STATUS OF INFORMATION COMMUNICATION TECHNOLOGY INTEGRATION IN MATHEMATICS TEACHING: A CASE OF PUBLIC SECONDARY SCHOOLS IN MOGOTIO DISTRICT, BARINGO COUNTY, KENYA

BY

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OCTOBER, 2013
DECLARATION

This project is my original work and has not been presented for a degree in any other University or for any other award.

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DEDICATION

This work is dedicated first, to my wife for her encouragement, advice and patience from the time I undertook this course to the time of writing this project. Secondly, to my lovely children Charity, David and Kevin for their persistent prayers and wishes of success in all my endeavors.
ACKNOWLEDGEMENTS

My deepest appreciation goes to my two supervisors; Prof. Jack G. Okech and Dr. Charles M. Magoma whose critical review of my write-ups enabled me to reach this far. I am grateful to my employer (TSC) for granting me a study leave to pursue my studies. My lecturers and student colleagues in the Curriculum Development class (2011) also deserve a special mention for the useful guidance and discussions that helped to shape my topic. I would like to absolve all individuals and institutions mentioned above for any errors of omission and/or commission or any interpretational error(s). I am solely responsible for these.
# TABLE OF CONTENT

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECLARATION</td>
<td>ii</td>
</tr>
<tr>
<td>DEDICATION</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>iv</td>
</tr>
<tr>
<td>TABLE OF CONTENT</td>
<td>v</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>viii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>ix</td>
</tr>
<tr>
<td>ABBREVIATIONS AND ACRONYMS</td>
<td>x</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>xi</td>
</tr>
<tr>
<td>CHAPTER ONE: INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Background to the Study</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Statement of the Problem</td>
<td>8</td>
</tr>
<tr>
<td>1.3 Purpose of the Study</td>
<td>9</td>
</tr>
<tr>
<td>1.4 Objectives of the Study</td>
<td>10</td>
</tr>
<tr>
<td>1.5 Research Questions</td>
<td>10</td>
</tr>
<tr>
<td>1.6 Assumptions of the Study</td>
<td>11</td>
</tr>
<tr>
<td>1.7 Limitations of the Study</td>
<td>11</td>
</tr>
<tr>
<td>1.8 Delimitations of the Study</td>
<td>11</td>
</tr>
<tr>
<td>1.9 Significance of the Study</td>
<td>12</td>
</tr>
<tr>
<td>1.10 Theoretical Framework</td>
<td>12</td>
</tr>
<tr>
<td>1.11 Conceptual Framework</td>
<td>13</td>
</tr>
<tr>
<td>1.12 Operational Definitions of Significant Terms</td>
<td>15</td>
</tr>
<tr>
<td>CHAPTER TWO: LITERATURE REVIEW</td>
<td>16</td>
</tr>
<tr>
<td>2.1 Integration of ICTs in Teaching and Learning</td>
<td>16</td>
</tr>
<tr>
<td>2.2 E-Readiness Status of Schools in the World</td>
<td>18</td>
</tr>
<tr>
<td>2.3 Integration of ICTs in Mathematics Teaching and Learning</td>
<td>21</td>
</tr>
<tr>
<td>2.4 Teachers’ Attitudes towards the Use of ICTs in Mathematics Instruction</td>
<td>23</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>2.5 Factors Inhibiting ICT Use in Mathematics Classrooms</td>
<td>24</td>
</tr>
<tr>
<td>2.6 Summary of Literature Review</td>
<td>26</td>
</tr>
<tr>
<td>CHAPTER THREE: METHODOLOGY</td>
<td>28</td>
</tr>
<tr>
<td>3.1 Research Design</td>
<td>28</td>
</tr>
<tr>
<td>3.2 Location of Study</td>
<td>28</td>
</tr>
<tr>
<td>3.3 Target Population</td>
<td>29</td>
</tr>
<tr>
<td>3.4 Sample and Sampling Procedures</td>
<td>29</td>
</tr>
<tr>
<td>3.5 Research Instruments</td>
<td>30</td>
</tr>
<tr>
<td>3.6.1 Questionnaires</td>
<td>30</td>
</tr>
<tr>
<td>3.6.2 Observation Schedule</td>
<td>30</td>
</tr>
<tr>
<td>3.7 Pilot Study</td>
<td>31</td>
</tr>
<tr>
<td>3.7.1 Validity of the instruments</td>
<td>31</td>
</tr>
<tr>
<td>3.7.2 Reliability of the instruments</td>
<td>32</td>
</tr>
<tr>
<td>3.8 Data Collection procedures</td>
<td>32</td>
</tr>
<tr>
<td>3.9 Data Analysis</td>
<td>33</td>
</tr>
<tr>
<td>CHAPTER FOUR: DATA PRESENTATION, ANALYSIS AND DISCUSSION</td>
<td>34</td>
</tr>
<tr>
<td>4.1 Demographic Information of the Respondents</td>
<td>34</td>
</tr>
<tr>
<td>4.2 Infrastructure for Integrating ICTs in Mathematics Teaching</td>
<td>35</td>
</tr>
<tr>
<td>4.3 Teachers’ Skills and Training for Integrating ICTs in Mathematics Teaching</td>
<td>37</td>
</tr>
<tr>
<td>4.4 Teachers’ Attitudes towards the Use of ICTs in Mathematics Instruction</td>
<td>38</td>
</tr>
<tr>
<td>4.5 Hindrances to Teachers’ Integration of ICTs in Mathematics Teaching</td>
<td>40</td>
</tr>
<tr>
<td>CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS</td>
<td>42</td>
</tr>
<tr>
<td>5.1 Summary of the Research Findings</td>
<td>42</td>
</tr>
<tr>
<td>5.2 Conclusion of the study</td>
<td>43</td>
</tr>
<tr>
<td>5.3 Recommendations</td>
<td>44</td>
</tr>
<tr>
<td>5.4 Suggestions for Further Research</td>
<td>45</td>
</tr>
</tbody>
</table>
REFERENCES ............................................................................................................................................. 46

APPENDICES: .......................................................................................................................................... 50
APPENDIX I: Questionnaire for Headteachers ......................................................................................... 50
APPENDIX II: Questionnaire for Teachers ................................................................................................. 56
APPENDIX III: Observation Schedule ........................................................................................................ 61
APPENDIX IV: Research Timetable ........................................................................................................... 62
APPENDIX V: Research Budget .................................................................................................................. 63
APPENDIX VI: Research Permit From NCST ............................................................................................. 64
APPENDIX VII: Research Permit from Mogotio District Education Office .............................................. 65
APPENDIX VIII: Research Permit ............................................................................................................... 66
<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Mogotio District Performance in Mathematics Subject from 2007-2011</td>
<td>8</td>
</tr>
<tr>
<td>4.1</td>
<td>Extent of ICTs Integration in Mathematics Teaching</td>
<td>38</td>
</tr>
<tr>
<td>4.2</td>
<td>Benefits of Integrating ICTs in Mathematics Teaching</td>
<td>39</td>
</tr>
<tr>
<td>4.3</td>
<td>Hindrances to ICTs Integration in Mathematics Teaching</td>
<td>40</td>
</tr>
<tr>
<td>4.4</td>
<td>Measures to Hasten ICTs Integration in Mathematics Teaching</td>
<td>41</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

Figure 1.1: Theoretical Framework showing how an Innovation is Perceived and Interpreted by the User ................................................................. 13

Figure 1.2: Conceptual Framework Showing Impact of ICT integration in Mathematics Instruction ........................................................................... 14

Figure 4.1: Number of Computer Laboratories in Secondary Schools ................................................. 35

Figure 4.2: Teachers with ICT Skills ....................................................................................................... 37
# ABBREVIATIONS AND ACRONYMS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAS</td>
<td>Computer Algebra Systems</td>
</tr>
<tr>
<td>CSFK</td>
<td>Computer for Schools Kenya</td>
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<tr>
<td>ERSWEC</td>
<td>Economic Recovery Strategy for Wealth and Employment Creation</td>
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<tr>
<td>ICT</td>
<td>Information and Communication Technology</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>KENET</td>
<td>Kenya Educational Network</td>
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<td>KESSP</td>
<td>Kenya Education Sector Support Program</td>
</tr>
<tr>
<td>KIE</td>
<td>Kenya Institute of Education</td>
</tr>
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<td>MDGs</td>
<td>Millennium Development Goals</td>
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<tr>
<td>MoE</td>
<td>Ministry of Education</td>
</tr>
<tr>
<td>PEOU</td>
<td>Perceived Ease of Use</td>
</tr>
<tr>
<td>PU</td>
<td>Perceived Usefulness</td>
</tr>
<tr>
<td>R &amp; D</td>
<td>Research and Development</td>
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<tr>
<td>SMASSE</td>
<td>Strengthening of Mathematics and Science in Secondary School Education</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
</tr>
<tr>
<td>TAM</td>
<td>Technology Acceptance Model</td>
</tr>
<tr>
<td>TSC</td>
<td>Teachers Service Commission</td>
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<tr>
<td>UNESCO</td>
<td>United Nations Education, Scientific and Cultural Organization</td>
</tr>
</tbody>
</table>
ABSTRACT

This study sought to investigate the status of readiness of public secondary schools in Mogotio District of Baringo County to integrate Information and Communication Technologies (ICTs) in Mathematics teaching. The study was guided by the following specific objectives: To assess the availability of ICT infrastructure like computer laboratories, computer hardware and software programs for integrating ICTs in Mathematics teaching in the schools; to establish the teachers’ readiness in terms of skills and training for integrating ICTs in the teaching of Mathematics; to determine the teachers’ attitudes towards the use of ICTs in Mathematics instruction; and to establish the hindrances that teachers are encountering in the integration of ICTs in the teaching of Mathematics in the schools. The study employed a descriptive survey design. Head teachers and Mathematics teachers of public secondary schools in the district were targeted. Systematic sampling technique was used to select 10 (45.45%) schools from a list of 22 public secondary schools obtained from Mogotio District Education Office. From the 10 sampled schools, all the 10 (45.45%) head teachers and all the 24 (60%) Mathematics teachers were purposively sampled to participate in the study. Questionnaires and an observation schedule were used to collect data. After coding the responses, data was entered into the Statistical Package for Social Sciences (SPSS) computer program. Descriptive statistics such as frequencies and percentages were used to analyze the data quantitatively. Qualitative data obtained from the open-ended questions was analyzed according to themes based on the study objectives. Analyzed data was presented using tables and charts. The findings of this study revealed that public secondary schools in Mogotio District are inadequately equipped with ICT facilities and equipment. In addition, most of the schools lack software, application programmes and digital content necessary for integration of ICTs in Mathematics. The following recommendations were made: Education stakeholders in the district should finance the provision of ICT facilities and digital equipment in public secondary schools; MoE should provide standardized mathematical software, application programmes and digital content to all schools to enable them implement effective ICTs integration in Mathematics teaching with ease; the SMASSE programme in Mogotio District should be encouraged, expanded and recommended to all the teachers and education managers because of its noted success in equipping Mathematics teachers with skills and attitudes necessary for ICTs integration in Mathematics teaching; and lastly, the government should increase its allocation in tuition fees and encourage schools to have a specific vote head for ICT integration so as to ensure reliable funding of ICT initiatives and projects by schools.
CHAPTER ONE
INTRODUCTION

This chapter looks into the background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, assumptions of the study, limitations of the study, delimitations of the study, significance of the study, theoretical and the conceptual framework.

1.1 Background to the Study

The use of Information Communication Technologies (ICTs) in the Mathematics classroom has long been a topic for consideration by Mathematics educators. In recent years, it has increasingly become evident that the use of ICTs together with skilful scaffolding by the teacher enhances the learning of Science and Mathematics and any other areas that are generally abstract or have a high cognitive demand for the students (Cox, et al, 2001).

According Polonoli (2001) and Goddard (2002) public perception also has it that ICTs like the computer represents both an excellent curricula tool and revolutionary classroom approach that can help students to realize important gains in learning and understanding of mathematical concepts. It is thus viewed as a powerful and realistic tool for the classroom and as having the potential of making teachers’ work easier and more efficient (Pelgrum, 2001; Kozma and Anderson, 2002).

Ittigson and Zewe (2003) posit that ICT supports constructivist pedagogy, wherein students use technology to explore and reach an understanding of mathematical concepts. This approach promotes higher order thinking and better problem solving strategies. Students can therefore use technology to concentrate on problem-solving processes rather than on
calculations related to the problems. Becta (2003) also lists out some key benefits of ICT as: It promotes greater collaboration among students and encourages communication and the sharing of knowledge; ICT gives rapid and accurate feedbacks to students and this contributes towards positive motivation; It allows students to focus on strategies and interpretations of answers rather than spend time on tedious computational calculations.

Some examples of ICT use in Mathematics include: portables, graphic calculators and computerized graphing, specialized software, programmable toys or floor robots, spreadsheets and databases. A range of portable devices exists which allow pupils to collect data, and manipulate it using spreadsheets and databases for work in numeracy. Some of these portable equipment also enable the study of Mathematics to move out of the classroom and to incorporate fieldwork investigations (Moseley and Higgins, 1999). The use of graphic calculators and computerized graphing in Mathematics speeds up the graphing process, freeing people to analyze and reflect on the relationships between data (Hennessy, Fung & Scanlon, 2001).

Specialized software such as Computer Algebra Systems (CAS), Dynamic Geometry Systems (DGS) and Mathematics curriculum software improve pupils' skills and understanding in algebra, allows pupils to manipulate and measure shapes leading to higher level of learning among them (Hennessy, et al. 2001; Clements, 2000). Programmable toys or floor robots controlled by instructions in programming languages (usually logo) were one of the earliest applications of ICT to mathematics, and where used were the cause of significant changes in mathematics teaching (Becta, 2003). Logo encourages pupils to
develop problem-solving skills, leads them to develop higher levels of mathematical thinking as well as learn geometric concepts (Clements, 2000).

The problem of effective ICT integration into the teaching of Mathematics is a complex innovation for teachers. They do not only need to have competent knowledge of teaching Mathematics but also need to be competent in the pedagogical use of ICTs in addition to having access to appropriate ICT tools (Voogt, 2008). Many studies have shown several obstacles that teachers experience in the integration of ICT in their classrooms. Jones (2004) found a number of barriers for the integration of ICT into lessons and listed them as: Lack of confidence among teachers during integration; lack of access to resources; lack of time for the integration; lack of effective training; facing technical problems while the software is in use; lack of personal access during lesson preparation; and the age of the teachers.

Snoeyink and Ertmer (2002) also identified other barriers to the integration of ICTs into Mathematics lesson as lack of computers, lack of quality software, teacher attitudes towards computers, poor funding, resistance to change, poor administrative support, lack of computer skill, poor fit with curriculum, scheduling difficulties, poor training opportunities, and lack of vision as to how to integrate ICT in instruction. It is evident that all these barriers relates to ICT infrastructure, teachers’ skills to integrate the ICTs in subject teaching and teachers attitude towards ICT use in instruction. This study seeks to assess how public secondary schools in Mogotio District are prepared with regard to integration of ICTs in the teaching of Mathematics.
Mathematics in Kenya is a core subject and a critical filter for career choices. However, student performance in the Kenya Certificate of Secondary Education examination (K.C.S.E) has been dismal over the years. According to Mogotio District Kenya National Examination Council (KNEC) Mathematics analysis as depicted in figure 1.1, the formidable problem currently facing Mathematics education in Kenya is therefore the need to improve the students’ performance in Mathematics.

According to Strengthening of Mathematics and Science in Secondary School Education (SMASSE) Report of 2008, the poor results have been attributed to various causes ranging from lack of learning materials and poor teaching methods to psychological factors like poor attitude towards the subject. To redress these causes, the Ministry of Education and other stakeholders have embarked on various large-scale capacity building seminars and workshops that are aimed at strengthening the teaching of Mathematics and the Sciences in Kenyan secondary schools. In 1998, SMASSE was piloted in nine of the former 65 Districts.

In 2003, the programme was implemented nationwide with the hope of solving pedagogical issues that have contributed to poor performance in Mathematics and science subjects over the years. The government has also allocated grants to public secondary schools for the purchase of basic resources like textbooks. The Ministry of Education (MoE) also introduced the use of scientific calculators for instruction and examination of candidates at KCSE aimed at enhancing performance in the subject (MoE, 2005). The SMASSE has also been in the forefront in advocating for the integration of ICTs in the teaching of Mathematics and sciences in secondary schools in the country. All these initiatives are
expected to yield outstanding results in the subject in terms of solving perennial problems inherent in the subject.

As pertains to policy and efforts to leverage use of ICTs in education, Kenya drafted an ICT policy in January 2006. Some of the strategies proposed in the growth and implementation of ICT in education are that the government will:

i. Promote the development, sharing and integration of E-learning resources to address the educational needs of primary, secondary and tertiary institutions.

ii. Enhance the dissemination of E-learning initiatives through provision of affordable infrastructure (Republic of Kenya, 2006a).

The ICTs in Education Options paper for the Ministry of Education, Science and Technology (MOEST) discusses the ways in which ICTs can be leveraged to support and improve the delivery of quality education for all Kenyans (Republic of Kenya, 2006a). The ideas presented here respond to the educational priorities outlined in Sessional Paper No. 1 of 2005 and the Kenya Education Sector Support Program (KESSP). The KESSP provides a roadmap for investment in E-learning and suggests provisional budgets to support educational activities. E-learning is identified in the following investment programs:

i. Primary Teacher In-service Training: This program aims at in-servicing teacher trainers on E-learning methodologies so that teachers can be equipped with the skills on how to integrate ICT in education; and

ii. ICT in Education Investment Program: This program outlines the strategies and policies that will foster E-learning delivery systems, build the necessary capacity and
promote the development of required ICT infrastructure and institutional management systems (Republic of Kenya, 2005b).

The Ministry of Education in collaboration with the private sector through the Kenya ICT Trust Fund developed a National ICT Strategy for Education and Training aimed at making ICT integration possible at all levels of education and training. The strategy outlines how Information and Communication Technology will be adopted and utilized to improve access, quality and equity in the delivery of education services in Kenya. It identifies the strategic pillars for sector ICT implementation as: establishment of a policy framework; digital equipments; connectivity and network infrastructure; technical support; harnessing emerging technologies; digital content development; integration of ICTs in education; training (capacity building including professional development); research and development; partnership and resource mobilization; legal and regulatory framework and monitoring and evaluation (Republic of Kenya, 2006b).

Other efforts include equipping of over 450 secondary schools with computers and provision of Ksh. 213 million by the government to 142 secondary schools to purchase computers. Education and Energy ministries in conjunction with the government of Finland have also embarked on a program to supply rural public secondary schools with power and internet connection (International Conference on ICT Development, Education and Training E-learning in Africa, 2007).
E-content is also now available and a curriculum innovation centre was launched at K.I.E in March, 2010 for purposes of enhancing curriculum delivery (ICWE, 2010). All these reflect the seriousness with which the government treats inclusion of ICT in classroom instruction. According to Kenya ICT 4E situational analysis (2009), the following achievements have also been realized: Ministry of education (MOE) has disbursed Ksh1.5 million to 213 schools evenly distributed across the country to be used to acquire 25 new computers per school, 1 printer per school, educational software and sensitize ICT teachers on technical maintenance. Computers for Schools Kenya (CFSK) reported to have installed 18,000 computers in over 600 schools with 20 computers per school.

The ICT Trust Fund has provided 200 schools with 20 computers each. The NEPAD e-schools project provided 6 schools with 20 computers each. The Rural School Project has provided 4,500 computers to a number of unidentified schools. Overall, the analysis indicated that 15,450 computers have been disbursed to 1,300 secondary schools out of over 4,000 schools. The government has also made effort to engage the private sector in the provision of laptops with the ICT integration team providing specifications and ensuring quality of laptops with the wider ICT integration agenda. Loans have also been availed by Teachers Service Commission (T.S.C) to teachers for laptop acquisition and subsequently recovered through check off systems. The purpose is to encourage teachers to use modern and dynamic educational tools (Kenya ICT 4E Situational Analysis, 2009).

Despite the aforementioned initiatives and efforts to leverage use of ICTs in public secondary schools in Kenya and the fact that research has clearly shown that ICTs increase
access to instructional materials and provides several other benefits that can enhance the teaching and performance of Mathematics, public secondary schools in Mogotio District of Baringo County are still registering poor results in Mathematics examinations as shown in Table 1.1.

**Table 1.1: Mogotio District Performance in Mathematics Subject from 2007-2011**

<table>
<thead>
<tr>
<th>Year</th>
<th>Performance in Mean Score</th>
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<tbody>
<tr>
<td>2011</td>
<td>3.313</td>
</tr>
<tr>
<td>2010</td>
<td>3.688</td>
</tr>
<tr>
<td>2009</td>
<td>3.089</td>
</tr>
<tr>
<td>2008</td>
<td>3.831</td>
</tr>
<tr>
<td>2007</td>
<td>3.128</td>
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</table>

*Source: Mogotio District Education Office*

This study therefore sought to assess the readiness of the schools to integrate ICTs in the teaching of Mathematics by investigating the availability of ICT infrastructure in the schools, teachers ICTs integration skills, teachers' attitudes towards the use of ICTs in Mathematics instruction, and the hindrances faced in the course of integration.

**1.2 Statement of the Problem**

Many efforts have been made by the Government of Kenya to improve the declining performance in KCSE Mathematics examinations. This includes initiatives such as inservicing of Mathematics teachers through the SMASSE project that started in 2003 and
which has been advocating for among other strategies the integration of ICTs in the teaching of Mathematics and Sciences. Besides, the Ministry of Education has launched a national ICT policy to integrate computers in classroom instruction. An effort has also been made to introduce computers in secondary school curricula including Mathematics instruction in some schools (Kenya ICT 4E situational analysis, 2009). Despite these efforts, Mathematics performance in public secondary schools in Mogotio District of Baringo County has continued to be poor as shown in Table 1.1, raising some concerns over the institutions' readiness to adopt the strategies that have been identified as being capable of enhancing instruction and performance of the subject. This study was concerned with the readiness of the institutions to integrate ICT tools in the teaching of Mathematics because ICTs have been proven to enhance access to instructional materials that are crucial in the performance of the subject. The study was especially concerned with the readiness as pertains to infrastructure, teachers' integration skills, and teachers' attitudes required in order to realize the full benefits of ICTs use to enhance performance in Mathematics. Studies by Jones (2004) and Snoeyink and Ertmer (2002) have alluded to the three variables as the main impediments to the integration of ICTs in subject teaching. Against this backdrop, the study sought to investigate the question: What is the readiness status of public secondary schools in Mogotio District to integrate ICTs in Mathematics teaching?

1.3 Purpose of the Study

The study sought to investigate the readiness of public secondary schools in Mogotio District of Baringo County to integrate ICTs in the teaching of Mathematics.
1.4 Objectives of the Study

This study was guided by the following objectives:

i. To assess the availability of ICT infrastructure (like computer laboratories, computer hardware and software programs) for integrating ICTs in Mathematics teaching in the schools;

ii. To establish the teachers' readiness in terms of skills and training for integrating ICTs in the teaching of Mathematics;

iii. To determine the teachers' attitudes towards the use of ICTs in Mathematics instruction; and

iv. To establish the hindrances that teachers are encountering in the integration of ICTs in the teaching of Mathematics in the schools.

1.5 Research Questions

The study sought to answer the following research questions:

i. What is the status of ICT infrastructure (like computer laboratories, computer hardware and software programs) for integrating ICTs in Mathematics teaching in the schools?

ii. What is the status of teachers' readiness in terms of skills and training for integrating ICTs in the teaching of Mathematics?

iii. What are the teachers' attitudes towards the use of ICTs in Mathematics instruction?

iv. What hindrances are the teachers encountering in the integration of ICTs in the teaching of Mathematics in the schools?
1.6 Assumptions of the Study

The following were the assumptions of the current study:

i. Secondary schools in Mogotio District had integrated ICTs in their teaching of Mathematics;

ii. Teachers had knowledge in using ICTs to give instructions in the teaching of Mathematics;

iii. Students had been taught how to use ICTs to receive instructions and use computer interactive mode of study; and

iv. Some secondary schools were not ready to integrate ICTs in the teaching of Mathematics.

1.7 Limitations of the Study

i. The study was limited to the availability of funds and time, thus a small sample of public secondary schools in Mogotio District was involved in the study.

ii. There was limited literature on Kenya secondary sector readiness to integrate ICTs in Mathematics teaching leading to difficulty in literature review for the study.

1.8 Delimitations of the Study

i. The study was delimited to public secondary schools because they are beneficiaries of Ministry of Education Computerization Project.

ii. The study was delimited to a small sample of public secondary schools in Mogotio District due to financial and time constraints.
1.9 Significance of the Study

The study findings are expected to be useful to the government, educators and curriculum specialists in Kenya in identification of barriers that limit the adoption of ICT by the public secondary schools for Mathematics instructional purposes. The study findings will also bring to the fore the level of ICT adoption in public secondary schools in Mogotio District and thus help the policy makers and planners in ICT policy formulation and implementation to revise the existing ICT policy to tackle the challenges affecting ICT adoption and use in schools in the country. The study will also contribute knowledge to the area of ICT integration in Mathematics teaching that can be useful to other scholars.

1.10 Theoretical Framework

This study was informed by the Technology Adoption Model (TAM) which is an information systems theory that models how users come to accept and use a technology. The model suggests that when users are presented with a new technology, a number of factors influence their decision about how and when they will use it. Technology Adoption Model (TAM) was developed by Fred Davis and Richard Bagozzi (Bagozzi et al., 1992; Davis et al., 1989). The TAM proposes two specific beliefs namely, perceived ease of use (PEOU) and perceived usefulness (PU) - that determine one’s behavioral intention to use technology as shown in figure below.
The theory was suited for the current study because it sought to investigate the readiness of public secondary schools to integrate ICTs in the teaching of Mathematics which has been proposed as one of the strategies that can enhance availability of instructional materials that are crucial for improving the performance of the subject.

1.11 Conceptual Framework

Research has consistently shown that the use of ICTs together with skilful scaffolding by the teacher enhances the learning of Mathematics and Science and any other areas that are generally abstract or have a high cognitive demand for the students (Cox, et al, 2001). ICTs have also been said to increase access to instructional materials as well as support constructivist pedagogy, wherein students use technology to explore and reach an understanding of mathematical concepts (Ittigson and Zewe, 2003). The conceptual framework shown in Fig 1.1 gives the desired impact of ICT integration in Mathematics teaching in secondary schools.
The above conceptual framework shows that when ICTs infrastructure are availed, teachers' ICT integration skills and their attitudes towards ICT use in Mathematics instruction; factors which are viewed as the independent variables (IV) are enhanced and supported by management support of ICTs and favorable ICT policies viewed as the intervening variables, then the performance of Mathematics in the public secondary schools can be enhanced through effective teaching of Mathematics which is the dependent variable (DV) of the study.
1.12 Operational Definitions of Significant Terms

**Computer**- An electronic device used for storing and processing data, making calculations and controlling machinery.

**Connectivity**- How are works easy and affordable to access and use.

**E-learning**- The ability to electronically transfer, manage, support and supervise learning.

**Information Communication Technologies**- Tools which allow digitized information technology.

**Infrastructure**- Computer hardware, software and network connections that can take advantage of the existing digital resources and to create new digital resources in schools.

**E-readiness**- The state in which an institution is prepared to use and benefit from information technology.
CHAPTER TWO
LITERATURE REVIEW

This chapter reviews literature related to the study. Literature has been reviewed on integration of ICTs in teaching and learning; e-readiness status of schools in the world; integration of ICTs in Mathematics teaching and learning; teachers' attitudes towards the use of ICTs in Mathematics instruction; factors inhibiting ICT use in Mathematics classrooms; and lastly, a summary of the literature reviewed is given.

2.1 Integration of ICTs in Teaching and Learning

The field of education has been affected by ICTs, which have undoubtedly affected teaching and learning. Yusuf (2005) observes that ICTs have the potential to accelerate, enrich, and deepen skills, to motivate and engage students, to help relate school experience to work practices, create economic viability for tomorrow's workers, as well as strengthening teaching and helping schools change.

Conventional teaching has emphasized content. For many years, courses have been written around textbooks. Teachers have taught through lectures and presentations interspersed with tutorials and learning activities designed to consolidate and rehearse the content. Contemporary settings are now favoring curricula that promote competency and performance. Curricula are starting to emphasize capabilities and to be concerned more with how the information will be used than with what the information is. Contemporary ICTs are able to provide strong support for all these requirements and there are now many outstanding examples of world class settings for competency and performance-based...
curricula that make sound use of the affordances of these technologies (Oliver, 2000). The integration of information and communication technologies can help revitalize teachers and students. This can help to improve and develop the quality of education by providing curricular support in difficult subject areas.

According to Oliver the flexibility time-space accounted for by the integration of ICT into teaching and learning processes contributes to increase the interaction and reception of information. Such possibilities suggest changes in the communication models and the teaching and learning methods used by teachers, giving way to new scenarios which favor both individual and collaborative learning. The ICTs by their very nature are tools that encourage and support independent learning. Students using ICTs for learning purposes become immersed in the process of learning and as more and more students use computers as information sources and cognitive tools (Reeves & Jonassen, 1996), the influence of the technology on supporting how students learn will continue to increase.

In the past, the conventional process of teaching has revolved around teachers planning and leading students through a series of instructional sequences to achieve a desired learning outcome. Typically these forms of teaching have revolved around the planned transmission of a body of knowledge followed by some forms of interaction with the content as a means to consolidate the knowledge acquisition. Contemporary learning theory is based on the notion that learning is an active process of constructing knowledge rather than acquiring knowledge and that instruction is the process by which this knowledge construction is supported rather than a process of knowledge transmission (Duffy & Cunningham, 1996). In
this domain learning is viewed as the construction of meaning rather than as the memorization of facts (Jonassen & Reeves, 1996). Learning approaches using contemporary ICTs provide many opportunities for constructivist learning through their provision and support for resource-based, student centered settings and by enabling learning to be related to context and to practice (Barron, 1998).

Elina (2008) observes that in a study carried out in Romania between August 2007 and May 2008, to investigate ICT use in education, 7 out of 10 teachers preferred to teach using computers. The teachers linked good performance in their disciplines to use of ICT. This study indicated that students considered the most important effect of using ICT for school lessons as a simplified learning process followed by easier understanding of content.

2.2 E-Readiness Status of Schools in the World

According to the US Department of Education (1996) by 1996, 91% of secondary schools in USA were using computers, 62% were using advanced telecommunications and 73% had integrated technology into school curriculum. In Spain, the penetration of IT in primary and secondary schools is very close to a 100% in urban areas and only schools located in isolated rural zones are unequipped (Betty, 1994).

In the Caribbean, Gaible (2008) noted that the base of ICT infrastructure in schools has the potential to contribute to education system more effective response to policy goals and to internal and external forces affecting the Caribbean today. Most secondary schools and some primary schools provide access to computers and, where the telecommunications systems
permit, to the Internet. Several countries- Jamaica, Trinidad and Tobago, Barbados and others- have major technology implementations in process or nearing completion. However, the study concludes that computers and the Internet have had limited impact in Caribbean primary and secondary education beyond serving as a base supporting students achievement on the practical portions of the Information Technology examinations. Major barriers to effective education, such as teacher's capacity, the relevance of the curriculum, information management, and graduates' competencies have not been affected by the past decade's investments in ICTs.

In terms of ICT Infrastructure for education in Africa, Farrell and Shafika (2007) noted that most countries have or are in the process of liberalizing their telecommunications policies to enable more competition and diversity of service providers in the industry. While this is having the effect of lowering the cost of access to information and telecommunication infrastructure, the cost of connectivity remain unaffordable for most educational institutions. Furthermore, there are huge gaps between urban and rural areas in terms of access to ICT infrastructure. For the case of infrastructure in schools, Farrell and Shafika (2007) observed that African Ministries of Education have begun to be more proactive in coordinating and leading the development of ICT infrastructure in schools systems as their ICT policies and implementation plans have taken shape. However, civil society, principally the Non Governmental Organizations (NGOs) working with donor agencies, continue to play a major role in providing computers to schools and lobbying governments to take a leading role.
As pertains to teacher professional development, the authors note that most countries have had some investment in developing the capacity of teachers to use ICTs as a teaching and learning resource through both in-service and pre-service programmes. Most teacher training programmes in Africa involve the development of basic ICT skills, sometimes as an end in itself, although in some cases these include the application of ICTs as learning tools for teachers.

In Kenya, a survey of ICT and education showed that very few secondary schools had sufficient ICT tools for teachers and students and even in schools that had computers, the student-computer ratio was 150:1 (Farrell, 2007). In addition, a study by Wabuye (2003) indicated that while ICT has penetrated many sectors including banking, transportation, communications, and medical services, the Kenyan educational system seems to lag behind. The study found that computer use in Kenyan classrooms is still in its early phases, and concluded that the perceptions and experiences of teachers and administrators do play an important role in the use of computers in Kenyan classrooms. Kenya School Net (2003) also found out that although schools were aware of benefits of computers, only a few had them.

Farrell (2007) observes that the education sector in Kenya lacks adequate connectivity and network infrastructure although a small number of schools have direct access to high speed connectivity through Internet service providers. These limitations notwithstanding, there is some hope as noted by Point (2008) who points out that Kenya has become the third African country to launch ICT in education facilities in secondary schools after South Africa and Nigeria. In its article, Point states that the program sponsored by Intel, aims at equipping
schools to use computers and wireless connectivity for all types of class work. The new program aims to replace the blackboard with touch screen and students to send their work to teachers through wireless connectivity. However, rolling of this program may not be effective in rural areas since they lack the basic infrastructure to enhance this type of learning.

2.3 Integration of ICTs in Mathematics Teaching and Learning

Ittigson and Zewe (2003) observed that technology is essential in teaching and learning Mathematics. The two note that ICT improves the way Mathematics should be taught and enhances student understanding of basic concepts. Becta (2003) summarized the key benefits of integrating ICTs in Mathematics teaching as: ICT promotes greater collaboration among students and encourages communication and the sharing of knowledge; it gives rapid and accurate feedbacks to students and this contributes towards positive motivation; it allows them to focus on strategies and interpretations of answers rather than spend time on tedious computational calculations and it also supports constructivist pedagogy, wherein students use technology to explore and reach an understanding of mathematical concepts. This approach promotes higher order thinking and better problem solving strategies which are key in learning Mathematics.

According to Keong, Horani and Daniel (2005) for a successful integration of ICT into the Mathematics curriculum, it is essential to have knowledge of the existing software that is used by Mathematics teachers. A survey carried out by Forgasz and Prince (2002) found that 61% of the respondents (teachers) used spreadsheets, 45% used word processing and 30%
used Internet browsers. In the same survey, it was found that 19% used Geometer's sketchpads, 19% used CD-ROMs that accompanied Mathematics textbooks, 18% used Graphmatica, 14% used Maths Blaster and 8% used other mathematics-specific software. Keong et al, however, notes that knowledge of the use of software on the part of the teachers is not the only criterion for integrating ICT into Mathematics lessons. The authors observe that a sound pedagogical knowledge on how to integrate it is another critical success factor. Amarasinghe and Lambdin (2000) described three different varieties of technology usage: Using technology as a data analysis tool; using technology as a problem-solving/mathematical modeling tool; and using technology to integrate Mathematics with a context. Meanwhile Balacheff and Kaput (1996) have discussed the impact of technological forces on learning and teaching Mathematics. These researchers argued that with the introduction of technology, it is possible to de-emphasize algorithmic skills; the resulting void may be filled by an increased emphasis on the development of mathematical concepts.

Technology saves time and gives students access to powerful new ways to explore concepts at a depth that has not been possible in the past. The power of computers leads to fundamental changes in Mathematics instruction. For example, the ability to build and run complex mathematical models, and easy exploration of "what if" questions through parametric variation has opened up new avenues for Mathematics (Dreyfus, 1991). Furthermore, as Munirah (1996) observes, the teaching of calculus has seen a dramatic change now that activities such as exploring Mata or graphical data analysis have been revolutionized by the computer technology. It is also reported that weaker students often are
better able to succeed with the help of technology, and thereby come to recognize that Mathematics is not just for their more able classmates (Wimbish, 1992).

2.4 Teachers’ Attitudes towards the Use of ICTs in Mathematics Instruction

Attitude has been defined as an inclination to act or to be in a state of ‘readiness’ to act (Gagne, 1985). A positive attitude arises due to previous successful experiences or from a perception that success is possible. The Technology Acceptance Model (TAM) by Davis et al. (1989) suggests that attitudes towards computer adoption directly influence intentions to use the computer and ultimately actual computer use. Davis et al. demonstrated that an individual's initial attitudes regarding a computer's ease of use and a computer's usefulness influence attitudes toward use and that training significantly improved the computer self-efficacy of both males and females (Torkzadeh, Pflughoeft & Hall, 1999). They also reported that training programs seemed more effective for male and female respondents with positive attitudes toward computers.

In Mathematics teaching and learning, teachers' beliefs about Mathematics learning with or without using technology are considered to be important because they could influence teaching and learning, and curriculum reform (Schoenfeld, 1987). This author argued that Mathematics teacher’s beliefs can be thought of as individual perspectives on how one engages in mathematical tasks and pedagogical practices.

Just as teachers hold beliefs about Mathematics that may influence how they teach or structure the learning environment, teachers also hold beliefs about the use of technology.
For example, the studies conducted by Li (2007) and Kynigos and Argyris (2004) on the nature of beliefs about technology use in the Mathematics classroom portrayed some difficulties in the different aspects of learning situations in different ways, and the impact of using computers on their beliefs about teaching Mathematics. Li’s (2007) study reveals contrasting beliefs between students and teachers. For example, the students commented that they wanted to learn in a more effective, efficient and fun way, which suggests that technology, may help weak students by increasing their confidence levels.

On the other hand, no teacher in the study considered the advantage of computer technology as an alternative to the traditional approach of teaching to improve weak students’ learning. Kynigos and Argyris (2004) study established the complexity of issues that play a pertinent role in forming beliefs and practices in the aspects of teacher intervention in the classroom, the emerging social roles and the possible influences of the school and the educational system. Their study also revealed that the type of intended innovation and the use of exploratory software played a major role in the kind of mathematical activity going on in the classroom.

2.5 Factors Inhibiting ICT Use in Mathematics Classrooms

Many studies have shown several obstacles that teachers experience in the integration of ICT in their classrooms. Jones (2004) found the following as barriers for the integration of ICT into lessons: Lack of confidence among teachers during integration; lack of access to resources; lack of time for the integration; lack of effective training; facing technical
problems while the software is in use; lack of personal access during lesson preparation; and the age of the teachers.

Snoeyink and Ertmer (2002) identified these or similar variations as widespread barriers: Lack of computers, lack of quality software, lack of time, technical problems, teacher attitudes towards computers, poor funding, lack of teacher confidence, resistance to change, poor administrative support, lack of computer skill, poor fit with curriculum, scheduling difficulties, poor training opportunities, and lack of vision as to how to integrate ICT in instruction.

A study conducted in Ghana among pre-service and in-service Mathematics teachers explored the influence of computer attitudes, competencies and access of the teachers on their levels of ICT integration using the will, skill and tool concept. The study reported low levels of ICT integration levels as a result of low competencies and access levels of ICT. Furthermore, the study showed fairly high levels of positive computer attitudes and indicated among others that it is necessary condition to prepare teachers for new teaching methods which are flexible and involve appropriate use of ICT (Agyei and Voogt, 2008).

Of equal importance to ICT integration is teacher preparation programmes. Researchers have shown that such programmes have not adequately modeled the use of technology in their method courses (Adamy and Boulmetis, 2006) or incorporated effective approaches to technology integration into a single technology courses (Brown and Warschauer 2006). Manoucherhi (1999) in a US study concluded the lack of computer use is due to lack
of experience and access to educational software; lack of adequate professional training and lack of professional support in the use of computers in mathematics instruction. In New Zealand and Australia, similar conclusions by D'Sousa, Sabita and Woods (2003); Palmer (2002) identified that the common barrier to technology use in the classroom was a lack of professional development and lack of access to computers.

One of the barriers that Mathematics teachers identified in failing to adopt the use of computers in the classroom, is the lack of professional development in technology. To address this issue, several authors prescribed different types of professional development in the use of technology. This can be in the form of formal training in technology courses (Swan and Dixon, 2006); training of teachers in the use of software packages (Toumasis, 2006); instructional strategies (Sorkin et al., 2004); and lesson planning integrating technology in mathematics (Hardy, 2004). In line with the need for on-going professional development (Wells, 2007 and Sprague, 2007); further training in software use (Sorkin et al, 2004) and teachers' preferences about who should provide training are some issues that should be looked at.

2.6 Summary of Literature Review

The above literature review shows that it is increasingly becoming evident that the use of ICTs together with skilful scaffolding by the teacher enhances the learning of Mathematics. ICTs have been shown to increase access to instructional materials as well as support constructivist pedagogy, wherein students use technology to explore and reach an understanding of mathematical concepts. The review also indicates that the USA and
countries in Western Europe have built a strong base for the ICT use in education field. This has largely been attributed to good e-strategies, developed infrastructure and large investments in the ICT sector.

In Kenya, the review shows that despite the many efforts and initiatives by the government and the private sector to invest in ICT usage in the education sector so as to enhance access and quality of education, the performance particularly in Mathematics and science subjects continue to decline going by the past national examinations results, thus raising the question of implementation of suggested strategies like ICT integration in Mathematics and Science teaching. This study thus seeks to investigate secondary schools’ readiness to integrate ICTs in mathematics teaching. Most studies have concentrated on e-readiness in education institutions in general and ICT constraints thus leaving a gap in knowledge about specific subject ICTs integration that this study seeks to fill.
CHAPTER THREE

METHODOLOGY

This chapter gives an account on research design, location of the study, target population, sample and sampling procedure, research instruments, piloting, data collection procedure and data analysis methods that was used in the study.

3.1 Research Design

The study employed a descriptive survey design. The design was appropriate for this study because as noted by Borg and Gall (2003) descriptive survey research is intended to produce statistical information about aspects of education that interest policy makers and educators. The study surveyed a sample of public secondary schools in Mogotio District of Baringo County so as to describe their state of readiness to integrate ICTs in Mathematics teaching.

3.2 Location of Study

The study was carried out in Mogotio District of Baringo County. The rationale for choosing the District was that it has been hosting the SMASSE programme since the year 2009 where schools have been encouraged to integrate ICTs in the teaching and learning of Mathematics and Sciences as a strategy to help boost performance in the two areas. Another reason for selecting the district for the study was due to the researcher's own interest and knowledge of the area. Singleton (1993) observes that the ideal setting for any study is one that is directly related to the researcher's own interests.
3.3 Target Population

Mugenda and Mugenda (2003) define the target population as that population to which a researcher wants to generalize the results of a study. The current study targeted the 10 head teachers and 24 Mathematics teachers in Mogotio District. The head teachers were required to give the status of ICTs readiness in their schools, level of ICTs investment and the strategies in place to enhance ICTs integration in their schools. Teachers were required to give information on their preparedness as pertains to skills of integrating ICTs in Mathematics teaching, their attitudes towards the use of ICTs in Mathematics instruction and the hindrances that they are encountering in the integration of ICTs in the teaching of Mathematics in their schools.

3.4 Sample and Sampling Procedures

Systematic sampling technique was used to select 10 (45.45%) schools from a list of 22 public secondary school obtained from Mogotio District Education Office. According to Orodho (2008) systematic sampling involves selecting members at equal intervals by picking some random points in the list and every $nth$ element is selected until the desired sample size is obtained. From the 10 sampled schools, all the 10 (45.45%) head teachers and all the 24 (60%) Mathematics teachers were purposively sampled to participate in the study. Orodho(2008) advices that a researcher should take all the respondents if their number is less than 30.
3.5 Research Instruments

The researcher used questionnaires and an observation schedule to collect data.

3.6.1 Questionnaires

According to Kombo and Tromp (2006), questionnaires facilitate the collection of information from a large sample and diverse regions. The questionnaire instruments will be preferred for this study because they allow greater uniformity of questions, hence ensuring greater comparability of the information elicited by each set. The two sets of questionnaires will include:

i. **Questionnaires for head teachers:** These sought to establish the availability of ICT infrastructure like computer laboratories, computer hardware and software programs for integrating ICTs in Mathematics teaching in their schools; level of ICTs investment and the strategies in place to enhance ICTs integration in their schools.

ii. **Questionnaires for teachers:** These sought to establish their level of preparedness as pertains to skills of integrating ICTs in Mathematics teaching, their attitudes towards the use of ICTs in Mathematics instruction, and the hindrances that they are encountering in the integration of ICTs in the teaching of Mathematics in their schools.

3.6.2 Observation Schedule

Kombo and Tromp (2006) explain that an observation schedule is used as a checklist to record what the researcher observes during data collection. In this study, the observation schedule was used to verify the information collected on the availability of ICT
infrastructure in each school, total number of computers available for use by teachers and students, the schools connectivity to the Internet and how teachers are integrating ICTs in the teaching of Mathematics.

3.7 Pilot Study

Before visiting the selected schools for data collection, the questionnaires were pre-tested using two schools in the neighboring Rongai District which have similar characteristics as the targeted schools. The purpose of the pilot study was to verify the reliability and validity of the research instruments, and to enable the researcher modify and remove any ambiguous items on the instruments.

3.7.1 Validity of the instruments

Mugenda and Mugenda (2003) define validity as the accuracy and meaningfulness of inferences, which are based on the research results. Thus, content validity is a non-statistical method used to validate the content employed in the research instrument. Firstly, the researcher went through the instruments and compared their content with the set objectives to ensure that they contained all the information that addressed the study objectives. Secondly, the researcher discussed with his supervisors and authorities in ICTs in education field about content validity of the instruments and thereafter incorporated their recommendations and inputs so as to improve on validity of the instruments.
3.7.2 Reliability of the instruments

According to Mugenda and Mugenda (2003) reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials. Test-retest method was used to check the reliability of the instruments. The instruments were piloted in two public secondary schools from Rongai District which were not included in the final sample of schools. Here the questionnaires were given to the respondents to fill in. The filled in questionnaires were then scored manually and after a period of two weeks the same instruments were administered to the same group and scored manually. A comparison of the first and second score was made using Pearson’s product moment correlation coefficient to determine the reliability of the instruments. The correlation coefficient of 0.8 obtained was considered high enough for judging the instruments as reliable as advised by Orodho (2008).

3.8 Data Collection procedures

The researcher obtained a letter of introduction from the University and then visited the National Council of Sciences and Technology (NCST) to seek a research permit. He then reported to the Mogotio District Education Officer for permission, before proceeding to book appointments with the head teachers of the sampled schools. During the visit, the researcher interacted and developed a rapport with the head teachers of respective schools while at the same time explaining to them the purpose of his study. After acquiring permission from head teachers, the researcher went on to sample the other respondents and explained to them the purpose of his study before administering the research instruments to all the respondents with their informed consent.
3.9 Data Analysis

After collecting the data, the responses were coded and then entered into the Statistical Package for Social Sciences (SPSS) computer program for analysis. Descriptive statistics such as frequencies and percentages were used to analyze data quantitatively. Qualitative data obtained from the open-ended questions were analyzed according to themes based on the study objectives and the research questions and thereafter, inferences and conclusions drawn. The analyzed data was presented using tables and charts.
CHAPTER FOUR
DATA PRESENTATION, ANALYSIS AND DISCUSSION

This chapter presents the findings of the study. The study sought to investigate the readiness of public secondary schools in Mogotio District of Baringo County to integrate ICTs in the teaching of Mathematics. The findings are discussed according to the following objectives:

i. To assess the availability of ICT infrastructure (like computer laboratories, computer hardware and software programs) for integrating ICTs in Mathematics teaching in the schools;

ii. To establish the teachers' readiness in terms of skills and training for integrating ICTs in the teaching of Mathematics.

iii. To determine the teachers' attitudes towards the use of ICTs in Mathematics instruction; and

iv. To establish the hindrances that teachers are encountering in the integration of ICTs in the teaching of Mathematics in the schools.

4.1 Demographic Information of the Respondents

The study involved a survey of public secondary schools in Mogotio District of Baringo County in Kenya. The school types included: two (20%) boys; one (10%) girls and seven (70%) mixed schools. The schools categories included: four (40%) county and six (60%) district schools. The respondents included: 10 (45.45%) head teachers (8 males and 2 females) and 24 (60%) Mathematics teachers (14 males and 10 females). All the head teachers and teachers involved in the study were found to be professionally trained educators suited for secondary school teaching.
4.2 Infrastructure for Integrating ICTs in Mathematics Teaching

The first objective sought to assess the availability of infrastructure for integrating ICTs in Mathematics teaching like computer laboratories, computer hardware and software programs. Data obtained from the 10 sampled secondary schools revealed that seven (70%) of the schools had no computer laboratory two (20%) had one computer laboratory each while one (10%) had two computer laboratories as shown in Figure 4.1 below.

Figure 4.1: Number of Computer Laboratories in Secondary Schools

The data also revealed that nine of the head teachers (90%) stated that the ratio of personal computers against the teachers and students population was inadequate in their schools. This is detrimental for effective integration of ICTs in Mathematics teaching because
computers are the main platform where other integration tools like mathematical software and Internet run.

In terms of software, application programmes and digital content for Mathematics teaching, the findings revealed that the secondary schools were ill equipped with only one (10%) of the schools affirming that they had acquired software suited for Mathematics teaching while nine of them (90%) did not have any of the afore said resources. No school was found to allocate funds for integrating ICTs in Mathematics teaching and learning.

These findings are in agreement with Farrell (2007) who from a survey of ICT and education in Kenya noted that very few secondary schools had sufficient ICT tools for teachers and students and even in schools that had computers, the student-computer ratio was very high to enhance any meaningful ICT integration in teaching. In addition, a study by Wabuyele (2003) indicated that while ICT has penetrated many sectors including banking, transportation, communications, and medical services, the Kenyan educational system seems to lag behind. The study found that computer use in Kenyan classrooms is still in its early phases, and concluded that the perceptions and experiences of teachers and administrators do play an important role in the use of computers in Kenyan classrooms. Kenya School Net (2003) also found out that although schools were aware of benefits of ICTs in teaching, only a few had adequate ICT tools like computers and Internet that are essential for effective ICTs integration in teaching.
4.3 Teachers’ Skills and Training for Integrating ICTs in Mathematics Teaching

The second objective sought to establish the teachers’ readiness in terms of skills and training for integrating ICTs in the teaching of Mathematics. Twenty one teachers (87.5%) said that they had acquired some ICT skills as shown in Figure 4.2 below.

Figure 4.2: Teachers with ICT Skills

```
Have you acquired ICT Skills

- Yes: 12.5%
- No: 87.5%
```

In addition, half of the sampled teachers reported that they have been inducted on integration of ICTs in Mathematics teaching mostly through the SMASSE programme. Eighteen of the teachers (75%) also said that they had acquired skills for preparing electronic content for Mathematics teaching. These findings reveal that most of the sampled teachers had the requisite skills and training for integrating ICTs in Mathematics teaching, courtesy of the SMASSE training programme that is a must for every Mathematics and Science teachers in Mogotio District.
This finding showed how SMASSE was a success in ensuring that teachers are equipped with ICT in teaching integration skills. Researches in other places have shown that such programmes have not adequately modeled the use of technology in their method courses (Adamy and Boulmetis, 2006) or incorporated effective approaches to technology integration into a single technology courses (Brown and Warschauer, 2006). Manoucherhi (1999) in a US study concluded that lack of computer use is due to lack of experience and access to educational software; lack of adequate professional training and lack of professional support in the use of computers in Mathematics instruction. In New Zealand and Australia, similar studies by D’Sousa, Sabita and Woods (2003) and Palmer (2002) identified that the common barrier to technology use in the classroom was a lack of professional development and lack of access to computers.

4.4 Teachers’ Attitudes towards the Use of ICTs in Mathematics Instruction

The third objective sought to determine the teachers’ attitudes towards the use of ICTs in Mathematics instruction. Thirteen teachers (54.2%) responded in the affirmative when asked whether they usually integrate ICTs in their teaching. These teachers said that they usually integrated the technologies in their lessons to the extents shown in Table 4.1 below.

Table 4.1: Extent of ICTs Integration in Mathematics Teaching

<table>
<thead>
<tr>
<th>Extent</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very great extent</td>
<td>2</td>
<td>8.3</td>
</tr>
<tr>
<td>Great extent</td>
<td>12</td>
<td>50.0</td>
</tr>
<tr>
<td>Very little extent</td>
<td>2</td>
<td>8.3</td>
</tr>
<tr>
<td>N/A</td>
<td>8</td>
<td>33.3</td>
</tr>
</tbody>
</table>
Table 4.1 shows that 14 teachers (58.3%) integrated ICTs in Mathematics teaching to a great and very great extent. When asked to state how integration of ICTs benefited teaching of Mathematics, the teachers gave the benefits as shown in Table 4.2 below.

**Table 4.2: Benefits of Integrating ICTs in Mathematics Teaching**

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of teaching materials</td>
<td>6</td>
<td>25.0</td>
</tr>
<tr>
<td>Ease development of teaching and learning materials</td>
<td>7</td>
<td>29.2</td>
</tr>
<tr>
<td>Brings abstract concepts to live</td>
<td>2</td>
<td>8.3</td>
</tr>
<tr>
<td>Makes teaching and learning of mathematics interesting</td>
<td>3</td>
<td>12.5</td>
</tr>
<tr>
<td>N/A</td>
<td>6</td>
<td>25.0</td>
</tr>
</tbody>
</table>

Table 4.2 above shows that 18 of the teachers (75%) gave some benefits that they derive from integrating ICTs in their Mathematics teaching. This shows that most of the teachers had positive attitude towards ICT integration in Mathematics instruction.

According to Davis et al. (1989), a positive attitude arises due to previous successful experiences or from a perception that success is possible. In their Technology Acceptance Model (TAM), Davis et al. suggests that attitudes towards computer adoption directly influence intentions to use the computer and ultimately actual computer use. These authors also demonstrated that an individual's initial attitudes regarding a computer's ease of use and a computer's usefulness influence attitudes toward use and that training significantly improved the computer self-efficacy of both males and females. The training of Mathematics teachers in Mogotio district mostly through the SMASSE programme can thus
be said to have shaped their positive attitudes towards ICTs integration in Mathematics teaching.

4.5 Hindrances to Teachers' Integration of ICTs in Mathematics Teaching

The fourth objective sought to establish the hindrances that teachers are encountering in their effort to integrate ICTs in the teaching of Mathematics in their schools. Table 4.3 below shows the main hindrances noted by teachers.

<table>
<thead>
<tr>
<th>Hindrances</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of sufficient ICT equipment</td>
<td>6</td>
<td>25.0</td>
</tr>
<tr>
<td>Lack of management support</td>
<td>6</td>
<td>25.0</td>
</tr>
<tr>
<td>Lack of teachers and students ICT skills</td>
<td>4</td>
<td>16.7</td>
</tr>
<tr>
<td>Lack of enough time to prepare</td>
<td>3</td>
<td>12.5</td>
</tr>
<tr>
<td>Lack of electricity</td>
<td>5</td>
<td>20.8</td>
</tr>
</tbody>
</table>

Table 4.3 above shows that half of the teachers (50%) noted lack of sufficient ICT equipment and inadequate management support as the main hindrances to ICT integration in Mathematics instruction. This finding is supported by nine teachers (90%) and eight head teachers (80%) who noted that ICTs in their schools were inadequate and that no financial resources are usually allocated for ICT integration in their schools respectively. The same issue also came afore when teachers were asked to give suggestions on the measures that could hasten ICTs integration in Mathematics teaching as shown in Table 4.4 below.
Table 4.4: Measures to Hasten ICTs Integration in Mathematics Teaching

<table>
<thead>
<tr>
<th>Measure</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer studies to be made compulsory in schools</td>
<td>2</td>
<td>8.3</td>
</tr>
<tr>
<td>All Mathematics teachers to be trained in ICT integration in teaching</td>
<td>2</td>
<td>8.3</td>
</tr>
<tr>
<td>Schools to be provided with adequate ICT infrastructure</td>
<td>13</td>
<td>54.2</td>
</tr>
<tr>
<td>MoE to provide schools with standardized mathematical teaching and learning software</td>
<td>2</td>
<td>8.3</td>
</tr>
<tr>
<td>Supply of electricity to all public secondary schools</td>
<td>5</td>
<td>20.8</td>
</tr>
</tbody>
</table>

Table 4.4 shows that 13 teachers (54.2%) suggested that schools should be provided with adequate ICT infrastructure for there to be an effective ICTs integration in Mathematics teaching. In essence, these findings agree with those of Jain (2006) who mentioned inadequate IT exposure in schools; poor communication infrastructure and expensive ICT equipment as being some of the major impediments to ICT use in education in Africa. This highlights the need to provide enough ICTs and their infrastructure for teachers’ and students’ use so as to enhance ICT integration in Mathematics teaching in public secondary schools.
CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter gives a summary of the findings, conclusion, recommendations and suggestions for further research. The purpose of the study was to investigate the readiness of public secondary schools in Mogotio District of Baringo County to integrate ICTs in the teaching of Mathematics. The study was guided by the following objectives:

i. To assess the availability of ICT infrastructure (like computer laboratories, computer hardware and software programs) for integrating ICTs in Mathematics teaching in the schools;

ii. To establish the teachers' readiness in terms of skills and training for integrating ICTs in the teaching of Mathematics;

iii. To determine the teachers' attitudes towards the use of ICTs in Mathematics instruction; and

iv. To establish the hindrances that teachers are encountering in the integration of ICTs in the teaching of Mathematics in the schools.

5.1 Summary of the Research Findings

Based on the results broadly presented in chapter four, the following is a summary of the study findings:

1. Seven of the schools (70%) in Mogotio District had no computer laboratories. In addition, nine of the schools (90%) were inadequately equipped with computer hardware like personal computers and software applications that could enable effective integration of ICTs in Mathematics teaching.
2. Half of the teachers (50%) have been inducted on integration of ICTs in Mathematics teaching mostly through the SMASSE programme while 18 of them (75%) have skills for preparing electronic content for Mathematics teaching.

3. Fourteen teachers (58.3%) usually integrated ICTs in Mathematics teaching to a great and very great extent. Eighteen of the teachers (75%) indicated that integrating ICTs in their Mathematics teaching had the following benefits: Avails instructional materials; eases development of teaching and learning materials; brings abstract concepts to live for students to understand; and makes teaching and learning of mathematics interesting.

4. Half of the teachers (50%) noted lack of sufficient ICT equipment and lack of management support as the main impediment to ICT integration in Mathematics instruction. Thirteen teachers (54.2%) indicated that schools should be provided with adequate ICT infrastructure for there to be effective ICTs integration in Mathematics teaching.

5.2 Conclusion of the study

From the findings of the study, it was concluded that:

1. Public secondary schools in Mogotio District of Baringo County were inadequately equipped with facilities like computer laboratories and equipment like computers required for the successful integration of ICTs in Mathematics teaching implementation. In addition, most of the schools lacked software, application programmes and digital content necessary for integration of ICTs in Mathematics;
2. Most of the teachers in the district had received the requisite skills for integrating ICTs in Mathematics teaching, courtesy of the SMASSE programme that is compulsory to all Mathematics and Science teachers in the district;

3. Most teachers in the district had a positive attitude towards the use of ICTs in Mathematics instruction. Most of them indicated that ICTs can avail instructional materials, simplify concepts and make the teaching and learning of Mathematics interesting—factors that are viewed as key for promoting performance of Mathematics.

4. Inadequate ICT infrastructure and management commitment were key impediments to effective ICTs integration in Mathematics teaching in Mogotio District.

5.3 Recommendations

Based on the findings from this study, the researcher makes the following recommendations:

1. Education stakeholders in the district should finance provision of ICT facilities and digital equipment in public secondary schools. This will enhance access to ICT facilities by students and teachers, improve the current teachers and student computer ratio and enable hands-on experiences with these resources during Mathematics teaching and learning. In addition, MoE should provide standardized mathematical software, application programmes and digital content to all schools to enable them implement effective ICTs integration in Mathematics teaching with ease.

2. The SMASSE programme in Mogotio District should be encouraged, expanded and recommended to all the teachers because of its success in equipping most of the Mathematics teachers with skills required for integrating ICTs in Mathematics teaching.
3. Teachers should continually be exposed to benefits of ICTs integration in Mathematics teaching through trainings and capacity building programmes so as to continue boosting positive attitudes towards ICT use in instruction.

4. The government through MoE should increase its allocation on tuition fees and encourage schools to have a specific vote-head for ICT integration so as to ensure reliable funding of ICT initiatives and projects by schools. The school managements should also be sensitized on the importance of integrating ICTs in Mathematics teaching and even in the teaching of other subjects. This will build the school management’s confidence on why they should allocate funds for ICT integration in classroom instruction.

5.4 Suggestions for Further Research

i. A similar study should be carried out in an urban setting so as to get a clearer picture on the status of ICTs integration in Mathematics teaching in all public secondary schools across the country.

ii. A study to establish the impact of ICTs integration in Mathematics instruction in public secondary schools should be undertaken.

iii. Comparative study involving public and private learning institutions can be carried out to establish the extent of ICT uptake in Mathematics instruction so as to guide the government in further planning of ICT integration in the education sector.
REFERENCES


Wimbish, J: (1992) Calculus students' difficulties in a technology-rich environment. In M. Artigue & G. Ervynck (Eds.), *Proceedings of Working Group 3 on Students' Difficulties in Calculus* (pp. 81-83). College de Sherbrooke, Quebec, Canada: 7th International Congress on Mathematical Education.

APPENDICES

APPENDIX I

QUESTIONNAIRE FOR HEADTEACHERS

This study seeks to establish the readiness of public secondary schools to integrate ICTs in Mathematics teaching. Your school is among the few that have been selected for the study and your honest response to this questionnaire will make it a success.

SECTION A: BACKGROUND INFORMATION

1. (i) Type of School
   Boys ( ) Girls ( ) Mixed ( ) (Please Tick appropriately)

(ii) What is the category of this school?
   National ( ) Provincial ( ) District ( )

(iii) What is your gender?
   Male ( ) Female ( )

(iv) What is your professional qualification?
   M.Ed ( ) B.Ed ( ) PGDE ( ) Diploma in education ( )

(v) Have you ever attended any course on integration of ICTs in schools?
   Yes [ ]
   No [ ]
   Don’t know [ ]
   N/a [ ]

(b) If yes above, indicate who organized the course and explain how the course has helped you to integrate ICTs in your school

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..............................................................................................................................................................................
..............................................................................................................................................................................
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..............................................................................................................................................................................
..............................................................................................................................................................................
SECTION B: ICT FACILITIES AND PERSONNEL

2. (i) How many computer laboratories are there in your school?

3. (ii) What is the total number of personal computers (PCs) in your school?

(iii) How adequate are the available computers against teacher and student population?

- Very adequate
- Adequate
- Not adequate

(iv) What is the student per computer ratio?

(v) What times of the day are computers accessible?

(a) Students: Morning ( )  Mid-day ( )  Afternoon ( )
(b) Teachers: Morning ( )  Mid-day ( )  Afternoon ( )

(vi) Has the school employed a computer laboratory technician(s)?

- Yes
- No

If yes, what is the qualification of the technician(s)?

(vii) What are the hindrances to acquiring ICT infrastructure in the school?

(viii) (a) Does the school allocate financial resources for ICT integration?

- Yes
- No
- Don’t Know
- N/a
(b) If yes above, state the adequacy of the financial resources allocated.

- Very adequate
- Adequate
- Don’t know
- Inadequate
- Very inadequate

(x) How is the school equipped with computer accessories?

- Well equipped
- Moderate
- Ill equipped

SECTION C: INTEGRATION OF ICT IN TEACHING

4. i) What is your schools’ policy as regards to ICT integration in teaching and learning?

ii) Are the software modules, application programmes and digital content to teach Mathematics available in your school?

- Yes
- No
- Don’t know
- N/A

(iii) Which of the following ICT applications does the school use? (Tick on the ones that are used in your school)

1. Web-based (online) learning
2. Computer-based learning
3. Virtual classrooms
4. Digital collaborations
5. None
(iv) Are there courses organized by your school for teachers who have no knowledge on use of electronic technologies (i.e. computers and Internet) in teaching and learning process?

- Yes
- No
- Don’t Know
- N/A

(v) If yes in (iii) above, please state the type of courses?

(vi) If no in (iii) above, please explain your response?

(vii) How are teachers periodically updated on the new developments on ICT use in education?

5. (i) (a) Is your school connected to the Internet?

- Yes
- No
- Don’t know
- N/A
(b) If yes, to what extent do teachers and students use Internet for teaching and learning?

- A very great extent
- Great extent
- Undecided
- Little extent
- A very little extent

(ii) (a) Is the cost of the Internet affordable to the school?

- Yes
- No
- Don’t know
- N/A

(b) Explain your response in (ii) above...

(iii) Do the students and teachers have access to Internet connected computers?

- Yes
- No

SECTION D: FINANCING OF ICT ACTIVITIES IN THE SCHOOL

6. Indicate the percentage of financial support from the following to ICT and services in the school.

- Government
- Donors
- Parents
- Others (specify)
(ii) (a) In your opinion, is financing of ICT integrations in your school adequate?

Yes  □

No  □

(b) Rate the extent of adequacy of ICT integration financing in your school.

Very adequate  □

Adequate  □

Average  □

Inadequate  □

Very inadequate  □

(iii) How can the financing of ICT integration be improved? ..........................................................
..........................................................................................................................................
..........................................................................................................................................

7. Suggest measures that can hasten the implementation of ICT integration in public secondary schools in Kenya ..........................................................
..........................................................................................................................................
..........................................................................................................................................
..........................................................................................................................................

Thank you for responding to this questionnaire.
APPENDIX II

QUESTIONNAIRE FOR TEACHERS

This study seeks to establish the readiness of public secondary schools to integrate ICTs in Mathematics teaching. Your school is among the few that have been selected for the study and your honest response to this questionnaire will make it a success.

SECTION A: PERSONAL INFORMATION

1. Gender: Male ( ) Female ( ) (Tick as appropriate)
2. Which are your areas of subject specialization?
3. (i) Have you acquired skills on using electronic technologies (i.e computers and the Internet)?
   Yes [ ]
   No [ ]

   (ii) If yes, how did you acquire the skills?
   Formal training in college [ ]
   Personal interaction with computers [ ]
   Seminars organized by school [ ]

   Others (specify) ........................................................................................................

   ........................................................................................................
   ........................................................................................................

   (iii) Rate the extent to which your ICT skills enhance your use of electronic technologies in your work.
   Very great extent [ ]
   Great extent [ ]
   Undecided [ ]
   Little extent [ ]
   Very little extent [ ]
SECTION B: INTEGRATION OF ICT IN TEACHING

4. (i) (a) In your teaching, do you integrate electronic technologies (i.e. Computer and Internet)?
   Yes
   No

(b) If yes, to what extent?

   - Very great extent
   - Great extent
   - Undecided
   - Little extent
   - Very little extent

(c) Please explain your response to (b) above

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................................................................................................................................................
................................................................................................................................................

(ii) Besides each of the aspects or components presented below, please indicate the frequency by which you integrate them in your teaching.

<table>
<thead>
<tr>
<th>Component/Aspect</th>
<th>Very frequently</th>
<th>Frequently</th>
<th>Less frequently</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Computer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. CD ROMS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Internet</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Email</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(iii) In which ways do you benefit from the integration of electronic technologies in your teaching?

................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
(iv) Do you use the Internet as an aid in the teaching and learning process?
Yes □
No □

(v) If yes to (iv) above, where do you normally access the Internet?
From my school □
From my server □
From cyber café □

(vi) Do your students submit their assignments through e-mail?
Yes □
No □

(vii) If yes, comment on the effectiveness of the arrangement?: 
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................

SECTION C: SKILLS TO INTEGRATE ICT IN MATHEMATICS TEACHING
5. (i) Have you acquired any training in integration of ICTs in Mathematics teaching?
Yes □
No □

(ii) If yes to (i) above, briefly state how the skills have enhanced your teaching.
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................

(iii) Do you have skills in the preparation of electronic content for use during your teaching?
Yes □
No □
If yes to (iii) above, do you always prepare electronic content for your students?
Yes [ ]
No [ ]

Which challenges do you encounter in preparing electronic content for your teaching?

SECTION D: ATTITUDES TOWARDS USE OF ICTs IN MATHEMATICS TEACHING

Please indicate whether you strongly agree (SA), agree (A), are undecided (U), disagree (D), or strongly disagree (SD) with the following statements relating to your views about the role of ICTs in Mathematics teaching:

<table>
<thead>
<tr>
<th>Statement</th>
<th>SA</th>
<th>A</th>
<th>U</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICTs enhance availability of Mathematics instructional materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICTs enhance development of teaching and learning materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICTs enhance dissemination of information and knowledge during teaching of Mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICTs support student centered methods of teaching Mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICTs bring abstract concepts to live during Mathematics lessons</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>ICTs make the teaching and learning of Mathematics interesting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SECTION E: HINDRANCES TO INTEGRATION OF ICT IN MATHS TEACHING

6. What are the hindrances to integrating electronic technologies in mathematic teaching in your school? ..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
7. Kindly comment on the accessibility to ICT facilities in your school by:
   i) The teachers
   ii) The students

8. In your view, which steps can be taken to hasten the integration of ICTs in Mathematics teaching in public secondary schools in Kenya?

Thank you for responding to this questionnaire.
APPENDIX III

OBSERVATION SCHEDULE

1. Name of the school ..........................................................................................................

2. Number of computer laboratories available ....................................................................

3. Number of computers available for use by
   i. Teachers ....................................................................................................................
   ii. Students ...................................................................................................................

4. Internet connectivity of the school ..................................................................................

5. Accessibility to ICT facilities by:
   i. Teachers ..................................................................................................................
   ii. Students ..................................................................................................................

6. Number of computer technicians available ....................................................................

7. Integration of ICTs in Mathematics teaching in the school ............................................
## APPENDIX IV

### RESEARCH TIMETABLE

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>DURATION</th>
<th>FROM-TO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation of proposal and writing</td>
<td>4 months</td>
<td>July-October, 2012</td>
</tr>
<tr>
<td>Correcting the proposal</td>
<td>1 month</td>
<td>November, 2012</td>
</tr>
<tr>
<td>Defending the proposal</td>
<td></td>
<td>December, 2012</td>
</tr>
<tr>
<td>Piloting</td>
<td>2 weeks</td>
<td>January, 2013</td>
</tr>
<tr>
<td>Data collection</td>
<td>2 months</td>
<td>February-March, 2013</td>
</tr>
<tr>
<td>Data analysis, writing and revision of first draft of project</td>
<td>3 months</td>
<td>April-June, 2013</td>
</tr>
<tr>
<td>Preparation and revision of final draft of project</td>
<td>2 months</td>
<td>July-August, 2013</td>
</tr>
<tr>
<td>Project examination</td>
<td></td>
<td>September-November, 2013</td>
</tr>
<tr>
<td>Graduation</td>
<td></td>
<td>December, 2013</td>
</tr>
</tbody>
</table>
## APPENDIX V

### RESEARCH BUDGET

<table>
<thead>
<tr>
<th>ITEM</th>
<th>AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Proposal writing</td>
<td></td>
</tr>
<tr>
<td>(i) Typing and printing</td>
<td>5,000</td>
</tr>
<tr>
<td>2. Piloting</td>
<td></td>
</tr>
<tr>
<td>(i) Photocopying research instruments</td>
<td>2,000</td>
</tr>
<tr>
<td>(ii) Travelling and subsistence</td>
<td>3,000</td>
</tr>
<tr>
<td>3. Data collection</td>
<td></td>
</tr>
<tr>
<td>(i) Photocopying of research instruments</td>
<td>5,000</td>
</tr>
<tr>
<td>(ii) Travelling</td>
<td>4,000</td>
</tr>
<tr>
<td>(iii) Subsistence</td>
<td>4,000</td>
</tr>
<tr>
<td>4. Data analysis and presentation</td>
<td></td>
</tr>
<tr>
<td>(i) Typing and printing</td>
<td>8,000</td>
</tr>
<tr>
<td>(ii) Photocopying and printing</td>
<td>8,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>39,000</strong></td>
</tr>
</tbody>
</table>
APPENDIX VI

RESEARCH PERMIT FROM NCST

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telephone: 254-020-2213471, 2241349, 254-020-2673550
Mobile: 0713 788 787, 0733 404 245
Fax: 254-020-2213215
When replying please quote
secretary@ncst.go.ke

Our Ref:

NCST/RCD/13/013/29

John Kirkok Kiprop
Kenyatta University
P.O.Box 43844-00100
Nairobi.

RE: RESEARCH AUTHORIZATION

Following your application dated 18th April, 2013 for authority to carry out research on “Status of Information Communication Technology integration in Mathematics teaching: A case of public secondary schools in Mogotio District, Baringo County, Kenya,” I am pleased to inform you that you have been authorized to undertake research in Mogotio District for a period ending 31st July, 2013.

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

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

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

Copy to:

The District Commissioner
The District Education Officer
Mogotio District.
APPENDIX VII

RESEARCH PERMIT FROM MOGOTIO DISTRICT EDUCATION OFFICE

MINISTRY OF EDUCATION

Telephone: ----------------------

District Education Office
Mogotio District
P.O. Box 91

MOGOTIO


MGT/ED/59/VOL.1/DPT/146

TO ALL PRINCIPALS
MOGOTIO PUBLIC SECONDARY SCHOOLS

REF: MR. JOHN KIRKOK KIPROP

You are notified that the DEO’s office Mogotio District has authorized the above named person, who is a student at Kenyatta University to carry out research permit No. NCST/RCD/13/013/29 on status of information Communication Technology integration in mathematics teaching in our public secondary schools from May 2013 ending 31st July 2013.

Please assist him to get the necessary information he requires for the success of his research.

JACKSON K. KIPLAGAT
For: DISTRICT EDUCATION OFFICER
MOGOTIO DISTRICT
APPENDIX VIII

RESEARCH PERMIT

THIS IS TO CERTIFY THAT:

Prof./Dr./Mr./Mrs./Miss/Institution
John Kirkok Klprop
of (Address) Kenyatta University
P.O.Box 43844-00100, Nairobi,
has been permitted to conduct research in

Location
Mogotio District

Baringo County

on the topic: Status of Information and Communication Technology integration in Mathematics teaching: A case of public secondary schools in Mogotio District Baringo County, Kenya.

for a period ending 31st July, 2013.

CONDITIONS

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

Research Permit No. NCST/RCD/13/013/29
Date of issue 2nd May, 2013
Fee received KSH. 1,000

Applicant's Signature

Secretary

National Council for Science & Technology

GPK605563m(10/2011)