
pattern in the 2008, 2009 and 2010 KCSE physics examination is found to be the
same with approximately 19% and 40% enrolments for girls and boys
respectively. These enrolment percentages translate approximately to a ratio of
1:2 between girls and boys, revealing the low appeal that physics has to females than to males.

This inequitable enlisting of girls and boys in physics at the secondary school level is perpetuated into the higher levels of learning in a pattern of a ‘leaky pipeline’. The leaky pipeline phenomenon sets in at transition to each successive level up the academic ladder: the entry into Form 3, at which students elect science-subject combinations and at the entry into tertiary education where the students get into specialized areas of studies.

This low enrolment of girls is despite the fact that both girls and boys access the same kinds of resources for their learning. Oyoo (2011) observes that girls’ schools, as compared to boys’ schools, are similarly endowed in terms of equipment for science teaching and staffed with equally qualified teachers. This situation of the under-representation of girls is an accumulative effect of, among other factors, teaching practices that tend to discriminate against girls in the learning of physics.

1.1.2. Performance of Boys and Girls in Physics

Martin, Mullis and Chrostowki, (2004) observe that boys worldwide show significantly greater achievement in science. In the United States for instance, besides the under-representation of females in science and technology-related
courses and careers, female students’ average scores are lower than those of male students in science tests at the secondary and post-secondary level (Lorenzo, et al., 2006). Furthermore, McGinnis and Pearsall (1998) observed that female students in Grade 12 in the US were on average outperformed by males in the 1996 NAEP science assessments. However, although in the US the gender gap in achievement has been closing in most scientific and technological fields, the largest disparity remains in physics (Lorenzo, et al., 2006).

In Kenya, the disparity in performance in physics is evident as illustrated in Fig. 1.1 of percentage of girls and boys in grade categories in the 2008 KCSE. The actual numbers and percentages are in given Appendix A. The grading system for the KCSE is on a 12-point scale from ‘A’ to ‘E’ with ‘A’ representing the highest performance grade and E the lowest performance grade.
As revealed in Fig. 1.1, the male students outperformed the female students in the quality grades category, grades A up to C+, in the KCSE physics in the year 2008. (Quality grades are those grades considered adequate for admission into a University course, the lowest being C+.) At grade ‘C’, the percentage of boys was approximately equal to that of the girls. But on the other side of the grading line from ‘C-’ to ‘E’, the percentage of girls was higher than that of boys. This pattern of performance, where boys outdo girls in the quality grades category, was repeated in the years 2009, 2010, and 2011.
1.3. Statement of the Problem

From the background of the study, it is evident that the disparity in enrolment and performance between boys' and girls' in secondary school physics examinations in Kenya is a reality that needs to be addressed. There might be two possible reasons for the disparity: either physics is simply a subject which appeals more to boys than to girls or the way the subject is presented is more attractive to boys (Al-Ahmadi, 2008) than to girls. The former reason relates to the content of physics, which espouses concepts and skills envisaged by the school physics curriculum generated by the Kenya Institute of Curriculum Development (formerly Kenya Institute of Education). The latter reason relates to teachers' instructional practices for facilitating the learning of physics, which include providing equitable opportunities that underpin and support the learning experiences of both the male and female students.

Given the above observation, it is important to investigate the type of instructional practices employed by teachers of physics in Kenya. Boaler (1997) notes that applying teaching practices that accommodate girls' ways of learning would result in more girls choosing and improving their academic achievement in physics. Therefore, in order to enhance girls' enrolment, active participation and achievement in physics, findings of this study provide a basis for decision making by teachers, teacher educators and other stakeholders concerned with promoting
gender equity and addressing issues of excellence in physics education. The result of use of findings of this study is wider participation of boys and girls in the social-economic development of Kenya and beyond.

There is a paucity of research literature on factors that influence the gender disparity in physics enrolment and achievement in Kenya. Instead, the available literature has mostly attended to issues such as describing the disparities and their implications for the economic development of the country (Amunga, Amadalo, & Musera, 2011) leaving the issue of equitable gender instructional practices lacking in the scholarship. There was, therefore, a need for a study to investigate the teaching practices in physics and their possible contribution to equitable boys’ and girls’ participation in the said school subject.

1.4. Purpose of the Study

From the foregoing, the purpose of this study was to investigate the influence of teacher instructional practices on equitable participation of girls and boys in learning of physics in co-educational secondary schools of Murang’a County, Kenya. The study entailed observing efforts by teachers to equitably engage learners in physics lessons; interviewing the teachers on the instructional practices in physics classrooms, and gathering data through students’ questionnaire on their perception of frequency of use of gender equitable instructional practices.
1.5. Research Objectives

In order to realize the purpose of the study, the following specific objectives were considered:

1. To identify the nature of instructional practices in physics classes in Kenyan co-educational secondary school.
2. To determine the underpinnings for the instructional practices in physics classes in Kenyan co-educational secondary school.
3. To establish the experiences of physics teachers in implementing gender inclusive pedagogy in Kenyan secondary school co-educational classrooms.
4. To investigate students’ perceptions of gender inclusiveness in the teaching and learning of physics.
5. To propose a teaching model that facilitates equitable gender engagement in the learning of physics.

1.6. Research Questions

This study had the following questions:

1) What is the nature of instructional practices in physics classes in Kenyan co-educational secondary schools?
2) What are the underpinnings for the instructional practices in physics classes in Kenyan co-educational secondary schools?

3) What are the experiences of physics teachers in implementing gender inclusive approach to teaching of physics in Kenyan co-educational secondary schools?

4) What are the students' perceptions of gender inclusiveness in teaching of physics in Kenyan co-educational secondary schools?

5) To what extent do physics teachers incorporate gender inclusive instructional practices in teaching physics in Kenyan co-educational secondary schools?

6) What instructional model would facilitate equitable gender engagement in the learning of physics in Kenyan co-educational secondary schools?

1.7. **Theoretical Framework for the Study**

This study was guided by feminist pedagogical theory, which is an emergent of feminist theory that has been shaped and influenced by notions and perspectives, and nurtured by three waves of feminist movements (Thorn, 2003). The agenda of the first wave, whose summit was Women’s Rights Convention in Seneca Falls, New York in 1848 spearheaded by Elizabeth Cady Stanton and Lucretia Mott, culminated with women’s suffrage - promoting women’s right to vote (A&E
Television Networks, 2012). The second wave that began in 1960s was concerned with women's liberation, and in science education realm, it called for equalizing access for males and females to the study and practice of science (Calabrese-Barton, 1997). In response to this second wave, for example, the USA government passed legislation referred to as Title IX in 1972, an amendment to the 1964 Civil Rights Act. The legislation was designed to promote gender equity in educational opportunities (Thorn, 2003).

However, this second wave of feminist movement did not focus on challenging the practice of science itself or its underlying epistemology (Brickhouse, 2001). Indeed, the American Association of University Women (AAUW) (1992) clearly documented the inexcusable state of gender inequity in education in the USA and inspired a wave of commitment to create gender-fair learning environments. Consequently, the third wave of advocacy for gender equity in education that began in 1990s was a continuation of, and a reaction to the perceived failures of the second wave (Harding & Parker, 1995). This third wave called for the need to appropriate girls' ways of learning, interests, and experiences in science curriculum and pedagogy (Howes, 1998) and particularly to make science more attractive and inviting to both male and female students.

The waves of feminist movements made a clarion call for gender equalities in political, economic and social spheres of the societies. The feminist theory that
emerged from these movements seeks to understand the nature of gender inequality and focuses on the social and political commitment to changing those structures that have historically favoured given sectors of the society (Brotman & Moore, 2008). The theory illuminates and bears feminist pedagogical theory, which is as an instructional approach that incorporates the voices and experiences of marginalized students into the academic discourse as well as educating all students for social justice and social change (Mayberry, 1998).

Feminist pedagogical theory is a model for grounding inclusive and transformative practices in the teaching and learning of science (Capobianco, 2007). It is predicated on constructivist, rich and thoughtful learner-centred pedagogies (Mayberry, 1998) with four instructional components: fostering participatory learning; validating learners' ideas and personal experiences; creating social understanding and inspiring positive implementation of acquired knowledge; and nurturing critical thinking skills and disposition (Hoffman & Stake, 1998).

The feminist pedagogic theory guides teachers in their choice of instructional practices that promote participatory classroom arena in which students fully and openly discuss among themselves and with the teacher (Hoffman & Stake, 1998). The teacher is required to make deliberate effort in constituting suitable working teams such as syndicate and peer learning groups. In addition, the teacher is
required to construct appropriately engaging tasks such as investigation-oriented laboratories and experiential and hands-on exercises. Meyer (1998) posits that, in participatory learning environments, students engage in explaining, predicting and interpreting; exploring, creating, making sense and making relevant connections; interacting and collaborating. These are activities that certainly promote equitable learning in any discipline of study, no less physics.

The feminist pedagogy theory invites the teacher to affirm students’ voices, viewpoints and personal experiences (Capobianco, 2007), which is central towards sustaining active participation in learning and change of self-image. It entails creating learning environments in which all students feel safe to make mistakes and not be harassed, tormented with scorn or ridiculed (Meyer, 1998). It calls on teachers to affirm the students’ contributions and inspire them to draw connections between what they learn in class and their own lives. Furthermore, the students are encouraged to use their experiences as one among several valid forms of evidence and authority (Hoffman & Stake, 1998). This teaching strategy helps to build the student’s self-confidence, which girls are said to be lacking in the study of physics (Haussler & Hoffmann, 2002).

Teachers employing feminist pedagogical approaches have a duty to encourage students to develop social understanding (Hoffman & Stake, 1998). This is with a view to helping the students to make connections between the class material and
the larger social and cultural contexts. In addition, the students are assisted in developing a commitment to act on their insights in the world at large (Hoffman & Stake, 1998) and to apply the knowledge gained to social action (Shrewsbury, 1993). This teaching pivots on using science-technology-society (STS) contexts which, according to Hughes (2000), aids girls in figuring out science concepts easily, but by no means disadvantaging boys.

In the application of feminist pedagogy, teachers train their students to develop critical thinking – cognitive skills (Hoffmann & Stake, 1998) and affective disposition. The students are encouraged to take critical stance toward conventional wisdom, and to carefully evaluate evidence from different sources and perspectives. The critical thinking skills include analysis, evaluation, inference, deductive reasoning, and inductive reasoning (Colucciello, 1997). In teaching for developing critical thinking disposition the teacher challenges learners to be truthful, inquisitive, analytical and open-minded to diverse perspectives and experiences, and to be ready to change in the face of new evidence.

In this study therefore, the feminist pedagogical model serves as a reference framework for viewing the instructional practices of physics teachers in attempting to equitably meet the learning needs for boys and girls in their classrooms. Teachers applying this model would teach their students through
participatory learning, foster development of self-confidence and non-stereotyped ways of being, encourage translation of classroom learning to the service of social justice, and nurture growth of critical thinking abilities for all learners.

1.8. Conceptual Framework for the Study

The essence of educating both boys and girls equitably in physics is to enable them to attain adequate proficiency in the subject for self-fulfilment. It is also to enable them widen their scope and become equally competitive in many physics-based career choices. However, in Kenya and elsewhere in the world, there has been a glaring underrepresentation and underperformance of girls in physics education. Amunga et al. (2011) note that poor scores in physics limit student opportunities in competitive professional courses like engineering and technology, which are very critical in driving a country’s economy, and improving the quality of life. The underrepresentation and underperformance of girls in physics education therefore undermine the potential of Kenya as a country in raising an adequate workforce for realizing her vision: a competitive nation with a high quality of life for all her citizens by becoming an industrializing middle income economy by the year 2030.

Scantlebury and Kahle (1993) assert that, equitable gender engagement in learning of physics is a function of learners’ own attitudes toward learning and toward the subject of physics; the engendering of physics curriculum; gender differences in
learning; school policies in supporting equitable access to the subject; and the teachers' instructional practices. This study focused on exploring the influence of instructional practices of the teachers of physics, that is, how such practices scaffold and constrain equitable boys' and girls' engagement in learning of physics. Figure 1.2 provides the conceptual framework for equitable gender learning of physics.

Fig. 1 2: Conceptual Framework for Equitable Gender Engagement in Learning of physics

Teachers' instructional practices for equitable involvement in learning provide all learners, irrespective of gender, with rich in-and-out of class environments in which they engage to realize their full potential. It utilizes resources that are free of gender bias. In other words, the instructional practices for equitable
engagement of boys and girls in learning of physics ought to eliminate classroom interaction barriers to participation. In addition, the practices require to be sensitive to stereotypes that limit the learning engagement; to widen the freedom, and expanding choices for all students (Blum, 1999). The consequence of this equitably engaging classroom environment is enhancement of positive attitude toward learning of physics which would result in higher enrolment and achievement for both boys and girls.

1.9. Significance of the Study

Brotman and Moore (2008) take the view that gender is socially and culturally constructed and not necessarily linked to one’s sex. Consequently, the underrepresentation and underachievement of girls is partly a response to the socially constructed teaching environment, and by extension the teachers’ instructional practices, as opposed to, as Kahle (2004) puts it, the girls’ maladaptive motivational patterns. The aim of this study was to investigate physics teachers’ instructional practices and how these practices interact with gender composition in classes, promoting equitable participation in learning of physics among girls and boys. The findings of the study have the potential of guiding attainment of gender equity in the classroom that would allow female and male students to participate more fully in their learning, improving the probability that females would have an equal place in both the workforce and society in
general. Data gathered from this study would be useful in helping teachers reflect on their instructional practices and how such practices promote parity among boys and girls in the learning opportunities provided in the physics classes.

Moreover, the data from this study would be valuable to teacher evaluators in developing schema to monitor and assess instructional practices of teachers towards gender inclusivity in their teaching. The findings of the study would also contribute to the knowledge base necessary for development of school curriculum and teacher education programs that are sensitive to gender equity, specifically in physics learning and education in general. This is in support of the view by UNESCO (2000) that sensitivity to gender equity is not only a social and ethical requirement for human development, but also essential for realizing the full potential of scientific communities world-wide and for orienting scientific progress towards meeting the needs of humankind. In addition, the findings of the study would contribute to knowledge and have the potential to benefit further research that would aim at extending and strengthening the evidence base for decision-making in uptake of physics by boys and girls at post-compulsory schooling level.

1.10. Scope and Limitations of the Study

The unequal access and performance of girls and boys in physics has been a subject of much research across the world and various factors have been attributed
to this disparity (Amunga, et al, 2011). Such factors include students’ attitudes and interests, and perceptions of usefulness of the subject to future careers (Smythe & Hannan, 2006). Ben (2011) observes that other studies looked at parental support and yet others looked at school and class-level factors that result in unequal participation of boys and girls in physics. The scope of this study was to investigate instructional practices of physics teachers and how such practices support or constrict girls’ and boys’ equitable learning of physics.

In order to make an in-depth study of the influence of instructional practices of physics teachers on gender equity in learning of physics, the study was limited to selected public co-educational secondary schools in Murang’a County, Kenya. It focused on establishing the nature of instructional practices in co-educational physics classrooms, and the underpinnings for the practices. It also aimed at determining the experiences of expert physics teachers in the selected schools with regard to inclusive gender pedagogical practices. It was also limited to investigating students’ perceptions of instructional frequency of gender-equity practices in the physics classroom. For reasons of manageability, the study did not include interviews with students and therefore could not offer an in-depth analysis of students’ perspectives of how equity issues play out in the teaching and learning of physics in co-educational classrooms.
Short (1997) noted that the research process is like “walking a careful line”. This was true with regard to this study because there were many strands of investigation that could be pursued, but was not possible given the limits of time, access to resources, and the expertise of the researcher. The various opportunities for further research on gender equity in the teaching and learning of physics in Kenya are discussed in the final chapter of this study. However, this study hopes to contribute in a way to the expansive puzzle of gender equity in the teaching and learning of physics.

1.11. Assumptions of the Study

The units of research in this study were the selected schools co-educational public schools, and the physics teachers and students in the schools became subjects for the study. The study assumed honesty and competence of the teachers and students in responding to research instruments, and that the presence of the researcher in the classroom would not affect behaviour of the teachers and/or the students.

The study also assumed that the participating students were appropriately guided in the selection of subjects for their study at the senior schooling level and that they had appropriate attitudes towards learning and toward the physics curriculum. It moreover assumed that there were no inherent gender differences in learning of school physics, and that the content of subject was relevant to both
boys and girls. In addition, the study assumed that the selected schools have supportive policies for gender equitable access to the different curricula offered by the school. Furthermore the study assumed that the teachers were motivated enough and had interest to deliver lessons laced with gender equity.

1.12. Summary of the Chapter

Disparities exist in the types of physics-related experiences among secondary school female and male students. In general, males experience a higher level of science activity as a result of contextualization of curricular materials and the differential attention and expectation they receive from their teachers (Jovanovic & King, 1998). This study investigated the influence of instructional practices of physics teachers on equitable boys’ and girls’ involvement in learning of physics. Teachers’ pedagogical knowledge and perceptions about gender inclusivity were explored as bases for the teachers’ instructional practices in the teaching of physics. Moreover, students’ perceptions were examined to assist in clearer conceptualization of frequency of gender inclusive teachers’ instructional practices. The findings of this study would be useful to teachers, teacher evaluators, curriculum developers, policy makers and educators in guiding the reconstruction of teacher instructional practices for gender-inclusive pedagogy in ways that characterize high achievement and the study of physics as an enterprise for both the female and male learners. The following section gives operational
definition of key terms in the study, followed by chapter two on review of literature on equitable boys’ and girls’ involvement in learning physics.
1.13. Operational Definitions of Key Terms

**Co-educational secondary schools:** Secondary schools in which boys and girls receive instruction together.

**Gender:** The term 'gender' is very central to this study. It is often used synonymously with the word 'sex'; however, the two terms have different meanings (Brotman & Moore, 2008). This study adopts the meaning described by Rennie (1998) that gender is a social-cultural construction of what it means to be male or female. In contrast, the term sex, although not exclusively (Gilbert, 2001), refers to the biological definition of being a female or a male.

**Gender inclusive approach to teaching of physics:** This is teaching approach that incorporates values of both boys' and girls' prior experiences and extends such experiences and learning. Such an approach takes account of the current interests, needs, concerns as well as preferred learning and assessment styles (Parker & Rennie, 2002) for the boys and girls.

**Instructional practices:** These refer to what the teacher does during instruction. It includes teaching strategies that invite and support students in engaging in learning activities such as investigative laboratory work, class discussions, creative writing, problem solving and project-based activities.
KCSE Quality grade categories: The grading of KCSE (Kenya Certificate of Secondary Education) is on a 12 grade points, ranging from A to E. The quality grade categories are those grades considered for admission into a University course, the lowest being grade C+.

Physics education leaky pipeline: This refers to a situation in which some students fail, at different transition points, to advance through the school system towards physics related career. The key determinants of the progression are the students’ choice of the subject and their performance in associated screening examinations.

Pure theory: This refers to lessons that are conducted through explanation and taking of notes.

Quasi-theory lessons: These are lessons that are conducted through explanation of concepts and deductive laboratory practical activities.

Single period and double period lessons: These are 40-minutes and 80-minutes lessons respectively as practiced in the Kenyan secondary school education sector.

Uptake of physics: The number of students who accept or take up the study of the physics offered in schools
CHAPTER TWO:

LITERATURE REVIEW

2.1. Introduction

This study investigated the influence of instructional practices of physics teachers on equitable gender involvement in the learning of physics. The teacher instructional practices are but one set of the many factors that account for and influence development of learners' attitudes towards, and interest and achievement in learning of any discipline, no less physics (Ben, 2010). Indeed, the instructional practices are important in inspiring learners, irrespective of their gender, to engage meaningfully in learning.

This chapter reviews research literature on the equitable boys' and girls' involvement in the learning of physics in coeducational settings in secondary schools in relation to the instructional practices of physics teachers. It will examine the teachers' perceptions and knowledge about gender inclusivity, and how the teachers implement gender inclusive pedagogies in their physics classrooms. The chapter will be organized into the following sub-topics: the science policy in Kenyan secondary schools system; the teachers' perceptions, knowledge and instructional practices in teaching of physics in gender equitable ways; and finally the chapter summary.
2.2. Science Combination Preferences in Secondary Education in Kenya

The learning of Physics in Kenya starts at the primary school level and proceeds uninterrupted into secondary education. At the primary level, physics is taught within the science curriculum, while at the secondary school level it is taught as a stand-alone discipline of science (Waititu, 2004) separate from the other two basic sciences (Biology and Chemistry).

The three sciences (Biology, Physics and Chemistry) that emerge from the primary school science curriculum are equally accessible to all the students up to the end of the second year (Form II) of secondary level schooling. At the end of Form II, students are allowed to select at least two sciences (MOEST, 2000) for purposes of overall grading in the Kenya Certificate of Secondary Education (KCSE) examination that is taken at the end of secondary level education.

Pursuant to the science subject selection policy, the possible subject combinations available to students are Biology-Physics (BP), Biology-Chemistry (BC), Physics-Chemistry (PC) and Biology-Physics-Chemistry (BPC) as illustrated in Fig. 2.1.
Fig. 2.1: KCSE Possible Science Subjects Combinations

Key:
P≠N; B≠N or C≠N means that physics, biology or chemistry does not stand alone
BP – biology and physics combination
BC – biology and chemistry combination
PC – physics and chemistry combination
BPC – biology, physics and chemistry combination

Fig. 2.1 reveals that the BP combination was taken by those students who did not take chemistry at all. The number of candidates taking the combination is, therefore, obtained by subtracting the chemistry registration from the total entry for the year.

In the same token, the BC combination was taken by those students who did not take physics at all. For that reason, the candidature in the BC combination is the difference between the total entry and the candidature in physics.

Similarly the candidature in the PC combination is the difference between the total entry and the candidature in biology. The candidates who enrolled for the three sciences (BPC combination) can be computed, for instance, by considering all students who took physics, and then subtracting the number of students in the combinations with physics. For the years 2007 and 2008, for instance, the
percentage of boys and girls in the subject combinations may be represented as shown in Fig. 2.2.

**Fig. 2.2: Percentage of Boys and Girls in Science Subject Combinations in KCSE 2007 and 2008**

Figure 2.2 reveals that, there was a low percentage candidature in subject combinations that have physics in the KCSE for the years 2007 and 2008. While this is true for the students to tend to avoid subject combinations that have physics, tending to enrol more in the BC Combination, the tendency is stronger with girls. For example, the percentage of girls enrolled in the CP, PB and PCB combinations was lower than that of boys, and in the case of CP, the proportion of girls approximates about one-third that of boys. However, in the BC combination, the percentage candidature of girls was much higher: approximately 81% of all the
girls registered for the examination, while approximately 60% of the boys registered in each of the two years under review. The low participation of students, and particularly girls, in physics education has been attributed to numerous factors. Such factors include the school environment, the physics curriculum, parental support, students’ motivation and prior achievement, students’ self-concept, teachers’ behaviours and attitudes among others (Ben, 2010). This study examines the role the teacher plays in supporting or limiting participation of boys and girls in learning of physics at the post-compulsory schooling level, and in particular the teacher instructional practices before, during and after instructional sessions.

2.3. The Transformative Stage in the Learning of Physics

Elective physics classes in Kenya begin in Form 3, the penultimate year of secondary education (the 11th grade in a 12-year basic education system), and continue to Form 4 at the end of which an exit national written examination is taken. Form 3 marks the beginning of many students’ clear manifestation of disinterest in physics, yet, it is at this stage in their schooling life that students are assumed to know enough basic knowledge and skills for pursuit of their educational interests (Ben, 2010). It is at this age/grade, middle and early high school years, that students tend to develop negative attitudes towards physics (Rodriguez & Zozakiewicz, 2004), with the girls preferring and choosing to
participate more in biological sciences while the boys prefer and choose physical sciences (Brotman & Moore, 2008).

Girls' overall interest in science often declines after elementary school, and more so in physics at the post-compulsory schooling level in Kenya (as witnessed from KNEC (2009) statistics) and in a number of other countries. For instance, in Germany a study on interventions to enhance girls' interest, self-concept, and achievement in physics classes, Haussler and Hoffmann (2002) noted that secondary level schooling is the period when students begin to get disinterested in physics because they cannot see any connection between what is being taught and how it can be applied in everyday life. Girls have more pronounced disinterest in physics than boys, hence the gender gap. Ben (2010), in a study of students' uptake of physics in South Australia and the Philippines, observed that it is at middle and early high school years that girls and boys tend to develop negative attitudes towards physics. In both middle and high school levels in Canada, females have less interest in science than do males, particularly when it comes to physics (Lupart et al., 2004). Zohar and Sela (2003) note that in terms of performance in physics, gender differences are usually non-existent or small in the early school years, with larger differences beginning in junior high school and increasing toward high school. Too frequently, however, the secondary school physics teachers fail to take advantage of the students' new levels of intellectual acumen, and do not integrate active inquiry and experimentation in their classes.
Thus they fail to capture and sustain the interest of both boys and girls in the subject. If physics is to attract more students at the post-compulsory level, among other intervention measures, a dedicated teaching force that is keen to implement gender inclusive pedagogical practices will be required.

2.4. Teacher's Gender-Inclusive Pedagogical Knowledge

The conscious and overt aim of most physics teachers in coeducational settings is to teach their male and female students equitably. However, equitable teaching remains elusive in many classrooms (Sadker & Zittleman, 2005) fuelled by the teachers' inadequate procedural knowledge on gender-inclusive pedagogies (Mougharbel & Bahous, 2010). The teachers are largely unaware of their sexist teaching behaviours. Labudde et al. (2000) in their study 'Girls and physics: teaching and learning strategies tested by classroom interventions in grade 11' reported that many teachers agreed that they did not know enough suitable techniques and specific examples to be able to implement effective gender-fair teaching strategies. Instructional practices of teachers with wide gender-equity knowledge, agreeably, nurture more equitable classroom interactions, (Bailey, Scantlebury, & Johnsone, 1999). Since the extent to which a teacher is knowledgeable and sensitive about gender equity issues and practices are predictors of quality for equitable classroom interactions (Labudde et al., 2000), it
was imperative for this study to explore the gender-equity knowledge for practicing physics teachers in Kenyan co-education secondary schools.

Most teachers are unaware of their inadequate knowledge and competencies in gender inclusive pedagogies. For instance, Ben (2010) in his study of students’ uptake of physics in Australia and the Philippines observed that physics teachers were not aware that they practice gender bias in their classroom by unintentionally catering more to males than females students. Zohar and Bronshtein (2005) in their study on physics teachers’ knowledge and perceptions regarding girls low participation rates in advanced physics classes noted that teachers had partial understandings of research findings; they also had limited knowledge and experience with gender-inclusive pedagogical practices.

That the teachers are unaware of their gender bias in the classroom vindicates the failure of teacher education programs to highlight and inculcate the necessary gender pedagogical knowledge. In a study of teacher education and gender equity, Sanders (1997) confirms a lack of gender equity programs in pre-service teacher education, despite the bubbling up of gender equity concerns for over decades of years. In a study of pre-service teachers’ awareness and implementation of gender-equitable teaching behaviours, Tracy and Lane (1999) observed that teacher education programs have failed to meet the challenge of preparing teachers to confront their biases. Sanders (2002) further noted that in
kindergarten through college years, teachers receive nominal knowledge on gender equitable teaching approaches. Moreover, Carinci (2002), in a dissertation on 'Gender equity training in pre-service teacher preparation programs' observes that the teachers are not aware nor have the training on the importance of gender inclusion methodologies and its impact on the learner. Brotman and Moore (2008) observe that teacher education is one strategy for addressing the issues of inequitable or sexist treatment of girls in the classroom.

Teacher education on equitable approaches prepares the teachers to make the appropriate changes in interaction patterns, teaching strategies, or choices of contexts and methods of assessments that would foster a gender equitable learning environment. Scantlebury (1995) suggests that such teacher education strategy could include a learning program of theory and practice of “gender-sensitive education”. In addition, Haussler and Hoffman (2002) propose that teachers need to learn more about the topics of preschool and out of school gender socialization processes, about typical communication behaviour in co-education classes, and about the sex stereotype behaviour of male and female teachers. This study sought to establish the gender pedagogical knowledge that physics teachers have gained in the fragmented areas of their educational training, that help them to benefit all learners equitably and to promote a positive physics-related self-concept, especially for their female students.
2.5. Teachers' Beliefs and Views about Gender Inclusive Pedagogies

Many science (physics included) teachers hold beliefs and views of gender-role stereotypes that may influence their teaching practices and behaviours (Kagan, 1992; Scantlebury, & Kahle, 1993). The teachers' views of gender-role stereotypes are products of the teachers' own socialization through education programs. Tracy and Lane (1999) assert that these education programs ignore the existence of gender inequalities in the school system. Janice (1994) asserts that teachers' gender beliefs diminish or contribute to the gender-differentiated schooling experiences for boys and girls.

Owing to these gender beliefs the teachers engage with boys and girls in discriminatory and biased ways: discriminatory means that teachers favour one sex in access to resources (American Association of University Women [AAUW], 1992), while bias means that the teachers interact more meaningfully academically with one sex (Sadker, Sadker, & Klein, 1991). Janice (1994) corroborates that discrimination tends to be demonstrated in overt denial of opportunity based on gender, while bias is more subtle and therefore more difficult to identify.

Gender bias constitutes an underlying network of assumptions and beliefs held by a person that males and females differ in systematic ways (in talents, behaviours or interests) other than physically. These assumptions and beliefs lead teachers
not to acknowledge gender equity as an issue in the classroom, and they are therefore 'blind' to the differential in quality of instruction, frequency of interaction and level of expectations among their students based on gender (Janice, 1994).

The American Association of University Women [AAUW] (1998) documented the inequitable educational experiences of girls. These inequitable girls’ experiences can be attributed to biased instructional strategies and techniques that were possibly supported by teachers’ gender perceptions (Fang, 1996) and or unconscious acceptance of gender-role stereotypes in science (Scantlebury & Kahle, 1993). The beliefs and stereotypes can be explained using innate and socialization differences models.

The innate differences model views differences in thinking and behaviour patterns as caused by genetic or hormonal factors while the socialization model relate to stereotypes based on culture. Either model of beliefs impacts on the teaching because, according to Fang (1996), beliefs act as a filter through which a host of instructional judgments and decisions are made. If a teacher perceives that boys and girls have different innately determined ways of thinking and learning, they may develop gender differentiated teaching practices.

With regard to socialization differences model, Janice (1994) notes that a teacher who believes in this model will endeavour to provide equal and equitable
treatment to the boys and girls: equal treatment means providing same opportunities for access and participation while equitable means treating the disadvantaged (at-risk) group in ways that help them improve the final outcomes of academic achievement. From the foregoing, gender beliefs and stereotype perceptions, which cannot be directly observed or measured (Pajares, 1992), scaffold the teacher’s biased verbal and non-verbal behaviours toward their learners. The strategies teachers employ and the messages teachers give communicate their beliefs about gender (Williamson, 1996). These gender beliefs also support the enactment of instructional practices and techniques that do not promote equitable boys’ and girls’ engagement in the learning of physics. This study explored teachers’ beliefs and views of gender role stereotype that influence how they enact gender inclusiveness in teaching and learning of physics.

2.6. Implementing Gender Inclusive Pedagogies

Physics Teachers in Kenyan secondary schools teach a fixed set of concepts prescribed by the national school’s curriculum centre – The Kenya Institute for Curriculum Development (KICD). However, the teachers are free in their teaching methods (KNEC, 2006) and in their choice of context and particular instances to exemplify a concept. Murphy and Whitelegg (2006) observe that while the curriculum provides the standards to be achieved, it is the responsibility of the teacher to include several teaching and learning strategies to make the
curriculum context-based and more appealing to the students, especially the females. But, KCSE statistics in KNEC (2009) reveal a clear gender gap in favour of boys in achievement in physics. This study therefore focused on establishing whether or not the teaching practices contribute to this gender disparity.

Both boys and girls in secondary schools have difficulties in experiencing their physics class as being interesting (Haussler & Hoffmann, 2002). Car lone (2004) in a study of the cultural production of science in reform based physics corroborates this observation that teachers portrayed physics as being difficult and esoteric, only accessible to some who usually ended up being the boys in the classroom. This situation can arguably be attributed to inadequate implementation of the gender inclusive (Rennie, 2003), also referred to as gender balanced (Labudde et al., 2000) pedagogies that attend to the learning styles, experiences, and interest of both boys and girls. This is particularly true for the contexts in which a topic is presented and for the activities in which learners are allowed to engage.

Through their teaching practices and behaviours, teachers’ can enormously influence their students’ self-perception of esteem and academic ability (AAUW, 1992). Such practices and behaviours can perpetuate stereotype perceptions about boys’ and girls’ ability in, aptitude for and suitability for (optional) science (Scantlebury & Kahle, 1993), and consequently play into the boys’ and girls’
career choices. In implementing gender inclusive pedagogies the focus is to help lessen the disadvantage for girls without making boys suffer. In such implementation, the teachers ought to be conscious of practices and behaviours that can affect learners in negative ways, and adapt the curriculum to contexts and experiences of the learners, and to facilitate learning styles and activities that interest all learners.

Teaching strategies for creating equitable learning environment stress construction of meaning and understanding as opposed to those for transmission of knowledge. Hughes (2000) observes that components of science–technology–society (STS) curriculum in the UK high school were treated marginalized and treated peripherally to the disadvantage of female students in comparison to the more abstract, traditional scientific content. Hughes argues that this way of treating the STS issues reinforces a central, superior place for masculinity in science.

Murphy and Whitelegg (2006) and Zohar and Sela (2003) provide a range of strategies to attract female (as well as male) students toward physics. Such strategies include assessment and use of students' prior knowledge; concept mapping to reveal misconceptions and assess conceptual change; active learning contexts for students; constructing models; class discussions; a democratic non-authoritarian teaching style; cooperative group work; science inquiries; and diverse assessment practices. Teachers therefore need to value and contextualize
the teaching of physics in STS issues in order to enhance comprehension of concepts by both male and female students. Inclusion of STS issues moreover does not alienate learning of physics by either gender. These pedagogies, together with equitable gender teacher-student interaction, are important in encouraging all students, but especially girls, to continue with physics.

Miller, Blessing and Schwartz (2006) found that girls frequently like biology and are attracted to science content that involve helping others. In this regard, pedagogy needs to emphasize social and societal connections with physics, as well as the relationship between physics and biology (Jones, Howe, & Rua, 2000).

Many studies, among them the Cavallo and Laubach (2001) and Heard, Divall, and Johnson, (2000) point to the possibility that girls in particular benefit from hands-on activities or inquiry-based learning, critical in developing manipulative and science process skills. This is in conformity with Burkam, Lee and Smerdon (1997) who showed that student-centred and hands-on laboratory experiences and activities related positively to both boys’ and girls’ achievement in physics and biology, and particularly improved the performance of girls in physics. Furthermore Von Secker and Lissitz (1999) in a study based on teacher reports of laboratory emphasis, found that a focus on laboratory inquiry was related to higher achievement for tenth graders overall but that this emphasis did not significantly impact the gap in achievement between girls and boys. Undoubtedly
However, hands-on laboratory and experimental science experiences are beneficial for both girls' and boys' achievement in science, and physics in particular and therefore should be implemented more frequently in the classroom (Harwell, 2000; Stark, 1999). In using the hands-on activities, the teacher needs to emphasise on activities that lead to acquisition of not only knowledge, but also the science skills, and to actively intervene to ensure equitable use of resources among boys and girls.

Gender balanced pedagogy for optimum learning, that targets to benefit both boys and girls involve adapting from a diversity of learning styles. Jones et al. (2000) and Zohar and Sela, (2003) show that girls, on average, are more relational and cooperative and less competitive than boys. In addition, Zohar (2006) notes that girls indeed reject more formulaic, rote learning and strive for deeper conceptual understanding.

However, both boys and girls would generally benefit from the utilization of constructivist pedagogical approaches (American Association for the Advancement of Science [AAAS], 1993), which encompasses collaborative learning (Capobianco, 2007) and gender inclusive pedagogical practices (Mayberry 1998). In an attempt to improve physics education, physics teachers have an obligation to include gender-inclusive learning styles that nurture collaborative environment in which all participants are encouraged to substantially
participate (Hill, Corbett, & Rose, 2010). In other words, teachers need to give attention to learning styles such as cooperative learning that emphasizes discussion and interdependence, and de-emphasizes individualistic and hard-core competitive learning episodes, aiming at developing learning for understanding and connected knowledge (Zohar, 2006) for both boys and girls.

Gender inclusive pedagogy involves ensuring that boys and girls receive the same opportunities for access to learning resources and content and for active participation. In their study of intervention to enhance girls’ interest, self-concept and achievement in physics, Haussler and Hoffman (2002) suggested seven guidelines for stimulating interest in physics among girls (and in boys). They argued that in order to stimulate interest and enhance self-concept and achievement for girls (and in boys) the teaching of physics ought to: provide opportunities to marvel; link content to students’ prior experiences; provide first-hand experiences; encourage discussions and reflections on the social importance of the content; connect the content with applications; show the content in relation to the human body; and demonstrate the benefit and use of treating the content quantitatively. While these steps may not apply in all cases, using a multiple of them would optimize learning for both boys and girls.

Teachers’ questioning technique and interaction patterns with students often vary depending upon the sex of the student to whom the question in addressed. For
instance, Scantlebury and Kahle (1993) observe that teachers ask boys more questions and also questions that target higher-order cognitive abilities. The teachers also respond differently to the students' ideas and thinking depending on the students' gender. Boys' contributions are praised while those of girls are merely accepted even though the quality is comparable (Tracy & Lane, 1999). Tobin and Garnett (1987) affirms this tendency of teachers by noting that teachers are more apt to expand on boys', than on girls' answers; they seek answers equally from both girls and boys for lower-order questions, while a majority of the times they call upon boys to answer higher-order questions. Kelly (1985) also observed that teachers provide hints, leading suggestions, or reword questions for boys, and when a girl replies inappropriately, teachers tend to ask another student, frequently a male, to reply. The teachers also tend to provide more time for boys to answer and give own ideas than they do to girls (Tracy & Lane, 1999).

The amount of time accorded to a learner is very important for the quality of response expected. In their review of literature, Rhine and Bryant (2007) observed that granting students adequate time to think about what they want to say in response to a prompt, creates a more thoughtful environment for reflection, which applies to both gender: reflective thought increases, contributions of low-achieving students increase, and fosters higher cognitive learning. The implication of these behaviours by the teachers is that, other than the classroom interaction supporting equitable involvement for boys and girls in the learning, the
boys get more advantaged in promoting their self-concept and better understanding of the content. This study sought to establish the teaching practices in physics classrooms vis-à-vis gender equitable involvement in learning.

2.7. Summary of the Literature Review

Gender-inclusive pedagogies are variably described by different researchers; however, Brotman and Moore (2008) observe that common features emerge from interventions attempted by the different researchers. Such interventions consider teaching behaviours and instructional strategies that, in accordance with Scantlebury and Baker (2007), foster an equitable gender environment, drawing upon boys’ and girls’ experiences, interests, and preconceptions.

The interventions prioritize active participation and pays attention to issues of sexism and gender bias resulting in a positive influence on students learning (Rennie, 2003). Brotman and Moore (2008) assert that gender-inclusive interventions include: using cooperative learning and small group instruction, monitoring and controlling the frequency to which certain students engage class time (answer questions), ensuring risk-taking students do not dominate classroom interaction; applying appropriate wait-times, and ensuring that all students have equal access to resources among others.
As pointed out by Roger and Duffield (2000), teachers who become aware of their own sex-stereotyped behaviour and who are willing to change it can make a difference. This study focused on exploring how the teachers' pedagogical practices foster gender inclusivity in the teaching and learning of high school physics. The following chapter discusses the design and methodology of the study.
CHAPTER THREE:
DESIGN AND METHODOLOGY OF THE STUDY

3.1. Introduction

The aim of this research was to investigate the influence of instructional practices of secondary school physics teachers on equitable boys' and girls' engagement in co-educational classrooms of physics in Kenya. The study identified nature of the instructional practices; determined underpinnings for these practices; established experiences of teachers in executing these practices and finally investigate perceptions of boys and girls on the instructional frequency of these practices. This chapter sets forth the design and methodology that was applied in carrying out the study. It describes the population, the sample and sampling procedures of the study. The chapter also describes the research instruments and how they were validated and tested for reliability through piloting. Finally the chapter explains the data collection process, ethical considerations and analysis procedures.

3.2. Research Design

This study employed a mixed research design. It considered descriptive and quantitative research components to establish and better understand the nature, underpinnings and experiences of physics teachers toward gender inclusivity in teaching and learning of secondary school physics. In addition, the study sought
to analyse data so as to identify those teacher instructional practices that lead to more equitable boys' and girls' engagement in the learning of physics. The study employed methods of constant comparison that, in accordance with Denzin and Lincoln (2005), make the studied phenomena visible in various ways. In this regard, the study collected both qualitative and quantitative data using classroom observation and teacher's interview schedules, and students' survey questionnaire.

Descriptive component of study has ability to collect data within a short time (Mugenda & Mugenda, 2003). It attempts to describe characteristics of subjects or phenomena, opinions, attitudes, preferences and perceptions of persons of interest to the study (Creswell 2009). Moreover, it uses a naturalistic approach that seeks to understand phenomena in natural, context-specific settings, undisturbed by application of experimental designs and artificial isolation. In other words, there are no attempts that are made in naturalistic approach to manipulate the phenomenon of interest (Patton, 1990).

Though quantitative and qualitative data are inherently different, they are remarkably the same (Maxwell, 2008) and complementary in informing study findings. Aray, Jacob, Sorensen & Razavieh (2009) affirm that the end result of mixed methods research constitutes findings that may be more dependable and provide a more complete explanation of the research problem than either method alone could provide. Qualitative research however, is undertaken in a natural
setting where the researcher gathers words or pictures which are analysed inductively focusing on the meaning of participants, and describing a process that is expressive and persuasive in language.

Quantitative measures yield useful information about the scope of a particular characteristic while the qualitative method collects additional data that assist in building a more in-depth understanding of the quantitative data (Creswell & Garrett, 2008). For this study, the quantitative and qualitative data aided in establishing findings that represent the population as a whole (Mugenda & Mugenda, 2003) with regard to the instructional practices of physics teachers towards equitable boys’ and girls’ participation in learning of physics. Figure 3.1 illustrates the process of the study, from sampling to the last activity of drawing recommendations for action and further research.
Figure 3.1 illustrates the process of the study. The initial stage after conception and developing the study proposal was sampling the units and subjects of the study. This was followed by actual collection of data from the study sites and subjects. In the third stage, the data were analysed and finally in the fourth stage, findings were drawn from the analysed data and conclusions and recommendations made.
3.3. Location of the Study

The study involved students and teachers drawn from co-educational secondary schools in Murang’a county of Kenya. The County was one of the forty-seven counties in Kenya and was quite informationally representative of the status of physics education in Kenya in terms of enrolment and performance at the KCSE level. For instance, analysis of KCSE data in the year 2010 reveals that the County had 34% of the candidates enrolled in physics, while at the national level the enrolments was 31% of the candidates. Further analysis of the data yields an achievement mean scale score of 5.0 at the County level and mean scale score of 5.2 at the national level on a scale of 1 to 12 in the year 2010. The enrolment and performance data at the County and at the national level were comparable and therefore, the county provided a representative case of many other counties in the country.

Murang’a County was also suitable as the study locale because it was one of the counties in the country that had a large number of secondary schools. It had 264 secondary schools in the year 2014, most of which were government sponsored, with a few of them being privately sponsored schools. Among the schools in the county two were national schools, 47 were county schools and 215 (about 81%) were districts schools (MOE, 2014). This pattern of distribution of schools in the
three categories is a replica of the situation in majority of the counties in the country.

Generally, the government sponsored schools in the country are categorized into National, County and District. Hitherto August 2010 when the Kenyan New Constitution was promulgated, the District schools were called “Harambee” schools. These District schools have a glaring shortage of basics instructional resources for engagement in rigorous teaching and active learning (Onsomu, Muthaka, Ngware & Kosimbei, 2006). All national and county schools are single sex, boarding schools, while majority of the district schools are co-educational.

The national schools’ admission is a fair representation of students from across the country and they admit the most highly performed students (score of about 400 marks and above out of the maximum 500 marks) in the primary exit examination.

The county schools admit students from the ‘left-overs’ of the national schools’ admissions, but not those with lower than 300 marks. The district schools admit from the ‘left-overs’ of the county schools’ admissions up to a minimum of 200 marks. Very few cases of highly performing students (mostly those who have financial and or any other challenges) enrol in the district schools.

In essence, the County remained well placed for the study because, like any other county in the country, it had a wide range of schools. On one hand, it has well-resourced schools with long history of existence and good performance. On the
other hand, it has schools that are newly established through the Constituency Development Fund and with meagre resources for meaningful academic engagement. Moreover, the County is conveniently located at about 40km from Kenyatta University and it was therefore cost effective in terms of time, effort and money in data collection exercise.

3.4. Target Population of the Study

The target population in the study comprised of physics teachers and students in co-educational secondary schools in Murang’a County. For this study, co-educational schools are those schools in which male and female students are given instruction together in classes. The focus on co-educational schools arose from the fact that these were information-rich sites with regard to involvement of boys and girls in the learning of physics.

The co-educational schools are in the majority in Kenya, and as Shiman and Mwiria (1987) observe, they are anything but optimal environments for learning. The net effect of this is that, academic achievement of students in these schools is generally lower than that of students in single-sex schooling environments. Indeed, in the order of merit of all schools in the country for the year 2010 KCSE examination there was only one government sponsored and a small number of privately sponsored co-educational schools in the top 100 schools (KNEC, 2011). This study therefore, targeted population from public co-educational schools
(illustrated in Table 3.1 and Fig. 3.2) where teacher instructional practices need to be, of necessity, gender inclusive. It collected data from the head teachers about the profiles of the schools and about their views with regard to learning of physics. It also collected data from the physics teachers about their pedagogical knowledge, beliefs and experiences in implementation of gender inclusive pedagogy. Data collected from the students were on their perceptions about the use of gender inclusive instructional practices in their classrooms.

3.5. Sample and Sampling Procedure Description

For practical and efficient conduct of the study, it is necessary to obtain a representative sample of the schools’ population (Marshall, 1995). Patton (1990) observes that the manner in which the sample is drawn is an important factor in determining how useful the sample will be for making inferences about the population from which it is drawn. It is quite possible to have a very large sample upon which no sound decision can be based. To be useful, the sample must be representative of the population about which generalizations are to be made. This study applied both random sampling and systematic (purposeful) sampling.

The random sampling method is generally the best and simplest way to draw a sample from a population as compared with non-random sampling processes. With random sampling, every member of the population has an equal opportunity to be included in the sample, and pure chance is the only factor that determines
who actually goes into the sample. Mugenda and Mugenda (2003) assert that a random sampling process produces a set of subjects with required characteristics within an acceptable degree of bias for the purpose of the study. It follows that, in all possible circumstances, the application of random sampling has such a clear advantage over most other methods with regard to the generalizations that can be made. In this study, stratified random sampling was applied to identify the research sites (the schools).

Purposeful or systematic sampling is a strategy in which particular settings, persons, or events are deliberately selected for the important information they can provide (Maxwell, 2008). Maxwell further notes that purposeful sampling can serve several intentions: to achieve representativeness or typicality of the settings, individuals, or activities selected; to capture adequately the heterogeneity in the population; to allow examination of cases that are critical for the theory in the study; and to establish particular comparisons to illuminate the reasons for differences between settings, individuals or activities. In this study, all these four issues were considered and therefore applied purposeful sampling techniques to select teachers and students for the study.

The sampling process for the schools in the study is illustrated in Fig. 3.2 and sampling of the teachers is illustrated in Table 3.1. At the first stage of the process, stratified random sampling was applied to select schools within the
Murang’a County. This was followed by purposeful selection of teachers within schools. All Form three physics students participated in the study.

**Table 3.1: Sampling Grid**

<table>
<thead>
<tr>
<th>Category of participants</th>
<th>Populations</th>
<th>Sample</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murang’a Co-educational Schools offering physics</td>
<td>136</td>
<td>14</td>
<td>~10%</td>
</tr>
<tr>
<td>Head teachers</td>
<td>136</td>
<td>14</td>
<td>~10%</td>
</tr>
<tr>
<td>Physics Teachers</td>
<td>148</td>
<td>14</td>
<td>~11%</td>
</tr>
<tr>
<td>Physics students</td>
<td>2367</td>
<td>258</td>
<td>11%</td>
</tr>
<tr>
<td>Total Number of study subjects</td>
<td>2651</td>
<td>286</td>
<td>~11%</td>
</tr>
</tbody>
</table>

Source: MOE (2010a & b)

### 3.4.1. Sampling of Schools

Murang’a County had a total of 208 secondary schools that registered candidates for the 2009 KCSE (MOE, 2010a). Of the 208 schools, 165 were coeducational. The remaining 43 were single sex schools, with 25 of them being for girls and 18 for boys. Since this study sought to establish gender inclusiveness in teaching and learning of physics, it was appropriate to target participants from the mixed schools. This is in conformity with several studies that have documented the allegedly detrimental effect of co-educational instructional settings on the education of girls, especially in mathematics and science (Deem, 1984, Milligan & Thomson, 1992). For the purpose of this study, a sample of schools was
therefore drawn from the co-educational schools, which are possible rich sites for data on gender instructional practices in physics learning.

Out of the 165 co-educational secondary schools in the Murang’a County, 21 schools did not offer physics at KCSE level in the year 2009 (KNEC, 2010) and were therefore not considered for the study. As at the time of the study, eight other schools were on the verge of phasing out one sex of the students, to become single sex schools (MOE, 2010b). This means that there was a population of 136 schools, which can be said to be too large for the study.

For the purpose of in-depth information gathering, a stratified random sampling method was used to select 10% (14) of these schools. Figure 3.2 illustrates the sampling process for the schools.
In order to ensure that participants in the study came from across the whole range of well to poorly resource-endowed school environments, the study considered the performance ranking list and applied a sampling interval of 10 schools. Participation of a selected school in the study was based on a number of criteria. First, the school should be one that offered physics up to KCSE level for both boys and girls. Secondly, the Form 3 class should have not less than 10 (total number of males and females) physics students; and thirdly, the school has trained physics teacher(s) who have at least five years of teaching experience. The number of students in the class is derived from GOK, (2009) which provides that -
“school” means an institution in which not less than ten pupils receive regular instruction, or an assembly of not less than ten pupils for the purpose of receiving regular instruction. Based on this definition, the study considered classes with no less than 10 students, and with no less than one-third of the students of either gender in line with the Constitution of Kenya (GOK, 2010). When the selected school did not satisfy these criteria, it was replaced with the school earlier on the list. If the replacing school also did not satisfy the criteria, the initially selected school was replaced with the immediately following school on the list.

3.4.2. Sampling of Teachers

In order to understand the gender inclusivity in teaching of physics, the study gathered data from teachers of physics in the selected schools. It ensured at least a one-third representation by gender among the participating teachers. It gathered data from the teachers because their perceptions (espoused by beliefs and knowledge) of gender differences can affect the way they interact and communicate with the learners (Gray & Leith, 2004).

The study applied purposeful sampling to identify trained and experienced physics teachers in the selected schools. Experience is a factor, which when coupled with motivation to move to higher levels of achievement, produces expertise. Experts, unlike novice teachers, use more goal directed strategies for solving problems, have greater and more organized knowledge, have greater motivation, engage in
more deliberate practice, tend to receive more social support, and are better monitors of their performance (Hatano & Oura, 2003). According to Priest and Lindsay (1992) expertise takes 5 to 10 years of experience to develop. Since the motivation to achieve would not be directly observable, this study therefore considered teachers of physics with not less than 5 years of teaching experience as having adequate expertise in the teaching of this subject.

In order to ensure that the study obtained data on pedagogical practices that related to equity in boys’ and girls’ engagement in the learning of physics, the study targeted those teachers who were teaching or had taught physics in Form 3. This was because the Form 3 students, having elected to study physics (subject selection done at the end of Form 2 schooling) are likely to be more sensitive to any discriminatory instructional practices that do not promote equitable gender involvement in the learning of the subject. In addition, most schools do assign the most “capable” teachers to take up teaching of students as from Form 3 owing to the high stakes in the exit examinations. The teachers would therefore apply instructional practices that they consider to yield the best results.

3.4.3. Sampling of Students

From the population of physics student in the schools, the study collected data from students in Form 3. The students in Form 3 were considered suitable for this study because they are more settled in the school system unlike their Form 2 or
Form 1 school mates, and are not under the kind of pressure associated with the Form 4, a KCSE candidate class. The Form 3 students were also appropriate for the study because they had elected to study physics and were therefore very well positioned to give a rich account of their experiences in learning the subject. That they had selected to study physics means that they were aware of the importance of the subject and would therefore have been keen to observe how their physics teachers responded to their learning needs. From the foregoing, it is clear that the Form 3 class was a rich source of data on gender inclusive teacher practice. All the Form 3 physics students in the 14 schools, a projected total of 258 (101 girls and 157 boys) based on the figures of 2009 KCSE registration, were earmarked for the study.

3.6. Research Instruments

The design for this study applied mixed data collection methods: qualitative and quantitative. The qualitative methods can use multiple approaches that include case studies, personal experiences, life stories, interviews and observations as well as drawing from historical, interactional, and visual texts that describe routine and problematic moments and meaning in individuals' lives (Creswell & Garrett, 2008). In this regard, the study used nonparticipant classroom observation guide and interview schedule for teachers to collect data on nature of instructional
practices, their underpinnings and the experiences of teachers in implementing
gender inclusive instructional practices.

Besides, the study used survey questionnaire for students with the aim of
obtaining a holistic or total view (Mwiria & Wamahiu 1996) of gender inclusive
practices in the teaching of physics. The questionnaire collected data on students’
perception of frequency of application of gender inclusive instructional practices.

3.5.1. Classroom Observation Schedule

In this study, the classroom observations took the form of qualitative ethnographic
note-taking. The observations focused upon the classroom set-up; the nature of
lesson content; teacher’ pedagogical content-knowledge; and learners’ interaction
during the lessons (Mougharbel & Bahous, 2010). The observation schedule
(Appendix B) was adapted from a model designed by Sadker, Sadker and Hergert
(1981), referred to as Interaction for Sex Equity in Classroom Teaching
(INTERSECT).

The INTERSECT has three comprehensive sections. The first section deals with
the climate of the classroom (desk arrangement, student composition, classroom
context). The second section looks into teacher and student interaction in the
classroom that includes praise, acceptance, remediation, and criticism. The third
section is concerned with tone-setting incidents that enhance or impede gender equity in the classroom.

3.5.2. Interview Protocol

This study utilized interview protocol to collect data from teachers. Merry et al., (2011) observe that in qualitative research approach interviews are often the preferred strategies for obtaining rich data, gaining an in-depth understanding of the experiences and perspectives of participants. There are three possible formats for interview design as summarized by Turner (2010): (a) informal conversational (non-structured) interview, (b) general (semi-structured) interview, and (c) standardized open-ended (structured) interview guide. This study made use of a general (semi-structured) interview protocol, which involved an outline of a set of issues to be explored with each of the participating teachers (Patton, 1990). The interview schedule is presented in appendix C

3.5.3. Survey Questionnaire for Students

One of the other instruments for data collection in this study was a students’ questionnaire. The purpose of a questionnaire is to collect data from many participants about their characteristics, experiences, and opinions (Gall, Borg & Gall, 1996). Burn (2000) observes that its inclusion in a qualitative study approach can provide an easy and fruitful method to explore research issues. Burn
continues to assert that a questionnaire provides comparable information from a number of respondents within a specific time frame and at a minimal cost. This study, therefore, utilized a questionnaire to survey students' perspectives about gender inclusiveness in the teaching of physics.

Questionnaire items are of two types: structured and unstructured types (Ary et al, 2009). Structured questionnaire items are the scoring types that are readily analysable using statistics. They provide quantitative information that explains how many people hold a certain (pre-defined) opinion (Kitzinger, 1995). These types of items however, have the disadvantage of limiting participants to only choosing from the provided alternatives. On the other hand, unstructured questionnaire items are open-ended, and responses to the questions might be rather demanding to analyse. Nonetheless, both structured and unstructured questionnaire items were considered in this study.

The questionnaire items for this study (Appendix D) were based on the four components of feminist pedagogy theoretical model. This is guided by Robson (2002) who asserts that, development of a survey instrument need to be guided by theoretical framework to prevent the process from degenerating into a 'fishing trip' where a question is considered because it appears a good idea at the moment.

The questionnaire was organized into three sections. In section one the it sought to tag the school and sex of the respondent. However, the school identity was not
a factor in the analysis other than for identification of the scripts. Section two had nineteen items that used a five point Likert scale to express frequency of specified instructional practice. The nineteen items were in the four categories relating to feminist pedagogical components: five items related to instructional practices that create participatory classroom environment; five items focused on instructional practices that validating learners’ voices; four items targeting instructional practices that encourage social understanding and activism; and five other items were on instructional practices that foster critical thinking and disposition. Section three contained eight open ended items that explore the opinions of students on gender inclusiveness in teaching of physics.

3.7. Validity and Reliability of the Instruments

Study validity and reliability are rooted in positivist research paradigms and depends on instrument construction (Creswell & Miller, 2000). In qualitative, naturalistic approaches, validity and reliability are collapsed to refer to credibility, transferability, and trustworthiness of the study findings. Creswell and Miller (2000) observe that these terms refer to the accuracy with which inferences from the study represent participants’ realities of the social phenomena and, in accordance with Guion, Diehl, and McDonald (2011), the inferences are certain (supported by the evidence). Data for validating and establishing reliability of the study instruments were collected through a pilot study.
3.6.1. Pilot Study

A pilot study was carried out in preparation for the main study. The purpose of the pilot study was to check the fidelity of the research instruments in order to maximize the appropriateness and utility of the instruments in the main study (Collins, Onwuegbuzie & Sutton, 2006).

The pilot study was carried out in two co-education schools, which were not part of the sample in the major study. In each of the schools, a lesson was observed, followed by administration of survey questionnaire to students and then an interview with the teacher. In one school, an eighty-minute, laboratory based lesson was observed and in the other, a forty-minute, classroom based lesson was observed. The information yielded by the pilot study was used to modify and to enhance the instruments. The pilot study also familiarized the researcher with the process of identifying any administrative aspects for smooth conduct of the research.

3.6.2. Validity of Qualitative Data Instruments

Validity in qualitative research depends on shared understanding of questions between the researcher and the subject. This means that it is heavily dependent on the researcher, who, according to Patton (1990), is also a research instrument. It is evaluated on the basis of whether the questions make sense and are worded in a
way that is clearly understood by the respondents. The evaluation techniques include thick description of data, member checking, triangulation, peer reviews, and external audits (Creswell & Miller, 2000). In this study, validity of the instruments was established by external audit undertaken by faculty with relevant expertise in the field of study. Furthermore, the researcher carried out reflective analysis and triangulation of data obtained through pilot interviews and observation of classroom teaching. This was to ensure that the identified themes, categories, explanations, and interpretations of data made sense and were credible.

3.6.3. Reliability of Quantitative Data Instrument

Any research based on measurement must be concerned with the accuracy or dependability, also referred to as reliability of measurement. This is the extent to which an instrument produces consistent results over time (Creswell, 2012). In this study evaluation of reliability was carried out with regard to the quantitative data gathered using the students' questionnaire. The data constitutes responses scored on a Likert scale continuum of 1 to 5, with 5 representing an always occurrence of the specified instructional practice. Cronbach’s alpha formula was applied on the data to determine the reliability coefficient of the instrument. George and Mallery (2003) provide the following rules of thumb in interpreting reliability from the Cronbach’s alpha coefficients (α): $\alpha \geq 0.9$ indicates excellent; $0.8 \leq \alpha < 0.9$ good; $0.7 \leq \alpha < 0.8$ Acceptable, $0.6 \leq \alpha < 0.7$ questionable, $0.5 \leq \alpha < 0.6$
poor and $\alpha < 0.5$ unacceptable. This rule was applied in this study in interpreting reliability of the questionnaire instrument. It attained a reliability coefficient of 0.74, meaning that the questionnaire was acceptable for the study.

3.8. Data Collection Procedures

Data collection process was embarked on upon clearance by the Graduate School, Kenyatta University, and the Ministry of Education, Kenya (Appendices I & J). The researcher made arrangements for the data collection through telephone conversation with the school principal and the physics teacher concerned. The discussions were specific on the research activities in the school; estimated amount of time to spend in the school; and that there was to be no disruption of the normal schools routine. The specific data collection procedure and consideration of research ethical issues are as outlined hereunder.

3.7.1. Data Collection from School Principals

Upon entry into the school, the researcher made courtesy call on the school principal. During the courtesy call, the researcher gathered data on school enrolment in the Form three physics class, and the enrolment in the previous KCSE physics classes. The discussion with the school principal also sought information on the schools status with regard to teaching and learning resources. In addition, the discussions inquired into their views about gender differences in
the physics classes and also about the teachers’ instructional practices. The data from the school principal was recorded in a research diary. Thereafter, the researcher sought clearance from the school principal to interact with the physics teacher and students in the Form three physics class. All schools in the sample had only one stream of the Form three physics class.

3.7.2. Data Collection in the Classroom

The physics teacher lead the researcher to the class, introduced him to class as one collecting data on how they learn and that the information was important in helping design ways to teach them more effectively. This style of introducing the researcher made the learners to relax and engage in the lesson in their normal ways. The teacher then identified a place at the back of the classroom, from where the researcher acted as a nonparticipant observer, observing and audio taping the lessons unobtrusively.

However, in two lessons the students’ behaviour, particularly at the lesson introduction appeared to be affected by the presence of the researcher in the class. The students kept glancing at the researcher as he was setting-up the computer for recording; they looked excited to be captured on video. After minimizing the webcam window the students settled and continued with their learning as though there was no stranger in their midst.
The researcher’s purpose as an observer was to experience a sense of the environments in which the teachers and learners were working, and to get a snapshot of the individual typical instructional styles and approaches in the classroom, and have the opportunity to meet informally with the students. Details of the observations are discussed later in this report as they apply to particular elements and issues of the study.

3.7.3. Data Collection Using the Survey Questionnaire for Students

The survey questionnaire for the students was administered immediately after the lesson observation. The researcher led the class in reading and interpreting each of the questionnaire items, after which the students indicated their views on the provided spaces. The exercise with the questionnaire took approximately 25 minutes.

3.7.4. Data Collection Using the Teacher’s Interview Schedule

The questionnaire administration was followed by the conduct of teacher’s interview using a semi-structured interview schedule. This was done in the most private space as identified by the teacher. Interview data was collected using a video record with the computer webcam and field notes.
Use of the semi-structured interview protocol in this study ensured systematic and comprehensive collection of information on the same issues from the large number of participants, ensuring that the limited time available for the interview situation was best utilized. It allowed for modification (flexibility and spontaneity) in the order and wording of the interview questions – one idea would thread into another, not necessarily in the order initially planned. The modifications in any case remained focused on the topic at hand, but provided the teachers with wide latitude in elucidating their beliefs, views and knowledge about gender inclusivity in the teaching of physics and their experiences in implementing gender inclusive pedagogy. The teachers, despite the fact that they were working in different teaching environments, were able to fully articulate their situation and points of view with respect to gender-inclusive teaching practices in physics.

Prior to the interview, the interviewee teacher was given the interview protocol containing list of themes for discussion. The intention of giving the list of themes was to provide the teacher with an advance opportunity to think about the themes and consider how s/he would want to respond. In this way, the teachers felt trusted, and this increased the depth of responses that they made.

The interviews, which took between 30 and 40 minutes each, were conducted immediately after lesson observation so as to obtain teacher’s perspectives on and
explanations of observed practices. The interviews were carried out in the available, most private and convenient venues in the schools that included the teachers' lounge (staffroom), their offices, and the laboratories (main hall or the preparation room). The interviews generated a lot of information that was to a great level of detail about the teachers' beliefs, knowledge, and experience with regard to gender-inclusive pedagogical practices.

Each interview was recorded using computer webcam and accompanying notes taken. Transcriptions of the interviews were done thereafter, and a copy of the text sent to the applicable teacher. The teacher was requested to make whatever corrections, additions and clarifications on the transcription so as to reflect the most accurate position of his/her responses

3.7.5. Ethical Considerations in the Study

Before commencing on the collection of data, the study considered the ethical guidelines for research with human subjects. It employed the three principles for ethics in research with 'human subjects' that aim to protect the subjects from harm. These tenets include informed consent, anonymity and confidentiality, and reciprocity. Bogdan and Biklen, (2007) assert that these guidelines attempt to ensure that informants participate voluntarily, understanding the nature of the study and the dangers and obligations that are involved. They also attempt to
ensure that informants are not exposed to risks that are greater than the gains they might derive.

In order to be certain of gaining informed consent, the subjects in the study were informed about the nature of the project. The information related to the interests and importance of the study, and the obligations of the participants and the researcher in the study. It also related to approximate amount of time for each component of the study. As guided by Denzin and Lincoln (2007), the participants were clearly told that they should not hesitate to indicate to the researcher at any point they felt uncomfortable with the process. It was also explained to them that they were at liberty to withdraw their participation at any stage of the research.

Upon entry into a school, the researcher sought from the school principal an informed consent to carry out research in the school. This is because schools are limited-entry social situations for research. Permission by the school principal was taken as representing the consent of the students, who, at Form 3 class level are children (GOK, 2010), and are therefore by law minors who cannot enter consent for participating in a research study. The researcher thereafter sought teacher’s informed consent to participate in the study.

In spite of the fact that this study has no dangers or risks involved, confidentiality and anonymity of the informants were ensured in analysis and writing of the study
report. The participants were assured that the information collected would not be shared with any unauthorized persons. The data was stripped of any personal identifiers before writing the report. Informants were also assured that pseudonyms would be used to disguise the schools, and any other personal identifiers would be masked. The following were the labels applied in the study report for the fourteen schools: Thera; Naa; Gata; Gits; Riga; Oya; Muke; Gik; Kabi; Kia; Mana; Nguru; Muru and Tugu.

As reciprocity for participating in the study, the schools were promised to receive a copy of the study report, which they could use to reflect on the instructional practices in their schools and to learn of the experiences in other schools. However, the study endeavoured to create dialogic and interactive environments that encourage resonance of conceptual formulations between the researcher and the subjects.

3.7.6. Limitations in the Data Collection Process

There were quite a number of schools in the initial sample that were phasing out one sex, to remain as single sex schools. The administration in these schools expressed the view that the students of the sex being phased out were feeling overwhelmed by the other sex and their behaviour fell short of the behaviour in a normal co-educational classroom. It was therefore their considered opinion that
the study would not benefit from data in such an environment. Such schools were then replaced with others in their respective sample intervals.

There were very few lady teachers in the initial sample of schools. Indeed many of the lady physics teachers were reported to have been teaching in single sex schools, and mostly girls' schools (interview remark by one of the physics teachers and SMASSE physics County Trainer). A re-evaluation of the study sample was then carried out to accommodate some lady teachers, and the efforts yielded five schools with seven lady teachers. Five lady teachers, one from each of the schools were sampled to participate in the study.

Some teachers in the initial sample gave all manner of excuses to avoid participating in the study. In one school, the teacher just said that his class was of low entry marks and that he did not think the study could get any useful data, while in another the teacher said she was unwell and was not willing to be observed teaching. In yet another school, the teacher said she was too busy with her studies to admit an observer in the class. In two other schools, the teachers were not in school for the appointed lessons; they had not given any apologies, and could not be reached over the phone. These schools were also replaced with others in the list in their respective sample intervals.
3.9. Data Analysis Procedures

In order to transform the raw data into findings and to interpret and make sense out of the data, a qualitative researcher must engage in active and demanding analytic processes throughout all phases of the research (Thorne, 2000). It is an on-going process throughout the period of data collection, as echoed by Bogdan and Biklen (2007), of searching and arranging data to come up with findings and meanings. The raw data for this study included vignettes of lessons observed, transcriptions from open ended, focused, but exploratory interviews with teachers (Mougharbel & Bahous, 2010), and questionnaire responses from students.

Analysis of data from the lesson observations, transcriptions of teachers’ interviews and responses from the open-ended students’ questionnaire in this study employed constant comparative approach. This approach applies in qualitative studies whose purpose is to generate knowledge about common patterns and themes within human experience (Thorne, 2000). It involves taking one piece of data (one interview, one statement, one theme) and comparing it with all others that may be similar or different in order to develop conceptualizations of the possible relations between various pieces of data. It uses several strategies that include categorizing, connecting, and use of memos and displays (Maxwell, 2008).
The categorization strategies involved breaking down and rearranging the data into categories that facilitate viewing similarities and differences across settings, individuals, or general themes in the study. On the other hand, the connecting strategy looked for relationships that connect the instructional practices of the teachers to their beliefs about gender inclusivity in their teaching. It also related the instructional practices to equitable engagement of boys and girls in learning of physics. The use of memos and displays such as tables, networks and concept maps facilitated thinking about the relationships identified in the data, making the ideas and analysis visible and retrievable. A two dimensional matrix, illustrated in Table 3.2 was particularly used to relate the study objectives and the feminist pedagogical components (FPC): Creating Participatory classroom Environment (CPCE); Validating Learners' Voices (VLV); Encouraging Social Understanding and Activism (ESUA); and Fostering Critical Thinking Skills and Disposition (FCTSD).
Table 3.2: Two Dimensional Data Analysis Matrix

<table>
<thead>
<tr>
<th>Study Objectives</th>
<th>(FPC)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CPCE</td>
</tr>
<tr>
<td>Identify nature of instructional practices in Kenyan co-educational physics classrooms</td>
<td></td>
</tr>
<tr>
<td>Determine the underpinnings of the instructional practices in Kenyan co-educational physics classrooms</td>
<td></td>
</tr>
<tr>
<td>Establish the experiences of physics teachers in implementing gender inclusive pedagogy in Kenyan co-educational secondary schools</td>
<td></td>
</tr>
<tr>
<td>Investigate students’ perceptions of gender inclusiveness in the teaching of physics in Kenyan co-educational secondary schools</td>
<td></td>
</tr>
</tbody>
</table>

Eventually, all the data were mapped into the two dimensional matrix, with the research objectives in one dimension and feminist pedagogical components in the other. Simultaneous to this analysis, was the interpretation in which findings were explained and framed in relation to the theory and other scholarship. Findings were also explained to show why they are important and to make them understandable (Bogdan and Biklen, 2007). The findings revealed how teachers’ instructional practices scaffold equitable participation of boys and girls in the learning of physics.
Descriptive statistical analysis was applied on the ordinal data from the Likert scale items. This type of analysis explains the attributes of the components of the study population but does not show or make inferences about causes for relationships that exist among the components (Fraenkel & Wallen, 2006). It plainly describes characteristics of a population. In this study, questionnaire sought students’ perceptions of frequency of gender inclusive pedagogical practices in physics classes. Mean scale score for each of the questionnaire items was computed. Based on this analysis inferences were made about the frequency of the instructional practices.

Non-parametric inferential analysis (the t-test) was applied on the mean scale scores to establish whether a statistically significant difference exists in the male and female perceptions of frequency of pedagogical practices in the physics classrooms. A non-parametric test is used to compare mean scale scores of two independent sets of respondents (Fraenkel & Wallen, 2006), and in this study, the male and female students. A significant level of $\alpha = 0.05$ confirmed that there is significant difference between the male and female students’ perceptions.

3.10. Conclusion

The focus of this study was on how instructional practices by physics teachers influence equitable boys’ and girls’ engagement in the learning of physics. The study employed a descriptive research design and was carefully informed by
current literature on good practices so as to ensure the data obtained are credible and reliable. It was carried out in coeducational schools in Murang’a, a County with diversity of schools that are informationally representative of other counties in the country in terms of gender participation and performance in physics. Sample for the study schools was selected using the stratified random sampling and the sample of the teachers and students obtained using systematic sampling method. Data were collected using lesson observation schedule, students’ questionnaires and interview protocol for teachers. The data collection process systematically dealt with huddles encountered and made due consideration of research ethics. The data were then prepared for analysis along the lines of the study objectives and feminist pedagogical components. Pseudonyms were assigned to schools so as to mask their identity. The following chapter provides a presentation, interpretation and discussion of the analysed data.
CHAPTER FOUR:

DATA PRESENTATION, INTERPRETATION AND DISCUSSION

4.1. Introduction

This study aimed at exploring the influence of physics teachers' instructional practices on boys' and girls' engagement when learning physics in Kenyan co-educational secondary schooling. Data were collected from three sources: teacher's interview, students' questionnaire and lesson observation in Form 3 classes.

The chapter begins with a presentation of the profile of the sampled schools and impressions by the head-teachers on the status of physics in their schools. This is followed by the profile of the physics teachers, and typical characteristics of the Form 3 students who participated in the study. The chapter then presents an analysis, interpretation and discussion of the data, based on the research objectives and in consonance with feminist pedagogical theory that espouses four components of learner centred pedagogy.

4.2. Profile of the Sampled Schools and Head Teachers' Impressions on the Status of Physics in their Schools

The study was carried out between May and October of 2013 in 14 selected public co-educational schools in Murang’a County in Kenya. All these schools were day
schools, with some of them attracting students beyond a radius of 4 kilometres (in excess of 1 hour walking distance). The common mode of commuting to school was by walking and/or cycling, meaning that on a school day, the students would be physically exhausted at the expense of using their energies on academic work. The schools were from across a KCSE performance divide of between a moderate mean score of 6.234 to a dismal mean score of 2.292. They were selected using systematic sampling method.

In nine of the schools the administrative heads were female teachers. Their teaching qualifications were in languages and humanity subjects. It was observed during courtesy calls that a few of these female head teachers expressed a lot of respect for their teachers in general; they were of the belief that the teachers and students were doing their best in the circumstances and within the resources available in the school. The other female head teachers, the majority in the set, appeared to have very low expectations of their students in the study of physics. The low expectation is exemplified by the words of the head teacher in Gits (pseudonym) secondary school who, when asked about the low uptake of physics in her school, said:

"Physics is a hard subject, it has a lot of abstract things and you have to be strong in mathematics; I myself never liked it when I was a student, the teacher would talk of this and that law which I never understood and then give calculations. I normally tell students, and particularly girls to concentrate on the subjects where they can score high. In the school we only allow the very bright, those who are strong in mathematics to enrol in it (physics). Even
though those enrolled are among the brightest, it still pulls down the school mean.” (Interview remarks by Head-teacher at Gits secondary school)

These impressions by the head teacher point at a number of implications with respect to the teaching of physics. The first implication is that physics is a seemingly hard (difficult) subject, only for the bright students with strong competence in mathematics. This impression is in line with findings of Carlone (2004) that teachers depicted physics as being difficult. Teaching of the subject however, ought to be such that it is inclusive, taking care of the varied backgrounds of the learners, both boys and girls.

Another implication of the expression by the head teacher at Gits secondary school is that physics content comprises of laws that are taught through rote learning and calculations. It is not surprising that the head teacher felt that physics is for those students who are strong in mathematics. Indeed Zohar (2006) notes that students and particularly girls reject more formulaic, rote learning and strive for deeper conceptual understanding. It is therefore important for the teachers of physics to focus more on students understanding the physical situations before getting into the mathematics involved. This way of teaching would benefit the girls without disadvantaging the boys in any way.

In another school, Riga (nickname) Secondary school, where physics was in the 8th position out of 11 in the subjects’ performance ranking, the head teacher mistook the role of the researcher for that of an inspector. When she was asked
about how she would explain the low performance of physics, yet she had a qualified (university education graduate) and a long serving (six years, with four of the years having been teaching in that school) physics teacher, she said:

"--------. The physics teacher is very arrogant, and thinks she is indispensable; she is always asking for things that the school cannot afford. In fact am happy that you are going to see her in class. Let us meet after your observation."

(Interview remarks by Head-teacher at Riga secondary school)

This expression by the principal of Riga secondary school suggests existence of a conflict of personality between her and the physics teacher. The expression notes that the teacher makes unnecessary demands for practical work resources. While it is true that practical work resources for physics may be more expensive than those of other science subjects, this only applies in the initial acquisition of physics equipment/apparatus and which are long lasting (Boulid, 1967). The expendable and consumable materials for the physics curriculum are cheap, and others can be easily improvised and or locally sourced without much cost (as later learnt from interview with the teacher at Muke (false name) secondary School). Therefore in the long run, implementing physics course is far less expensive compared to other science subjects.

In any case learning physics (science) requires that students have equitable and frequent opportunities to use a wide range of equipment, materials and other resources for practical work (Jones et al, 2000). The practical work activities not
only help to develop science process skills, but also are important in whetting interest and curiosity of learners and more so that of girls (Zohar & Sela, 2003) towards science.

Five of the schools in the study had male teachers as the administrative heads. Three of these head teachers were graduates in science teaching while the other two were graduates in teaching of humanity subjects. Of the three science graduate head teachers two had physics as one of their teaching subject, and one of them was a subject in the study while the other one was not teaching the Form 3 class at the time of the study. Generally all these male head teachers perceived physics as an important subject, but just like their female counterparts, they believed that the subject is for the few students who were bright and strong in mathematics, and who happened to be mostly male students.

Analysis of 2012 KCSE achievement results revealed that eight out of the fourteen schools in the study had a higher mean score for physics than the overall school mean. This was clear vindication of the students’ ability in the study of physics. However, parallel to the national trends in performance, girls were underperforming and underrepresented in the subject in all the study schools in the 2012 KCSE candidacy. Going by the class registers, girls were also underrepresented in the 2013 Form III physics class as well. The head teachers interviewed lamented the low enrolment in the subject and proposed that to
improve this situation the teachers need to be more sensitive to the different needs of both boys and girls.

Data from interviews with the school principals farther revealed that teaching/learning resources were inadequate in their schools. These resources included laboratory facilities, physics equipment and materials, and also students’ text books. In ten of the schools, there was only one book-title for both the teacher’s and students’ use, and the copies were on average in the ratio of 1 to 4 students. Teachers in these schools with inadequate resources reported to experience a lot of stress and anxiety in their teaching. Indeed, they taught mostly through lecture method, and any laboratory exercises were for verifying the concepts taught. There was no reported gender bias in accessibility of the resources.

4.3. Profile of the Physics Teachers

Fourteen physics teachers, one from each of the selected schools participated in the study. From the interview and lesson observation data, there were a total of 5 female and 9 male selected from 7 female and 12 male teachers that had qualified to participate in the study. Those teachers who did not participate in the study happen not to have been teaching the Form 3 class at the time of data collection.

The fact that there were more male than female teachers in the study may not have been of any significance. Ashley and Lee (2003) and Lingard, Martino, Mills and
Bahr (2002) observe that the teacher's gender plays little or no influence in participation of either boys or girls in learning. Rather, the participation is influenced by certain teacher traits and skills, such as the ability to teach well and to engage students through providing a relevant curriculum; setting firm boundaries in terms of managing classroom behaviour; establishing a friendly and warm approach in the classroom; relating to students as people and to explain concepts (Lingard, et al, 2002).

Analysis of the interview data identified two professional attributes: qualifications and years of teaching. All the teachers in the study were professionally qualified. Physics was either a major or a regular subject for all of them, and in combination with mathematics, except in one case where the teacher combined physics with chemistry. Besides, each of the teachers had taught for more than five years, a long enough duration of service for one to be considered as experts in teaching (Priest & Lindsay, 1992). The professional qualifications and teaching experience in terms of years of service for the teachers are as shown in Table 4.1.
Table 4.1: Profile of the physics teachers

<table>
<thead>
<tr>
<th>Sex of Teachers</th>
<th>Number of teachers (Percentages in Brackets)</th>
<th>Qualifications</th>
<th>Years of teaching physics</th>
<th>Total Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Male</td>
<td>9 (64)</td>
<td>1 (7)</td>
<td>5 (36)</td>
<td>1 (7)</td>
</tr>
<tr>
<td>Female</td>
<td>5 (36)</td>
<td>1 (7)</td>
<td>4 (29)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Total Percentage</td>
<td>100</td>
<td>14</td>
<td>64</td>
<td>7</td>
</tr>
</tbody>
</table>

Key for teacher’s qualifications: A = Diploma of Education; B = Bachelor of Education; C = Diploma + Bachelor; D = Bachelor + Master of Science students as at time of this study

Table 4.1 reveals that besides the teachers having expert-years in teaching, twelve (86%) of them had professionally trained up to the Bachelor of Education level. The other two (14%) had Diploma of Education which is an adequate professional qualification for secondary school physics teaching. Fig. 4.1 illustrates the percentage of the male and female teachers in the identified categories of the two professional attributes.
The qualifications and level of expertise of the teachers as shown in Table 4.1 and Fig. 4.1 encapsulate suitable competencies for delivery of quality and gender sensitive lessons. In pre-service teacher education however, Sanders (1997) notes that there is underemphasise of gender equity programs.

With regard to expertise in teaching, MOE (1999) observes that teachers lacked in-service fora for upgrading and enhancing their professional knowledge and competencies resulting in burn-out and development of negative attitude towards
Having not had formal exposure and training, the teachers were therefore unaware of their gender biases and inadequacies in teaching co-educational classes.

From the interview data, all the teachers in the study had attended a full course of SMASSE training, and indeed four (29%) of them were District trainers. With regard to improvement of professional qualifications, ten (71%) of the teachers looked forward to further training with two of them, who were male teachers pursuing Master of Science in physics. The other four sagged with the idea of engaging in further professional training. Three of those who sagged were female teachers. They all indicated unequivocally that they had no interest in pursuing further professional training mainly because they were bogged down with domestic responsibilities and lack of sponsorship. The male teacher who sagged with the idea of further education looked tired, unenthusiastic in teaching and self-forgotten. The fact that majority of the teachers in the study were keen on professional upgrading implies that they could successfully motivate their learners into serious engagement in learning.

During lessons, all the teachers were observed to be decently and neatly dressed as professional educators, and as required by code of regulations for teachers in Kenya (TSC, 2013). Five of them even wore white dust-coat apparel during the laboratory lessons. The dressing in general beamed a good professional appearance and demeanour which, Mosca and Buzza (2013) inferred to be a sign
of confident and well-meaning teachers that have respect for themselves and their students. The dressing did to distract the boys or the girls in the learning except in one case where the teacher (reported through the questionnaire by some boys in her class) had adorned a strong perfume.

4.4. Typical Characteristics of the Form 3 Physics Students

The study was conducted in Form 3 class because, in the Kenyan context, the learning of physics as an elective subject starts at this level, though, there are exceptions where some schools are starting at Form 2 level. At the Form 3 class level, students are at a higher cognitive level and are alert to the need for preparing adequately for exit examination in the following year. They would therefore be expected to pay keen attention to their studies. However, analysis of lesson observation data revealed the following characteristics among the learners:

a. Students appeared quite excited to be in the laboratory: they ran to the laboratory, pushing and shoving at the entrance to the laboratory and scrambling for the front bench seats. This reaction gave the impression that the students were enthused by opportunities for doing laboratory work. The jostling for the front seats was an indication that the learners were not organised into specific working groups and that they were not widely exposed to such laboratory activities.
b. Students were shy to give their ideas/views/opinion or to express themselves. This was exemplified by the fact that the students were not volunteering to describe or explain what they had observed. Even when nominated to say something, many of the students shied away, and as was later discovered through teacher's interview, the students, and particularly the girls had low self-esteem and dismal competence in the language of instruction. Generally the students tended to talk in low voices when answering questions. Often the teacher would move close to a learner and then amplify the answer given by the student.

c. Competency in the language of instruction: The schools in the study were public day schools which attract students in the lower performance ranks in the Primary exit-examinations (KCPE). These students demonstrated inadequate competency in the language of instruction through the kind of responses that they made to teacher's questions. They made sentences with grammatical errors and often provided one word or short sentence answers. For instance, at Gik secondary school, when asked to explain how refraction of water waves does occur, a female student answered, "bend". At Oya secondary schools, when asked to explain the assumptions in the working of a hydraulic press, a male student answered "bring up". These answers are grossly inadequate; stated in a manner that is below the standards of a Form 3 class level, manifesting the low
competency in the language of instruction for both the male and female students.

d. Students appeared not used to cooperative and collaborative learning – most of the times, the male and the brighter students (as later learnt from interview with teacher at Kabi secondary school) in any group were the most active, dominating in the conduct of experiments while the others just looked on, waiting to be asked to do academically very non engaging activities.

e. The students seemed intimidated through such remarks as “This kind of question can come in KCSE”; “You don’t get high marks for that kind of answer”. Their motivation for learning appeared to be guided by what would likely come in the final exit-examination. In some other cases, the students, and particularly girls were intimidated through ridicules and punishments by the teacher for incorrect responses. In one school, specifically Muke secondary school, seven of the seventeen male students said (in the questionnaire) that their teacher always acted harshly to those who do not give correct answers and those who happen not to have completed home-works.

These characteristics do not promote quality engagement, for boys or for girls in the learning process. The teachers need to be alive to these facts that act to
constrain learning and establish suitable strategies to enhance learner’s self-image and quality participation of both boys and girls in the learning process.


In order to identify the nature of instructional practices in the Kenyan co-educational physics classes, the study gathered data using the lesson observation instrument. The observation of the lessons aimed at identifying gender-inclusive instructional practices in relation to: seating arrangement; lesson content; teacher’s content knowledge; and learners’ interactions. Table 4.2 shows the number of lessons (percentages in bracket) under the general categories of the lessons.

Table 4.2: Number (Percentage in Bracket) of lessons under each of the General Categories

<table>
<thead>
<tr>
<th>General Categories of the lessons</th>
<th>Lesson duration</th>
<th>Lesson venue</th>
<th>Lesson content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single period</td>
<td>Double period</td>
<td>Classroom</td>
</tr>
<tr>
<td>Number of lessons (Percentage in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bracket)</td>
<td>4 (29)</td>
<td>10 (71)</td>
<td>4 (29)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 (71)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 (43)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 (57)</td>
</tr>
</tbody>
</table>

Fig. 4.2 displays distribution of the lessons in the general categories. Percentage labels are shown in order to clearly illustrate the comparative magnitude of lessons in each general category.
Table 4.2 and Fig. 4.2 reveals that the study observed four (29%) single period (40-minutes) and ten (71%) double period (80-minutes) lessons. The four (29%) single period lessons were conducted in the classroom while the ten (71%) double period lessons were conducted in the laboratory. Six (43%) of the lessons, four of which were single period and another two which were double period lessons, were fundamentally of pure theory content and were delivered using expository teaching strategies (explaining and dictation of notes). The other eight (57%) lessons were quasi-theory double-period lessons conducted through explanation and deductive laboratory activities.
The general practice in the schools was to conduct the single period lessons in the classroom and the double period lessons in the laboratory. The following is a précis of the nature of instructional practices in the observed lessons in relation to: seating arrangement; lesson content; teacher's content knowledge; and learners’ interactions.

4.4.1. Instructional Practices in Relation to the Seating Arrangement

The seating layout fell in to two main categories: the arrangement during theory lessons that were either conducted in the classroom or laboratory and the arrangement during practical-work lessons that were conducted in the laboratory. The seating arrangement in all classroom-based lessons was in tiered seats in row-and-column patterns. The students had specific seating places. This is typified in Fig. 4.3, which shows the seating arrangement during a physics lesson observed at Naa secondary school.
The class had a total of 38 students, 18 of whom were girls and 20 were boys, nearly 1:1 ratio for boys to girls. The entrance door was at the front of the classroom to the teacher’s right and large windows lined the side of room to the teacher’s left. The seating arrangement in the class was in three columns. The column starting from near the class entrance had 12 students: 10 girls and 2 boys seated in rows of two students, with the two boys seating at the rear end of the column. The middle column had 16 students: 3 girls and 13 boys seated in rows of three students, with two of the girls seating beside a boy and the other girl seating by the side of two boys. The last of the three columns had 10 students, 5 girls and 5 boys seated in rows of two students. The row-and-column seating arrangement was the norm in all the classroom lessons despite the fact that it does not stimulate intense participation in the classroom discourse and more frequent question-asking by students of either gender (Marx, Fuhrer & Harting, 1999).
Teacher-student verbal interaction during lessons is strongly related to student position in the class (Montello, 1988). Unconsciously, the teacher interacts more with students seating along an “Action Zone” (Koneya, 1976). The action zones take the shape of a “T” or a triangle and comprise the front and centre seats (Marx et al, 1999). This notwithstanding; the teacher at Naa secondary school interacted more with some students (male students) sitting towards the rear of the column to his left hand side. These students were the brighter in the class as was later learnt from the interview with the teacher. In most of the instances, the girls were seated up-front in the class and were completely ignored throughout the lessons.

Inter-sex dyads in the pure theory lessons were observed in very few instances. Rather, single sex seating dyads appeared to be the norm, where the students sat in rows-and-column patterns. As was later learned from interview with the teacher at Naa secondary, he preferred this arrangement because of sharing of the limited resources (text books) among students. In addition, he believed that students would be more willing to work collaboratively in the single sex groups, a view that Parker and Rennie (2002) also shares. However, the instructional strategy in the lesson was teacher talk and copying of notes; there were no academic tasks that invited students to interact. There was therefore no instructional relevance in how the students paired during the lessons.

In the lessons carried out in the laboratory, whether a theory or practical work lesson, the students localized themselves in the neighbourhood of their friends
(information from interview with teachers). During practical work, the students clustered and formed mostly single sex working groups. In a laboratory lessons at Kia secondary school where there were 22 boys and 11 girls, the boys mainly took up front seats while the girls populated the back rows in a class of four rows as illustrate in Fig. 4.4.

**Fig. 4.4: Seating Arrangement During a Lab Lesson at Kia Secondary School**

![Seating Arrangement Diagram](image)

The practice of single sex groupings as illustrated in Fig. 4.4 was common in all the laboratory lessons observed. The single sex groupings implies that there was very little interaction across sexes except in an instance in a lesson at Tugu secondary school where a pair of girls working from the back in the laboratory had managed to get a sum correct. Some few of the boys came to check their solutions against that of the pair of the girls. The boys and girls remained segregated in their learning interactions, and had little opportunity to interact.
Generally, the girls took positions at the rear of the laboratory. This was not by choice, but rather due to the pushing and shoving by most of their male classmates at the entrance to the laboratory. The girls tended to lay back and wait until it was easy to enter the laboratory, by which time the positions available for them were at the back of the laboratory. Given opportunity, as Weinstein in Marx et al (1999) observed, motivation, personality variables and participation are key factors that drive students’ selection of their own classroom position. There was therefore a lot of instructional sense to smoothen entrance into the laboratory such that learners, and particularly girls, could select their working positions so as to enhance their participation in the lessons.

In the laboratory lessons, the teachers tended to concentrate their attention on the groups upfront. Incidentally, most of the learners seating upfront were the male students. The girls, who were mostly at the back of the class, therefore received little attention from the teachers as compared to boys who grouped towards the front of the class. The teachers tended to spend more time with the upfront groups than with the groups at the back in the laboratory. During interviews most of the teachers confessed to have been unconscious of the need to have inter-sex interaction in the class activities and discourse, and the fact that they paid more attention to the needs of upfront students in the laboratory.

The space available in the classrooms or the laboratories was more than adequate for any group formation for purposes of interaction among the learners. This is
mainly because of the low enrolment in the subject, which is optional as from Form 3 class level in the Kenyan education system. Naa secondary school, the highest enrolled among the study schools had 38 physics students, which was approximately 51% of 75, the total enrolment in the class. The 38 students had a lot of space in the classroom that could have been used for configuring suitable learning groups. Indeed, the classrooms or laboratories were really spacious, and particularly at Rungu secondary school that had 11 students, the lowest enrolled of the observed classes. Albeit the small enrolment in the physics class at Rungu School, the students were generally accorded limited opportunities for laboratory experiences as confessed by the teacher during interview.

4.4.2. Instructional Practices in Relation to Lesson Content

The content for the observed lessons fell into two categories: pure theory and quasi-theory contents. These contents were executed one of five instructional strategies that were identified. Table 4.3 illustrates the number of lessons (percentage in brackets) for each type of instructional strategy; and by sex of the teachers and venue for the lesson.
Table 4.3: Number (percentage in bracket) of Lessons by Type of Content and by Teacher’s Sex

<table>
<thead>
<tr>
<th>Type of Content</th>
<th>Instructional Strategy</th>
<th>Number of lessons</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure Theory</td>
<td>Direct teaching - lecture</td>
<td>Total</td>
<td>Male</td>
<td>Female</td>
<td>C/room</td>
</tr>
<tr>
<td>lessons</td>
<td></td>
<td>4 (29)</td>
<td>3 (21)</td>
<td>1 (7)</td>
<td>2 (14)</td>
</tr>
<tr>
<td></td>
<td>Solving mathematical questions</td>
<td>1 (7)</td>
<td>1 (7)</td>
<td>0 (0)</td>
<td>1 (7)</td>
</tr>
<tr>
<td></td>
<td>Revision of Tests</td>
<td>1 (7)</td>
<td>1 (7)</td>
<td>0 (0)</td>
<td>1 (7)</td>
</tr>
<tr>
<td>Quasi-Theory</td>
<td>Computer aided lessons</td>
<td>1 (7)</td>
<td>1 (7)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>lessons</td>
<td>Expository class experiments</td>
<td>7 (50)</td>
<td>2 (14)</td>
<td>5 (36)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

Table 4.3 shows that there were six pure theory-content lessons. Five of these six lessons were taught by male teachers and one by female teacher. Quasi-theory content lessons were eight, with three having been taught by the male teachers and five by the female teachers. Four of the pure theory lessons were conducted in the classrooms and 2 in laboratories. All the eight quasi-theory lessons were conducted in laboratories.

4.4.2.1. Instructional Practices in Pure Theory Content Lessons

A total of six pure theory lessons were observed. Four of the lessons were delivered using direct teaching (lecture) and notes dictation; one was through problem-solving exercise and yet another one on revision of a test that had been done the previous week. Fig. 4.5 shows the percentage of pure theory lessons conducted through each of the instructional strategies. The figure also shows the
percentage of lessons conducted by male and by female teachers; and in addition, the percentage of lessons conducted in classroom and in the laboratory.

**Fig. 4.5: Percentage of Lessons Conducted Using Pure Theory Instructional Strategies**

![Bar chart showing the percentage of lessons conducted using different strategies](chart.png)

Figure 4.5 shows that four (29%) of the lessons, twenty one per cent of which were conducted by male teachers were executed through direct teaching – lecture strategy. The direct teaching – lecture strategy involved teacher explanation of the concepts followed by dictation of notes. For instance, in a lesson at Oya secondary school, the teacher explained the working principle of hydraulic
machine with the aid of a free hand chalk-board diagram of the machine. He had a lot of mathematical working presented on the chalkboard premised on the relationship: volume of liquid pushed by effort piston = volume of liquid that enters load piston. After establishing the relationship, the teacher dictated notes to the students; worked out examples on chalkboard and finally gave homework exercise based on the formulae. This was cognitively hollow for all the students and more so for the girls who tend to reject more formulaic, rote learning and are more apt to strive for deeper conceptual understanding (Zohar, 2006).

Intermittently, during the teacher’s explanations and chalkboard work, he asked a few, scattered, ad hoc knowledge-level questions that were not pegged to the lesson development strategy. He also asked a number of rhetorical, choral and yes-no answer questions. These kind of questions served very little purpose in learning because they demand neither knowledge nor thought from the learners (Farrant, 1997).

The students’ participation in the lesson was fundamentally through listening to the teacher and copying down notes. In a number of instances where the students could attempt the low-order questions, the teacher moved in to give the answer himself whenever the students did not do so quickly. The few answers from the class were given by boys. There were thirty students, 11 of whom were girls, and 19 boys. The lesson failed in providing opportunities for learning, and more so in the context of perceived low academic abilities among the learners. The lesson
failed to seize clearest opportunity to illustrate application of physics in daily life, and also to assign students an activity of improvising the hydraulic press.

With regard to the lesson that applied the strategy for solving mathematical questions, the engagement of learners was not any different from that in the lessons that applied direct teaching. In this lesson, the teacher solved a question on effective resistance of each of resistors in series and in parallel, and then gave leaners some questions to try. No questions were asked to the class, and the teacher did not invite questions from the class.

In the examination revision lesson (conducted at Naa secondary school by a male teacher), the main activity was to revise a test that had been done a week earlier. However, none of the learners appeared to have revised the questions. For instance, one question that required learners to state the law of refraction, the teacher invited a girl to try out on the chalkboard. The girl did not move but shrunk her head, looked away from the teacher, fiddled with a pen in her hand and did not provide an answer. The teacher then invited a boy to try, and the boy gave an inaccurate answer. Another boy volunteered to try, but also gave an inaccurate answer. It was clear from this lesson event that the boys were more active in this class than the girls. The teacher did not make efforts to provide hints to the girl nor did he probe the thinking of the boys, but instead went on to read out the answer for the learners to copy into their note books.
In another question that asked students to compute time taken by an object to fall through a distance of 20m in the air, the teacher asked one of the boys, the best in the class as later learnt from interview with the teacher, for an answer. The boy gave a correct answer. He asked the boy “How did you answer that one?” But rather than letting the student to demonstrate the answer, the teacher went to the board and showed the working for the answer. In divergence to observations by Capobianco (2007, the teacher did not help the students to feel more comfortable and successful by incorporating their own experiences as part of some of the learning activities and class discussion.

Realizing the unpreparedness of the learners in the revision exercise, the rest of the lesson comprised of the teacher reading the question and then working out the solution on the chalkboard. The learners’ participation in the lesson, mostly by boys, comprised of responding to choral and yes-no answer questions on simple computations. The learners also participated through copying down answers from the chalkboard into their note books. The lesson was able to ‘revise’ through a little more than half of the test items.

The revision lesson was one in which the teacher could have had learners assigned homework to work out solutions for the questions, and then engage in table groups and a whole class plenary sharing of their solutions. In this way even the shy in the class and those with less interest in physics especially girls (Haussler
&Hoffmann, 2002), would have had more quality interaction with the content of the lesson.

Two of the pure theory lessons were double period lessons and were conducted in the laboratory. Taking the class to the laboratory served no pedagogical purpose, but instead, it interfered with the students’ comfort as they sat on the high stools in the laboratory for the 80 minutes. For instance, during the lesson at Mana secondary school, some of the students were observed sitting by the edge of the stools, others standing all together while yet others sat with their legs dangling and nearly all were seen squirming severally on the stools. In these cases the upfront seats were taken mostly by the boys while most of the girls took the rear seats, rending the girls less visible in the lessons.

4.4.2.2. Instructional Practices in Quasi-Theory Content Lessons

The study observed eight quasi-theory content lessons as shown in Table 4.3. All the lessons were conducted in laboratory. Fig. 4.6 displays the percentages of the lessons in each of the lesson strategies and percentage of sex of the teacher implementing the lessons.
One (7%) of the lessons strategies was centred on computer based simulations and was implemented by a male teacher. The other seven (50%) of the lessons, two (14%) of which were by male teachers and five (35) by female teachers, were developed using expository class experiments.

### 4.4.2.2.1. Instructional Practices in the Computer Aided Lesson

The computer aided lesson was of 40-minutes duration conducted at Gik secondary school. The lesson was on interference of waves. The teacher began the lesson by naming the various sources of waves (light, sound and water);
reviewed the concepts of refraction and diffraction of waves. Within the lesson (introduction, body and conclusion), there was outright visible differential attention towards boys' and girls' participation and rewarding of their efforts.

In the review of the concepts of refraction there was a clear preferential rewarding of the boys over the girls. For instance, in one of the questions on how refraction of water waves does occur, the teacher nominated a girl to answer. The girl as later learned from interview with teacher was the brightest among the girls in the class. The girl gave an accurate answer (water in shallow get short wavelength) though with some grammatical errors. However, the teacher went on to re-explain the concept. He moved to the chalkboard and drew some four standing parallel lines and indicated that it was the deep end of the water. He invited a boy (one among the bright one in the class) to complete the diagram by illustrating how the waves appear on entering the shallow region of the water. The boy drew standing parallel lines that were closer together in the “shallow” part of the water. The teacher then remarked to the boy, “that is very good”. Similar remark ought to have been accorded to the girl’s answer, but this was not the case; just as observed by Tracy and Lane (1999), there was a clear preferential rewarding of boys’ efforts over those of the girls.

As gathered from interview with the teacher, he was unaware of the favoured attention he gave to boys over the girls during the lesson introduction. This was manifested in the way the teacher interacted with the learners when he asked the
class "what did we say is diffraction?" He called on a boy (by name even) to answer the question. The boy could not give a correct response, and the teacher then went on to explain, showing a tendency to pay more attention to boys as affirmed by Tobin and Garnett (1987). He asked the students to refer to their notes to find the conditions necessary for diffraction to result in circular waves. Though a number of both the boys and the girls had put up their hands, the teacher picked on a boy who gave a correct answer \((\text{the hole - aperture is} = \text{equal (to) or less than wavelength (of the wave)})\). The teacher was quick to commend the boy, "that is very good Kiama (nickname for the student)!

In the main body of the lesson, there was limited number of instances where learners actively took part in learning activities, and in these instances only boys were invited to participate. The learning activities related to meaning of phase between two waves, and constructive and destructive interference of waves. With regard to the concepts of phase between two waves it seemed the teacher expected the learners to have had an earlier experience. This was because he kept asking learners to remember what it means for two waves to be in phase: equal amplitude, in the same direction, and same frequency. The expected earlier familiarity ought to have provided opportunity for learners’ deep engagement in the learning process; however, the teacher asked only rhetorical questions to which the learners chorused. An outright preferential encouragement of boys to participate was observed during a demonstration on the concepts of "in phase" and
“out of phase”. In this demonstration only boys had a hands-on participation using a swinging-pair of balls suspended with strings from the same stand.

Again in a learning activity on the concepts of constructive and destructive interference of waves, the teacher gave the girls a blackout in the hands-on activities. He attempted to teach these concepts using two speakers placed about a meter from each other on two adjacent benches. A male student was asked to walk in-between the benches and identify where he could find a loud sound. All the other students watched and waited to be told the identified locations for the loud sound. No girl was called upon to make an attempt to locate the sites for the loud sound. The boy was not able to pick any loud sound as he moved either to or away from the loud speakers. The teacher then concluded the activity by telling the class that the student should have identified areas of loud sound and areas of low sound. The teacher then drew a chalkboard diagram of the expected results and asked the students to copy and make notes from the text book.

In a kind of wrap up, and appearing like he was losing on time, the teacher hurriedly moved to show computer animations of interference, diffraction and superposition of water waves. The learners quietly watched as the teacher made changes to various variables for instance type of dipper, frequency of the wave, and diffraction aperture. He then told the students (in summary) to revise on meaning of interference and conditions for constructive and destructive interference. He was categorical that the revision was because “we are asked in
exams”, meaning an invitation to rote learning, which girls reject (Zohar, 2006), and which does not relate well to deep understanding of concepts.

4.4.2.2. Instructional Practices in the Expository Class Experiment Lessons

The seven class experiment lessons were fundamentally developed through a theory followed by an experiment to verify the concepts taught. The theory teaching comprised of teacher-talks that provided description and explanation of concepts and variables in the experiment. Besides, the teachers also explained the list of apparatus and the experimental procedure after which, the learners copied notes. The teacher-talks were buttressed with rhetorical and low order thinking ability questions that were fairly distributed among the boys and girls. This was in line with the views of Tobin and Garnett (1987) who observed that teachers in co-educational classes tend to seek answers equally from both boys and girls for lower-order questions. Nonetheless, more boys than girls were granted opportunity to answer the questions.

Another instructional component in these lessons was a prior take-home assignment of copying the experimental procedures from textbooks. The lessons in all cases therefore began by confirming if the learners had copied the procedure and thereafter identifying the equipment/apparatus for the experiment. Learners in these classes reported in the open-ended questionnaire that their teachers were
very harsh to those who had not completed the assignment, and particularly towards girls.

Learners’ participation in these class experiment lessons was basically limited to following the clearly written procedure. This practice is exemplified by the following cameo of a lesson at Muke secondary school on heat transfer by method of mixtures.

The lesson started by checking completion of assignment that had been given during previous lesson. The assignment was on copying procedure for the experiment from the class text book. The teacher scolded those who had not finished copying, most of whom were girls. After checking the assignment the lesson began by explaining the concept of heat transfer by method of mixtures, as indicated in the following:

“We are going to look at the specific heat capacity of a solid by method of mixtures. The other day we talked about mixtures, especially when you are cooking “ugali (meal of maize flour). You mix boiling water with cold unga. When you mix boiling water with cold unga, what loses heat? ....” The class was lead through question and answer, three of which were answered by boys and one by a girl, to stating a word equation/formula on the heat exchanges: Heat lost by hot water + sufuria (cooking pan) = heat gained by cold unga.

The teacher related the word formula to the day’s experiment saying, “In today’s lesson, we have a similar case whereby we are going to have a piece of a metal that will be transferring heat.” The teacher then read through the list of apparatus from a chart affixed on the chalk board and explained the use of each one of the
apparatus. The learners were asked to confirm that they had the apparatus on the table.

After explaining the list of apparatus, the teacher took the learners through the experiment procedure, which they had already written in their notebooks. Before embarking on doing the experiment, the teacher demonstrated to students at each work station how to use the only available weighing balance. The students weighed the metal solid and the calorimeter when empty and when with water. They measured the temperature of the cold water in the calorimeter. They put the metal solid into some boiling water for about five minutes. The metal solid was then transferred into the calorimeter and after stirring for about one minute, they measured the temperature of the water. All girls, except one were relegated to observer status in the conduct of the experiment. The lesson ended before some of the groups could complete doing the experiment and the use of the formula on the data was postponed to the next lesson.

This character of a lesson where learners had been assigned prior reading and copying of notes from the text book was observed with all the practical work based lessons and even some of the theory lessons. From the interview with the teachers, it appeared the assignment was given so as to pre-arrange the lesson for a positive impression on the observer about the participation of the learners.

The intended effect of pre-arranging the lesson was however not realised because prior reading was not the normal practice. The learners having written down the procedure could have been asked to identify and discuss the use of the resources in the experiment other than the teacher reading from the list and explaining the use. The use of discussion is an attractive learning experience to girls and no less
to boys that aids learning for understanding and connected knowledge (Zohar, 2006). For conduct of discussions and experimental work the teacher needed to be aware of the domineering tendencies of the boys in mixed-sex groups (Brotman & Moore, 2008) and monitor and control interactions to ensure fair access of class time and other learning of resources.

4.5. Underpinnings for Instructional Practices by the Physics Teachers in the Co-educational Secondary Schools

Analysis of the interview data identified three underpinnings of instructional practices in Kenyan co-educational physics classes. These underpinnings were: teacher’s pedagogical content knowledge; the resources; and teacher’s beliefs about gender inclusivity in the teaching of physics.

4.5.1. Teacher’s pedagogical content knowledge

Certifications for the teachers in the study (Table 4.1) indicate that they were quite strong in mastery of subject matter and pedagogical content knowledge. The teachers were academically qualified to teach secondary school physics, and had taken a full course of SMASSE training. The SMASSE training, according to one of the teachers (who was a District trainer) taught teachers how to create, select and use learning activities; how to actively engage learners during lessons (making lessons student-centred); how to facilitate development of science process skills in learners using experiments (applying science inquiry activities);
and how to facilitate learning and application of concepts learnt using improvised resources. These tenets of SMASSE training relate very closely to suggestions by Haussler and Hoffman (2002) on practices that would stimulate interest and enhance self-concept and achievement for both girls and boys in learning of physics.

Despite being highly academically qualified, the teachers executed their lessons through expository methods that comprised dictation of notes from text books and or carrying out expository experiments to illustrate application of concepts learned. Table 4.4 illustrates the main characteristics of instructional practices in the lessons.

Table 4.4: Characteristics of Instructional Practices in the Lessons

<table>
<thead>
<tr>
<th>Stage of lesson</th>
<th>Characteristics by type of lesson</th>
<th>Theory</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>• Let’s us continue from where we reached during our last lesson</td>
<td>• Stating aim of experiment</td>
<td>• Reviewing the theory as previously taught</td>
</tr>
<tr>
<td></td>
<td>• Reviewing content of previous lesson</td>
<td>• Explaining the list of apparatus and experiment procedure</td>
<td></td>
</tr>
<tr>
<td>Development</td>
<td>• Explaining concepts and copying notes</td>
<td>• Aiding and supervising students as they carried out the experiment</td>
<td></td>
</tr>
<tr>
<td>Conclusion</td>
<td>• We shall continue from there in our next lesson; • Assignment to copy notes • Assignment on answering questions from text book</td>
<td>• Assignment to analyse data</td>
<td></td>
</tr>
</tbody>
</table>
Table 4.4 shows that the teachers introduced the theory lessons by saying “Let us continue from where we reached during our last lessons”. This was followed by few review questions and then some explanation and dictation of notes. For the laboratory lessons, there was a review of the theory as taught during the previous lesson. This was followed by an explanation based on notes copied from text books, having been an assigned during the previous lessons. The notes were on aim of experiment, the list of apparatus and then the procedure of how to mount the apparatus, to measure the required quantities, to analyse and to conclude from the data. The teachers tended to pose rhetorical and low-order questions. There were no questions forthcoming from students even when the teachers explicitly invited the student to ask questions (usually at the tail end of the lesson). These practices imply an inadequacy in the teachers’ pedagogical content knowledge.

Teachers’ pedagogical content knowledge is very critical in providing for all learners in a class. It is an intellectual resource that significantly affects student achievement (Hill, Rowan & Ball, 2005) and also influences interaction characteristics between the teacher and the students. Hill et al (2005) further explains that pedagogical content knowledge is the ability to understand and use subject matter knowledge to carry out the task of teaching.
4.5.2. Teachers’ Perception about their Students

Teachers’ perceptions about their students’ abilities and dispositions was another of the underpinning in their instructional practices. Generally, the teachers considered the students to have low self-esteem. This is exemplified in the remarks by three of the schools:

“The form 3 physics class ironically is larger than that of biology (in the school) but they are very weak in physics. The most affected are the girls, and they tend to make little effort”. (Interview with a male physics teacher at Oya secondary school),

“------the class is weak but most of the time the girls just pick what you give them. They tend to believe that way and will not come another time unlike the boys. The girls just remain with what you give them.” (Interview with a male physics teacher at Mana secondary school)

“My class normally has few girls (six out of a class of 23 students) although I have always encouraged them (to take up physics). That mentality (of avoiding physics got into them) since they joined Form 1. To be honest this is because they are very weak and also there are people (other teachers and peers) who discourage them right from the word go and tell them that physics is hard just like mathematics even before they taste it. So girls are very emotionally affected and influenced. They don’t believe in their abilities and are shy in class. I keep trying to encourage them; making them think that it is not that hard, that they can make it and also I was also a girl like them and I opted for it. (Interview with a lady physics teacher at Muke Secondary)

These expressions by the teachers at Oya, Mana and Muke secondary schools exemplify the general perception of the physics teachers with regard to the academic ability of their students. They had very low hopes that majority of their
students, and particularly girls would achieve meaningfully. The teachers also considered girls to be more teacher dependent, shy in class (less volunteering in learning activities), while boys were considered to be more interestable in learning. Such low expectations, as observed by Lotter, William, Harwood and Bonner (2007), acts as a constraint to quality and inclusive instructional practices.

Furthermore five (~36%) of the teachers' perceived their learners to harbour feeling of discontentment with their school environments; that their schools were disadvantaged in terms of resource allocation by the government to "Centres of Excellence". The contention was that, the supplies were being provided to already far better established schools than theirs, which, according to the teacher at Oya secondary school, "tends to lower the self-esteem of these students". This feeling was said to have been stronger among the boys than among the girls, which is consistent with observations by Parker and Rennie (2002) that boys are more extroverted. The implication of this perception was that the teachers tended to pay more attention to views of the boys than to those of the girls.

Besides, seven (50%) of the teachers perceived the boys to have a deeper sense of their self-image. These teachers expressed that their students, and particularly boys, do not like being compared with those in other schools, but rather to be seen in the light of their potential. This is illustrated in the following reflection by one of the teachers:
"Our students have not wanted to be compared with other students; they want to be compared with what they want to be (their potential). This is more with boys than with girls. The girls have many challenges as day scholars that lower the amount of attention they give to their studies. They care less about what one thinks about them in terms of achievement." (Interview with a lady physics teacher at Oya secondary school)

This reflection implies that boys have better self-image than girls in terms of their vision in academic achievements. Ben (2010) notes that, students' self-concept is a strong factor in their participation in learning. Enhancement of such self-image is through providing active learning scenarios. Haussler and Hoffman (2002) guides that learning scenarios that stimulate development of self-image include link to students’ prior understanding and know-how; first-hand experiences in exploring the content; and discussions and reflection of the importance of the content. However, such opportunities were very limited in the classes of the teachers in the study. These teachers mostly used expository teaching approaches that did not facilitate enhancement of the learners’ self-image.

Two (~14%) of the teachers perceived that their students would like them more if they exuded subject-matter mastery during teaching. This perception is typified by interview remarks of one the teachers who said:

"What I have also noted with my students, and particularly the boys, they like somebody who knows the stuff, one that is confident with good mastery of content". (Interview with physics teacher at Naa secondary school)
This countenance gives the underpinning of the instructional practice where teachers did a lot of explaining, and at times applied mathematics to develop concepts with no link to the physical phenomenon. This type of instructional strategy encourages rote learning that disadvantages girls who, as Zohar (2006) observed, tend to strive for deeper conceptual understanding.

Eight (~57%) of the teachers explained that their female students were more competent in English than their male counterparts. The girls would express themselves more readily unlike the boys, particularly during theory lessons. Despite this advantage in English skills that provide the medium for engagement with academic content (Lee, 2005), the girls’ achievement still lagged behind that for the boys. Probably this could be attributed to the boys’ keen interest in the practical as expressed by the teacher at Nguru secondary school

--- when it came to practical sessions, the boys would shine. One teacher said that the boys say: we are the people of the wire, we are the men, we are the ones who do wiring. (Interview with physics teacher at Nguru secondary school)

4.5.3. Teachers’ views about the teaching-learning resources

Twelve (~86%) of the physics teachers in the study expressed that they had inadequate teaching-learning resources at their disposal. The resources concerned were the class text books and those for practical work. The teachers lamented that the inadequacy of these resources constrained quality of their teaching. While it is
true that quality of teaching gets affected by inadequacy of resources, the teachers, according to MOE (1999) are also guilty of not using the available resources optimally.

With regard to text books, the best case scenario had one book to two students. The allocation of these text books was to single sex teams. Where the books were fewer, the tendency was to issue more to the girls as illustrated in a remark by the teacher at Oya secondary school: “in fact we have to give girls more so that they feel encouraged”. The issuance of the text book to single sex teams influenced the seating arrangement (illustrated in Fig. 4.1) in class as well, and more so guarded against monopoly of the books by the boys (Remarks by the teacher at Naa Secondary school during interview)

The inadequacy of the text books meant that learners spent a lot of learning time copying lesson contents into their notebooks. This is evident from the following interview remarks by the teacher at Gata secondary school:

I normally give them (students) homework to copy notes from the text books. When they have copied, I can move faster, just telling them to refer. I make sure they have written (copied) them (notes) and drawn those diagrams in their books and all that, I come and check and then move on. If they have not written, they have to do it first. (Interview with physics teacher at Gata secondary)

These remarks by the Gata secondary school teacher were to explain why he took close to 35 minutes of the 80 minutes (double period lesson) in the introductory
part of the lesson. The remarks demonstrate how shortage of text books rendered teaching ineffective; copying of notes is an instructional strategy for rote learning, which is not acceptable to girls (Jones et al., 2000).

Resources for practical work and or for experimental activities in the Form 3 physics were reported to be quite inadequate by the twelve (~86%) teachers. However, other two (~14%) teachers indicated that they had fairly adequate resources. The adequacy of resources was exemplified by interview remarks from the teacher at Muke secondary school:

*In this school I can say there is no problem as far as resources are concerned because we have a very supportive principal; what we require she gets a few here and there even if we don't get everything".* (Interview with physics teacher at Muke secondary school)

In interviews with thirteen (93%) of the teachers, they reported that equipment-apparatus and materials that had been used in past KCSE practical examinations were in adequate quantities. They otherwise said to have been solving the challenge of inadequacy of the resources by improvising. In one such case, the teacher said he uses bottle tops and bicycle gears to illustrate the concept of gears. However, the teachers generally decried the inadequacy of equipment such as the ripple tank, calorimeter, ammeters and voltmeters; equipment that are considered to be expensive and of low usage frequency as observed by the principal at Kabi secondary school during interview.
With regard to sharing of the laboratory work resources, students were asked to work in groups. However, in most cases the assemblage of students during the laboratory sessions was not planned for optimum utilisation of the resources. It was ad hoc, friendship based, fundamentally single sex and some having too many or too few students (illustrated in Fig. 4.7). One teacher (the physics teacher at Muke secondary school) when asked about this kind of student clustering during lab work remarked "In fact I never noted. So next time I will be a bit careful so I realized I messed. In fact I normally insist that they should be equally distributed and every group should have some girls."

4.6. The Experiences of Physics Teachers in Implementing Gender Inclusive Pedagogy in Kenyan Co-educational Secondary Schools

Data on experiences of the physics teachers in implementing gender inclusive pedagogy was gathered using classroom observation instrument and interview schedule. The study categorised the experiences into those relating to managing learners' interactions during lessons; teacher's daily routine; success and frustrations in teaching of physics; managing struggles by physics students; and dealing with interactions with learners outside class time.

4.6.1. Managing Learners' Interactions During Lessons

Data from class observation reveal that, in all the lessons there was no deliberate design for interaction among learners. Where groupings and seating arrangement could have been suitable for quality interactions, this did not occur. For instance,
in classrooms the learners sat in fixed locations with no regard for grouping by
sex. Mostly, the teaching was done through direct lectures and notes writing.
Even where lessons were on a task like revising or working out sums (as in
lessons at Gits and Naa Secondary Schools), there were no instructional plans for
interaction among the learners. During the seven laboratory lessons, the students
worked in purely single-sex groups or blended with a few from either sex. The
situation is illustrated in Figure 4.7 (a) and (b) of two moments in a laboratory
session in one of the observed lessons.

Fig. 4. 7: Moments in Laboratory Sessions during Physics Practical Lesson

In Fig 4.7 (a) the students were listening to the teacher as she explained the
experimental procedure. The students thereafter carried out the experiment at the
benches where they were seated. At the front bench, the number of students was
higher than at the rear. In Fig. 4.7 (b), some two girls are seen working at the back bench in the laboratory.

Appropriate learners’ interaction in a learning process is expected to trigger learning mechanisms such as induction, deduction, compilation among others. The teachers’ role is to provide opportunities for increased probability for such interactions to take place (Dillenbourg, 1999). Such opportunities are created through setting of syndicate or buzz working groups and providing tasks and resources to facilitate interaction; specifying collaboration roles and rules; and monitoring and regulating interaction. However, in all the observed lessons, there was no effort to group the students for optimal interaction. One teacher when asked how she ensured suitable groupings, felt guilty of not paying attention to the groups and then said that in future she would not allow the students to work in friendship groups.

4.6.2. Teacher’s Routine on a School Day

The routine for the teachers on a school day was influenced by the teaching workload and other school duties. Since all the schools were day schools they operated on a teaching program of 40 periods per week of 40-minutes each. Thirteen (93%) of the teachers had a teaching workload that ranged from 25 to 28 periods per week, with a frequency mode of 25. One other teacher had a teaching workload of 16 periods per week in addition to administrative duties as a school
principal. Though the range of the teaching workload was standard (MOEST, 2000), the teachers felt that it was still heavy for them as science teachers. Those teachers commuting long distances and or against the flow of traffic felt the workload to be even heavier; they found it difficult to do the early morning or the late afternoon classes.

The balance of 12 to 15 periods per week was shared among the out-of class professional duties that included preparation for teaching, marking assignments and consultation with learners and other physics teachers. However, many of the teachers expressed that this amount of time was insufficient for effectively accommodating all these duties; they found themselves having to utilize some of the tea and lunch break time and also to spend some time in the evening and the weekend on these duties. The consequence of the insufficient time was teacher burn-out and developing a don’t-care attitude towards their professional duties, attending mostly to only students who were outgoing in the study of physics, majority of whom were boys.

With regard to preparation for teaching, all the teachers used text book flow of content: they did not have customised schemes of work or written lesson plans. Five (36%) of the teachers expressed that the text book sequenced the content well enough, while three (21%) of the teachers had filled copies of some schemes of work from other schools that were presumably better performing. The implication of this practice was that teachers did not adequately search for learning activities
that are engaging and interesting to the learners; activities that would result in more girls choosing and improving their academic achievement in physics (Boaler, 1997), without at all disadvantaging the boys.

None of the teachers had the practice of developing a written lesson plan. Instead, they implemented their lessons using lesson notes, which were substantially copies of the text book. This is exemplified in the following interview remarks by the teacher at Nguru secondary school:

*I make sure I plan my work at least so that I don't go to class and get stranded and feel in adequate and disorderly. But because we don't have a library, I use the text book and then I can give the students to copy before we come for lesson. I make sure they have drawn those diagrams in their books and all that, I come and check and then move on. I don't write them (drawing charts for the diagrams) regularly because I give them (students) homework to do before I come to class.* (Interview remarks by the teacher at Nguru Secondary school)

The implication of these remarks is that the teachers desired to feel confident and orderly in doing the lessons. However, the lessons were totally expository, emphasizing on rote learning. Such lessons require very little effort in planning, and indeed the teacher at Nguru secondary school did not even bother to develop charts to aid learning. The academic benefits of rote learning to both the boys and girls are very limited (American Association for the Advancement of Science [AAAS], 1993), the students and especially girls require to engage in more inquiry and constructivist learning tasks, which stimulates interest in learning of physics
and enhances self-concept and achievement for girls and boys as well (Haussler & Hoffman, 2002).

Besides lesson planning as one of the out-of-class professional duties, the teachers reported to have also been using some of the 12 to 15 lesson per week in marking learners' assignments. Two types of assignments were given by the teachers: writing notes prior to the lesson; and answering textbook questions. Much of these assignments however, were hurriedly checked and or marked at beginning of lessons, with the teachers at times just shouting the answer and asking the learners to mark for themselves. There was therefore no adequate attention given to identifying individual learner challenges from the assignments so as to provide accurate, specific guidance and support for the learning. This practice in general disadvantaged girls because of the culturally assigned domestic chores that the girls have to do, at the expense of academic work (Brotman & Moore, 2008).

The inadequacy of the time for out-of-class duties limited the extent to which teachers could offer academic consultation equitably to the learners (Kahle, 2004). Even beyond the teaching time, which is before 8:00am and after 4:00pm, consultations were not possible. Before the start of the lessons at 8:00am, the students had a preparation time from 7:30, which was too little for any meaning consultations with the teachers. Besides, many of the teachers in the study and some of the students were commuting by walking or by cycling for 8-10km from
their homes. They therefore would arrive at the school exhausted and would utilize the 30 minutes in quick preparation for the day’s lessons.

Again, in the evening after classes, interactions were not possible because the school program was for students to go for games or for club activities and they do general cleaning of the school compound up to about 4:45pm after which they went home. Any opportunities therefore that were available during tea and lunch break, the consultations favoured boys who (as described by the teacher at Thera secondary during interview) were the highly motivated and aggressive learners.

Conferencing on subject content-pedagogy with other teachers was reported to be rare because in majority of the cases, the teacher was the main authority in the subject. In one of the cases, the teacher said:

"----- currently because of shortage of staff I teach Physics throughout to all classes and Mathematics in form 4 only". (Interview remarks by the teacher at Gits Secondary school)

Opportunities to share even with physics teachers in neighbouring schools did not exist except in SMASSE District annual training that used to take place in April school holidays. The net effect of lack of opportunities for the teachers to confer with colleagues was a burn-out, recycling methods and resources that improved neither the academic achievement nor the enrolment in physics.
4.6.3. Teachers' Success and Frustrations in Teaching of Physics

Analysis of the interview data revealed the successes and frustrations that the teachers were experiencing in implementing gender inclusiveness in teaching of physics. The successes related to increasing enrolment in the physics classes and early completion of the syllabus.

Nine (~64%) of the teachers cited a growing number of both male and female students electing to study physics. These teachers were those that had about 5 years' service in their respective school teaching physics. The main strategies for interesting the students into studying physics are embodied in the following interview remarks by one of the teachers:

--- out of 22 courses that the Kenyatta University was offering during my time of training, 16 of them required physics knowledge or physics was an added advantage. I try to tell my students that with physics you have a broad choice of courses, you can be a electrician, mechanic among other jobs, and you can be self-employed or work in the counties. Also I share when they were in form 2 and form 1 about learning to use physics technology and also share about great people in physics like Albert Einstein who everybody had put down, yet he became a great contributor in Physics. In addition, I also invite motivational speakers to inspire them in life. (Interview remarks by the teacher at Oya Secondary school)

The implication of these remarks is that the students get more interested in learning when they become aware of the utilitarian value of the subject: the job opportunities in the Counties, openings for farther education and training and
about the use of physics in technology. This relates to views of Hoffmann and Stake (1998) who pointed out that gender inclusive teaching requires that the teachers help students to recognise connections between course content and the social context within which it is embedded. In such teaching, the girls become more interested in the subject, and not in any way limiting the interest of boys as well.

An early completion of the syllabus was considered to be one other success by some (50%) of the teachers. The teachers said they were able to complete the syllabus by 2\textsuperscript{nd} term of the Fourth Form and from then they engage students with revision work. The strategy for realizing early coverage of the syllabus included giving students reading assignment, copying notes in advance of the lesson, and doing teacher-centred lessons that concentrate on explaining concepts. One teacher specified to have been concentrating more on the girls during revision, giving them tasks (theory and practical based questions) which the teacher then marked and made follow-up.

Analysis of data revealed that the teachers experienced frustrations with three main presumptions in implementing gender inclusive teaching and learning. These presumptions were low academic ability for the learners; tedious process of acquisition of resources; and heavy workload.
The teachers expressed to have been frustrated by students’ “low ability” to comprehend concepts in class and generally, the students’ low academic achievements in KCSE physics. The following teachers’ interview remarks exemplify this frustration:

--- like you go to class and then you teach ,you give the simplest question or even the one you have already discussed with them ,then students fail. Like when you were in class there was that one for frequency (calculating the frequency of a wave given its speed and wavelength), that one I had done with them on the chalk board. Then the next week I bring in an exam and then they fail, that one is a frustration it is like your effort are not paying. My students do not revise I think it is something like in the entire school you give them something today but until you come back. -----the most affected are the girls. (Interview remarks by the teacher at Gata secondary school)

---- you put in a lot of effort and energy. We normally finish the syllabus very early and start our revision in 2nd term. So we revise the whole of 3rd term we do a lot of revision we get all the techniques of the calculator. Sometimes we even go to the maths table and we try to derive the formula from the unit we go backwards. We have a lot of revision practicals, we do so many. So sometimes I expect a very high mean only to realize it is not as I expected”. (Interview remarks by the teacher at Muke secondary school)

These remarks indicate that the teacher’s instructional practices were of the type that requires students to reproduce what was taught, rather than to help students to understand and formulate relations between concepts. The most affected by these instructional practices were the girls. The girls (as well as the boys) are stimulated more by use of active learning context (Zohar & Sela, 2003) in studying physics.
Furthermore the remarks show that the presumed low conceptual ability permeated into the KCSE examination in which the girls performed even lower than the boys. The teacher at Muke secondary school remarked that all the effort to cover the syllabus, revise calculator techniques, deriving mathematical formulae and doing a lot of practicals did not result in her expectations. These experiences in return affected the teachers’ beliefs about the conceptual ability of the learners which, according to Fang (1996) acts as a filter through which a host of instructional judgements and decisions are made, mostly to the disadvantage of girls.

The frustration with the experience of acquisition of resources was expressed by all the teachers. The acquisition was through two processes: buying and borrowing processes. This frustration is exemplified by what one teacher said during interview:

*When it comes to practicals you order for some instruments and materials but at times you are told the school is financially unstable. The principal thinks that physics equipment are expensive, but at the end of the day you have to cover the syllabus; you encourage yourself that you can improvise or just give theory. You can also can borrow from other schools or the SMASSE centres in the neighbourhood though the process is long and at times costly in terms of time and money. The process of acquiring the materials for physics is very tedious.* (Interview remarks by the teacher Riga Secondary school)

These remarks indicate that the teachers did not own the process of acquisition of resources. They had formed an opinion that it was very tedious. The procurement
BJ

process depended on the goodwill of the school principals who, as revealed in the interview, thinks physics equipment is very expensive. This frustration permeated into the teachers’ attitude, who as a consequence applied instructional practices that do not promote relational understanding and develop critical thinking skills and disposition (Hoffmann & Stake, 1998).

Frustration with the professional workload was experienced by twelve (~86%) of the teachers. Generally the tasks in the professional workload of a physics teacher includes marking students’ assignments, reading for lesson planning, doing the lab preparations, conferring with colleague teachers on instructional matters, and offering consultancy to the learners. These tasks were supposedly to be carried out in the 12 to 15 out-of-class periods in a week, the periods when the teacher was not directly engaged in the classroom. The teachers were of the view that these out-of-class periods were too few for the tasks. The consequence of this view was that the teachers employed instructional settings and practices (Milligan & Thomson, 1992) that did not facilitate quality learning, and particularly for the girls.

4.6.4. Teachers’ Experiences in Managing Students’ Struggles in Learning Physics

From the interview data, the study identified teachers’ experiences and techniques in managing learners’ struggles in learning of physics. The study categorised the struggles into two: struggles with self-image and struggles with inadequate
learning time. The teachers used a variety of techniques to help the students deal with their self-image and to catch up with lost learning time.

One of the struggles identified by the study was with regard to self-image. This struggle was particularly acute among the girls as one teacher observed in the following interview excerpt.

_I think the major struggle is with the self. Like now in a mixture like this, the girls feel when they are together with the boys they are denied some opportunity to practice and sometimes girls want to be together and struggle together. They feel the boys are rough and don’t really give them time to express themselves. Sometimes girls are slow when it comes to expressing their ideas. They also have a bit of low self-esteem. You see like some have their answers correct but you cannot even hear what they are saying. So one needs to encourage them to believe in themselves and to come up._ (Interview remarks by the teacher at Riga Secondary school)

These remarks indicate that the girls tended to feel academically inferior to boys and they were shy in expressing themselves. They had a poor self-image. The teachers gave the following as the strategies they employ to encourage and to interest students, particularly the girls in learning physics:

1. Providing the students with analysis of data from past KCSE examinations, which showed that the academically high performing students in the schools were those taking physics;

2. Sharing with the students about biography of successful women in science like Marie Curie who did a lot in the field of radioactivity. This sharing also
touched on the need for the girls to ignore the culturally negative gender stereotypes in the study of science and for the boys to consider girls as equally capable in doing science.

3. Demonstrating usefulness and applicability of physics in daily life as noted by one of the teachers:

--- we should also be dynamic and involve our real life situations in our teaching so that they can see physics is not some strange thing; it is something that we live with in our daily chores like cooking and make them realize the importance of the subject. (Interview remarks by the teacher at Kia secondary school)

4. Distributing questions among all the students in the class and balancing between the girls and boys. The teachers also challenge the girls to answer some of the questions as said by one of the teachers during interview:

------ if male students answer any 2 to 3 questions consecutively I will try to impress on the female, “you mean you are not in class? Say something”. Even if it is wrong at least somebody has spoken up, then they are encouraged from there. (Interview remarks by the teacher at Nguru secondary school)

5. Requiring the girls to be actively involved in the class experiments or practical work. One teacher said the following during interview:

I don't choose the same gender, they alternate and also I mix them in the group. ---- I also distribute the work so well, for instance in doing the electricity practicals, if it's a girl who will read the voltmeter, a boy will read the ammeter and somebody else will be recording. (Interview remarks by the teacher at Kabi secondary school)
6. Having girls only groups, particularly during lab sessions. Some teachers explained that the girls like it that way, and they can be seen to be more engaged and to talk more. This, was necessary to protect the girls, according to the words of one of the teachers during interview:

I realized when they are mixed girls are just shying off it is boys who are doing everything. They only wait to be told (by the boys) what to record. (Interview remarks by the teacher at Tugu secondary school)

7. Exuding a positive attitude when teaching so as to interest the students in the subject. One teacher said:

---when it comes to physics teachers we should be role models we should be positive because there are some people who are not positive yet they are teaching the subject. (Interview remarks by the teacher at Muru (nickname) secondary school).

Another of the learners’ struggle in learning physics was with regard to inadequate learning time. This was due to inconsistency in attending school. Within any given school term, many of the students lost learning time having been sent home for school fees balances. This was attributed to parent’s low financial status. It mostly affected the girls who as a result had to make a lot of effort to catch up with missed classes. To support these disadvantaged students, in one school, the teachers and students had established a fund:

We agreed with my students that they shall be contributing Kshs.10 every week, they are 53 of them and I will be contributing Kshs.100 every week and every week we collect Kshs.630. We are also planning to borrow that plot behind the class to do some economic activity. From the funds raised,
we help a student who is very promising but is unable to pay. (Interview remarks by the teacher at Oya secondary school)

4.7. Students' Perception of Gender Inclusiveness in Teaching and Learning of Physics in Kenyan Co-educational Schools

Data on the students' perception of gender inclusiveness in teaching and learning of physics was collected using a survey questionnaire (Appendix D). The data was in two categories: quantitative and descriptive. The descriptive data sought the students' views about what made them to study physics, what they liked or did not like about their teachers; what they liked or did not like about teaching of physics; and what they would like changed in the way they were being taught physics. These data (summarised in Appendix E) was purposed to collaborate the ratings of quantitative data items.

The quantitative data comprised of students' perceptions of frequency of teachers' usage of instructional practices that: create participatory classroom environments; validated learners' voices during lessons; encourage social understanding and activism; and foster critical thinking and disposition. Fig. 4.8 illustrates return of the questionnaires from the students.
Fig. 4.8 shows that a total of 197 (~76%) of the projected number of 258 students (all Form 3 physics students in the 14 study lessons) responded to the questionnaire. Preliminary analysis of the questionnaires identified sixteen (16) scripts (8% of the returned scripts) that could not be placed by sex of respondents. Another 20 scripts (~10%): seven (7) of which had multiple or no rating for about half the number of items; another six (6) had ratings of 5 (on the five-point Likert scale) on all the items and yet another seven (7) had very scanty, inconceivable or no information at all on the open-ended items. The remaining 161 scripts (about 82%) of the 197 scripts, 103 for male and 58 for female students were analysed.
Mean scores for each item were computed for the responses of both the male and female students. The score was on a scale of 1 to 5 representing frequency of occurrence of specified instructional practice. The scale key was as follows: 1 representing “Not at all”, 2 representing “Rarely”, 3 representing “often”, 4 representing “very often” and 5 representing “Always”. In addition, the analysis evaluated the difference in the male and female mean score for each item using t-test, at significant level of $\alpha = 0.05$. The analysis yielded the following findings which are presented in tabular and graphical forms.

**4.7.1. Learners Perceptions of Instructional frequency of Practices that Create Participatory Classroom Environment (CPCE)**

One of the components in gender inclusive pedagogy relates to creating a participatory classroom environment (CPCE) (Mayberry, 1998). Data on students’ perceptions of how often their physics teachers applied instructional practices that create CPCE were gathered using 5 items on the students’ questionnaire. Analysis of the data yielded the results shown in Table 4.5 and Fig. 4.9.
Table 4.5: Students' Mean Perception Ratings of CPCE Instructional Frequency

<table>
<thead>
<tr>
<th>My physics teacher</th>
<th>Mean scale rating for male students (5)</th>
<th>Mean scale rating for female students (5)</th>
<th>t-test values (a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Gives us work to carry out in groups.</td>
<td>1.3</td>
<td>1.8</td>
<td>0.0397</td>
</tr>
<tr>
<td>1.2 Ensures that the groups have equal number of students.</td>
<td>1.2</td>
<td>1.4</td>
<td>0.2746</td>
</tr>
<tr>
<td>1.3 Ensures that the working groups have both boys and girls.</td>
<td>1.7</td>
<td>2.2</td>
<td>0.0235</td>
</tr>
<tr>
<td>1.4 Provides us with a set of clear roles for each member of the group.</td>
<td>1.4</td>
<td>1.7</td>
<td>0.0434</td>
</tr>
<tr>
<td>1.5 Teaches in a ways that I am able to participate in the lessons</td>
<td>2.5</td>
<td>2.1</td>
<td>0.0361</td>
</tr>
</tbody>
</table>

Fig. 4.9: Students' Mean Perception Ratings of CPCE Instructional Frequency
Table 4.5 and Fig. 4.9 reveal that the students generally had a below average view, on the scale of 1 to 5, of their teachers’ usage of instructional practices that enhanced participatory classroom atmosphere. The girls rated item 1.3 the highest. They perceived more than the boys that the teachers ensured that the working groups had both boys and girls. On the other hand, the boys’ highest rated item was 1.5. The boys felt more than the girls that the teachers frequently taught in a ways that enabled them (the students) participate in lessons.

Generally, the female students had higher mean scale ratings than boys on all except item 1.5. The t-test values indicate that there was significant difference between the boys’ and girls’ ratings for all items except 1.2, where the students were to indicate the frequency of teachers ensuring that the groups had equal number of students during lessons. It was clear even from the lesson observations that group formations were not teacher facilitated and the teachers cared less about the numbers and equitable gender distribution.

The below average rating of the frequency of application of CPCE instructional practices was collaborated by the views of the students gathered using the open-ended questions (Appendix E). Table 4.6 below gives some of the views (in abridged version) as discerned from the students’ responses. The views have been categorized into what the students do not like and what they would like in execution of physics lessons. Some of the views were noted to have been repeated over by a number of students and across the sexes.
Table 4.6: Students’ Views about CPCE Instructional Practices

<table>
<thead>
<tr>
<th>Concerns by female students</th>
<th>Concerns by male students</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Do not like:</strong></td>
<td><strong>Do not like:</strong></td>
</tr>
<tr>
<td>• Teacher talking fast;</td>
<td>• Teacher making people to sleep</td>
</tr>
<tr>
<td>• Teacher boring the lesson</td>
<td>• doing without a practical;</td>
</tr>
<tr>
<td>• Teacher doing a lot of explaining;</td>
<td>• The notes, they sometimes are too long;</td>
</tr>
<tr>
<td>• Teacher always lecture to us;</td>
<td>• Teacher asking only a person who knows answer;</td>
</tr>
<tr>
<td>• We don’t (do) experiments as required to do;</td>
<td>• Teacher calling somebody to the blackboard to do something you don’t know;</td>
</tr>
<tr>
<td>• Teacher does not have gender equalization; is gender discriminator</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Would like:</th>
<th>Would like:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• use of discussion;</td>
<td>• working in groups for more understanding;</td>
</tr>
<tr>
<td>• group students and give them questions so as when discussing they will be able to know afterwards ask the teacher questions;</td>
<td>• teachers to give students chance to ask questions;</td>
</tr>
<tr>
<td>• Notes to be dictated and not telling us to copy from text book;</td>
<td>• The teacher should involve students so as to make class interesting</td>
</tr>
</tbody>
</table>

The students’ perceptions and views in Table 4.6, Fig. 4.9 and Table 4.7 vividly manifest rare application of CPCE instructional practices. Instead learners viewed the lessons as boring, with listening and writing dictated notes as the main learning activities. Such environment does not provide for quality and gender inclusive teaching and learning.
4.7.2. Students’ Perceptions of Instructional Frequency of Practices that Validate Learners’ Voices (VLV)

Data about the students’ perceptions regarding frequency of occurrence of instructional practices that validated learners’ voices (VLV) were gathered using 5 items in the quantitative questionnaire. Mean scale rating of the perceptions and t-test values between the boys’ and girls’ perceptions were computed. Results of analysed data are presented in Table 4.7 and Fig. 4.10.

Table 4.7: Students’ Mean Perception Ratings of VLV Instructional frequency

<table>
<thead>
<tr>
<th>My physics teacher:</th>
<th>Mean scale rating for male students (5)</th>
<th>Mean scale rating for female students (s)</th>
<th>t-test values (α)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Encourages us to ask questions and or give our experiences in class.</td>
<td>1.6</td>
<td>1.6</td>
<td>0.8177</td>
</tr>
<tr>
<td>2.2 Is open to new ideas and opinions</td>
<td>1.8</td>
<td>1.4</td>
<td>0.0361</td>
</tr>
<tr>
<td>2.3 Is concerned when I am not doing well.</td>
<td>1.4</td>
<td>1.6</td>
<td>0.3853</td>
</tr>
<tr>
<td>2.4 Is willing to answer my questions</td>
<td>1.7</td>
<td>1.4</td>
<td>0.0428</td>
</tr>
<tr>
<td>2.5 Uses gender free examples in the class</td>
<td>1.6</td>
<td>1.3</td>
<td>0.0397</td>
</tr>
</tbody>
</table>
From Table 4.7 and Fig. 4.10 it is evident that students perceived the application of VLV instructional practices to be of generally low frequency. However, the boys tended to give a higher rating than the girls, except in item 2.3. The item 2.3 required the students to indicate frequency at which the teachers seemed concerned when the student is not doing well. Generally, the boys felt more than girls that the teachers' instructional practices validated their voices.

A comparison of the boys and girls perceptions reveals that there was a significant statistical difference on items 2.2; 2.3 and 2.5 that attained less that α =0.05 of the t-test values. The items related to how often teachers were open to new ideas and opinions; how often teachers were willing to answer learners' questions; and how
often teachers used gender free examples in physics lessons. In all these three items, the boys' ratings were higher than those of girls. For the other two items, item 2.1 and item 2.3, the statistical difference was not significant at $\alpha = 0.05$ t-test level.

Data from lesson observation and the open-ended questionnaire items also support the learners' observations of low VLV instructional frequency. Table 4.8 presents some of the learners' expressions regarding instructional practices that affirm their views and experiences as discerned from responses to the open ended questions.
Table 4.8: Students’ Expressions of VLV Instructional Practices in Physics Lessons

<table>
<thead>
<tr>
<th>Concerns by female students</th>
<th>Concerns by male students</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like physics because:</td>
<td>I like physics because:</td>
</tr>
<tr>
<td>• Physics is for my career choice</td>
<td>• It is applicable to many careers</td>
</tr>
<tr>
<td>(engineer, accountant, a physics teacher, ...)</td>
<td>(doctor, engineer in computer, electrical , )</td>
</tr>
<tr>
<td>• I get rewarded for excelling</td>
<td>• When I have no job I can invent my work</td>
</tr>
<tr>
<td>• Teacher is not harsh to us</td>
<td>• Teacher encourages me even though I fail</td>
</tr>
<tr>
<td>• Teacher always encourages me so much;</td>
<td>• Teacher always willing to answer my questions</td>
</tr>
<tr>
<td>• Teacher has no favour</td>
<td>• Teacher cares about my academic in physics</td>
</tr>
<tr>
<td>• Teacher is interested towards my performance</td>
<td>• Teacher makes polite corrections</td>
</tr>
<tr>
<td>I do not like :</td>
<td>I do not like :</td>
</tr>
<tr>
<td>• Teacher saying that some people are not supposed to do physics</td>
<td>• Teacher not asking questions on what we learned last</td>
</tr>
<tr>
<td>• Teacher making a joke on one’s idea</td>
<td>• Teacher discouraging some people by not being gender sensitive to them</td>
</tr>
<tr>
<td>• Teacher is sometimes rude to me</td>
<td>• When we don’t know a certain question teacher starts giving bad names</td>
</tr>
<tr>
<td>• Teacher not being able to notice when am not feeling well</td>
<td></td>
</tr>
<tr>
<td>• Many times in exams we are given questions from topics which were not properly understood</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.7, Fig 4.10 and Table 4.8 illustrates students’ perceptions of instructional scenario relating to validating learners’ voices. The learners felt intimidated and did not feel free to get it wrong, to explore new ideas, to talk to each other, to raise their voices. The teaching was generally teacher-centred and content driven.
4.7.3. Learners’ Perceptions of Instructional Frequency of Practices that Encourage Social Understanding and Activism (ESUA)

The students’ perceptions about the frequency of application of ESUA instructional practices were considered from 4 items in the quantitative questionnaire. Mean scale rating of the perceptions and t-test values between the boys’ and girls’ perceptions were computed. Table 4.10 and Fig. 4.11 present results of the analysed data.

Table 4.9: Student’s Mean Perception Ratings of ESUA Instructional Frequency

<table>
<thead>
<tr>
<th>My physics teacher:</th>
<th>Mean scale rating for male students (5)</th>
<th>Mean scale rating for female students (5)</th>
<th>t-test values (α)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Relates our personal experiences to the content of lesson.</td>
<td>1.3</td>
<td>1.6</td>
<td>0.0459</td>
</tr>
<tr>
<td>3.2 Applies learning activities that help us to understand the connection between class material and current issues and problems in our society</td>
<td>1.5</td>
<td>2.1</td>
<td>0.0168</td>
</tr>
<tr>
<td>3.3 Explains to us how we can use physics knowledge to make a positive change in society.</td>
<td>2.1</td>
<td>2.4</td>
<td>0.0361</td>
</tr>
<tr>
<td>3.4 Encourages us to use physics in action against problems we see in society</td>
<td>1.3</td>
<td>1.4</td>
<td>0.6608</td>
</tr>
</tbody>
</table>
Table 4.9 and Fig. 4.11 reveal that students' perceived application of instructional practices that encourage social understanding of physics and inspire action in the larger world based on learned insights was generally of low frequency. The highest rated was item 3.3 that related to teacher explaining to the students how they can use physics knowledge to make a positive change in society. On the other hand, the lowest rated was item 3.4 that sought students' views about the frequency of teacher encouraging them to use physics in action against problems they encounter in society. However, the girls generally had the higher of the rating on all the items.

The t-test between the boys' and girls' perceptions on the frequency of application of ESUA instructional practices shows that the difference was significant for all
except item 3.4. There was very clear agreement between the ratings of boys and girls that rarely do the teachers encourage learners to use physics in action against problems they encounter in society. For the other items 3.1, 3.2, and 3.3 the statistical difference between the boys’ and girls’ perceptions was at less than $\alpha = 0.05$ significant level, with item 3.2 attaining the lowest. The item 3.2 related to instructional frequency of learning activities that help students to connect between class materials and issues and problems in the society.

Analysis of the open-ended questionnaire revealed a number of observations that demonstrated that there was low frequency of instructional practices that encouraged social understanding and activism. Table 4.10 presents some of the students’ concerns in this regard.
### Table 4.40: Students' Views Relating to ESUA Instructional Practices

<table>
<thead>
<tr>
<th>Concerns by female students</th>
<th>Concerns by male students</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What I like about teaching of physics:</strong></td>
<td><strong>What I like about teaching of physics:</strong></td>
</tr>
<tr>
<td>• Teacher tells us about the positive of physics</td>
<td>• Teacher gives good examples, gives them correctly and in a way we understand.</td>
</tr>
<tr>
<td>• It coordinates in real life situation</td>
<td>• Its relation to real life situations e.g. writing (lighting) fire using friction of a</td>
</tr>
<tr>
<td>• It applied many places like washing sufuria in home as a kind of friction</td>
<td>match (stick) box; use of friction in braking bicycle; connection circuits to light and</td>
</tr>
<tr>
<td>• It has interesting things which help for future studies</td>
<td>connecting radios; using wheels to carry heavy goods; using a siphon to empty a tank;</td>
</tr>
<tr>
<td>• Helps me understand many things in life situations</td>
<td></td>
</tr>
<tr>
<td><strong>What I do not like about teaching of physics:</strong></td>
<td><strong>What I do not like about teaching of physics:</strong></td>
</tr>
<tr>
<td>• Calculation of mathematical question</td>
<td>• Contains many calculations</td>
</tr>
<tr>
<td>• We don’t (do) experiments as required to do</td>
<td>• Many times it is explained mathematically</td>
</tr>
<tr>
<td>• Inadequate revision text books and copies of the course book</td>
<td>• It is not explained deeply</td>
</tr>
<tr>
<td>• Having lessons late in the afternoon</td>
<td>• Use of many laws/principles which need to be directly stated as it is written in the</td>
</tr>
<tr>
<td></td>
<td>book</td>
</tr>
<tr>
<td></td>
<td>• We have not been going for trip for example to see how a certain machine works as you</td>
</tr>
<tr>
<td></td>
<td>know it is good to see with fact</td>
</tr>
</tbody>
</table>

As evidenced from Table 4.9, Fig. 4.11 and Table 4.10, the students observed generally rare instructional frequency of practices that encouraged social understanding and activism. The teaching was not context based teaching and did not inspire the students to apply insights gained in the classroom into the larger world.
4.7.4. Learners' Perceptions of Instructional Frequency of Practices that Foster Critical Thinking Skills and Disposition (FCTSD)

The students' views of instructional frequency of practices that foster critical thinking skills and disposition (FCTSD) were gathered using 5 items in the quantitative questionnaire. Mean scale ratings of the perceptions and t-test values between the boys' and girls' perceptions were computed. The results of computations are presented in Table 4.11 and Fig. 4.12.

Table 4.11: Students' Mean Perception Ratings of FCTSD Instructional Frequency

<table>
<thead>
<tr>
<th>My Physics teacher:</th>
<th>Mean scale rating for male students (5)</th>
<th>Mean scale rating for female students (5)</th>
<th>t-test values (α)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Puts questions that requires us to think</td>
<td>1.3</td>
<td>1.4</td>
<td>0.6246</td>
</tr>
<tr>
<td>4.2 Assigns us inquiry laboratory activities</td>
<td>1.3</td>
<td>1.5</td>
<td>0.0997</td>
</tr>
<tr>
<td>4.3 Encourages us to consider views and opinions of others during physics lessons</td>
<td>1.7</td>
<td>1.4</td>
<td>0.0446</td>
</tr>
<tr>
<td>4.4 Requires us to reach consensus during group discussions</td>
<td>1.7</td>
<td>2.6</td>
<td>0.4200</td>
</tr>
<tr>
<td>4.5 Encourages us to consider issues from a variety of perspectives.</td>
<td>1.5</td>
<td>1.8</td>
<td>0.0477</td>
</tr>
</tbody>
</table>
It is apparent from Table 4.11 and Fig. 4.12 that students' perceived rare instructional frequency of practices that foster development of critical thinking skills and disposition. The highest rated was item 4.4 that related to teacher requiring students to reach consensus during group discussions. The girls felt that instructional frequency for item 4.4 was often while the boys felt that it was rare.

Assessment using t-test showed that there was significant difference at $\alpha = 0.05$ t-test level between boys' and girls' perceptions of instructional frequency on items 4.1, 4.2 and 4.4. Nonetheless, the difference was not significant for items 4.3 and 4.5. There was virtual agreement between the boys' and girls' perception on item
4.1, about the instructional frequency of putting questions that require students to think, however, the girls rating was slightly higher than that of the boys.

Data from the open-ended questionnaire confirms that instructional practices that promote development of critical thinking skills and dispositions were rarely applied. Table 4.12 presents some of the students' observations in this regard. The observations are in the form of what the students don't like about the teacher and teaching of physics.

**Table 4.12: Students' Views Relating to FCTSD Instructional Practices**

<table>
<thead>
<tr>
<th>Observations by female students</th>
<th>Observations by male students</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What I don’t like about the teacher and teaching of physics:</strong></td>
<td><strong>What I don’t like about our teacher and teaching of physics:</strong></td>
</tr>
<tr>
<td>- Quite speed</td>
<td>- Some maths are too difficult</td>
</tr>
<tr>
<td>- A lot of explaining</td>
<td>- Use of many laws/principles which need to be directly stated as it is written in the book</td>
</tr>
<tr>
<td>- Areas where is mathematics</td>
<td>- It is not explained deeply</td>
</tr>
<tr>
<td>- Always lecture to us</td>
<td>- Not use a lot of experiments in class</td>
</tr>
<tr>
<td>- Always give us notes to write from his note book</td>
<td>- Calling somebody to the blackboard to do something you don’t know</td>
</tr>
<tr>
<td>- Telling us to copy notes from text book</td>
<td></td>
</tr>
<tr>
<td>- Give us many questions even when our mind are tired</td>
<td></td>
</tr>
<tr>
<td>- Makes a joke on ones idea and one is discouraged</td>
<td></td>
</tr>
</tbody>
</table>

The students' views in Table 4.11, Fig. 4.12 and Table 4.12 clearly indicate that there was barely any instructional effort to nurture critical thinking skills and disposition. There was a loud cry from the students for opportunities to do
experiments, though such experiments are mostly the expository type. The students generally detested the expository teaching methods used by the teachers.

4.8. Teaching Model for Facilitating Equitable Gender Engagement in Learning of Physics

In order to propose a model for instructional practices that facilitate equitable gender engagement in the learning of physics, the study reviewed data for each of the objectives. The review was along and in relation to the components of the feminist pedagogical practices.

With regard to the nature of instructional practices in the Kenyan co-educational physics classes, the study noted that there were two seemingly different types of lessons: pure theory and quasi-theory lessons. Despite the fact that all teachers demonstrated strong mastery of content knowledge, in neither of the two types of lessons was there any conscious consideration of practices that stimulated intense participation (Marx et al, 1999) of learners and particularly that of girls. The teachers generally explained content of lesson and then gave notes for the learners to copy. In the case quasi-theory lessons, besides the explanations and copying of notes, the teachers gave expository experiments to confirm the theory, a practice that does not appeal especially to the female students (Murphy & Whitelegg, 2006). Seating arrangement during the lessons were not planned to uphold any instructional strategy (Marx, et al, 1999) and the instructional practices tended to engage the boys more than with the girls (Haussler & Hoffmann, 2002).
The study noted that teachers' pedagogical-content-knowledge on gender equity, their beliefs about gender inclusivity and the availability of teaching/learning resources as the underpinnings for the instructional practices in the Kenyan co-educational physics classes. Despite possessing certificates of high academic qualifications, the teachers in the study demonstrated inadequate competence in nurturing more gender equitable engagement in the learning of physics. This is line with the observations by Bailey et al (1999) that teachers require to possess wide gender-equity knowledge for more gender equitable classroom engagement.

The teachers also ought to belief in the abilities of their learners, and particularly for the girls. In the study, the teachers remarked that their learners and particularly the girls had poor self-image about their abilities in the study of physics. Rather than applying instructional practices that facilitate development of self-concept, the teachers tended to engage with the boys and the girls in discriminatory and biased ways (AAUW, 1992). The teachers also ought to monitor learning so as to prevent cases of some learners, and particularly boys monopolising learning resources, especially materials and equipment for laboratory experiments (Scantlebury & Kahle, 1993).

Experiences of the teachers in implementing gender inclusive pedagogy were categorized into those relating to managing learners' interactions during lessons; dealing with out-of class professional duties; successes and frustrations in teaching of physics and in managing learners' struggles in learning of physics.
With respect to managing learners’ interactions during physics lessons, there was no effort on the part of the teachers to group learners for optimal interactions. Such interactions are necessary for triggering cooperative and relational learning mechanisms (Dillenbourg, 1999), which are more appealing to girls (Zohar & Sela, 2003), but in no way disadvantaging the boys.

Out-of class professional duties, particularly planning for teaching, marking assignments and conferencing with learners, were rarely undertaken. The teachers’ considered the allotted out-of class periods to be inadequate for those activities. They therefore did not look for appropriate learning activities that are engaging and interesting to the learners, and that would have resulted in more girls choosing and improving academic achievement (Boaler, 1997), without in any way disadvantaging boys. They also did not offer consultation and remedial opportunities to learners, and particularly to girls who culturally spend more time on assigned domestic chores at the expense of academic work (Brotman & Moore, 2008).

Nine (~64%) of the teachers indicated to be satisfied with growing number of both male and female students electing to study physics. This was fundamentally due to the teachers helping their students to recognize connections between the course and its utility value in society (Hoffmann & Stake, 1998). However, the teachers employed instructional settings and practices (Milligan & Thomson, 1992) that
did not facilitate quality learning and for the learners, particularly the girls, to manage their struggles with self-image and inadequate learning time.

Students’ perception of frequency of gender inclusive instructional practices in the teaching and learning of physics were evaluated on a 5-point Likert scale with 1 representing “Not at all” and 5 representing “Always”. The practices were in the four categories of feminist pedagogy: CPCE; VLV; ESUA; and FCTSD.

In all the categories of the feminist instructional practices, the students (both the boys and the girls) considered gender inclusiveness to have been rarely practiced during physics lessons. This perception was further supported by the students views gathered through the open-ended questionnaire.

Both the boys and girls observed rare gender inclusiveness in learning of physics. However, there was significant difference (evaluated at $\alpha = 0.05$) in their opinions of the gender inclusive frequency for majority of instructional practices.

The discussion in this section is wrapped in the model illustrated in Figure 4.13. The model specifies the classroom instructional practices for each of the feminist pedagogical components (FPCs), and webs those instructional practices via the FPCs to the gender equitable engagement of students in the learning of physics. The arrows in the model point in the direction of influence.
The instructional model in Fig. 4.13 invites teachers to create a participatory classroom environment. Such a classroom makes use of collaborative learning groups which, as observed by Mayberry (1998), enhance informal classroom relationships where students construct and share knowledge interdependently through conversation. In the participatory classroom environment, teachers engage learners through active learning techniques, for instance using open and whole-class discussion. The teachers pace the lesson flow in a way that permits all learners to grow in their understanding of concepts and mastery of science process skills. They also watch out for instances where some students, particularly boys, hog reading materials and, as noted by Scantlebury and Kahle (1993), they also monopolize materials and equipment for laboratory experiments.
Fig. 4.13: Instructional Practices Model for Gender Equitable Engagements of Students in Physics Classroom

- Using group work
- Ensure suitable group sizes and equitable distribution of boys and girls in the groups
- Clarify roles for individual group members; discourage domineering tendencies and hogging of learning resources
- Guide learners to make own notes
- Encourage asking of questions

- Using open and whole class discussion tasks
- Invite learners' views and experiences equitably from the boys and girls
- Facilitate summarizing of the learners' views and experiences
- Commend efforts equitably among the boys and girls; ensure all learners feel free to participate

 Besides, the instructional model encourages teachers to validate views and experiences of all learners. It requires teachers to build a classroom atmosphere
where students feel safe to participate in the learning process. This would be possible if learners engage in opportunities for exploring the lesson content and are accorded space to share their views and to narrate their stories. In addition, the learners are encouraged to seek clarifications from the teacher, and to ask for the teacher’s opinion on their views and experiences. This is as opposed to the application of expository teaching strategies that were widely applied in the lessons observed. In application of this strategy the teachers mostly accepted views of volunteers to the low order thinking ability questions, and mostly from boys.

Furthermore, the instructional model persuades teachers to create social bearing and to inspire positive use of insights gained in the learning. Such teaching requires that teachers use visuals, materials and community resources to aid clear conceptualization, and to contextualize the concepts in students’ world of life.

Moreover, the instructional model requires teachers to nurture critical thinking skills and disposition in their learners. Cardak, Onder, and Dikmenli, (2007) and Dikmenli (2009) show that well designed laboratory activities increases interest in science, develops critical thinking and problem solving skills, as well as fostering learners’ conceptual and theoretical understanding.
4.9. Conclusion

This chapter has presented data analysis, interpretation and discussion. The findings of the study have clearly shown that many of the physics teachers used theory content for their teaching. The practice of teaching using experiments was very limited and where attempts were made, the teachers applied quasi-practical lesson for purposes of confirming the theory taught or practicing how to do measurements. The findings have identified three underpinnings for the nature of lessons implemented by the physics teachers. These underpinnings included: teachers' beliefs about gender inclusivity in teaching of physics; physics teachers' content-pedagogical-knowledge; and the resources for teaching physics. Moreover, the findings revealed the experiences of the teachers in implementing gender inclusiveness in their teaching. The experiences related to managing learners' interactions during lessons; teacher's dealing with their daily routine; success and frustrations in teaching of physics; managing struggles by physics learners; and dealing with interactions with learners outside class time. Furthermore, the findings manifested the students as perceiving rare instructional frequency of gender inclusive teaching practices in the physics classrooms. All the findings have been discussed in relation to the theoretical framework, considering the four components of feminist pedagogy. The following chapter provides summary of findings and recommendations.
CHAPTER FIVE:

SUMMARY OF FINDINGS AND RECOMMENDATION

5.1. Introduction

The aim of this study was to explore the influence of teacher instructional practices on equitable participation of girls and boys in learning of physics. The study gathered data from sampled co-educational secondary schools in Kenya. This chapter provides a summary of findings from the study. In addition, the chapter presents the study recommendations.

5.2. The Study Objectives

To realize the research purpose, the study was guided by the following specific objectives: to identify the nature of instructional practices in Kenyan secondary school co-educational classrooms of physics; to determine the underpinnings for these instructional practices; to establish the experiences of physics teachers in implementing gender inclusive pedagogy in the co-educational secondary school; to investigate students’ perceptions of gender inclusiveness in teaching and learning of physics; and to propose a teaching model that facilitates equitable gender involvement in the learning of physics. The following is a summary of the findings.
5.3. Summary of Findings


The study identified two types of lessons that were executed in physics classrooms of the selected co-educational schools. There were pure and quasi-theory lessons. These lessons were executed through expository teaching methods.

The pure theory lessons were delivered using lecture type instructional practices, supported by chalkboard diagrams. The teachers explained and dictated notes to the learners. In other cases, the teachers just explained having given students assignment of copying notes from the class text book, and yet in others, it was all about the teacher solving numerical questions on the chalkboard and the students copying down the answers. There was no opportunity for the learners to share their ideas and experiences other than in answering few rhetorical low order questions posed by the teacher. These lecture-type instructional practices fell-short of the feminist pedagogy: Environment in the lessons was not participatory and there were no opportunities for validating learners’ voices. There were no lesson strategies to encouraging understanding and activism, and to foster development of critical thinking skills.

In the quasi-theory lessons, also referred to as expository laboratory tasks (Domin, 2007), concepts were explained to the students who were subsequently given practical work activities to verify the concepts or as simple application of the
concepts, particularly relating to how to carry out the associated measurements. The practical work activities could have provided opportunities for equitably engaging boys and girls in the learning process. Nevertheless, some degree of learner participation in the learning process was observed, but there was little or no effort towards dissuading hogging of equipment and materials by boys to the disadvantage of girls. The instructional practices did not provide occasions for the students to share their findings and experiences; neither did the lessons illustrate the usefulness of the learned concepts in the students' world of life and the larger community. Since the students were explained the whole experiment procedure, the laboratory tasks did not create opportunities for building critical thinking and problem solving skills. The students were not expected to give reasons, provide evidence and explain how they arrived at their conclusions.

5.2.2. The Underpinnings for the Instructional Practices in Kenyan Co-Educational Classrooms of Physics

Data analysis revealed three issues underpinning the instructional practices in the Kenyan secondary school co-educational physics classrooms. These were: teachers' beliefs about gender inclusivity in teaching of physics; physics teachers' content-pedagogical-knowledge; and the resources for teaching physics.
5.2.2.1. Physics Teachers’ Beliefs about Gender Inclusivity in Teaching of Physics

One of underpinning issues in the instructional practices was the teachers’ beliefs about gender inclusivity in teaching the co-educational physics classes. Some of the teachers described their classes as weak. They did not have much expectation that their students would achieve appropriate grades for the kind of careers the students claimed to aspire for. This low expectation was more particularly for girls than for boys. Lotter, et al (2007) observed that such a belief acts as a constraint to quality and inclusive instructional practices.

With regard to who between boys and girls were more interestable to learn physics, the teachers indicated without hesitation that the boys were more interestable. This belief was manifested during lessons. In the few instances where learners participated through answering questions, the teachers mostly invited responses from boys. In the laboratory activities, many of the teachers were noticed to spend more time with male than with female students.

5.2.2.2. Physics Teachers’ Content-Pedagogical-Knowledge

All teachers participating in the study were professionally qualified, with some of them pursuing a Master of Science degree in Physics. However, they acted without due regard for the expected competencies that relate to such qualifications.
Shulman (1986) suggested that it is not only knowledge of content but also knowledge of how to teach content that influences teachers' effectiveness. Analysis of data revealed that instructional practices by the teachers were basically expository in nature: explaining and dictating notes directly from the course book and in some lessons from teachers' notes book. They conducted practical activities to confirm or to illustrate applications of concepts taught. These practices are especially detrimental for girls who, according to Gallagher (1991), often do not have the same level of science skills and knowledge from out-of-school activities as boys.

5.2.2.3. The Resources for Teaching Physics

Data analysis reveals that the teachers felt there was inadequate reading as well as practical work resources for physics in the study schools. Anyway, the best case scenario had a 1:2 ratio of text book to students, while in one of the worst cases, there was only three copies in a class of 24 students, one copy of which was being used by the teacher. The instructional practices in these cases were to assign students tasks of copying from the text book and or to read for students to copy into their note books. The teachers applied direct lectures supported by rhetorical low-order-thinking ability questions, for which, well the teachers tended, as also observed by Tobin and Garmett (1987) to seek answers equally from boys and girls.
The quantity of resources for practical work lessons permitted constitution of groups of not more than 5 students; otherwise the teaching was through class demonstration. Even then, the teachers applied recipe-type instructional mode, giving students the whole procedure of the practical work activity. The procedure was given in a lecture style, explaining the apparatus required and how to use in the experiments. In nearly all cases, the lessons ended at data collection, and the rest of the work was to be done in subsequent lessons. In one case of a demonstration on the interference of waves, the students could not make the required observation of the low and high sound, and the teacher then gave the expected findings and their interpretation.

Though there were issues of inadequate resources, the instructional practice lacked in guiding the students to acquire clear understanding and applicability of the concepts in their world of life. The practices did not also help students in developing ability for critical thinking and disposition.

5.2.3. Experiences of Physics Teachers in Implementing Gender Inclusiveness in Teaching and Learning of Physics

All teachers indicated to have learnt in college the need and importance of active participation in learning; valuing the contribution of all learners; contextualising the learning to students' world of life; and of using well-paced activities that promote development of high order thinking abilities. However, there was a great disconnect between their pedagogical knowledge and practices in the classroom.
They used lectures accompanied by rhetorical low order thinking ability questions and also dictation of notes; hurriedly trying to cover a large amount of content. In the cases of laboratory work, the activities were for no more than just trying to verify concepts explained or to practice doing some measurements.

This difference between the college-teaching knowledge and the practices in the classroom was nurtured by teachers’ feeling that they had a high workload of between 25 to 28 out of 40 lessons per week. Due to the perceived high workload, they complained of lack of adequate time to read for lesson planning and to prepare learning activities; and for checking the performance of assignment by learners. Besides, the teachers and students were commuters, some from more than one-hour-walk distances, reducing their academic contact to only those interaction instances in the classroom.

The difference between the college-teaching knowledge and the practices in the classroom was also attributable to the teachers believe that their students are weak and that the syllabus is overloaded. As a consequence, the teachers were of the opinion that their students would benefit more from direct instructional practices. This is as opposed to feminist instructional practices that apply collaborative learning; incorporate more hands-on experiences that allow students to manipulate, tinker, and work with equipment; provide opportunities for students to connect the classroom insights with real-life experiences; and use open-ended
tasks and problem based learning to expand learners’ critical thinking ability and disposition.

5.2.4. Students’ Perception of Frequency of Gender Inclusiveness in Teaching Practices

The students’ choice of science in the study schools was between chemistry-physics and chemistry-biology subjects’ combinations. It is without doubt therefore that the students in the chemistry-physics class ought to like their physics teachers and the way those teachers taught. Many of the students indicated that they chose the subject because of their future careers which included teaching physics, mechanical engineering, electrical engineering, and aircraft pilot among others. These careers however, were completely off the way for students in the study schools considering the below average performance among predecessor candidates in the schools.

The fact that the students had a strong valuing for the subject constitutes a very good basis for quality instructions. What the teachers then ought to have done is to exploit this goodwill. However, the students’ perception was that there was generally rare instructional frequency of practices that foster participatory learning; validate learners’ voices to enhance self-confidence and esteem in learning of physics; encourage social understanding and activism; and nurture critical thinking skills and disposition. This clearly demonstrates that gender
inclusive teaching and learning was hardly practiced in the co-educational classes in the study.

The difference between the boys’ and girls’ perceptions of instructional frequency of gender inclusive practices was statistically significant for majority of the questionnaire items. In only five of the nineteen items was the difference not significant. The five items included item 1.2, item 2.1, item 2.3, item 3.4 and item 4.1. For all the five items, the mean rating of instructional frequency was “rare”, however, the ratings are consistently higher for girls than for boys. Generally there was a clear difference in the way girls and boys perceived frequency of gender inclusive instructional practices and this calls on the teachers to be alive to these differences and tailor instructional practices so as to equally benefit their students equitably.

5.2.5. Model for Equitable Gender Engagement of Students in Teaching and Learning of Physics

In order to enhance equitable gender engagement in co-educational teaching of physics in Kenya, the study proposes an instruction model illustrated in Figure 4.13. The model builds from the study findings, relating closely to the feminist pedagogical theory. It illustrates a web-link relationship between specific classroom instructional practices and the feminist pedagogical components (FPCs). The relevance of these instructional practices is to promote active learning and stimulate interest in learning physics. The effect of active and
stimulated interest in learning is to raise achievement level for all students and as Johnson and Johnson (1987) observed, particularly for the middle and low ability students, as well as that for girls.

5.4. Recommendations

The recommendations by this study fall into three categories: (1) classroom based recommendations; (2) policy recommendations to teacher educators, quality assurance and standards officers, and education managers; (3) and finally, suggestions for further study.

5.3.1. Classroom Based Recommendations

Generally, the teaching settings in the study lessons were quite limited in variety. The stereotype of teacher talking to the class for most of the lesson time is supported by the data from this study. In majority of the lessons, the teaching used straight lecture, devoid of thoughtful questions. A few other lessons were developed through concept explanation and then followed by a laboratory session to verify the concepts learned. These lesson strategies did not promote equitable gender involvement in the learning process.

This study therefore recommends that teachers for co-educational physics classes adjust their instructional methods in line with proposed “web-link instruction model” in Fig. 4.8 in order to provide all learners with opportunities to achieve at their highest level. They need to make use of active learning strategies and to
fashion suitable learning groups with clear collaboration roles and rules. They also need to create an environment free of harassment and intimidation of learners and to closely monitor and regulate interaction among the learners. The teachers should also be aware that boys often intimidated and denied girls access to equipment/apparatus during laboratory activities. This explains why boys are more advantaged than girls in that they will take risks and hog materials and apparatus in case of shortage.

5.3.2. Policy Recommendations

The study found that the teachers had training certifications that indicated adequate mastery of content pedagogical knowledge for teaching physics. However, there was a clear gap between the knowledge and practice. As an indicator and a consequence of this, the teachers’ implementation of gender equitable classrooms was grossly lacking. In order to develop the necessary competencies and attitudes for gender equitable classroom practices, the study recommends that:

1. Teacher education programs craft an emphasis on the extent and depth of knowledge and practices in gender inclusive teaching.

2. Serving teachers be put through an in-service education and training (INSET) program that focus deeper understanding of and competencies
to identify and use gender equitable pedagogical practices in the teaching of physics.

3. Serving teachers be facilitated to form small professional communities (cells) within which they would support one another in exercising equitable gender participation in the learning of physics.

5.3.3. Recommendations for Further Study

1. This study observed that the teachers of physics had qualifications raging from Diploma in Education to Bachelor of Education and some pursuing Master of Science degree in Physics. There is need to carry out further study on gender inclusiveness of the instructional practices by teachers in the different qualification categories.

2. The study revealed that students of physics in the co-educational schools had an acute challenge in the mastery of the language of instruction. There is need to investigate the extent to which students' competence in the language of instruction constrains their performance in physics, and particularly how it plays into equitable gender engagement in learning of physics.

3. Analysis of data from the study indicated that girls sat upfront during classroom based lessons while they localized at the rear in the laboratory.
based lessons. There is need for further study to establish the reasons for this practice and its consequence on learning for both boys and girls.

4. Proportionately, more male teachers in the study tended to conduct theory lessons compared to their female counterparts. There is need for an in-depth study to establish the underpinnings of this scenario.

5. The study used students’ questionnaire to collect quantitative and qualitative data on the instructional practices in physics classes. Analysis of the data showed that the students generally felt that equitable gender instructional practices were rare in the lessons and that there was no statistically significant difference between boys’ and girls’ perceptions for majority of the questionnaire items. There is need for more research to explore instructional practices from data of students’ interview

5.5. **Conclusion**

This chapter consolidates the findings of the study. It has provided a model that interlinks instructional practices to the components of feminist pedagogy and gender equitable engagement of students in the learning of physics. The chapter has also suggested recommendations on transforming classroom practices so as to improve participation of particularly the girls, without in any way limiting participation of the boys. Further, the study has made recommendations on policy
issues regarding training and retraining of teachers on competencies and attitudes for gender equitable classroom practices, and also on how to strengthen and sustain the gains accrued in the trainings. Finally the chapter has specified some suggestions for further study, widening up the field for research on gender equitable students’ engagement in the learning of physics.
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### 2008 KCSE Physics candidates in grade categories

<table>
<thead>
<tr>
<th>Sex</th>
<th>Entry</th>
<th>Grade categories</th>
<th>A</th>
<th>A-</th>
<th>B+</th>
<th>B</th>
<th>B-</th>
<th>C+</th>
<th>C</th>
<th>C-</th>
<th>D+</th>
<th>D</th>
<th>D-</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>66263</td>
<td></td>
<td>2799</td>
<td>1866</td>
<td>3654</td>
<td>3540</td>
<td>3361</td>
<td>5956</td>
<td>7106</td>
<td>6855</td>
<td>11966</td>
<td>8551</td>
<td>3964</td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>26,404</td>
<td></td>
<td>907</td>
<td>602</td>
<td>1241</td>
<td>1216</td>
<td>1326</td>
<td>2344</td>
<td>2696</td>
<td>3,026</td>
<td>3,116</td>
<td>5,057</td>
<td>3,395</td>
<td>1,478</td>
</tr>
<tr>
<td>total</td>
<td>92,667</td>
<td></td>
<td>3,706</td>
<td>2,468</td>
<td>4,895</td>
<td>4,756</td>
<td>4,687</td>
<td>8,300</td>
<td>9,341</td>
<td>10,132</td>
<td>9,971</td>
<td>17,023</td>
<td>11,946</td>
<td>5,442</td>
</tr>
</tbody>
</table>

### 2008 KCSE Physics percentage of candidates in grade categories

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>A-</th>
<th>B+</th>
<th>B</th>
<th>B-</th>
<th>C+</th>
<th>C</th>
<th>C-</th>
<th>D+</th>
<th>D</th>
<th>D-</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>4.2</td>
<td>2.8</td>
<td>5.5</td>
<td>5.3</td>
<td>5.1</td>
<td>9.0</td>
<td>10.0</td>
<td>10.7</td>
<td>10.3</td>
<td>18.1</td>
<td>12.9</td>
<td>6.0</td>
</tr>
<tr>
<td>Girls</td>
<td>3.4</td>
<td>2.3</td>
<td>4.7</td>
<td>4.6</td>
<td>5.0</td>
<td>8.9</td>
<td>10.2</td>
<td>11.5</td>
<td>11.8</td>
<td>19.2</td>
<td>12.9</td>
<td>5.6</td>
</tr>
</tbody>
</table>
Appendix B: Class Observation Instrument

Teacher’s Gender             Years of experience teaching physics
Number of students by sex in class  ------------------Boys ------------------Girls

Observation areas:
1. Classroom setting
   a. Seating arrangement – Adequacy of space for the students
   b. Grouping of students – check any considerations for gender
   c. Check how well the class setting enables students to interact with each other

2. Nature of lesson content
   a. Objective of the lesson – check if it focuses on knowledge, science process skills (practical activity) or both
   b. Check if lesson content is expository or inquiry
   c. Resources for the lesson – Check gender and lesson objective suitability and also adequacy for individual / group work
   d. Check if the lesson activities are gender friendly – Cooperative type [Jigsaw, circles of learning, group tasks, songs, games, peer tutoring, out-of-class, etc]

3. Teacher’s pedagogical content knowledge
   a. Check accuracy of lesson content
   b. Check relevance of examples / illustrations given to the lesson objectives
   c. Check if examples were gender balanced, interdisciplinary and related to real world issues
   d. Check extension or adjustment of lesson content based on gender learners’ needs
   e. Check how introduction of lesson is appealing to both gender; sets gender balanced targets to be achieved by end of lesson
   f. Check teacher’s use of students’ prior knowledge and experiences
   g. Check the questioning techniques – Types of questions and who the teacher invites answers from; wait-time;
   h. Check if motivational cues were gender fair
   i. Check teacher’s attention to the learners contributions (ideas, questions and answers to questions) and reinforcement of learning (praise and criticism)
   j. Check how well students’ were engaged in learning – strategies used to raise and maintain engagement
   k. Check how the teacher interacted with the students – providing support to needy cases; maintain eye contact with learners; movement in class
   l. Check pacing of lesson if it is gender friendly
   m. Check how the teacher monitors and responds to students’ behaviors based on gender
4. Learners’ interactions
   a. Check how teacher facilitates social-academic interaction and respect of opinions among students – students talk in turns; listen to each other; critique other’s ideas intelligently, etc
   b. Check how teachers assign roles during the lesson activities
5. Others
   a. Exhibits a professional appearance and demeanor
   b. Demonstrates a positive, enthusiastic attitude toward teaching

Any other observation / comments
Appendix C: Semi-Structured interview schedule for the teacher

<table>
<thead>
<tr>
<th>Main question</th>
<th>Probing items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Could you tell me about yourself with regard to teaching of physics?</td>
<td>Age; Length of time you have been teaching (physics); Professional qualifications and how satisfied you are with them; Your major and minor subject; Your teaching workload and your feeling about it</td>
</tr>
<tr>
<td>2. Please describe your Form 3 class to me.</td>
<td>The composition of the class; Account for the composition; The kind of learners – dependent, interestable,</td>
</tr>
<tr>
<td>3. Would you share with me about the resources for teaching physics in your class?</td>
<td>Types of resources (For instance Text books; student research resources; hands-on activity resources); Describe adequacy of the resources; How do you share the resources among the students?</td>
</tr>
<tr>
<td>4. If I was to follow you around on a typical day of your teaching of physics, kindly describe to me what I would see you doing.</td>
<td>Time in doing the lesson planning Time preparing teaching materials How you consult with other physics teachers After lesson activities</td>
</tr>
<tr>
<td>5. Please share with me about your successes and frustrations in teaching of physics.</td>
<td>Successes / Frustrations: marketing the subject; improving learners’ competences and attitudes Perceptions about the gender best placed to understand physics</td>
</tr>
<tr>
<td>6. Can you describe to me the struggles by the male and female students in the physics classes that you teach?</td>
<td>Strategies to help students in mastering physics (efforts you make to support the at-risk group of learners - reinforcing and encouraging; language How students respond to your strategies based on their gender</td>
</tr>
<tr>
<td>7. Would you share with me about your learning-related interaction with the students outside class time?</td>
<td>Who of the male and female students interact with you most Issues for the interaction / How you deal with the issues</td>
</tr>
<tr>
<td>8. Are there any other issues relating to gender and learning of physics that you would like to share with me?</td>
<td>Positive / Negative issues What can schools / teachers do to help the disadvantaged gender to participate more in lessons</td>
</tr>
</tbody>
</table>
Appendix D: Pooled Interview data

<table>
<thead>
<tr>
<th>Main question</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Please share with me about yourself with regard to teaching of physics.</td>
<td>The teachers had taught physics for between 5 and 22 years.</td>
</tr>
<tr>
<td></td>
<td>Professional qualifications: lowest was Diploma in Education and the highest was Bachelor of Education + Masters in Science (physics) in training. All the teachers had attended the full course of SMASSE training and four of them were District trainers.</td>
</tr>
<tr>
<td></td>
<td>Two of the teachers (female) indicated that they had no desire to pursue further professional training mainly because of domestic responsibilities and lack of sponsorship.</td>
</tr>
<tr>
<td></td>
<td>As per their certificates of training, physics was a either a major or regular subject for all the teachers, and in combination with mathematics and in one case with chemistry. However, they all majored in teaching of physics.</td>
</tr>
<tr>
<td></td>
<td>The teaching workload was between 25 and 28 periods per week. Your teaching workload and your feeling about it</td>
</tr>
<tr>
<td>2. Please describe your Form 3 class to me.</td>
<td>Generally, the teachers considered the students to have low self-esteem and inadequate competence in the language of instruction. In one school, the teacher remarked:</td>
</tr>
<tr>
<td></td>
<td>The form 3 physics class ironically is the larger than that of biology (in the school) but they are weak in physics. The most affected are the girls, and they tend to make little effort.</td>
</tr>
<tr>
<td></td>
<td>The teachers also believed that the students felt their schools were disadvantaged in terms of resource allocation by the government. This feeling was said to have been stronger among the boys than among the girls.</td>
</tr>
<tr>
<td></td>
<td>The teachers considered the boys to be more informed than the girls about government supplies to “Centers of excellence”. The contention was that, the supplies were to already far better established schools than theirs, and the tendency was to lower self-esteem of these students.</td>
</tr>
<tr>
<td></td>
<td>The ratio of boys to girls in majority of the classes was more than 2:1 (the national average). Teachers of these</td>
</tr>
</tbody>
</table>
classes held the belief that the girls were less able in physics, just as in mathematics.

My class normally have few girls although I have always encouraged them (to take up physics). That mentality (of avoiding physics got into them) since they joined form I. There are people who discourage them right from the word go and tell them that physics is hard just like mathematics even before they taste it. So girls are very emotionally affected and influenced. I keep trying to encourage them. Making them realize that it is not that hard, they can make it and also I was also a girl like them and I opted for it.

They considered girls to be more teacher dependent, shy in class (less volunteering in participation in learning activities), while boys were considered to be more interesting in learning.

Some of the teachers perceived that their students would like them more if they exuded subject-matter mastery during teaching.

What I have also noted with my students, and particularly the boys, they like somebody who knows the stuff, one that is confident with good mastery of content.

Some teachers expressed that their students, and particularly boys, do not like being compared with those in other schools, but rather to be seen in the light of their potential.

Again our students have not wanted to be compared with other students; they want to be compared with what they want to be.

The focus on their potential was more with the boys than with girls who, some of the teachers argued, had many challenges as day scholars than boys.

Some teachers expressed that students, especially girls would like the subject more if they are able to share even their personal deepest feeling with the teacher. Such students have the confidence and trust to talk to their teacher particularly “when their time come for menstruating” as remarked by one male teacher.
Some teachers explained that their female students were more competent in English than the male students. The girls would express themselves more readily unlike the boys, particularly during theory lessons. However, when it came to practical sessions, the boys would shine. One teacher said that the boys say: we are the people of the wire, we are the men, we are the ones who do wiring.

The girls were said to be more dependent on the teachers. One teacher observed: I think the girls are more dependent because most of the time they just pick what you give them. They tend to believe that way and will not come another time unlike the boys. The girls just remain with what you give them.

3. Would you share with me about the resources for teaching physics in your class?

Nearly all the teachers lamented the inadequacy of teaching-learning resources. The resources concerned were the class text books and those for practical work.

With regard to text books, the best case scenario had one book to two students. Where the books were fewer, the tendency was to issue more to the girls (in fact we have to give girls more so that they feel encouraged). However, the allocation of these text books was to single sex teams. This sharing of the text book influenced the seating arrangement in class as well (illustrated in Fig. 4.2).

Resources for practical work and or for experiment demonstrations in the Form 3 course work were reported to be quite inadequate by most teachers. However, few other teachers indicated that they had fairly adequate resources. *In this school I can say there is no problem as far as resources are concerned because we have a very supportive principle; what we require she gets a few here and there even if we don’t get everything.*

Mostly equipment-apparatus and materials that had been used in past KCSE practical examinations were in adequate quantities. In one other case the teacher said that he solves the challenge of inadequacy of the resources by improvising. He said he uses for example bottle tops and bicycle gears to illustrate the concept of gears. However, the teachers decried the inadequacy and in other cases lack of equipment such as the ripple tank, calorimeter, ammeters and voltmeters; equipment that are considered to be expensive and of low usage frequency.
4. If I was to follow you around on a typical day of your teaching of physics, kindly describe to me what I would see you doing.

With regard to sharing of the laboratory work resources, students were asked to work in groups. However, in most cases the students’ assemblage during the laboratory sessions was not planned for optimum utilisation of the resources. It was ad hoc, friendship based, fundamentally single sex and some having too many or too few students (illustrated in Fig. 4.3). One teacher when asked about this kind of student clustering during lab work remarked “In fact I never noted. So next time I will be a bit careful so I realized I messed. In fact I normally insist that they should be equally distributed and every group should have some girls”

Usually there is planning for the lesson. “I make sure I plan my work at least so that I don’t go to class and get stranded and feel in inadequate and disorderly”. The planning includes reading and preparation of notes. It also includes at times checking assignments and preparation of teaching aids, and sometimes organizing and trying out equipment and apparatus for experiment. With regard to preparation of the teaching aids, one teacher commented: I don’t write them regularly because I give them (students) homework to do before I come to class. I make sure they have drawn those diagrams in their books and all that, I come and check and then move on.

Many of the teachers expressed that the 12 to 15 lessons per week was grossly insufficient for quality preparation. This was because, for some teachers, they were commuting against the flow of traffic, which made it difficult to do the early morning or the late afternoon classes, leave alone meeting students for consultation. Some other teachers indicated that they have to be in school by 7:00am, utilize some of the tea and lunch break time, and also spend some time in the evening and the weekend to do some marking and lesson preparation. One teacher explained about using internet to enrich his preparation. He said: I have been teaching on reflection of light. I just google reflection of light then I get to those basic laws and examples on reflection of light. There is a lot of knowledge there which I now integrate with what I have been given in the course book. Like from the book the history may not be given but I need something different for myself that one
I don’t get from the text book I get from the internet.

Conferencing on subject content-pedagogy with other teachers was reported to be rare because in majority of the cases, the teacher was the main authority in the subject. In one of the cases, the teacher said “---- currently because of shortage of stuff I teach Physics throughout to all classes and Mathematics in form 4 only”. Opportunities to share even with physics teachers in neighbouring schools did not exist except in (the dishonourable) SMASSE training during school holidays.

5. Please share with me about your successes and frustrations in teaching of physics.

Many of the teachers cited a growing number of both male and female students electing to study physics. These teachers were those that had about 5 years’ service in the school teaching physics. They cited informing their students about the job opportunities in the Counties and in farther education and training for those students qualifying with physics. One teacher pointed out that, he interests his students into studying physics by telling them: --- out of 22 courses that the Kenyatta university was offering during my time of training, 16 of them required physics knowledge. I try to tell my students that with physics you have a broad choice of courses. Also I share when they were in form 2 and form 1 about great people in physics like Albert Einstein who everybody had put down, yet he became a great contributor in Physics. In addition, I also invite motivational speakers to inspire them in life.

An early finish of the syllabus was considered to be one other success by some of the teachers. The teachers explained that they are able to cover the syllabus early by giving students reading assignment, copying notes in advance of the lesson, and doing teacher-centered lessons that concentrate on explaining the concepts. One teacher explained that he could have covered three-quarters of the book had not been for the strike by teachers. Some of other teachers said they are able to be through with the syllabus by 2nd term of the Forth Form and from then they engage students with revision work. One teacher specified that to have been concentrating more on the girls during the revision, giving them tasks (theory and practical based questions) which the teacher then marks and makes follow-up.

Some of the teachers expressed to have been frustrated by
students’ low ability to comprehend. One teacher had this to say: --- like you go to class and then you teach you give the simplest question or even the one you have already discussed with them then students fail. Like when you were in class there was that one for frequency (calculating the frequency of a wave given its speed and wavelength), that one I had done with them on the chalk board. Then the next week I bring in an exam and then they fail, that one is a frustration it is like your effort are not paying. The teacher lamented that “My students do not revise I think it is something like in the entire school you give them something today but until you come back”

The other frustration cited by the teachers was that the KCSE results did not reflect their efforts. “---- you put in a lot of effort and energy. We normally finish the syllabus very early and start our revision in 2nd term. So we revise the whole of 3rd term we do a lot of revision we get all the techniques of the calculator. Sometimes we even go to the maths table and we try to derive the formula from the unit we go backwards. We have a lot of revision practicals, we do so many. So sometimes I expect a very high mean only to realize it is not as I expected”.

When it comes to practicals you order for some instruments and materials but at times the school is financially unstable but at the end of the day you encourage yourself that you can improvise. You can also borrow from other schools or the SMASSE centers in the neighbourhood though the process is long and at times costly in terms of time and money.

Many of the teachers indicated that they felt overloaded with work: marking students’ assignments, reading for lesson planning, and doing the lab preparations. These tasks are carried out in the 12 to 15 lessons in a week when the teacher is not engaged in the classroom. The only consolation, as one teacher said was that the number of students doing physics was not high.

| 6. Can you describe to me the struggles by the male and female students in the physics classes that you teach? | I think the major struggle is with the self. Like now in a mixture like this, the girls feel when they are together with the boys they are denied some opportunity to practice and sometimes girls want to be together and struggle together. They feel the boys are rough and don’t really give them time to express themselves. Sometimes girls are slow when it comes to expressing their ideas. They also have a bit of low self-esteem. You see like some have their |
answers correct but you cannot even hear what they are saying. So one needs to encourage them to believe in themselves and to come up.

The strategies to encourage particularly the girls included:

8. providing them with KCSE data, which shows that the high performing students were those taking physics (indeed physics was achieving higher than the school mean score in majority of the schools in the study);

9. sharing with them about successful women in science like Marie Curie who did a lot in the field of radioactivity;

10. Distributing questions among all the students (I rarely ask two questions consecutively to the same gender). One teacher said that if male students answer any 2 to 3 questions consecutively he “will try to impress on the female, you mean you are not in class? Say something. Even if it is something is wrong at least somebody has spoken up, then they are encouraged from there”.

11. Giving the girls some leadership roles and requiring them to be actively involved in the carrying out group experiments of practical work. (I don't choose the same gender, they alternate and also I mix them in the group. ---- I also distribute the work so well, for instance in doing the electricity practicals, If it's a girl who will read the voltmeter, a boy will read the ammeter and somebody else will be recording)

12. Having girls only groups, particularly during lab sessions. This, was, according to the words of one of the teachers “I realized when they are mixed girls are just shying off it is boys who are doing everything”. Some teachers explained that the girls like it that way, and they can be seen to be more engaged and to talk more.

13. Some teachers considered that in order to interest the students in the subject, one has to have a positive attitude. One teacher said: when it comes to physics teachers we should be role models we should be positive because there are some people who are not positive yet they are teaching the subject.

14. Another of the ways to interest students in physics is to demonstrate usefulness and applicability in daily life. One teacher had this to say: --- we should also be dynamic and involve our real life situations in our teaching so that they can see physics is not some strange it is something that we live with and make them realize the
importance of the subject.

Another of the struggle was with regard to consistency in attending school. This was attributed to parent’s financial inadequacies. It mostly affected the girls who as a result had to make a lot of effort to catch up with missed classes. To support these disadvantaged students, in one school, the teachers and students had established a fund: We agreed with my students that they shall be contributing Kshs.10 every week, they are 53 of them and I will be contributing Kshs.100 every week and every week we collect Kshs.630. We are also planning to borrow that plot behind the class to do some economic activity. From the funds raised, we help a student who is very promising but is unable to pay.

7. Would you share with me about your learning-related interaction with the students outside class time?

None of the teachers in the study indicated to have academic interactions with the students outside class time. The interactions could only take place in the morning before start of the day’s lessons at 8:00am or in the evening after the lessons at 4:00pm. Before the start of the lessons at 8:00am, the students have a prep time from 7:30, which is too little for any meaningful consultations with the teachers. Besides, many of the teachers in the study and some of the students were commuting by walking or by bicycle riding for 8-10km from their homes. They therefore would arrive at the school exhausted and would utilize the 30 minutes in quick preparation for the day’s lessons. Again, in the evening after classes, interactions were not possible because the school program was for students to go for games or for club activities and they do general cleaning of the school compound up to about 4:45pm after which they go home. However, during revisions for the KCSE, many of the students attempt past paper questions which they bring to the teacher for marking. Boys were reported to be the most aggressive in this type of consultation.

8. Are there any other issues relating to gender and learning of physics that you would like to
share with me?
Appendix E: Students' Questionnaire

This questionnaire invites you to give your experiences relating to the teaching and learning of physics in your class. The information you give will be useful in generating suggestions for improving the practices in teaching of physics in co-educational secondary schools. The questionnaire is confidential and you do not need to indicate your name. Most of the questions ask you to put a tick in appropriate box to show your views. Remember: the study is interested in your views and, your opinions matter, so please try to answer all of the questions and with all honesty.

Sex  Male-----------------Female----------------------Your initials ------------------------

Science subject combination: Physics _______Chemistry _______Biology _______

Please put a tick in the appropriate column to indicate your views about how often your teacher does the following during physics lessons:

<table>
<thead>
<tr>
<th>My physics teacher</th>
<th></th>
<th>Always</th>
<th>Very often</th>
<th>Often</th>
<th>Rarely</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Gives us work to carry out in groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1.2 Ensures that working groups have equal number of students</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1.3 Ensures that working groups have both boys and girls</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1.4 Provides us with a set of clear roles for each member of the group.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5 Teaches in a way that am able to participate in the lesson</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>My physics teacher:</th>
<th></th>
<th>Always</th>
<th>Very often</th>
<th>Often</th>
<th>Rarely</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Encourages us to ask questions and or give our experiences in class.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2 Is open to new ideas and opinions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3 Is concerned when I am not doing well.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4 is willing to answer my questions.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5 Uses gender free examples in class</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>My physics teacher:</th>
<th></th>
<th>Always</th>
<th>Very</th>
<th>Often</th>
<th>Rarel</th>
<th>Not at</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Teaches in a way that am able to participate in the lesson</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1 Relates our personal experiences to the content of the lesson.</td>
<td>y</td>
<td>often</td>
<td>y</td>
<td>all</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
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<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2 Applies learning activities that help us to understand the connection between class material and current issues and problems in our society.</td>
<td>y</td>
<td>very often</td>
<td>y</td>
<td>all</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3 Explains to us how we can use physics knowledge to make a positive change in society.</td>
<td>y</td>
<td>often</td>
<td>y</td>
<td>all</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.4. Encourages us to use physics in action against problems we see in society.</td>
<td>y</td>
<td>very often</td>
<td>y</td>
<td>all</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>My Physics teacher:</th>
<th>Always</th>
<th>Very often</th>
<th>Often</th>
<th>Rarely</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 puts questions that requires us to think.</td>
<td>y</td>
<td>often</td>
<td>y</td>
<td>all</td>
<td></td>
</tr>
<tr>
<td>4.2 Assigns us inquiry laboratory activities.</td>
<td>y</td>
<td>very often</td>
<td>y</td>
<td>all</td>
<td></td>
</tr>
<tr>
<td>4.3 Encourages us to consider views and opinions of others during physics lessons.</td>
<td>y</td>
<td>often</td>
<td>y</td>
<td>all</td>
<td></td>
</tr>
<tr>
<td>4.4 Requires us to reach consensus during group discussions</td>
<td>y</td>
<td>very often</td>
<td>y</td>
<td>all</td>
<td></td>
</tr>
<tr>
<td>4.5 Encourages us to consider issues from a variety of perspectives</td>
<td>y</td>
<td>often</td>
<td>y</td>
<td>all</td>
<td></td>
</tr>
</tbody>
</table>

**Open-ended questions**

1. What made you to decide to study physics?
2. What do you like about your physics teacher?
3. What do you like about the way physics is taught?
4. What don’t you like about your physics teacher?
5. What don’t you like about the teaching of physics?
6. What would you like changed in the way you are taught physics?
7. What things does the physics teacher do to help you participate in learning?

Thank you for your time
## Appendix F: Summary of students’ responses to open-ended questions

<table>
<thead>
<tr>
<th></th>
<th>Female students</th>
<th>Male students</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. What made you to decide to study physics?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like the subject because I get rewarded for excelling in it, I was the best in my class after some test.</td>
<td>It is my favourite subject; I love the subject; easy to understand if concentrated</td>
<td></td>
</tr>
<tr>
<td>I had an attitude towards biology</td>
<td>It is applicable to many careers (to be a doctor, computer engineer, electrical engineer; mechanical engineer; communication engineer)</td>
<td></td>
</tr>
<tr>
<td>I like the teacher who is teaching us – tells us about the positive of physics</td>
<td>When I have no job I can invent my work</td>
<td></td>
</tr>
<tr>
<td>For my career choice (engineer, accountant, a physics teacher)</td>
<td>This is due to techniques used by the teacher</td>
<td></td>
</tr>
<tr>
<td>I like the way our teacher teaches it and makes it enjoyable to me</td>
<td>Encouragement he gave me even though I failed</td>
<td></td>
</tr>
<tr>
<td>Physics is a real life experience subject</td>
<td>Good grade compared to optional biology</td>
<td></td>
</tr>
<tr>
<td><strong>2. What do you like about your physics teacher?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>He is good in the subject</td>
<td>He is very understanding and is very funny</td>
<td></td>
</tr>
<tr>
<td>Honest and kind when teaching</td>
<td>He is very encouraging; has good advice</td>
<td></td>
</tr>
<tr>
<td>Always cares about my educational success</td>
<td>He teaches very well</td>
<td></td>
</tr>
<tr>
<td>He teaches well - Makes us understand</td>
<td>Always ready and willing to answer our questions</td>
<td></td>
</tr>
<tr>
<td>Always encourages me so much; Interested towards my performance</td>
<td>Commitment in the subject, his work and to make us pass; comes to class every time at his lesson</td>
<td></td>
</tr>
<tr>
<td>He has positive attitude; Has good behaviour</td>
<td>uses available and reasonable examples</td>
<td></td>
</tr>
<tr>
<td>He is very positive when teaching and has no favour</td>
<td>He makes a joke</td>
<td></td>
</tr>
<tr>
<td>(4) Asks questions and makes sure he marks all the students books in the class</td>
<td>Gives good examples; gives them correctly, and in a way we understand</td>
<td></td>
</tr>
<tr>
<td><strong>3. What do you like about the teaching of physics?</strong></td>
<td>Cares about student’s academic in physics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Does not favour some students more than others</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Free to all of us</td>
<td></td>
</tr>
<tr>
<td></td>
<td>She is calm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Makes sure students are not doing distractive things like chewing in the classroom</td>
<td>Makes polite corrections</td>
</tr>
<tr>
<td>The way teacher uses of examples in teaching</td>
<td>Explanation of the words and simple notes</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>-------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>The fun, enjoyable &amp; It is of reality</td>
<td>The team work given by the teacher</td>
<td></td>
</tr>
<tr>
<td>It coordinates in real life situation</td>
<td>The teacher tells everyone to do his experiment and answer questions</td>
<td></td>
</tr>
<tr>
<td>It applied many places like washing</td>
<td>Its relation to real life situations e.g. writing</td>
<td></td>
</tr>
<tr>
<td>sufuria in home as a kind of friction</td>
<td>(lighting) fire using friction of a match (stick)</td>
<td></td>
</tr>
<tr>
<td>It has interesting things which help for</td>
<td>box; use of friction in braking a bicycle;</td>
<td></td>
</tr>
<tr>
<td>future studies</td>
<td>connection circuits to light and connecting</td>
<td></td>
</tr>
<tr>
<td>Teacher starts a subtopic in form of a</td>
<td>radios; using wheels to carry heavy goods;</td>
<td></td>
</tr>
<tr>
<td>question making it easier to understand</td>
<td>using a siphon to empty a tank;</td>
<td></td>
</tr>
<tr>
<td>Helps me understand various concepts in</td>
<td>Doing experiments; experiments are very</td>
<td></td>
</tr>
<tr>
<td>life situations</td>
<td>interested</td>
<td></td>
</tr>
<tr>
<td>Giving examples</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. What don’t you like about your teacher?

<table>
<thead>
<tr>
<th>Talking fast</th>
<th>At times he is very boring making people to sleep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quite speed</td>
<td>The teacher comes to class with a very smelly perfume</td>
</tr>
<tr>
<td>Always gives us notes to write from his note book whereas I would prefer to be dictated the notes</td>
<td>Not asking us question what we learn last</td>
</tr>
<tr>
<td>Is harsh to us as students, Harass a student for no apparent good reason; Says that some people are not supposed to do physics although they see physics being easy than biology. Being of bad tempers when notes and homework assignments are not completed</td>
<td>Not use a lot of experiments in class</td>
</tr>
<tr>
<td>Makes a joke on ones idea and one is discouraged</td>
<td>Calling somebody to the blackboard to do something you don’t know</td>
</tr>
<tr>
<td>Give us many questions even when our mind are tired</td>
<td>Sometimes he is gender discriminator</td>
</tr>
<tr>
<td>Teacher not being able to notice when am not feeling well</td>
<td>Discouraging some people by not being gender sensitive to them</td>
</tr>
<tr>
<td>He is never ready to help when you ask him a question, he even sometimes become rude to you</td>
<td>Does not have gender equalization</td>
</tr>
<tr>
<td>He sends some people outside of class because of not attending classes;</td>
<td>Asks questions randomly hence you opt to be attentive in class</td>
</tr>
</tbody>
</table>

5. What don’t you like about the teaching of physics?
A lot of Explaining
Areas where is mathematics
Calculation of mathematical question
Lack of apparatus to do practicals in the lab; inadequate revision text books and copies of the course book.
The twisting of quiz
We don’t (do) experiments as required to do
Many times in exams we are given questions from topics which were not properly understood
We should be tested at the end of every topic to enhance proper understanding
Always lecture to us
Having lessons late in the afternoon

Contains many calculations
Some maths are too difficult
The question that deal with mathematic and formulas
The notes, they sometimes are too long
It is not explained deeply
Use of many laws/principles which need to be directly stated as it is written in the book
Sometimes it is explained mathematically
Asking a person who knows answer
When we don’t know a certain question she starts giving bad names
I don’t like doing without a practical
Slow pace of covering the syllabus

<table>
<thead>
<tr>
<th>6. What would you like changed in the way you are taught physics?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes to be dictated and not telling us to copy from text book</td>
</tr>
<tr>
<td>The teacher not to favour other students</td>
</tr>
<tr>
<td>To be given tests regularly</td>
</tr>
<tr>
<td>I would like to be doing a lot of experiments</td>
</tr>
<tr>
<td>I wish most to use practical experiment</td>
</tr>
<tr>
<td>To be doing more practicals in laboratory</td>
</tr>
<tr>
<td>Use more examples and be expressed (related) to our real life</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7. Anything else you would like to share about teaching and learning of physics.</th>
</tr>
</thead>
<tbody>
<tr>
<td>To have physics contest with other schools</td>
</tr>
<tr>
<td>Use of discussion</td>
</tr>
<tr>
<td>After any topic which has a practical to be carried, we should do it</td>
</tr>
<tr>
<td>More use of experiments and exposure</td>
</tr>
<tr>
<td>We be assisted to know how to do experiments</td>
</tr>
<tr>
<td>The teacher shouldn’t bore the lesson</td>
</tr>
<tr>
<td>Provide us text books for physics</td>
</tr>
<tr>
<td>Group students and give them questions so as when discussing they will be able to know afterwards ask the teacher questions</td>
</tr>
<tr>
<td>We need to do a lot of practicals; All apparatus required should be invented (available) in school</td>
</tr>
<tr>
<td>The teacher should involve students so as to make class interesting</td>
</tr>
<tr>
<td>Working in group for more understanding</td>
</tr>
<tr>
<td>Give us a CAT after every topic we do</td>
</tr>
<tr>
<td>I would like to be doing an exam after a topic</td>
</tr>
<tr>
<td>Give as many sample questions as possible</td>
</tr>
<tr>
<td>Teacher should give students a chance to ask some questions</td>
</tr>
<tr>
<td>I would like physics teacher and students to have different books of physics</td>
</tr>
<tr>
<td>We be going for trip for example to see how a certain machine works as you know it is good to see with fact</td>
</tr>
<tr>
<td>We need more time to cover the syllabus; time should be increased for physics</td>
</tr>
</tbody>
</table>
Appendix G: List of Schools that Participated in the Study

1. Kiguoya Secondary School
2. Mukerenju Secondary School
3. Gitongu Secondary School
4. Gathera Secondary School
5. Ngarariga Secondary School
6. Gatanga Secondary School
7. Gikoe Secondary School
8. Kiairathe Secondary School
10. Mananga Secondary School
11. Naaro Secondary School
12. Kirunguru Secondary School
13. Muruka Secondary School
14. Gitugu Secondary School

NB: School labels in the text of this document are false names
Appendix H: The Murang'a County
Appendix I: Research Authorization Letter

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telephone: 254-020-2133471, 2041249, 254-020-2672550
Mobile: 0713 788 787, 0735 804 246
Fax: 254-20-2133215
When replying please quote
secretary@ncst.go.ke

Our Ref: NCST/RCD/14/013/1137

Dale;
June 2013

Michael Muchoki Waititu
Kenyatta University
P.O Box 43844-00100
Nairobi.

RE: RESEARCH AUTHORIZATION

Following your application dated 19th June, 2013 for authority to carry out research on “Influence of teacher instructional practices on boys’ and girls’ engagement in learning physics: The case of selected secondary schools in Murang’a County, Kenya.” I am pleased to inform you that you have been authorized to undertake research in Murang’a County for a period ending 30th June, 2014.

You are advised to report to the County Commissioner and County Director of Education, Murang’a County before embarking on the research project.

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

DR. M. K. RUGUTT, PhD, HSC.
DEPUTY COUNCIL SECRETARY

Copy to:
The County Commissioner
The County Director of Education
Murang’a County.

The National Council for Science and Technology is Committed to the Promotion of Science and Technology for National Development.

Appendix J: Research Permit
THIS IS TO CERTIFY THAT:
Prof./Dr./Mr./Mrs./Miss/Institution
Michael Muchoki Waititu
of (Address) Kenyatta University
P.O Box 43844-00100, Nairobi.
has been permitted to conduct research in

Location
District
County

on the topic: Influence of teacher instructional practices on boys' and girls' engagement in learning physics: The case of selected secondary schools in Murang'a County, Kenya.

for a period ending: 30th June, 2014.