TEACHERS' READINESS TO IMPLEMENT ICT FOR TEACHING AND LEARNING OF SCIENCE IN PUBLIC SECONDARY SCHOOLS IN WEST POKOT COUNTY, KENYA

BY

FRANCIS SEUREI KIPCHUMBA

A THESIS SUBMITTED TO THE SCHOOL OF EDUCATION IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF EDUCATION IN RESEARCH AND POLICY STUDIES, SCHOOL OF EDUCATION, DEPARTMENT OF EDUCATIONAL MANAGEMENT AND POLICY STUDIES

MOI UNIVERSITY

2021

DECLARATION

Declaration by the Candidate

This thesis is my original work and has not been presented for a degree in any other University. No part of this thesis may be reproduced without the prior permission of the author and/or Moi University.

……………………………………. **……………………………**

SEUREI KIPCHUMBA FRANCIS Date

EDU/PGR//1011/17

Declaration by the Supervisor

This thesis has been submitted for examination with our approval as University Supervisors.

…………………………………. ……………………………

Professor André du Plessis Date:

Faculty of Education

Nelson Mandela University, South Africa

……………………………………. ………………………….

Professor Laban Ayiro Date

Department of Curriculum, Instruction, and Educational Media

Moi University, Kenya

DEDICATION

I dedicate this work to my wife Leonida, my children Jabez and Esmeralda my, parents and all the scholars from the fields of research that made this work a success.

ACKNOWLEDGEMENT

Many people played crucial roles in ensuring that this thesis is finally successful. Hence their understanding, co-operation and encouragements are very important without which all could have been a failure, it's difficult to pass sincere gratitude to each and every person In a special way I would like to thank my supervisors professor Laban Ayiro and Professor André du Plessis for their constructive advice, positive criticism and encouragement in this course of writing this thesis. I fill most grateful for the sacrifices you made in going through my work.

I can't forget the contribution of Professor Paul Webb at the initial stages of my proposal writing, he helped me shape the proposal and we came up with suitable study and instruments for data collection. Also thank you to Ms Kirstie Eastwood, the statistician at Nelson Mandela University, for her input and support with the statistics. Further, gratitude goes to Professor Boit who guided me during data analysis and presentation of the finding, to all principals and teachers of the schools I visited in West Pokot County for their worm reception and contribution during data collection. Finally in a special way, I salute my father Samson Seurei my mother Magdalene Seurei for their support and prayers. To all I say may God bless you abundantly.

ABSTRACT

This study investigated science teachers' readiness to implement or adopt (utilize) ICT for teaching and learning science in pubic secondary schools in West Pokot County, Kenya. It is argued that if teachers are willing and show a positive disposition towards readiness, this might lead towards greater implementation, utilization and integration of ICT for teaching and learning. Research on the readiness of Kenyan science teachers in public secondary schools in West Pokot County has not been conducted and hence this study aims to fill this gap and as such the research could be valuable for the government, as it provides an overview of the current status related to ICT readiness for implementation. The hypothesis of the research study formulated was: H_{01} There is no statistical significant relationship between the attitude towards use of ICT and the integration of ICT in the teaching of sciences in public secondary schools in West Pokot County, Kenya; H_{02} There is no statistical significant relationship between motivation to use ICT and the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya; H_{03} There is no statistical significant relationship between facilitating conditions and the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya and; H_{04}There is no statistical significant relationship between behavioural intention to use of ICT and the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya. The study is underpinned by the positivistic paradigm and utilized a survey (questionnaire) in order to collect quantitative data. The sample size was 250 science teachers from one hundred public secondary schools with a response rate of 233 or 93.2%. The dependant variable was ICT integration (implementation, adoption and usage) while the independent variables were attitude, motivation, behavioural intention and facilitating conditions. The adapted questionnaire data were analysed using descriptive and inferential statistics. The findings of the study showed that **attitude** towards the use of ICT was ($p=.000$, $\rho<0.05$), **motivation** to use ICT was ($p=.086$, $\rho>0.05$), **facilitating condition** was ($p=.000$, $\rho<0.05$) and **behavioural intention** was ($p=.122$, $\rho>0.05$). Furthermore, two hypotheses were rejected (H_{01} & H_{03}) while two were accepted (H_{02} & H_{04}). Both attitudes towards integration and motivation to use ICT for assimilation had a negative correlation relationship with ICT integration while both behavioural intention and facilitating conditions had a very strong positive correlation. It is thus clear that there is a great need for interventions by stakeholders such as the Kenyan government, Non-Governmental Organisations (NGOs), business community, schools and parents to come up with meaningful strategies that could positively enhance the lower variables from negative or moderate to a strongly positive correlation with statistical power 0.05 inversely related. It is also vital to provide the necessary facilitating conditions. There is thus a great need for teachers to be enabled by means of teacher development programmes related to 'how to' utilize and plan for the implementation of ICTs by creating a context in which the enablers that have been identified can be implemented in order to facilitate the use of ICT for the teaching and learning of science.

TABLE OF CONTENTS

DECLARATION ii
DEDICATION iii
ACKNOWLEDGEMENT iv
ABSTRACT v
TABLE OF CONTENTS vi
LIST OF TABLES x
LIST OF FIGURES xii
LIST OF ABBREVIATIONS xiii
CHAPTER ONE 1
INTRODUCTION 1
1.1 Background to the Problem 1
1.2 Statement of the Problem 4
1.3 Purpose of the Study 7
1.4 Main Objective 7
1.4.1 Subsidiary Objectives 7
1.5 Hypothesis 7
1.6 Significance of the Study 8
1.7 Scope of the Study 9
1.8 Limitations of the Study 9
1.9 Assumptions of the Study 10
1.10 Theoretical Framework 10
1.10.1 Performance Expectancy 12
1.10.2 Effort expectancy 13
1.10.3 Social influence 13
1.10.4 Facilitating conditions 14
1.11 Operational Definition of Terms 16
CHAPTER TWO 18
LITERATURE REVIEW 18
2.1 Introduction 18
2.2 ICT Policy in Kenya 18
2.3 ICT Implementation and Integration Matrix 20
2.3.1 Types of Integration 21

2.3.2 Stages of Implementation 24
2.4 Teachers' Readiness to Use ICT for Teaching and Learning 25
2.5 Exploring Research: Aspects that are Important for Readiness to Utilize ICT(s) for Teaching and Learning 26
2.5.1 International Perspectives 27
2.5.2 African Perspectives 34
2.5.3 Kenyan Perspectives 38
2.5.4 Kenyan Science Teachers' Readiness Perspectives 44
2.6 Aspects related to Readiness from Research 48
2.7 Barriers Typology to ICT Use in Teaching and Learning 49
2.7.1 First-order barriers: Extrinsic to the self 50
2.7.2 Second-order barriers: Intrinsic to the self 51
2.7.3 Third-order challenge: System-wide support 52
2.7.4 Fourth Order Challenge: Design Skills 54
2.8 Ameliorating ICT Barriers or Challenges 54
2.8.1 Addressing First-Order Barriers or Challenges 55
2.8.2 Addressing Second-Order Barriers or Challenges 56
2.8.3 Addressing Third-Order Barriers or Challenges 57
2.8.4 Addressing Fourth-Order Barriers or Challenges 57
2.8.5 Framework to Assist with Addressing Barriers 58
2.9 Readiness for ICT Integration (Adoption, Implementation and Usage) 64
2.10 Summary of Reviewed Literature 64
CHAPTER THREE 65
RESEARCH DESIGN AND METHODOLOGY 65
3.1 Introduction 65
3.2 Research Paradigm 65
3.3 Research Methodology 65
3.4 Research Design 66
3.5 Target and Accessible Population 66
3.6 Sampling Techniques and Sample Size 67
3.7 Data Collection Tool 68
3.8 Reliability and Validity of Research Instrument 68
3.8.1 Reliability 68
3.8.2 Validity 70

3.10 Collection Procedure........73
3.11 Data Analysis........74
3.12 Ethical Issues under Considerations........78
CHAPTER FOUR........79
DATA PRESENTATION, ANALYSIS, INTERPRETATION AND DISCUSSION........79
4.1 Introduction........79
4.2 Results........80
4.2.1 Demographic Information of Participants........80
4.2.2 Descriptive Statistics........84
4.2.2.1 ICT Integration........85
4.2.2.2 Attitude........89
4.2.2.3 Motivation........91
4.2.2.4 Behavioural intention........94
4.2.2.5 Facilitating conditions........98
4.2.3 Factor Analysis for Integration of ICT........103
4.2.3.1 Factor Analysis for Integration of ICT........110
4.2.3.2 Factor analysis for attitude towards the use of ICT........114
4.2.3.3 Factor Analysis for Motivation towards the Use of ICT........117
4.2.3.4 Factor analysis for behavioural intention towards the use of ICT........120
4.2.3.5 Factor analysis for facilitating conditions to use of ICT........123
4.2.4 Test of Regression Assumptions........126
4.2.4.1 Test of Normality........126
4.2.4.2 Test of independence of the error terms........129
4.2.4.3 Multicollinearity Diagnostics........129
4.2.4.4 Correlation Analysis........131
4.3 Regression Results and Test of Hypotheses........132
4.4 Discussion of Findings........137
CHAPTER FIVE........142
SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS........142
5.1 Introduction........142
5.2 Summary of Findings........143
5.3 Conclusion........147
5.4 Recommendations........149

5.5 Suggestions for Further Research 151
REFERENCES 152
APPENDICES 167
Appendix I: Letter of Invitation 167
Appendix II: Consent Form 168
Appendix III: Questionnaire for Teachers 169
Appendix IV: Questionnaire comparison 172
Appendix V: Recommendation Letter 175
Appendix VI: Research Permit 176
Appendix VII: County Commissioner Letter 177
Appendix VIII: County Director of Education letter 178

LIST OF TABLES

Table 3.1: Reliability Results of raw data....70
Table 3.2: Likert scale item response mean per statement 74
Table 3.3: Likert scale response overall mean value interpretation per item for 1 to 5 scale (Okoo, 2016, p. 98) 75
Table 4.1: Demographic Information 81
Table 4.2: Information about Schools on Facilitating Conditions....82
Table 4.3: ICT integration for the teaching of science 86
Table 4.4: Attitude towards ICT use for the teaching of science....90
Table 4.5: Motivation to Use ICT for the teaching of science....92
Table 4.8: KMO and Bartlett's Test related to ICT integration (implementation)....110
Table 4.9: Total variance explained related to the integration of ICT....111
Table 4.10: Unrotated component matrix related to ICT integration (implementation, adoption, usage)....113
Table 4.11: KMO and Bartlett's Test related to attitude 114
Table 4.12: Total variance explained related to attitude....115
Table 4.13: Rotated component matrix related to attitude....116
Table 4.14: KMO and Bartlett's Test related to motivation 117
Table 4.15: Total Variance explained related to motivation....118
Table 4.16: Rotated component Matrix related to motivation 119
Table 4.17: KMO and Bartlett's Test Results related to behavioural intention to use of ICT 120
Table 4.18: Total variance explained related to behavioural intention to use of ICT 121
Table 4.19: Rotated Component Matrix related to the behavioural intention towards the use of ICT....123
Table 4.20: KMO and Bartlett's Test Results related to facilitating conditions....124
Table 4.21: Total Variance Explained related to Facilitating Conditions 124
Table 4.22: Rotated Component Matrix related to Facilitating Conditions....126
Table 4.23: Normality Test Results 127
Table 4.24: One-Sample Kolmogorov-Smirnov Test Results 128

Table 4.25: Collinearity Statistic for variables - integration of ICT, attitude towards use, motivation to use, behavioural intention and facilitating condition 130
Table 4.26: Correlation Coefficients..132
Table 4.27: Regression Results - Model Summary 133
Table 4.28: Summary of the Hypotheses Tests Results...137

LIST OF FIGURES

Figure 1.1: Theoretical framework 11
Figure 1.2: Conceptual Framework 16
Figure 2.1: ICT Implementation Matrix 23
Figure 2.2: Proposed ICT implementation heuristic for schools in disadvantaged contexts 61
Figure 2.3: Enhanced proposed ICT implementation heuristic for schools in rural areas or disadvantaged contexts 63
Figure 4.1: Scree plot for extracted components of integration (implementation, adoption) of ICT 111
Figure 4.2: Scree plot for extracted components related to attitude towards the use of ICT 115
Figure 4.3: Scree plot for extracted component related to motivation to use ICT..... 118
Figure 4.4: Scree plot for extracted component for behavioural intention to use of ICT 122
Figure 4.5: Scree plot for extracted component for facilitating condition................ 125

LIST OF ABBREVIATIONS

AG	Attitude towards use Grand mean
AUC	Actual Computer Usage
BIG	Behavioural Intention Grand mean
EFA	Exploratory Factor Analysis
FCG	Facilitating Condition Grand mean
FIR	Fourth Industrial revolution
ICDL	International Computer Driving Licence
ICT	Information Communication Technology
ICTG	ICT integration Grand mean
IDT	Innovation Diffusion Theory
IMG	Intrinsic Motivation Grand mean
KESSP	Kenya Educational Sector Support Programme
KICD	Kenya Institute of Curriculum Development
KMO	Kaiser-Meyer-Olkin
MDG	Millennium Development Goal
MM	Motivational Model
MPCU	Model of Personnel Computer Utilization
NACOSTI	National Commission for Science, Technology and Innovation
NCATE	National Council for Accreditation of Teacher Education
NGOs	Non-Governmental Organisations
PC	Model of Personnel Computer
SCT	Social Cognitive Theory
SDG	Sustainable Development Goals
SMASSE	Strengthening Mathematics and Science in Secondary Education

SPSS	Statistical Package for Social Sciences
SWOT	Strengths, Weaknesses, Opportunities and Threats
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
TSC	Teachers Service Commission
UNESCO	United Nations Education, Scientific and Cultural Organisation
UTAUT	Unified Theory of Acceptance and Use of Technology

CHAPTER ONE

INTRODUCTION

1.1 Background to the Problem

Institutions around the world have recognized the use of Information Communication Technology (ICT) as an indispensable tool in revolutionizing the teaching and learning process in classrooms (Kumar, *et al.*, 2008; Livingstone, 2012; Chan, 2014). This has been prompted on the premise that ICT could have a significant role in enhancing curriculum implementation in schools (Kipsoi *et al.*, 2012). According to scholars, ICT is not only a tool for improving teaching approaches, but is seen also as a significant tool to assist with teaching and learning (Al-Awidi & Aldhafeeri, 2017). As such, educational institutions around the world are now integrating ICT in the teaching and learning process (UNESCO, 2011a; Player-Koro, 2012).

At this point, it is important to note that within this study when the researcher refers to the readiness of secondary science teachers in West Pokot County for ICT, the focus was on the participating teachers' readiness to adopt or implement ICT in terms of utilizing ICT resources for the teaching and learning of science. The term integrating is thus referring within this study and the literature to the readiness for adoption or implementation of ICT in terms of utilizing ICT for the teaching and learning of science.

The effective integration (or adoption, implementation and utilisation) of ICT in the teaching and learning process largely depends on how well teachers are ready (Baya'a & Daher, 2013).This is because the use of ICT has transformed the learning environment in the classroom (Gray, 2011). As such, it is therefore critical for teachers to be prepared and to be ready in these times of the digital transformation period, to assist students (which includes school learners) to learn in different ways in the information age (Al-Awidi & Aldhafeeri, 2017), now referred to as the fourth industrial revolution period; learners will thus not be able to escape the fourth industrial revolution (FIR) (Davis, 2016). Davis (2016, par. 2) refers the FIR as technology changing our ways of being, or as he posits:

> "Technologies are emerging and affecting our life's in ways that indicate we are at the beginning of a Fourth Industrial Revolution, a new error that builds and extends the impact of digitalization in new and unanticipated ways it is therefore worthwhile taking some time to consider exactly what kind of shifts we are experiencing and how we might collectively and individually, ensure that it creates benefit for the many, rather than the few."

According to Bonanno (2011), for teachers to effectively integrate ICT for teaching and learning, they need to have several competencies related to knowledge and skills in order to utilize ICT resources for teaching and learning process when implementing the school curriculum. As such, one very important aspect related to readiness is ICT design for teaching and learning (Tsai & Chai, 2012).

Various countries across the world have embraced integration of ICT in education over the years, for example in Malaysia, Singh and Chan (2014) indicated that the government's vision was to improve the quality of learning in the country through the provision of internet access to all schools and also to improve teacher capacity for integrating ICT in their teaching and learning process. In Egypt, Hanan and Huwai (2008) suggested that teachers are required to possess an International Computer Driving Licence (ICDL) in order that they have at least some minimum level knowledge and ICT skills to enable them to implement and utilize ICT resources in facilitating teaching and learning. In the United States of America, the National Council for Accreditation of Teacher Education (NCATE) emphasizes that teachers should take advantage of having adequate technological skills for effective teaching and learning (Afshari, Ghavifekr, Siraj, & Jing, 2013). This shows that efforts have been made to improve teachers' readiness towards integrating ICT in curriculum implementation in schools in developed countries.

Mndzebele (2013) reports that the introduction of ICT in schools in Sub-Saharan Africa appears to be a recent phenomenon, as it is less than 30 years old. The author reported that the government of Swaziland formulated an education sector implementation plan on the use of ICT in teaching and learning, but a number of barriers exist in the execution of this plan in public secondary schools. In South Africa, Sympathonia (2016) observed that the provision of ICT in schools required teachers to adopt and integrate ICT in improving teaching and learning in schools. However, various factors have influenced successful integration of ICT in schools such as teachers' lack of ICT skills, low levels of ICT proficiency, negative attitude, inadequate training and low teacher confidence in using ICT in the classroom (Munanu, 2014; Raman & Yamat, 2015). The researcher of this study posits that this state of affairs reveals a mismatch between policy planning (theory) and implementation (practice).

The adoption of ICT and readiness by teachers to use ICT in various East African countries is diverse. UNESCO (2019) report on improvement of quality and relevance of education through mobile learning in Rwanda discovered that Rwanda government had a master plan which laid out vision for transforming their economy through implementing SMART classroom initiative. By 2019, half of the schools in Rwanda had ICT devices and many teachers had received various training to make them be ready to use them in classrooms. Whereas in Uganda, Newby *et al.* (2012) revealed that ICT usage by teachers in pedagogical instruction was at 45.0%. The result showed that ICT was rarely used because the teachers lacked internet connection. Kihoza *et al.* (2016) conducted a survey in Tanzania and found that teacher trainees and their tutors had low ICT pedagogical abilities and a slow readiness for transition. In another study Ngeze (2017) found that most of Tanzania's schools did not have ICT infrastructure in place, however, teachers were prepared to use ICT, but they did not have the appropriate skills. This called for teacher training to equip them with skills to enable them to use ICT in the classroom.

In Kenya, the government of Kenya enacted the National ICT Policy in the year 2006 to guide ICT education in Kenya (Republic of Kenya, 2006). However, Munanu (2014) reported that ICT integration in teaching and learning is still far from being realized, as most schools do not have the required resources and facilities. Ojwang (2012) reported that there were some teachers who were competent in integrating ICT resources in the teaching and learning process in Kenya, but that this does not appear to be the norm. Despite the fact that many countries have embraced and promoted ICT for teaching and learning, to which was alluded to in the previous paragraphs, it appears countries in sub-Saharan Africa still have not yet embraced the integration of ICT (Hennessy, Harrison, & Wamakote, 2010).This state of affairs motivated the researcher to investigate the status of West Pokot high schools and teachers’ readiness for the integration of ICT in the teaching of Science.

1.2 Statement of the Problem

ICT integration in education is not a new concept in Africa. Various strategies by educational stakeholders have been initiated and tried before (Minishi-Majanja, 2007). For example, the African Development Partners (NEPAD) set up centres of excellence in selected schools in a number of African countries such as. The strategy provided computers, internet connectivity and training of teachers. The objective of the NEPAD strategy was to promote the integration of ICT in the selected schools as well as provide a workable example to other schools that did not benefit from the project to emulate and initiate ICT integration in their schools (Laaria, 2013).

Research has shown that classrooms use of ICT in most African countries, Kenya included are still significantly low. For instance, Farrell (2007) reports that only 27% of schools in Kenya have access to ICT, *i.e.* desktops, tablets and internet connectivity. This is worrying, especially that ICT integration is a key essential in attaining the 2030 Sustainable Development Goal (SDG) number 4 *'Quality education'* and number 9 *'Innovation'* (Rieckmann, 2017).

The situation is even worse in West Pokot County, given the fact that West Pokot County is classified as a hardship area (Republic of Kenya, 2012). Hence, the implication of poor ICT integration in West Pokot County places the schools in a more disadvantaged situation in terms of a poor road network, electricity, internet connectivity and general infrastructure (KNBS, 2020). The KNBS population and housing census 2019 noted that the usage of internet in West Pokot stood at 8.1% against the national average of 28.1%. Moreover, the usage of desktop and laptops for population aged 3 years and above for the county was 3.0% for West Pokot County against the national average of 13.45%. Further, the CIDP 2018-2022 indicates that despite the presence Turkwel Dam that generates electricity, only 2% of the entire population of west Pokot have access to electricity. Analysis of 2019 KCSE performance results for secondary schools in the county shows poor performance in physics, chemistry and Biology subjects with majority of learners scoring a mean grade of D (KNEC, 2019).

The Government through the Ministry of Education, NGOs, parents, teachers, community members and its leaders have invested in setting up computer laboratories and installed ICT equipment to ensure these goals are achieved. It is argued by the researcher that ICT integration can no longer be ignored, as most students are technologically literate by means of mobile devices. Their teachers need also to be skilled with reference to how to utilize ICT. However, research studies reviewed, have indicated that there has been resentment by teachers to use ICT, as some are ICT illiterate while others are resisting change in many sub Saharan African countries (Bingimlas, 2009; Kihoza *et al.*, 2016; Ngeze, 2017). If this problem is not addressed, West Pokot County - being an already marginalized arid and semi-arid county – teachers and learners will be left behind SDG number 4. Consequently, learners and the community will not gain from the use of ICT as a tool that affords possibilities to promote and enhance teaching and learning. As such, it is important to ascertain the readiness of teachers in adopting ICT in teaching and learning. This research study has thus the potential to provide a snapshot to the Kenyan government and teachers pertaining to the readiness of ICT implementation in schools by science educators through specifically ascertaining aspects related to participating educators' attitudes, behavioural intervention, facilitating conditions and intrinsic motivation.

1.3 Purpose of the Study

The aim of conducting this study was to investigate the teacher's readiness with reference to integrating ICT for the teaching of science public secondary schools in the West Pokot County, Kenya.

1.4 Main Objective

The main objective of the study was to investigate teacher readiness to use ICT for the teaching of science and ICT integration in a secondary school in West Pokot County, Kenya.

1.4.1 Subsidiary Objectives

The study was informed by the following subsidiary objectives:

1. To determine the relationship between the attitude towards the use of ICT and the integration of ICT in the teaching of sciences in public secondary schools in West Pokot County, Kenya.
2. To determine the relationship between motivation to use ICT and the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya.
3. To determine the relationship between facilitating conditions and the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya.
4. To determine the relationship between behavioural intention to use of ICT and the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya.

1.5 Hypothesis

The following hypotheses have been formulated, namely:

H_{01} There is no statistically significant relationship between the attitude towards the use of ICT and the integration of ICT in the teaching of sciences in public secondary schools in West Pokot County, Kenya.

H_{02} There is no statistically significant relationship between motivation to use ICT and the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya.

H_{03} There is no statistically significant relationship between facilitating conditions and the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya.

H_{04} There is no statistically significant relationship between behavioural intention to use of ICT and the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya.

1.6 Significance of the Study

This study holds significance, as it has the potential to inform the Ministry of Education (MOE), Teachers Service Commission (TSC) and the Kenya Institute of Curriculum Development (KICD) since it will provide these stakeholders with a picture of the teachers' readiness to integrate ICT in teaching and learning of science. As such, the findings could inform policy formulation on teachers' readiness and ICT Integration with a view to possible planning for assistance and to draft a teacher development plan.

The research findings might be of significance to teachers in public secondary schools as issues pertaining to their readiness will be identified or the purpose of possibly improving their classroom instructional practices – aspects, to which the stakeholders referred to above, could be addressed. In addition, teacher training colleges might also benefit from the study's findings, as the findings could assist them to think about the structure of their pre-service and in-service training courses for science teachers related to ICT use.

1.7 Scope of the Study

This study was conducted to determine the status of schools' and teachers' readiness with reference to integrating ICT for the teaching and learning of science. The study has been confined to selected public secondary schools in West Pokot County, Kenya (See Appendix IX). The respondents for this research were teachers only, because they prepare, plan and conduct the actual teaching and facilitating knowledge skills and attitudes to learners. The researcher collected information through the use of an open and close-ended questionnaire during a time frame of approximately three months (September-Nov 2018). As stated previously, the participants of this study were confined to selected public secondary schools in West Pokot County in Kenya.

The data instrument that was utilized, was based on the UTAUT instrument of Venkatesh, Morris, Davis and Davis (2003), but was adapted (see Section 1.10 and Appendix IV) in order to focus on the variables that this study explored and to be in line with the objectives and hypotheses indicated in Sections 1.4 and 1.5. The independent are ICT integration (readiness towards adoption, implementation and usage) by teachers, teachers' attitude, facilitating conditions (barriers to ICT integration in schools), teachers' motivation and behavioural intention towards adoption (willingness towards adoption, implementation and usage) of ICT.

1.8 Limitations of the Study

Various possible limitations may affect this study in one way or another. Two main limitations were identified. First, some respondents could not understand the concept under study. Further, some teachers experienced fear of reprisal from their heads when responding to research items in certain ways. The above-mentioned limitations were addressed by explaining individually to each participant what the study entailed and by means of a written hand-out to each participant. The respondents were requested not to write any name on the data gathering instrument and to place it in sealed envelopes as a means to address the possible concerns that might arise.

1.9 Assumptions of the Study

The study was informed by the following assumptions: science teachers are in a position to integrate ICT in teaching and learning. All teachers have at least some form of knowledge in ICT usage. ICT resources and facilities are available in public secondary schools. The ICT infrastructure is readily available and in use in public secondary schools. Teachers are motivated to use ICT and the integration of ICT in teaching of science is taking place in public secondary schools. The facilitating conditions are readily available and the integration of ICT in the teaching of science is already in place in public secondary schools in West Pokot County, Kenya. Lastly, the behavioural intention to use ICT in the teaching of science is high among teachers in public secondary schools. The last assumption also resonates with the hypothesis (see section 1.5).

1.10 Theoretical Framework

This study was guided by the Unified Theory of Acceptance and Use of Technology (UTAUT) that was developed by Venkatesh, Morris, Davis and Davis (2003) as cited by Kyllönen (2018). Their theory integrated eight previous theories and models of technology adoption. These theories and models are; the Theory of Reasoned Action [TRA] (Fishbein &Ajzen, 1975), Social Cognitive Theory (Bandura, 1986), Technology Acceptance Model [TAM] (Davis, 1989), Theory of Planned Behaviour [TPB] (Ajzen, 1991), Model of Personnel Computer [PC] Utilization [MPCU] (Thompson, Higgins, & Howell, 1991), Motivational Model [MM] (Davis, 1992), Innovation Diffusion Theory [IDT] (Rogers, 1995; 2003) and Combined TAM-TBP theories (Taylor & Todd, 1995). The model is illustrated in Figure 1.1.

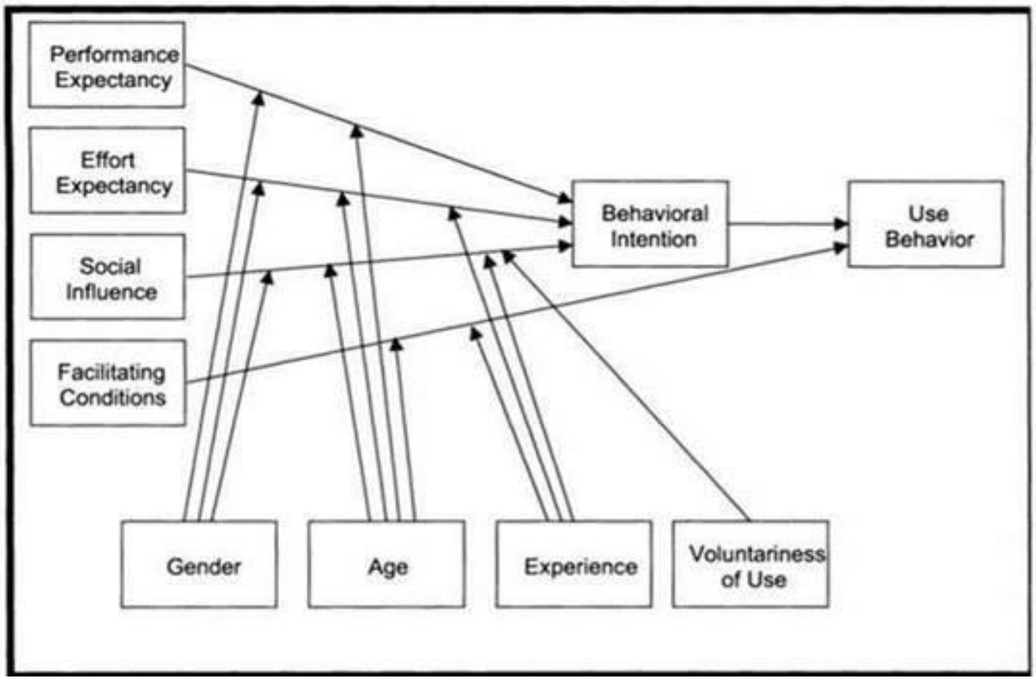

Figure 1.1: Theoretical framework
Source: Venkatesh *et al.* (2003: 447)

According to Venkatesh *et al.* (2003), UTAUT consists of four factors that influence individual decisions to use information communication technology. These are: performance expectancy, effort expectancy, social influence and facilitating conditions (Kyllönen, 2018). Venkatesh *et al.* assume that the following attributes act as moderating variables in the model, namely: demographic characteristics; voluntariness, experience, gender and age.

The authors posit that UTAUT may be able to account for 70% of the change in individuals' intentions to use a particular technology, which is significantly higher compared to the former eight theories and models that were applied before. This unified theory attempts to explain user intent to utilise an information system and consequent usage behaviour. However, the application of this unified theory is not consistent in different research settings and geographical environments (Saliza & Kamil, 2012). This theory therefore cannot be totally be relied upon to determine user acceptance because of variability in explanatory power. Brown and Chan, (2010) argued that the UTAUT model is integrative, but appears to be weak in its explanatory capacity. With reference to independent variables for this study, the theory may fit to be used, but with few adjustments. The discussion below discusses how the constructs of the theory fit in this study.

1.10.1 Performance Expectancy

Performance expectancy refers to the extent to which an individual believes that when he/she uses a specific tool (ICT for the purpose of this study), this tool will be able to enable him/her to achieve the required performance objectives. According to Venkatesh *et al.* (2003), the five constructs from five theories and models that are related to this construct are as follow: Perceived usefulness (from TAM/TAM2 and C-TAM-TPB), Extrinsic motivation (MM), Job fit (MPCU), Relative advantage (IDT) and Outcome expectations (from SCT).

For each individual model, performance expectancy as construct within the individual model remains the strongest predictor of intention to use a particular tool. Performance expectancy with reference to this study is related to the science teachers' readiness to utilize ICT for teaching and learning in the classroom. This is because readiness ascertains the extent to which a teacher believes that utilizing ICT would improve the teaching and learning process, the capacity of the ICT system to improve teacher instructional performance and the perceptions that teachers may have that utilizing ICT could be significant in achieving teaching and learning objectives or outcomes. It may also assist with determining the perceptions that teachers have towards the relative advantage of integrating ICT in the classroom for teaching and learning.

1.10.2 Effort expectancy

Effort expectancy is the second construct in the unified model. According to Venkatesh *et al.* (2003), this is the degree of ease associated with the use of the tool. This construct came from a combination of three models; perceived ease of use (TAM/TAM2), complexity (MPCU) and ease of use (IDT). In relation to this research, the degree to which teacher perceives that using ICT would be free of any struggle-simplicity and not complexity, the degree to which teacher perceive ICT to be relatively difficult to use and understand and the degree of utilizing ICT is seen as being difficult to use. In relation to the study, the effort expectancy construct questions will be used to determine teachers' attitudes towards using ICT in teaching and learning.

1.10.3 Social influence

Social influence is the third construct for the study and Venkatesh *et al.* (2003) defines it as the extent to which an individual perceives that important others believe he/she should use the system. It is a direct determinant through which behavioural intent is represented as a subjective norm in the following models: TAM2, TRA, C-TAM-TPB, TPB/DTPM, MPCU social factors and image in IDT. Considering that this research targets teachers of science, it will not be possible to apply social influence as a construct in this research, since students and head teachers are not involved.

1.10.4 Facilitating conditions

Facilitating conditions refers to the extent that an individual believes that there will be organizational and technical infrastructure support which will assist towards utilizing the tool. It has been developed based on constructs taken from three models: perceived behavioural control (TPB/DTPB, C-TAM-TPB), facilitating conditions (MPCU), relative advantage (IDT) and compatibility (Venkatesh *et al.,* 2003). All these constructs have been embedded to include features related to the organisational and technological environment with a view to eliminating barriers to ICT use. Perceived behavioural control reflects the perceptions of internal and external constraints on behaviour and includes self–efficacy, resource facilitating conditions and technology facilitating conditions (Venkatesh & Viswanath, 2000). Facilitating conditions refer to objective factors in the environment that enables the observer/individual to perceive that what has been done is not too complicated, but relatively simplistic, which also includes the availability of the necessary ICT facilities (Legris, Ingham & Collerette, 2003).

Compatibility, on the other hand, refers to the degree to which an innovation is perceived to be consistent with existing values, needs and experience of the potential adopters (Moore, 1991). In this study, the focus is on establishing enablers and barriers that science teachers face when using ICT. These barriers may be first order, second order, third order and fourth-order barriers (see sections 2.7, 2.7.1, 2.7.2, 2.7.3 and 2.7.4).

Considering the variables under study and the respondents to be involved, the researcher made adjustments to Venkatesh *et al.*’s (2003) UTAUT, as illustrated in Figure 1.2 and constructed a questionnaire (see Chapter 3) with similar statements and added statements. As the study did not intend to explore all the constructs in their model, three constructs from their model had been selected and motivation was added. Venkatesh *et al.’s* (2003) model or framework indicates that performance expectancy, effort expectancy and social influence informs behavioural intention and use behaviour while facilitating conditions inform use behaviour. In addition, aspects related to attitude, anxiety and self-efficacy are also embedded in this model. For the purpose of this study, the researcher made several assumptions as indicated in the objectives and hypotheses sections. These assumptions are that the researcher assumes that there exists a significant relationship between the teachers’ readiness and use of ICT in teaching and learning of science subject in schools with reference to the constructs indicated in Figure 1.3, namely teacher attitude, facilitating condition, intrinsic motivation and behavioural intention. As such, the researcher utilized constructs or variables of Venkatesh *et al.’s* (2003) model (but not all of these variables) with a view to ascertaining whether there is a relationship between the constructs in Figure 1.3 and the stated in the objectives and hypotheses adopted (see Section 1.11 and Appendix IV). For the purpose of this study, the statements within the constructs that Venkatesh *et al.’s* (2003) model presents were included in addition to other statements that were refined to fit the context of this particular study. The statements of this study and their associated constructs or variables are presented in the methodology chapter, Chapter 3.

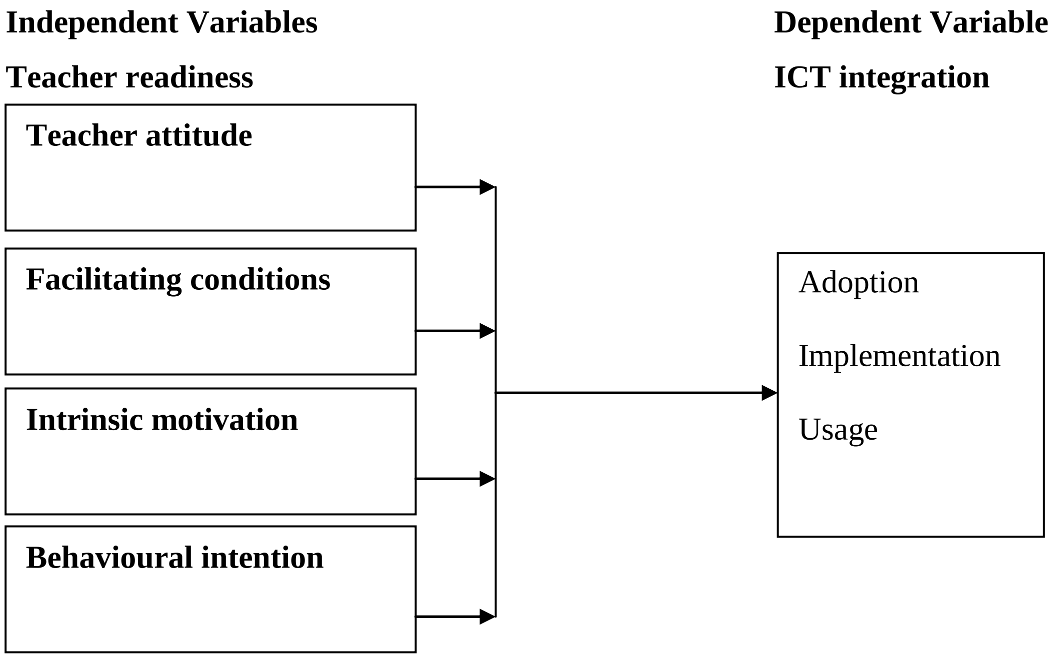

Figure 1.2: Conceptual Framework

Ertmer (1999) has argued that there are several challenges or barriers that play a role in reference to ICT integration (implementation). These are the first-, second-, third- and fourth-order barriers (see Chapter 2). The facilitating conditions can be associated with first-order challenges whereas teacher attitude, motivation and behavioural intention are related to second-order challenges. The third order barriers (Subramanien, 2014) comprise system wide support while Tsai and Chai (2012) referred to design skills as a third-order barrier. As such, these two authors attribute different aspects to third order barriers.

1.11 Operational Definition of Terms

The two operational terms are presented in a holistic manner below. These terms are the integration of ICT and readiness to harness ICT.

ICT readiness is a measure of the tendency of an individual to make use of opportunities provided by information communication technology. In terms of this study, readiness refers to ICT integration (adoption, implementation and/or usage) of participating teachers in terms of realizing that there is a relative advantage or some form of performance enhancement linked to ICT usage.

Readiness refers to a willingness to do something, quickness, rapidity swiftness and sharpness (Soanes & Stevenson, 2004).

Technology Integration (implementation or usage) is the use of technology resources which include computer, mobile devices such as smart phones, tablets and software application (Herro, Kiger & Owens, 2013) having a possible relative advantage or performance enhancement (Venkatesh *et al.*, 2003).

Teachers' attitude: refers to the perceptions that teachers have towards the relative advantage of integrating ICT in classroom teaching and learning

Facilitating conditions: Refers to the degree to which an individual believes that organisational and technical infrastructure exists to support use of ICYT systems and facilities in schools.

Behavioural intentions: they are motivational factors that influence a certain behaviour where the stronger desire to perform the behaviour the more likely the behaviour will be performed.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The chapter starts with a brief overview of the ICT policy in Kenya. This is followed by the ICT implementation matrix. The next sections present the review of related literature on the teacher perception on readiness to integrate ICT in teaching and learning process. This is followed by literature pertaining to aspects that influence teacher readiness and is done by presenting literature and research from the international context, an African context, Kenyan perspective and then a Kenyan science perspective. The aspects related to readiness are then presented by identifying the aspects which were identified in the literature and research pertaining to readiness from the international, African, Kenyan and Kenyan science perspective. This is followed by a presentation of challenges pertaining to ICT implementation in the form of a four-order typology. The chapter concludes with suggestions of ways to ameliorate ICT implementation barriers. The theoretical framework was presented in Chapter 1.

2.2 ICT Policy in Kenya

The Kenyan government through the ministry of education developed a programme in 2005 called Kenya Educational Sector Support Programme (KESSP). The ministry was tasked with the objective of mainstreaming ICT in teaching and learning as the first priority. The ICT integration was given necessary attention as this initiative mandated the Ministry of Education to develop a policy framework on technology in education in Kenya. A document, referred to as the ICT Policy on Education, was developed in 2006. The Republic of Kenya (2006:14) policy had the following objectives: ICT in education; digital equipment; connectivity and network; access and equity; technical support and maintenance; digital content; integration in education; harnessing emerging technologies and integration in education (Omare *et al.*, 2018). The monitoring and evaluation of the policy document referred to above was to be done by the Ministry of Education tailored to be in line with Global Education Goals such as Education for All and Sustainable Development Goals (MDG) 2030. The 2006 ICT policy was revised in the year 2016 and it laid more emphasis on infrastructure development. The intention was to increase the internet penetration base, as well as other infrastructure that needed expansion to enable socio-economic growth. As such, the government developed an infrastructure policy that increasingly looked at economic growth which included looking at the effectiveness; affordability and spread off of ICT service (Republic of Kenya, 2006; 2016).

Furthermore, the policy laid emphasis on acquisition and nurturing of skills by Kenyans in order to boost the country’s ICT workforce, which will help reduce the dependence on the importation of ICT experts. Hence, it laid emphasis on realigning technical and vocational training to meet the job market needs. As such, the curriculum had as its intention to develop and maximize a wide range of opportunities that come with the application of ICT in educational pedagogy, for example, the use of simulations during teaching and learning subject areas in the school curriculum.

With the above in mind, the Republic of Kenya (2016) policy focused on the following fundamental aspects of ICT integration: increasing ICT skilled human resources in Kenya equipped with skills and knowledge; improving the quality of education through distance learning, the use of ICT and not only ICT as a subject, but also content delivery in all subject areas; the development and distribution of ICT in a way that will stimulate a rise in the quality and size of the ICT-skilled human resource base in Kenya. Making use of ICT to advance the quality of teaching and learning as well as training including distance learning, so as to enhance the learning experience itself. Widening and progressing adult-education, and both general and digital literacy programmes and life-long learning notably for re-skilling and retraining the existing workforce.

There is need for integrating ICT as an everyday life activity without eliminating those that need skills development. Supporting and encouraging ICT training for community and civil society leaders, political decision-makers along with public and private sector executives; giving special attention to the provision of ICT access and new learning opportunities for the youth, women, the disabled and disadvantaged, particularly marginalised and illiterate people, with the aim of addressing social inequities. Develop and set up a countrywide e-Education system and facilities that support schools, higher education and training by connecting them with each other and with other relevant knowledge centres.

From the above, it appears that there is a strong emphasis on ICT implementation from the school level and hence the importance of this study by the researcher to explore *'how ready'* teachers are to embrace ICT for teaching and learning with reference to the variables identified.

2.3 ICT Implementation and Integration Matrix

Teachers are the people who are the key persons that can promote ICT implementation or integration in a successful manner (Ertmer, 1999; Fullan & Smith, 1999; Mouza, 2005; Prensky, 2008) and hence it is vital to challenge their beliefs with a view to promote their readiness towards ICT integration in teaching and learning, likere-culturing of their existing thinking and practice (Fullan & Smith, 1999). In the following subsections, types of ICT implementation or integration and stages of ICT implementation or integration are elaborated upon.

2.3.1 Types of Integration

Du Plessis and Webb (2012, citing Morrison, Lowther, & De Meulle, 1999; Reigeluth & Joseph, 2002) are convinced that technology integration does not refer to the use of computers to support conventional or the usual methods of teaching, for instance, learning *'from'* the computer using drill-and-practice, tutorials and hypermedia applications. Rather, they perceive technology integration as going beyond traditional teacher-centered pedagogies to creating a learning environment where learners make use of the technology to learn *'with'* and *'through'* computers (Du Plessis & Webb, 2012, citing Jonassen, Peck, & Wilson, 1999).

Subsequently, Du Plessis and Webb (2012, citing Hodgkinson-Williams, 2006; citing Du Plessis, 2010) highlight three types of integration. They referred to the first type of integration as *'Learning about computers'*, where the focus is not on integration, but on mere computer literacy or learning technical terms related to computers. As such, *'computer literacy'* has been the main focus of this approach, which merely includes using computer applications devoid of any link to what is taking place in the classroom. Basically, learners get limited exposure to computers as they only access them for a short time in the week during the computer lessons in the computer labs and then return to their classroom without the computers. They argue that computer utilization is not linked to what is happening in the classroom and hence is an *'added* *on'*. The second type of utilization is implementation with integration to achieve traditional goals (Du Plessis & Webb, 2012). This type frequently results in learning *'from'* the computer, *i.e.* the learner receives instructions from the computer and the outcome is that the computer becomes the conveyor of knowledge and the computer becomes a tutor or teacher (Jonassen, Peck, & Wilson, 1999 as cited by Du Plessis & Webb, 2012). The third type of integration is referred to as integration to promote a constructivist learning context which is a form of meaningful integration. They posit that with this approach related to integration, learning happens *'with'* or *'through'* using computers (Jonassen, Peck, & Wilson, 1999 as cited by Du Plessis & Webb, 2012). This integration is also referred to as the generative use or generative mode under which computers or ICT's are manipulated as transformational, meditational or cognitive tools (Hodgkinson-Williams, 2006, as cited by Du Plessis & Webb, 2012).

Du Plessis (2016) has developed a matrix based on the suggestions of several authors that he referenced to indicate five possible perspectives related to ICT types of integration. These ways of implementation are the computer literacy stage, instructivist stage, socio-constructivist generative cognitive tool stage, an unintended stage where existing tools are redefined or adapted and a combination of the previous three stages into an eclectic stage where ICT tools are utilized in a different ways based on the teaching and learning needs or goals at that point in time (Du Plessis, 2016).

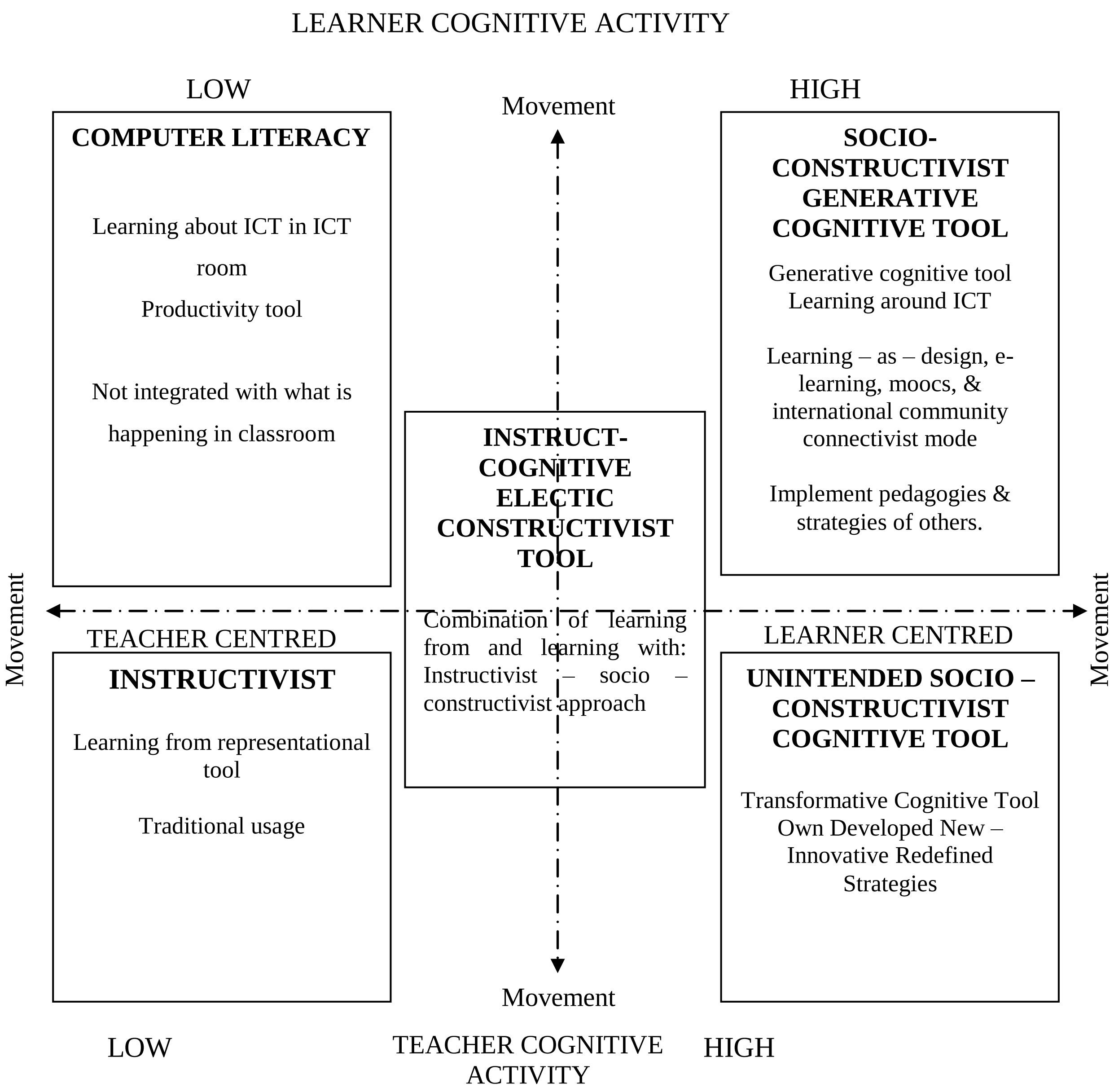

Figure 2.1: ICT Implementation Matrix
Source: Du Plessis (2016, p. 143)

In addition, Du Plessis (2016) also indicated in the matrix whether the learner’s cognitive activity or the teacher’s cognitive activity is high or low related to these five ways of ICT implementation (integration). A brief description of these five ways of implementation is indicated in each of the blocks in Figure 2.1.

2.3.2 Stages of Implementation

From the literature and what has been presented in Section 2.3.1, it becomes evident that the implementation of ICT (technology) for teaching and learning does not happen in the same way for every person or every school. In order to attain the various opportunities of integrating ICT in teaching and learning, there are various stages that teachers and their schools have to follow through in order to arrive at the stage to which they aim to. Additionally, several frameworks were noted in the literature. For instance, the framework relating to the Classrooms of Tomorrow (ACOT) project highlighted five stages which teachers and their schools come across, namely an entry phase, adoption phase, adaptation phase, appropriation phase and an invention phase (Sandholtz, Ringstaff, & Dwyer, 1997). Toledo (2005) has also presented a five stage model, thus concurring with Sandholtz, *et al.* (1997) position of five stages. He refers to these stages as the pre-integration, transition, development, expansion and system-wide integration stages.

On the other hand, Kopcha (2008) has recommended that a systems-based mentoring model approach should be considered to promote ICT where there are four stages or phases as foci. The author argues that during stage one, the main focus of the mentor is on the initial setup with the focus on troubleshooting and developing a system that is making it easier for the teacher to manage the technology; thus helping teachers to spend less time managing the technology. Stage three is the teacher preparation stage and the mentor’s main areas of focus are on developing basic teacher technology skills, providing training and monitoring teacher development progress. In addition, practical showcasing of how technology could be utilized has also to be shown to teachers. During this stage, the mentor should focus on curricular related aspects and

Kopcha (2008) argues that it can be achieved through establishing communities of practices that share their experiences which emphasis how learner-centred teaching and learning has been achieved, hence the focus of the teachers should be on the design of a learner-centred activities. Lastly, stage four requires that the mentor consolidates the previous stages and establish technology leaders who can then serve as mentors themselves in their communities of practice at their school (Kopcha, 2008).

2.4 Teachers' Readiness to Use ICT for Teaching and Learning

ICT readiness can be described as the tendency to make use of technologies for achieving goals (Godoe & Johansen, 2012 citing Parasuraman & Colby, 2001).Teachers appear to be most enthusiastic to have new technologies such as ICTs, however, Copriady (2015) notes that even though some teachers have not appreciated the significance of ICTs, many teachers believe that ICT technologies offer possibilities to assist overcoming difficulties encountered in teaching and learning. Al-Awidi and Aldhafeeri (2017; see also Rogers, 1995, 2003) posit that readiness has to do with teachers' perceptions, knowledge, awareness, attitude and their competencies and skills related to ICT for technology integration, as well as their experience related to their utilization of educational technology.

Earle (2002), describes ICT implementation related to education as the successful and efficient application of technology in every facet of educational process comprising the curriculum including required infrastructure and teaching-learning context. These factors are viewed as essential for the attainment of any technological advancement in teaching and learning.

Godoe and Johansen (2012) state that Technology Readiness (TR) refers to people's tendency to embrace and use technologies for achieving goals in home life and at work, based on personal technology readiness. They further classified technology readiness into five segments of sceptics, pioneers, laggards, paranoids and explorers. Rogers (1995, 2003) categorize adopters of innovations, which can include ICTs as an innovation; as innovators, early adopters, early majority, late majority and laggards. Rogers (1995, 2003) developed the perceived attributes theory which posits that a person based his or her decision to adopt (which includes to use or implement) an innovation or to adopt something that is not new, but which has been around for some time, based on aspects such as its simplicity, trialability, observability, relative advantage and compatibility. In addition, he states that knowledge is a key factor too, as well as the power of persuasion by others when any innovation is introduced (Rogers, 1995, 2003). It appears thus that Rogers' (1995, 2003) position also refers to or implies readiness or willingness.

In the following section, findings from studies related to teacher readiness are explored to ascertain what appear to be the main aspects that inform readiness.

2.5 Exploring Research: Aspects that are Important for Readiness to Utilize ICT(s) for Teaching and Learning

In this section, as stated before, the researcher will be obtaining a snapshot related to studies pertaining to teacher readiness, in order to explore what are some of the main constructs that inform readiness for adoption, integration or implementation. In the first subsection, international aspects are explored. This is followed by African aspects as a subsection and then Kenyan related aspects. This section then concludes with a section summarizing the key aspects identified related to teacher readiness for ICT implementation, usage or integration based on the literature.

2.5.1 International Perspectives

Marcinkiewicz (1993) argues that teacher' beliefs and attitudes towards technology impact on how they make use of ICT in the classrooms. Sonia (2012) states that teachers who are computer literate will realize that this tool offers a number of benefits that their peers are not able to understand if these peers possess little or no computer knowledge and skill. The above concurs with Rogers (1995, 2003) who posits that knowledge about an innovation is one of the key aspects in the innovation-decision process which could lead to being persuaded to adopt an innovation and in the context of this research the innovation refers the readiness to adopt ICT for teaching and learning.

Walsh and Farren (2018) investigated barriers that affected the use of iPads in primary schools in Ireland. The results showed that iPads usage had positive effect on learning. However, the instructors needed more training on the iPad features and applications and ways of using them effectively during classrooms teaching and learning. Afshari, Bakar, Luan, Samah and Fooi, (2009) analyzed various literature to explore the attitude of the teachers concerning ICT. They established that individual characteristics such as age, gender, individual's educational level, educational experience, experience with the computer for educational purposes and economic status are likely to influence the attitude of teachers related to ICT and the effect of ICT use.

In a Grecian study, Jimoyiannis and Komis (2006) investigated secondary education teachers' attitudes toward and beliefs about ICT integration. They observed a noticeable growth in teachers' attitudes towards the use of ICT for instructional activities, as most of the study participants reported that they had used ICT to prepare and communicate more willingly during actual teaching or allocating ICT-based tasks to learners. In addition, despite the lack of basic computer skills among the teachers, most of the teachers exhibited positive attitudes towards the effectiveness of ICT in improving teaching and learning practices. It was noted that the following factors informed the participants' attitudes in the study: the importance to motivate teachers on the application of ICT in education, teachers' uncertainty on the success of ICT teaching and the anxiety that learners may possibly be more well-informed about computers than their teachers.

In a Turkish study by Albirini (2006a), it was established that the majority of the respondents in this study displayed positive attitudes towards ICT. The participants considered computers as an effective instruction device, which can stimulate significant improvements in teaching and learning. It was also found that the participants were in the decision phase, *i.e.* to decide whether they were going to adopt or reject computer implementation which thus suggests that they were in the thirds stage of the innovation-decision process (see Rogers, 1995, 2003). The study also identified a very strong connection between teachers' perception of computer attributes (see Rogers, 1995, 2003) and attitudes towards ICT in education.

Kumar, Rose and D'Silva (2008) investigated teacher readiness in Malaysia in Asia from a sample secondary school Mathematics, Science and English language (MSE) teachers. The authors referred to readiness in terms of Actual Usage of Computers (AUC) and what the implications are with reference for future professional teacher development. The results indicated that the AUC and these teachers' acceptance of technology was at a moderate level and that attributes such as attitude, observed ease of use, practical usefulness and task relevance and computer compatibility are important attributes or factors related to AUC. The above indicates thus the importance of these constructs for ICT adoption, implementation and integration.

Simonson (2008) explored the technology use of Hispanic bilingual teachers and from the study it was evident that teachers' perceptions, attitudes and skills influenced their use implementation of ICT related to teaching and learning. It also appears that the more skilled teachers were in ICT, the more likely they were to use it in their classroom (Simonson, 2008). It is argued by the researcher that the usefulness of ICT is a key element that drives ICT utilization, which has been corroborated by the sources above. This position is also confirmed by Mwendwa (2017) who stated that:

> "Teachers using new technology would have to consider the perceived usefulness in the use of the new technology to accept it. They would need to believe the new technology to accept it teachers would require to trust that using the new technology would enhance their job performance. Moreover, the teachers would have to consider the perceived ease of use of the new technology which is why they have to know the extent to which they believe that using a particular system would be free from effort."
> (Mwendwa, 2017, p. 416)

Tezci (2009) in his study on the effect of ICT related to teachers' readiness posits that technology integration in classrooms depends on the level of experience teachers have with using computers. He suggests that when the knowledge on the use of ICT technology is high, then the chances of integrating ICT into teaching is high. This indicates that teachers' knowledge plays an important role in the integration of ICT in education (Celebi, 2019). A study by Wood (2010) examined the perceptions of lecturers regarding the adoption of virtual world technology into the classroom as learning space. The study (Wood, 2010) found that although the higher education faculty acknowledged the prospective of virtual world technology as a convenient teaching tool, lack of or inadequate hardware and software support from their institutions limited its use in classrooms.

Olasina (2012) posits that teachers express a need for teacher training on basic computer skills. The study found that teachers' training should not be limited to teachers who teach computer lessons, but should be spread to the entire school. Teachers need to know the use of computers first before they can integrate them. Teacher knowledge and skills influence the successful implementation of curriculum innovations and changes (Mwaka, Wambua, Syomwene, & Kitainge, 2013).

A study by Kaygisiz, Baglibell and Samancioglu (2011) discovered a high level of computer utilization among science teachers which as a result of their positive attitudes toward Computer-Supported Teaching (CST). The study revealed a strong positive correlation between teachers' attitudes toward CST and ICT use. Similarly, Sing and Chan (2014) found that their study participants (teachers) had a moderate level of ICT knowledge with regard to presentation applications, spreadsheets, internet and email use. Outstandingly, they pointed out that the participants exhibited a positive attitude towards use of ICTs in teaching and learning. Furthermore, the participants were of the view that ICT provided teachers with the possibility of transforming teaching and learning in classrooms (Sing & Chan (2014).

Demir and Bozkurt (2011) posit with reference to mathematics teachers in Turkey that teachers' proficiency influenced their competency in integrating ICT. They recommended that teachers should undergo in-service training related to ICT implementation (integration) and pedagogy as part of their professional development in order to promote the exploration of teachers related to ICT and its integration. This, they argue could positively impact teacher beliefs.

Bozkurt (2011) investigated why teachers integrate (or implement) technology (ICT) as part of their lessons, what technology they implemented and how they integrated it. The results indicated that teachers who had been exposed to ICT developmental training had a good understanding of what ICT related tools to select (software related) for a particular reason. It also appears from their study that teachers that are not well-versed or new to technology seemed to use ICT resources in traditional or conventional ways and not in innovative ways. The author also highlighted the importance of attitude related to using ICT tools for teaching and learning (Bozkurt, 2011), hence affirming the importance of attitude as being part of readiness for adoption. Similarly, Badri, Rashedi and Mohaidat (2013) and Badri, Al Rashedi, Yang, Mohaidat and Al Hammadi (2014) from the United Arab Emirates highlight the importance of teachers' attitude in relation to their intention (behavioural intention) to implement ICT and how they respond to ICT implementation either as an explorer, pioneer, sceptic, paranoid or laggard. Badri *et al.* (2013) also highlighted that gender, background, the number of students responsible for, age, experience, education and work location had either significant or partial effects. A study by Buabeng, and Andoh (2012) on ICT integration in Turkey found that the ICT skill level of educators is one of the most significant determinants in the use of technology in the educational setting. In addressing this problem, the ICT competence of the teachers seems to be a crucial competency in overcoming this challenge.

Alazzam, Bakar, Hamzah and Asimiran (2012) researched the ICT readiness of technical and vocational teachers in Malaysia. Their study revealed that teachers with a moderate level of ICT skills had an above-average application of ICT knowledge, which could probably be linked to the positive attitude towards ICT integration in teaching and learning. Wilmore and Betz (2000) from Australia and the United States post that implementation of ICT in schools would be thriving when schools are fully supported and can afford up-to-date infrastructure, sufficient professional development and support staff during implementation. Congruently, Kirimi (2014) argues that apart from possessing in-depth knowledge of the curriculum, it is significant for teachers to be proficient in integrating ICT in teaching and learning, as well as understanding the administrative and social dimensions of ICT usage for educational purposes.

The general and widely accepted belief is that attitudes affect behaviour directly or indirectly (Rogers, 1995, 2003; Zimbardo, Ebbesen & Maslach cited by Asiri, Mahmud, Bakar, & Ayub, 2012a; see also Asiri, Mahmud, Bakar, &Ayub, 2012b). Albirini (2006b) posits that ICT offers educational possibilities as a tool that can foster substantial improvement to schools and classrooms and also came to the conclusion that teacher attitudes played a significant role with reference to implementation (adoption, integration). According to Baya’a and Daher (2013) teachers with positive perceptions of their competence in technology and ICT integration were ready for the integration of ICT in their teaching. Their Israeli study also suggested that teachers with positive attitudes towards ICT integration in teaching had successful classroom experiences.

In Indonesia, Copriady (2014, with reference to Siti Aishah *et al.*, 2002 & Robiah *et al.*, 2003) states that it appears that many teachers are not comfortable to adopt or implement ICTs for teaching and learning, as they are comfortable with the status quo of conventional tools that they are accustomed to. This suggests that there appears not to be a great level of readiness among some teachers. He continues by stating that many teachers appear to lack the will to improve their knowledge and skills pertaining to ICTs and as such, many lack the basic computer skills such as for example not even being able to use the Microsoft Office Suite. However, one has to take note that these claims date seventeen years back in 2019 and as such there might have been a change since then. However, the point that is trying to be made is that there appears to be a hesitance to adopt ICTs and thus a lack of readiness. At the same time, Copriady (2014) also refers to Yunus and Wekke (2009) who indicated that many teachers do not harness the possibilities that the internet offers. Copriandy (2014) argues that teacher readiness to adopt or explore ICTs is linked to teacher attitudes and motivation.

Raman and Yamat's (2015) study sought to ascertain why sufficient technical supports provided to teachers had not yielded a positive impact on the effective use of ICT in the classrooms. The study showed that effective use of ICT in teaching and learning was not just an issue of provision of ICT technologies and facilities, but one that depended on other factors such as the teachers' readiness in integrating ICT, teacher's ICT knowledge and skills, individual's age and experience in teaching, the amount of workload a teacher had to handle and the time available. Raman and Yamat, 2015 (citing Hennessy, Harrison,& Wamakote 2010) also indicated that other vital teacher-related factors which are influencing the integration of ICT in teaching and learning were teachers’ attitude, confidence and ICT knowledge.

In a study in Shanghai China, Dong (2018) conducted research regarding the perceptions and barriers to ICT use. The teachers perceived that ICT use had a positive effect on increasing pre-school children knowledge and competencies. The children were found to exhibit some competencies on ICT use because of their earlier exposure at home and this challenged teachers to have adequate ICT training and professional development.

2.5.2 African Perspectives

Padayachee (2017) determined the extent of ICT usage in South African schools within the Tshwane area. The study revealed that there was a low uptake of technology in the sample of South African schools. It further indicated that the average frequency of the usage of ICT contextual tools was 41%, sharing of information and as an idea tool was 29%, experiential tools were 26% and reflective dialogue tools were 18%. Padayachee (2017, referring to Mooketsi and Vhigona) states that there appears to be a mismatch between the expectations of the government related to ICT implementation and the teachers’ usage of ICTs for teaching and learning.

Mndzebele (2013) reviewed the readiness of teachers to teach ICT as a subject, the integration of ICT in other subjects and challenges the teachers encountered in Swaziland schools pertaining to teachers’ readiness. The study showed that there was a need for the ministry of education to establish an educational training system that could enhance the teaching of ICT as a subject, as well as training related to ICT integration in teaching and learning.

Ouardaoui, Legrouri, Darhmaoui and Loudiyi (2012) investigated how ICT integration motivates enhanced student performance in science at the middle school level. Their study's results showed that ICT integration increased student motivation for learning and improved their performance in subjects like chemistry. They also noted that in-service training of teachers positively influenced teachers to integrate ICT into their lessons. Ouardaoui *et al.* (2012) also highlighted the importance of planning for implementing ICT in lessons and the adaptation thereof when one embarks on projects (or workshops) as opportunities for implementation of ICTs. They further argue that it is vital to establish a context in which the participants feel confident (Ouardaoui *et al.*, 2012).

Oyeronke and Fagbohun (2013) carried out a study examining the level of ICT literacy among selected secondary school teachers in Nigeria and how they integrated ICT for teaching and learning. The findings of the study showed that teachers acknowledged the importance of ICT literacy in enhancing the teaching and learning of the curriculum content. Though the study also revealed that the bigger percentage of secondary school teachers were ICT literate, Oyeronke and Fagbohun indicated that even though there was a positive indication of ICT literacy among the sampled population, there was more still to be done. Another study by Aduwa-Ogiegbaen, and Iyamu (2005) which examined the status of information technology use in public institutions revealed that institutions still use the manual way of keeping records.

Still in Nigeria, Lawrence and Tar (2018) conducted a research to establish what prompted teachers to adopt and integrate ICT in classrooms learning. The study results showed that many teachers indicated that learning how to integrate ICT in classroom teaching and learning was time consuming, others feared that ICT would replace them in their jobs and this explained why the level of integration was low. Another study by Sympathonia (2016) explored teachers' experiences in using ICT in South African schools. The study's results revealed that most teachers underscored the benefits of ICT integration in teaching and learning particularly in facilitating better methodological strategies, improving the accessibility of relevant information, enhancing collaboration among teachers and their capacity to accommodate learners with different abilities and learning styles when ICTs are utilised.

Du Plessis and Webb (2012) presented research regarding teachers' perceptions of their readiness related to implementing Information and Communication Technology (ICT) in six previously disadvantaged South African schools. They stated that prior to 1994, the level of ICT resources in schools was insignificant as a result of the South African apartheid policy and that the schools situated within the townships that were marginalized during apartheid lacked basic ICT infrastructure. The data showed that, in as much as the schools were provided with computers and teacher training, a number of first and second-order barriers still existed (Du Plessis & Webb, 2012) (Section 2.7 for more about the barriers typology) for instance, the absence of or inappropriate project leadership in the schools, inadequate ICT resources to accommodate a large number of learners and a need for continuous in-service teacher training and support.

The barriers stated above were found to have hampered the progress of the initial integration. Hence, most of the schools did not achieve the desired ICT integration in teaching and learning, as well as improving teacher characteristics (teachers' perception, the structure of learning in the institution) and characteristics of students in classrooms - sum total of first and second order barriers which could make ICT integration a success (Du Plessis & Webb, 2012 with reference to Hung & Koh, 2004). Du Plessis and Webb (2012a, 2012b) proposed a heuristic for teacher ICT development based on their data that had as its focus teachers' internal or second order challenges that they have to deal with at heart. These aspects included being caring, patient, motivational and containing anxiety to name a few only (Du Plessis & Webb, 2012b).

Msila (2015) conducted a case study in Gauteng province by means of observations and interviews. The findings indicated that training is essential and lack of it could lead to the participants' inability to properly use ICT, thus being perceived as not competent in class. It also seems that younger teachers were more inclined to utilize ICT resources than older teachers. Msila (2015) argues that attitude and knowledge play a key role in successful ICT implementation. Msila (2015) contends that competent teachers are likely to be unsuccessful in their classrooms if they have a negative attitude towards innovation or curriculum changes. As ICT implementation is something new for many teachers, its incorporation in the school context and the classroom can be viewed as an innovation that can be rejected, as Rogers (1995, 2003) posit that this can happen with any innovation.

Msila (2015) indicated that training is essential and that without the necessary training, the participants felt that they could be perceived as not competent in class when they cannot use it properly also seems that younger teachers were more inclined to utilize ICT resources than an older teacher. He also stated that attitude and knowledge play a key role towards successful ICT implementation. As such, a teacher’s attitude remains to be a vital characteristic linked to the adoption and implementation of ICT within a classroom and school (Msila, 2015).

Mndzebele, Gama, Mavuso, Ndzimandze, Nkambule and Tfwala (2014) study in Swaziland focused on the integration of ICT in schools and classrooms and explored the impact of the perception of teachers with little or no ICT knowledge and skills especially among schools that offered ICT. The study found out that teachers without ICT knowledge and skills had a negative attitude on the integration of ICT in teaching and learning which resulted in poor integration of ICT in teaching and learning.

2.5.3 Kenyan Perspectives

A study by Kiboss (2002) on computer use for teaching and learning to augment lessons in classrooms indicated a mixed reaction among teachers interviewed. However, the majority of the teachers interviewed recommended the use of technology as a powerful tool to enhance teaching and learning. Farrell (2007 as cited by Kiboss, 2002) posits that education policy of 2006 on ICT encouraged the use of technology in all levels of learning (primary, secondary and tertiary). The policy laid emphasis on the use of ICT in teaching and learning in the country in order to ensure that quality education is achieved. However, there are challenges that hinder successful implication of ICT use in teaching and learning, this includes electricity power outages, high poverty level among Kenyan people in rural areas, luck of computers hardware and software to be used in schools, admission of large numbers of students to the available computers with the ration of 150:1 (Kiboss, 2002).

A study by Kinuthia (2009) identified a number of factors which influence ICT use in schools such as the lack of time for training at hand, teachers' lack of enthusiasm to appreciate ICT, the type of computer hardware and software available for usage, uneasiness from handling equipment, being anxious as it is perceived that they will not be in charge of the classroom in the manner that they wanted to be, not receiving the necessary technical support that they would require and new developments that might lead that their current knowledge and skills become irrelevant.

The Sessional Paper No. 1 of 2005 outlines the Ministry of Education policy on the integration of ICT in education. The aim of the policy is to provide a framework for the utilization of modern ICT in education. Through the policy, the Ministry laid down strategies that called for the effective assimilation of ICT in education, In which case the teachers and learners learn about and with ICT. When learners *'learn about'* ICT, they become ICT literate, and this may as well add to the improvement of ICT usage. On the other hand, *'learning with'* ICT ensures that learners acquire and effectively use ICT knowledge and skills relevant to education in the 21^{st-}century knowledge economy. In this regard, the Republic of Kenya (2012) identified various issues and challenges facing ICT integration within the Kenyan education system. Some of the issues and challenges included: the use of ICT in administration being over-emphasized; a small number of schools (approximately 2%) in the country were identified as having networked ICT laboratories; intentional supply of old and used computers to schools and limited development and use of digital content and curriculum materials due to financial resources constraints.

To mitigate the issues and challenges stated above, the Republic of Kenya (2012) put across the following recommendations: development and adoption of an elaborate policy and strategic framework for efficient ICT integration in the teaching and learning; provision of support and reinforcing institutional framework that will assist in effective ICT integration across the education sector; boosting ICT access and capacity through the provision of ICT infrastructure to schools and establishment of a national ICT centre that will test modern ICT tools, demonstrate and recommend ICT for use in teaching and learning in Kenya’s education and training institutions; set standards and guidelines which will assist educational institutions in embracing and integrating ICT for teaching and learning and make internet connectivity available to all schools.

A study by Manduku, Kosgey and Sang (2012) revealed that in spite of strategies that were initiated by the Kenyan government to promote the teaching and integration of ICT, the majority of the participating schools in the study had not adopted the implementation of ICT to support teaching, learning and management. Another Kenyan study by Gakuu and Kidombo (2015) indicated that effective integration of ICT in the secondary school curriculum was hampered, as integration is very much dependent upon the ICT literacy skills of the teachers and having the necessary ICT policy in place. In addition, they also indicate that the ICT skills of school administrators play an important role in ICT integration.

Additionally, Katitia (2012) while reviewing the meaning of ICT integration in education warns that viewing ICT integration as only referring to using computers in teaching and learning plainly showcase how most people get the wrong idea about the complexity of the integration process itself. Katitia (2012) is of the view that ICT integration should be understood as a combination of interrelated parts that should work together as a unified whole. The ‘parts’ comprise the school framework and environment under which ICT integration is to occur, the equipment provided, the teachers’ methodological skills, the technical assistance provided for the hardware and software installation, upgrading and maintenance of the ICT system and the motivation and skills of students. Regrettably, he alludes that ICT integration in the Kenyan educational context has often been understood to mean teaching basic computer knowledge and skills to students.

Katitia (2012) further indicates that the vision of the Kenyan Government through the Ministry of Education is to implement ICT as a universal means for education. Further, its mission is geared towards facilitating operational use of ICT to effectively increase access, learning and management in delivery of educational programmes and services. The main objective of the Ministry of Education is to integrate ICT in the curricula content delivery. Katitia (2012) notes that the key challenge that may derail realisation of the vision and mission of the Government is the inadequate digital equipment in almost all levels of education, whereby the ICT access rate in the country is estimated at one computer to 150 students.

Munanu’s (2014) research focused on the factors that influenced teachers’ readiness in applying ICT in teaching and learning in public secondary schools within the

Gatundu North district in Kenya. The study indicated that ICT training affects teachers' readiness as it enables teachers to acquire knowledge and skills which also promotes confidence and competence. The study (Munanu's, 2014) further exposed that a good number of teachers did not have adequate skills with reference to computers.

Tondeura *et al.* (2015) identified while exploring the introduction of ICT in Kenyan secondary schools that the provision of costly equipment and lack of support for teachers' professional development as some of the leading setbacks affecting ICT programmes in education. They also noted that although the principals of the four schools in their study recognized the significance of an all-inclusive school ICT policy plan, none had established any plan with clear set goals. Additionally, Tondeura *et al.* (2015) found out that the schools faced challenges in formulating a shared vision due to a lack of educational facts among stakeholders with reference to the title role of ICT in education. The principal also reported difficulties in accomplishing the shared vision as involving all stakeholders in the decision-making process was a tall order. Tondeura *et al.* (2015) further report that even though use of ICT in schools had gradually increased in Kenyan schools, it was mostly used by teachers to look for information and presentation rather than being used by learners. As such, the use of ICT in schools had not encompassed the Ministry of Education's ICT strategy which recommends the use of ICT to facilitate teaching and learning of the curriculum content to realize better-quality education results.

Kisirkoi (2015) carried out a case study in a secondary school in Kenya to investigate computer literacy level of teachers, the reason for which ICT was utilized by teachers, the aspects that led to the successful use of ICT in the school as a teaching-learning resource, the inspiration for the teachers use of ICT as teaching-learning resource, as well as the impact of ICT use on students' learning. Kisirkoi (2015) found that the schools under study had integrated ICT in teaching and learning to the advantage of both teachers and learners. She further states that teachers' desire to teach better came out as the foremost drive for the integration of ICT in the school. The support from the school leadership was recognized as a second leading role. Furthermore, Kisirkoi (2015) is of the view that teachers' knowledge and skills are critical in enhancing their efforts to try new pedagogies. However, is not the case in Kenya, as the application of new innovations in secondary schools is still far from being realized despite the fact that government has invested heavily in ICT in secondary schools (Manduku, Kosgey & Sang, 2012).

Atyang *et al.* (2018) conducted a research on ICT use in teaching of English language in specific secondary schools in western Kenya. The study discovered that the level of ICT delivery in classroom learning was low because of schools had inadequate ICT facilities which made it impossible for teachers to access computers, teachers low level of ICT skills, teachers unwillingness to increase their knowledge of ICT and preference towards conventional methods. This state of affairs made majority of schools not to utilise the opportunity provided by ICT to revolutionise teaching and learning. Further, Bariu (2020) examined the status of ICT facilities in teaching and learning in secondary schools. Bariu discovered that many schools had no adequate ICT facilities because of the costs associated with procuring the machines, software among other accessories. This has made it impossible for teachers to practice their technological skills.

2.5.4 Kenyan Science Teachers' Readiness Perspectives

The government through the Ministry of Education has also implemented several measures such as in-servicing of teachers through Strengthening Mathematics and Science in Secondary Education (SMASSE) programme. The SMASSE program aims to integrate ICT in teaching and learning of sciences for better learner achievement (Makanda, 2015). Siele (2006, as cited by Makanda, 2015) posits that availability, accessibility and effective use of teaching and learning resources (ICT technology included) improve the quality of science and mathematics education being offered. It is with this hypothesis that the Kenyan Government in partnership with educational stakeholders and development partners have equipped most schools with ICT facilities such as computers, Liquid Crystal Display (LCD) projectors, printers, Television (TV) sets, radios, Digital Versatile Disk (DVD) players, among others so as to advance the quality of teaching and learning science and mathematics in Kenyan schools (Makanda, 2015). Despite all these developments, the government's substantial investment in ICT related teaching and learning resources, students' performance in Kenya Certificate of Secondary Education (KCSE) examinations in sciences over the years has been dismal (KNEC reports, 2019).

According to Makanda (2015), a survey was undertaken by the SMASSE project established that the theoretical approach to teaching and learning of concepts was a leading cause of dismal performance in sciences, particularly in physics. This is due to the fact that most concepts in physics are abstract and learners find it challenging to conceptualize when taught theoretically. Theoretical teaching has been identified as one of the factors that make learners develop a negative attitude towards physics hence leading to poor performance (Makanda, 2015). Therefore, integration of ICT in lesson delivery is seen as a relevant and useful way of boosting learners' understanding and retention of concepts learned in physics (Makanda, 2015).

Makanda (2015) conducted a study in selected secondary schools in Bungoma County, Kenya, to examine the status of adoption and integration of ICT in the teaching and learning of physics. The study examined: teachers' and students' perceptions towards the use of ICT; ICT competence among physics teachers; teachers' and learner's access to computers; teaching experience and technical and management's support. Findings from the study indicated that physics teachers in the sample schools had a fairly high ICT competency level with the majority of the teachers using word processing and the Internet. This study also recognized that majority of the teachers only accessed computers for almost an hour per day.

According to Makanda (2015), the teachers pointed out the importance of ICT use in instruction and exhibited a positive attitude towards ICT. The study also found that the school management/administration played a key role in the adoption of ICT and facilitated provision of technical support, for example, employment of computer teachers and the provision of ICT facilities. However, use of ICT in lesson delivery was still found to be low. The following aspects were recognized to influence the integration of ICT in the teaching and learning of physics in the Kimilili District, Kenya, as Makanda (2015) further posits that teachers' possession of the necessary knowledge and skills in the use of ICT will determine the extent of integration of ICT in teaching and learning of physics. He is of the opinion that though a good percentage of the teachers teaching science subjects within the sample schools appraised themselves as *'good'* in the usage of ICT tools, however, it was found that they moderately made use of ICT in the teaching and learning process; mostly at the preparation stage of a lesson. This may possibly mean that teachers teaching physics lacked the requisite skills to integrate ICT in actual lesson delivery.

Teachers' and students' attitudes towards the use of ICT in teaching and learning of physics also influence integration of ICT in physics lessons (Makanda, 2015). Though the study established that majority of physics teachers and students had positive attitudes towards use of ICT in teaching and learning, the actual usage was not reflected. This mismatch between the actual usage of ICT and teachers' and students' positive attitudes can be attributed to barriers such as insufficient skills, absence of adequate ICT facilities and lack of time among others (Makanda, 2015).

Mulambe (2017) carried out a study to evaluate school-related factors that influenced the adoption of SMASSE teaching skills in Physics among selected secondary schools in the Uasin Gishu County, Kenya. The study found physics teachers' adoption of physics SMASSE skills was greatly influenced by the availability of physics learning resources. Mulambe (2007) labels scarcity of learning resources or relevant infrastructure as part of school level barriers, which include school circumstances that may prevent teacher adoption of information, such as old hardware, poorly maintained hardware and lack of suitable educational software among others. Mulambe (2017) further argues that small classrooms combined with the big number of students made it difficult for teachers to incorporate learner centred illustrations, demonstrations and experimentation during lessons, that is, barriers to use of ICT technology and innovations in classroom teaching and learning thus included congested classes among other factors.

According to Mulambe (2017) most of the study's participants (teachers) stressed that inadequate or absence of appropriate physics laboratories discouraged teachers from adoption of physics SMASSE skills. The study recognized that accessibility of physics learning resources, management or administrative support, school programs and school culture influenced the adoption of physics SMASSE teaching skills in the selected secondary schools. Mulambe (2017) proposes that teachers' accessibility to technology remains a main factor influencing teachers' adoption and integration of innovation into teaching. The workload given to the Physics teachers was also seen to be a key factor in influencing adoption of innovations such as SMASSE in teaching. Mulambe (2017) posits that too much course content also made it difficult for teachers to adopt a new technology or innovation in teaching. Furthermore, Mulambe (2017) states that increased workload in an already overcrowded curriculum and very busy workday were proving to be a difficult challenge for Physics teachers. In addition, Mulambe (2017) indicated that the school programs and school culture in the selected secondary schools had greatly influenced the adoption of physics SMASSE teaching skills. The adoption of SMASSE Physics teaching skills was found to be very low among schools with rigid routines, restrictive curricula, inadequate cooperation among teachers, inadequate motivation among other factors and lack of strong leadership (Mulambe, 2017). Adoption of SMASSE Physics teaching skills was found to be high among schools whose culture had ways of motivating the teachers for good work done (Mulambe, 2017).

Another study by Mwanda *et al.* (2017) carried out in Rachuonyo South Sub-County in Kenya established that apart from the SMASSE program, the Ministry of Education had provided five secondary schools in Rachuonyo with funds from the Economic

Stimulus Package to set up ICT infrastructure and to advance more capacity-building of science teachers on ICT integration in teaching and learning. The study was also able to identify that other schools in Rachuonyo had acquired computers and other ICT equipment through the centre of excellence funds, grants Constituency Development Fund (CDF) or donations from well-wishers (Mwanda, *et al.*, 2017).

In spite of all these developments, the use of ICT for instruction in the teaching of sciences in secondary schools was found to be still minimal, as learner achievement in Biology and other Sciences continued to be poor (Mwanda, *et al.*, 2017).This could be attributed to the fact that most schools in Rachuonyo had few computers coupled with inadequate teacher training on the use of ICT technology and applications, hence majority of teachers did not make use of ICT for personal growth and instructional purposes (Mwanda, *et al.*, 2017). The study called for increased ease of access to computers, sufficient training on the use of ICT and the development of an appropriate policy framework on effective ICT integration in the instruction process (Mwanda, *et al.*, 2017).

2.6 Aspects related to Readiness from Research

In this section, the key aspects are listed in bulleted form related to what appears to be the aspects that could be explored that would indicate some form of readiness related to ICT implementation, usage or integration based on what was found in the previous sections. It is important to note that the researcher does not claim that all aspects had been indicated in the list that follows, but that the list is only an attempt to portray what was found from the reviewed research literature. The following aspects were identified which appears to play a role, namely: accessibility, administrative and social dimension; age, attitude, beliefs, competencies related to skills and attitude towards ICT, confidence, economic status, experiences with computer use for educational purpose and facilitating conditions such as enough time, resources, training and internet access. The others include, gender, ICT skills, individual education level, knowledge, perception, teacher readiness, teaching experience, technical support, time available and training or development by government and/or schools. This study by the researcher explored teacher attitude, intrinsic motivation, behavioural intention and facilitating conditions as attributes to ascertain the readiness of secondary science teachers to implement (adopt or use) ICT for the teaching and learning of science.

2.7 Barriers Typology to ICT Use in Teaching and Learning

Various typologies exist to categorise the challenges or barriers that could be impediments towards ICT implementation, usage and integration. An overview of these categories can be found in Bingimlas (2009), Ertmer (1999), Kirkland and Sutch (2009) and Subramanien (2014). For the purpose of this study, the classification of Ertmer (1999) related to first- and second-order barriers will be utilized for the next sections, based on the adaptation of Subramanien (2014) for her analysis and presentation of ICT findings related to the multi-grade school context.

Subramanien (2014) also included third-order barriers in addition to Ertmer's (1999) first- and second-order barriers. Subramanien (2014) referred to first-order barriers as extrinsic or meso-level (immediate level related to school context) barriers, second-order barriers as intrinsic to the self or micro-level individual (personal) barriers and third-order barriers as macro-level (beyond the self and the immediate school context), thus beyond the school which implies at a district, provincial or national level. For the purpose of this study, a four order barrier typology is presented, namely first-order barriers (extrinsic to the self or individual), second-order barriers (teacher-related), third-order barriers (system-wide support) and fourth-order barriers (design skills).

2.7.1 First-order barriers: Extrinsic to the self

First-order barriers are extrinsic to the self or individual (Ertmer, 1999). Ertmer identified extrinsic factors as first-order barriers, which include capacity building, infrastructure, time and access to technology, financial and material support. Ertmer further states that second-order barriers tend to be (self) barriers which include perception, attitude towards use and refusal to use technology.

Some of the identified first order self-related challenges include inadequate time, shortage of computers, technical challenges, high levels of computer illiteracy, inadequate funding, inadequate support from the school administration, resistance to change, the curriculum not being aligned towards ICT competency, poorly conducted training opportunities and lack of knowledge and skills on technology into learning integration processes (Hadley & Sheingold, 1993; Ertmer, 1999; Pelgrum, 2001; Bariso, 2003).A study by Ford and Botha (2010) established that ICT illiteracy amongst teachers and insufficient training in technology and unreliable infrastructure seriously interfered with ICT integration in South African schools. Ertmer (1999) and Ely (1999), Aduwa-Ogiegbaen and Iyamu (2005) also highlight that internet accessibility, especially high-speed internet, is another big challenge that is making ICT integration in schools fail.

Bingimlas (2009) indicated that institutional internal factors and external factors (which involve the community and teacher’s own issues) influence ICT integration in teaching and learning. Kanvaria (2018) classifies ICT barriers into two categories, namely manipulative and non-manipulative barriers. These barriers include existing policy guiding ICT integration, teachers' knowledge and experiences, teachers' attitude, skills and institutional commitment to integrating ICT in teaching and learning. According to Harden (2000) as cited by Allawidi (2005) extrinsic barriers could be referred to as organizational barriers, while intrinsic barriers are categorized as administrative, personal attributes and teachers' characteristics. In Bangladesh, Obaydullah and Rahim (2019) observed that teachers lacked competence, in service training and technical support, in addition to technological pedagogical content knowledge on how to integrate ICTs into teaching and learning of primary science subject n schools. Ifinedo, *et al.* (2020) noted that three constructs (perceived knowledge for integrating technology, teachers′ knowledge [excluding technology and perceived technological knowledge) directly influenced the′ technology integration by teachers in classrooms.

2.7.2 Second-order barriers: Intrinsic to the self

Second-order barriers refer to those challenges that are intrinsic to the self, thus teacher-related barriers (Ertmer, 1999). As earlier mentioned, teacher's personal ability and ease of use computers is a critical basis of whether or not they use ICT. Marcinkiewicz (1993) and Waema, (2005) assert that the attitude and belief held by a teacher in reference to technology greatly impact their readiness to use and integrate ICT in the classroom. Sherman and Howard (2012) postulate that second-order barriers among South African teachers should be blamed for the failure of ICT integration. It also appears that most teachers have an inclination to traditional teaching which influences how ICTs are utilized. Du Plessis (2016) found that even newly trained teacher students focus on using ICT in traditional ways for teaching in the science classroom.

There also seems to be a common misconception that teachers would become motivated and readily apply ICT to teaching and learning if there is open access to technology (Kozma, McGhee, Quellmalz, &Zalles, 2004). However, research has shown that the lack of time, tight schedules for preparation and the failure by the government to put in place a comprehensive national ICT policy (educational) are the main drawbacks for ICT integration in schools (Kozma, *et al.*, 2004).Tella, Tella, Toyobo, Adikaand Adeyinka (2007) identified a lack of expertise among teachers in the schools as the noticeable factors hampering teachers' readiness in using ICT. Omare *et al.* (2018) discovered that most teachers had no set up adequate time to prepare and conduct lessons through the ICT facilities available in their schools which was compounded by low level of interest towards them.

2.7.3 Third-order challenge: System-wide support

Monograde schools (traditional schools) and multigrade schools require support from beyond the immediate school context. The Department of Education of a country can here play a vital role, however, it appears that the Departments of Education in various countries do not support schools' resource- and training-wise as they should (Du Plessis & Webb, 2012a, 2012b; Subramanien, 2014). The schools practicing multi-grade education are virtually marginalized and under-resourced (and possibly also all under-resourced schools) has third-order challenges related to a lack of system support (Subramanien, 2014).

Also, it appears that in both the multi-grade context (Subramanien, 2014) and in the mono-grade context (Du Plessis & Webb, 2012a, 2012b) there are various system challenges such as the lack of training and professional development, resource challenges and lack of finance from the macro level, *i.e.* the Department of Basic Education and beyond (Subramanien, 2014).From the above, it is evident that system-wide support is thus a vital element for ICT implementation. The importance of support from all levels were also highlighted by several authors such as (Bingimlas, 2009; Ertmer, 1999;Goktas, Yildirimand Yildirim, 2009; Pelgrum, 2001; Rodden, 2010; Schoepp, 2005) as these authors argued that support and resources must be available for ICT integration to be successful. Ertmer (1999) and Albugami and Ahmed, (2015) argued that the lack of technical support at school level negatively impacts on ICT integration. In Kenya, some of the barriers that impede the use of ICT in teaching and learning in schools include inefficient in-service training among teachers, lack of software that are appropriate to the needs of teachers, a curriculum that is designed in a way that it is not ICT friendly and the absence of technical support for teachers when they encounter a problem during teaching and learning (Serpil, Özdemir 2017). Tondeur (2019) discovered that system wide support variables like; lack of ICT facilities, connectivity to internet and electricity affected the integration of technology in classrooms. It appears that African countries are still crippled with infrastructural challenges which could have enabled successful integration of ICT in teaching and learning and these challenges includes limited supply of electricity, lack of computer laboratories, lack of desktop computers, laptops, smart screens, cameras, data projectors, high cost of bandwidth and/or lack of internet access (Barakabitze et al., 2019).

2.7.4 Fourth Order Challenge: Design Skills

Tsai and Chai (2012) have argued that Ertmer’s (1999) two barrier topology should be extended to include a third-order barrier, namely, lack of design skills for implementing ICT into teaching and learning. Utilizing Subramanien’s (2014) typology for presenting her findings, it is argued by the researcher of this thesis that Tsai and Chai’s (2012) position should rather be referred to as a fourth-order challenge or barrier. The researcher of this study argue for this, as it appears that the ‘design challenge’ encompasses all three previous three challenges or barriers and for the ‘design challenge’ to be ameliorated, it will be required action within and from the self (second-order), action from the immediate surrounding (first-order) and action from the larger system *i.e.* beyond the school support (third-order) and hence, design skills could then serve as a bridge to overcome the first, second and third-order barriers.

Kyllönen (2018) researched on Finnish in-service teachers’ acceptance of ICT in teaching through UTAUT Model (Venkatesh *et al.*, 2003). Four groups of technology acceptance were identified when assessing teachers’ stipulations set for technology use in instruction: 1) Personal technological skills and perceived capacity to learn new technologies (PSC), 2) Advantages related to pedagogy and learning technologies (APT), 3) Environmental influences (EI) and 4) Resources of the use and commissioning (RUC).

2.8 Ameliorating ICT Barriers or Challenges

In this section, a brief overview is provided pertaining to ‘how to’ possibly ameliorates the challenges or barriers that teachers and their schools are facing or might be facing. This section will be reported by making use of the following divisions, namely, reporting on ameliorating first-order barriers, second- order barriers, third-order barriers, fourth-order barriers and lastly by presenting two African suggested frameworks or heuristics that could be useful for the African context and especially Kenya. As this study was Kenyan based and Kenya is in Africa, it was deemed important that suggestions from literature from Africans should be consulted when referring to the typology of how these challenges or barriers could be addressed. The suggestions in section 2.8.5 were an attempt to suggest how the typology of barriers could be addressed in an integrative manner.

2.8.1 Addressing First-Order Barriers or Challenges

Bialobrzeska and Cohen (2005) and Creighton (2003) advocate that when resolving first-order barriers, one of the areas, to begin with, would be the formation of a common vision of technology integration and implementation, which comprises a clearly formulated technological plan that provides a strategic way forward. Bialobrzeska and Cohen (2005) are of the view that 'Strengths, Weaknesses, Opportunities and Threats' (SWOT) strategy guides educators to provide a suitable and workable plan that take into consideration knowledge and skills of the teachers as well as the ability and the needs of the learners(Trilling & Hood, 1999). Such preparation ought to take into account equity of teacher access to technology (Flanagan & Jacobson, 2003) in addition to the provision of the financial, administration and infrastructure support (Surry, Porter, Jackson, & Hall, 2004).

According to Surry *et al.* (2004) some more recommendations to solving the challenges to the effective integration of ICT in public schools of contemporary societies include: allocation of more funds for the education sector; adopting the assembly of locally available hardware/software to avoid reliance on imported one to reduce the cost of infrastructure; maintaining periodical revision of the education policy and curricula to factor in meeting the demand of the present era; enhancing teacher training programs to include ICT based methodology for all subjects; providing alternative means of electricity in remote areas; providing professional development courses for teachers to inspire confidence and a positive attitude towards the use of ICT. Subramanien (2014) seems to suggest from her findings that the most important aspect related to the 'self' is that the teacher has to be encouraged not only to make a mind-set change, but to actually live this mind-set change practically.

2.8.2 Addressing Second-Order Barriers or Challenges

In ameliorating second order and subsequent challenges, researchers seem to agree that teacher development is the key to develop the self; thus *i.e.* a process and not a one-time activity (Ertmer *et al*., 2001). Ertmer *et al.* (2001) further states that it appears that one cannot *'force'* ICT or technology implementation on teachers, as not all teachers will appreciate it in a similar manner. Therefore, teacher progress sessions concerning ICT or technology integration planning and usage have to target increased teacher self-efficacy, motivating personal beliefs concerning the capability to acquire or execute classroom implementation strategies and ICT related skills at a certain level (Ertmer *et al.*, 2001).

It appears thus that the ICT professional development of teachers is a key aspect and that one should take note of the stages and phases of integration as presented in sections 2.3.1 and 2.3.2. However, one does not to necessarily be influenced by these stages or phases, as research findings frameworks and heuristics from the African context by Du Plessis and Webb (2012a, 2012b) and Subramanien (2014) seem to suggest that the reported phases and stages in sections 2.3.1 and 2.3.2 might be overcome in a speedier manner by following the African framework.. However, in spite of many fist- and second order barriers, it appears that the training of teachers with reference to ICT skills, increasing hardware equipment's access and the creation of ICT labs and innovation centres in schools to improve quality of teaching and learning in Africa is on the increase (Erhan, & Eralp, 2018).

2.8.3 Addressing Third-Order Barriers or Challenges

As the researcher has referred to third-order challenges as *'system-wide support'* in section 2.7.3 based on Subramanien (2014), it is argued that the Department of Education should play a pivotal role as suggested by Du Plessis and Webb (2012a, 2012b) and Subramanien (2014). The implication is that the Department of Education should ensure that schools have ICT resources and internet access. Furthermore, the importance of teacher enabling by means of teacher professional development (training) should be at the centre. These aspects referred to above, as well as a number of other aspects that should be considered for system-wide support are also evident from Du Plessis and Webb (2012a, 2012b) and Subramanien (2014) which are presented in Figure 2.1, Figure 2.2 and Figure 2.3 [see section 2.8.5 and onwards for representations of these figures].

2.8.4 Addressing Fourth-Order Barriers or Challenges

Fourth-order barriers were defined as *'design skills'* (see section 2.7.4). It is argued that if teachers are not enabled from a *'system-wide support'* initiative to enable teachers to design lessons for the inclusion of ICT for teaching and learning, it is highly unlikely that they would implement or integrate ICT in their lessons. Tsai and Chai (2012) referred to the above as a '*design skills'* barrier. The importance of being enabled to design lessons for ICT implementation has also been highlighted by Du

Plessis and Webb (2012a, 2012b) and Subramanien (2014), which is evident in their heuristics [see Figure 2.1, Figure 2.2 and Figure 2.3 in section 2.8.5 and onwards]. The above yet again also relates to Rogers' (1995, 2003) position that observability in practice related to the *'how to'* of an innovation is very important and hence teachers will have not only be exposed to the *'how to'* design ICT integrated lessons, but opportunities to share their experiences with their peers as a form of learning from one another, should also be planned for (Du Plessis & Webb, 2012a, 2012b; Subramanien, 2014).

2.8.5 Framework to Assist with Addressing Barriers

As stated in Section 2.8, the suggested heuristic for ICT implementation in an African context of Du Plessis and Webb (2012a, 2012b) is presented in this section. The heuristic will be presented as two figures, namely a textual verbatim figure (see Figure 2.2), a visual blocked pictorial figure (Figure 2.3) and an enhanced visual blocked figure of Subramanien (2014) that extended Du Plessis and Webb's (2012b) heuristic, which shows the various role players or contexts to be taken into consideration and what to ensure or plan for during each of the stages or phases.Du Plessis and Webb (2012a) presented their heuristic based on their findings from a South African study that focused on marginalized schools, *i.e.* schools which are still experiencing a number of issues due to the apartheid legacy, as well as their personal experiences while engaging with these schools. Their suggestions for the steps to cater for and plan for are presented below (Du Plessis & Webb, 2012a, p. 321):

> "The heuristic and stepwise process that is described below is aimed at those (for example NGOs and Departments of Education) who wish to drive an ICT implementation strategy and who have at least some access to the structures/resources that make it possible to implement:

Step 1: Create of a passionate ICT support Team which is made up of people who want to make a difference, people that will walk the extra mile and who believe in the potential of ICTs.
Step 2: Conduct a SWOT analysis that focuses on school structures, classroom dynamics, teacher beliefs and student (learner) behaviours; i.e. the possibilities that ICT integration offers, the possible threats of zones of discomfort that ICT integration might bring and exploration of how to address these issues.

Step 3: Survey the school's needs by means of quantitative and qualitative data which provides detailed personal insights. These include ICT skills analysis in order to determine teacher and learner needs.

Step 4: Plan an adaptable workable strategy related to the implementation process based on the teachers' and schools' needs, which includes a shared vision, goal setting, timelines as well as the envisaged teaching styles/strategies that could be followed to serve the envisioned needs.

Step 5: Select 5 to 10 volunteers per school. Keep in mind the possible support capability/capacity that the support team can offer, i.e. be realistic. Equally important, start with those teachers who are committed and want to participate. Do not force the process on all teachers.

Step 6: Provide teacher training related to using computers in context. Start with basic computer literacy where necessary. Allow teachers to see the administrative value, online resource usage and teaching planning possibilities that ICTs offer. Allow the participants to experience as much success as possible in order to raise self-efficacy.

Step 7: Reward participating teachers with the necessary equipment such as laptops and internet connectivity that can also be used at home where possible by soliciting, or helping them to solicit, support from all potential sources.

Step 8: Provide ongoing training and school-based onsite support as well as onsite classroom visits to support participants implement their strategy. Monitor and manage the process on a weekly basis.

Step 9: If in a resource provision mode, allow access to the computers for teaching only after the vision, goal setting and timetabling is in place and only after the participating teachers had been well trained.

Step 10: Provide opportunities for participating teachers to share – within the school and among neighbouring institutions – success stories as well as the challenges they experience. Enable participating teachers and the ICT support team to discuss, brainstorm and model strategies or practices that can be tried out in order to address their particular challenges.

Step 11: Appoint a technical person(s) who are responsible for servicing the school's ICT infrastructure who can also train interested teachers with troubleshooting and basic ICT troubleshooting skills. Appoint one teacher

> leader responsible for initial basic learner ICT training and teacher assistance for the whole school."
>
> (Du Plessis & Webb, 2012a, p. 321)

Du Plessis and Webb (2012a) also provide a visual presentation in Figure 2.2 of their heuristic in order to visualise their proposal.

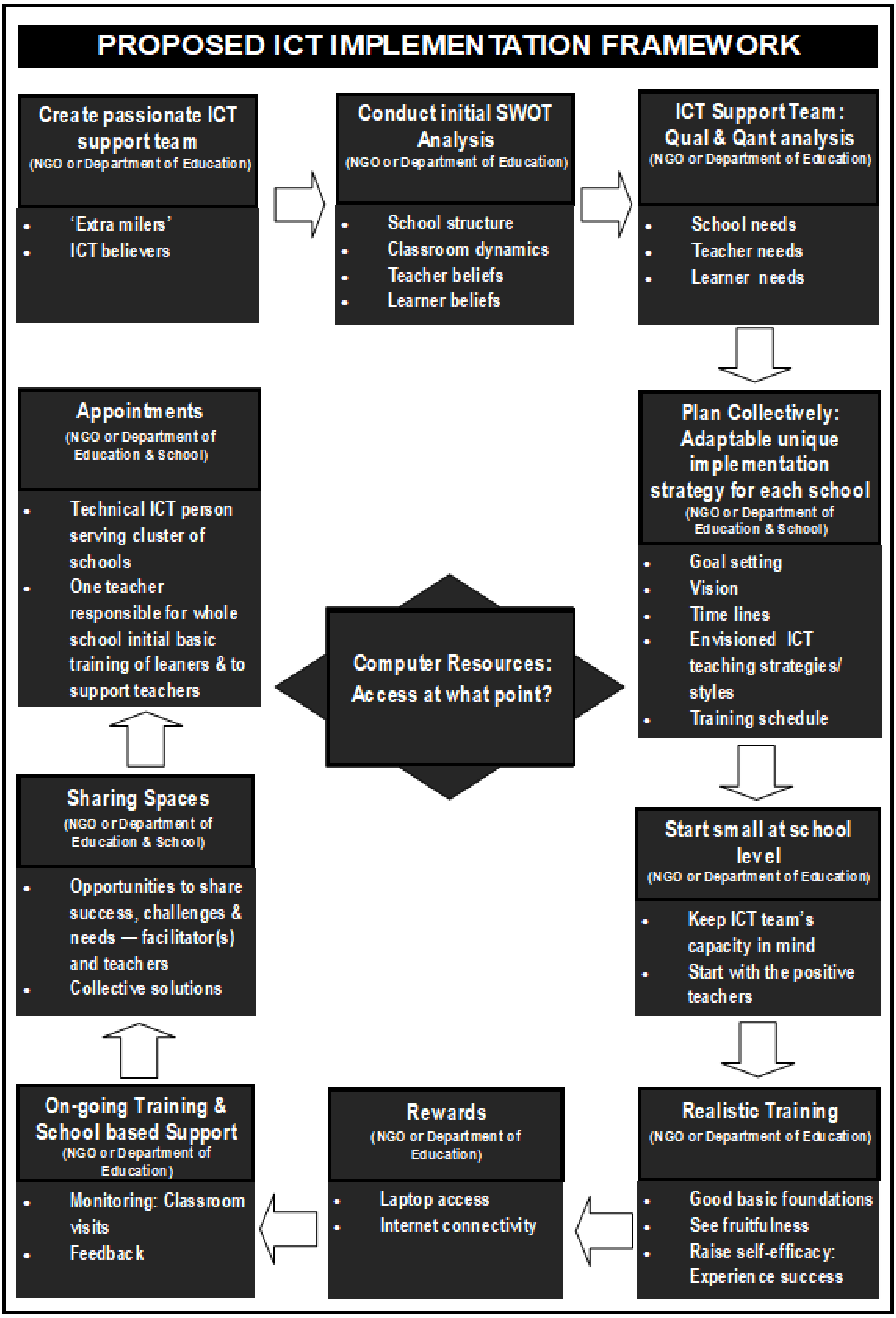

Figure 2.2: Proposed ICT implementation heuristic for schools in disadvantaged contexts

Source : Du Plessis & Webb (2012a, p. 322)

Du Plessis and Webb (2012b) also presented their $C^2RHOAR^3FS^2R^2$ heuristic for ICT implementation and integration in schools (see Figure 2.3) which was enhanced by Subramanien (2014). Du Plessis and Webb (2012b) argue that there are three dimensions, each with sub-dimensions that form key to the teacher development process for ICT implementation and integration, namely facilitator related aspects, training context-related aspects and school-related aspects that have to be planned for and realized in practice.

Subramanien (2014) found from her research findings that this heuristic is indeed useful, however, she indicated that two aspects that appear to be sub-assumed in the Du Plessis and Webb (2012b) heuristic should be made more specific, namely the ‘Self’ which relates to the training context-related aspects and ‘Sustainable support’ which related to the school-related aspects.

Subramanien’s (2014) findings from the multigrade school context, which is also a marginalised context, is that the Intel® Teach Programme with its teacher development courses such as Intel® Teach ICT Skills for Teachers, Intel® Teach Getting Started and Intel® Teach Elements were extremely useful to promote multigrade teachers’ implementation of ICT for teaching and learning as showed by both her qualitative data and pre- and post-quantitative results. She also presented a stepwise use cycle of ICT within the multigrade context based on the usage suggestions of Biablobrzeska and Cohen (2005), but adapted it based on her findings from her multigrade research results. These uses are also indicated in Figure 2.3 [see next page].

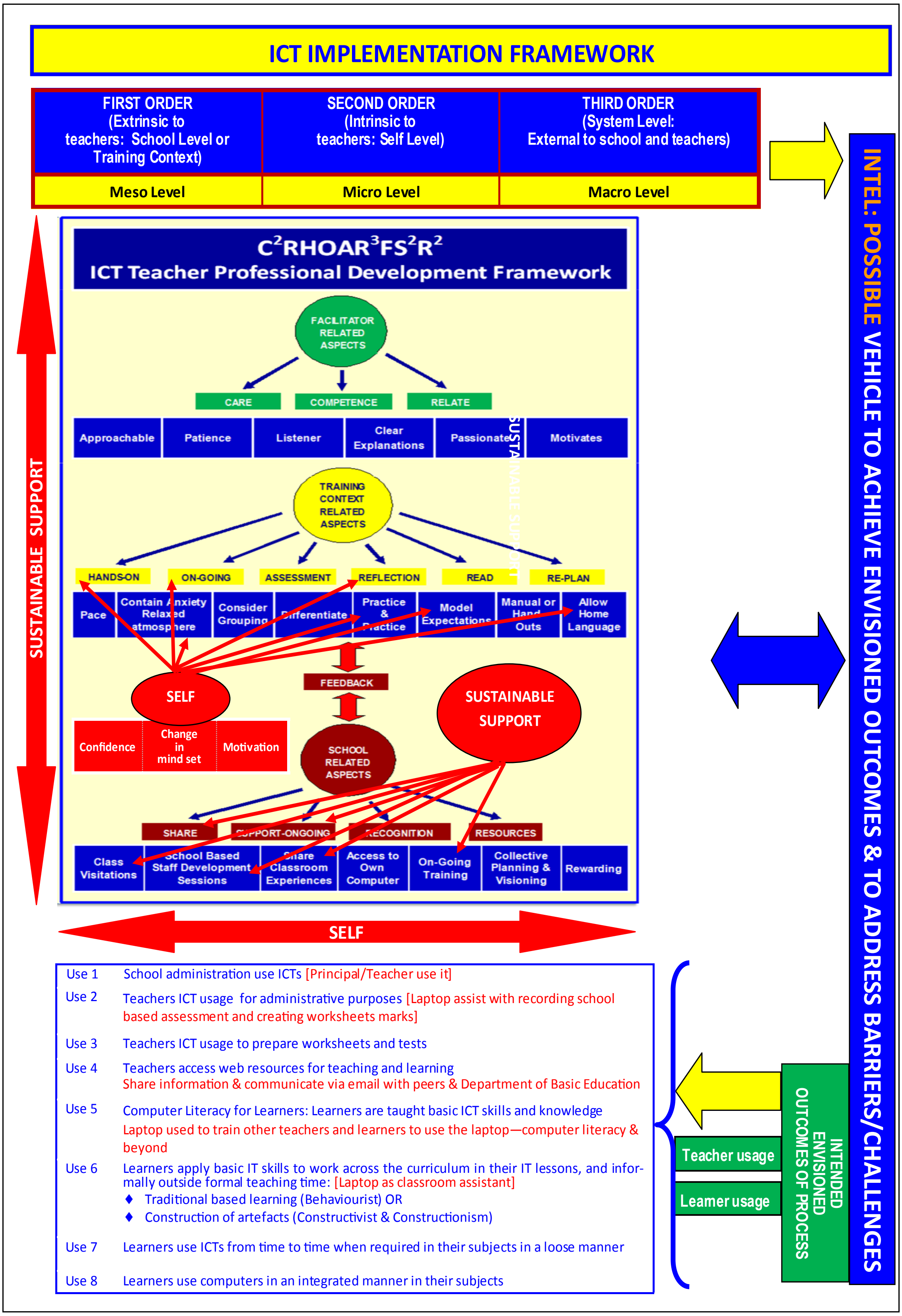

Figure 2.3: Enhanced proposed ICT implementation heuristic for schools in rural areas or disadvantaged contexts

Source: Subramanien (2014, p. 216) based on Du Plessis & Webb (2012b, p. 52)

The examples of possible steps to follow and the accompanying heuristic that were presented based on findings within the South African context from data collected from marginalized schools on the periphery of a city and from marginalized multi-grade schools residing in rural areas where poverty is huge and resources are lacking, highlight that there are African suggestions for the African context by Africans. As such, it is thus important to note that these localized ideas should hence be taken note of when planning for ICT implementation with a view to realizing ICT integration within the African context.

2.9 Readiness for ICT Integration (Adoption, Implementation and Usage)

From the literature and research reviewed in this chapter, it is evident that teacher attitude, motivation, behavioural intention and facilitating conditions are four of the main factors that influence readiness for adoption. As such, these four variables have been formulated as hypotheses, which have been indicated in Chapter 1.

2.10 Summary of Reviewed Literature

This chapter has presented a review of related literature on status and teacher readiness to use ICT in teaching and learning of science subjects in schools. The studies reviewed have mostly been conducted in developed and under-developed countries with few being conducted in Kenya. The challenges or barriers have been identified that serve as impediments for ICT implementation. Lastly, the variables which this study identified to explore have been indicated.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter presents the research design and methodological aspects; *i.e.* the research paradigm, research methodology, research design, location of the study, target population, sampling, research instruments, validity, reliability, data collection procedures, data analysis and ethical considerations for this study.

3.2 Research Paradigm

The study was guided by the positivistic research paradigm. According to Ogula and Onsongo (2009), positivism is a useful method of conducting social science research and it affords the possibility to obtain close approximations to a true account of reality. The positivistic research paradigm posits that if something exists then it can be measured (Hjørland, 2005). The primary assumption of positivism includes the belief that the social world can be considered in the same way as in natural world; *i.e.* by being systematic and being objective, one can measure by following the methods of the natural sciences(Johnson & Onwuegbuzie, 2004).The researcher chose the positivistic paradigm as research approach to answer research questions framed as hypotheses on the status of integrating ICT in teaching and learning science subjects in selected public secondary schools in West Pokot County, Kenya. The research utilized the formulation of hypotheses to be tested by means of obtaining quantitative survey data that were analyzed.

3.3 Research Methodology

There are three types of research methodologies namely, qualitative, quantitative and mixed-method research (Klassen, Creswell, Clark, Smith, & Meissner, 2012).

Considering this study is grounded in positivism as philosophy, it is mainly associated with quantitative research methodology. Experimental strategies used by a survey use tools which yield statistical data (Klassen, *et al.*, 2012). The quantitative research approach was chosen by the researcher, because the researcher wanted collected data that was in ordinal and interval forms (Klassen, *et al.*, 2012). The advantage of the quantitative approach utilizing a survey with an appropriate sampling size is that this quantitative approach affords and opportunity to present findings that can be generalized to the entire population when the appropriate designs and sampling techniques are used (Klassen, *et al.*, 2012).

3.4 Research Design

Considering that this study is quantitative research, a cross-sectional survey strategy was used for this study. It is one of the survey research design used to collect data from a large number of subjects drawn from a defined population (Watters & Biernacki, 1989). Data was collected from members of a given population for the purpose of estimating one or more population parameters. The cross-sectional survey involved data being collected from the target population or sample at one point in time.

3.5 Target and Accessible Population

The target population for this study involved all public secondary schools in West Pokot County four sub-counties; Central Pokot, West Pokot, Pokot North and Pokot South. However, the accessible population for this study involved 126 public secondary schools that have installed ICT resources as per data collected from West Pokot County. The target population for this study were science teachers from 126 public secondary schools. These science teachers were the ones teaching the subjects

Chemistry, Biology and Physics. The researcher estimated that there were approximately four teachers teaching any of these science-related subjects in the majority of the schools. Therefore, 400 teachers from 100 public secondary schools formed the possible target population for the research.

3.6 Sampling Techniques and Sample Size

Sampling is the process of choosing a group of people or things from the population. Sampling is undertaken since it is not possible for the researcher to engage with all the target members of the population (Lohr, 2009). For instance, in this study, it was extremely tedious and costly to reach all 400 science teachers in 126 public secondary schools, thus the sampling required had to be representative of the whole population. This, in turn, resulted in reduced costs related to collection of data. On the other hand, having a relatively large sample size with a large group of completed questionnaires assists with a greater possibility of generalisation within the sampled context or stated in another way, the analysis of the data and the data's accuracy rate is enhanced. To calculate the sample size for this study, 62.5% of the population was chosen with a margin of error of $\pm$3.0% resulting to a corresponding sample size of 250 science teachers.

To select 250 science teachers out of 400 to participate in the study, a simple random sampling method was used by means of lottery method. Here, the researcher made a list of all science teachers in 100 schools and assigned each on a specific number. Thereafter, a table with random numbers was used to draw a sample of 250 from the list. This was done by selecting rows as starting point, then selecting all numbers that follow in that particular row. The researcher proceeded to the next rows until the required number of respondents (250) was achieved. The advantage of using this method is that it ensured that each science teacher had an equal probability of being selected in the study. From the 250 data questionnaires distributed, 233 were returned. The response rate was thus 93.2%.

3.7 Data Collection Tool

This study used a research questionnaire that was modified based on the Venkatesh *et al.* (2003) UTAUT model (see Section 1.11 and Appendix IV). The research questionnaire used was structured according to the objectives of the study in order to reject or confirm the four hypotheses related to the objectives. All themes (aspects) pertaining to this study were covered in the questionnaire. Various measurement scales were used when developing the research instrument, namely nominal, ordinal and interval scales. Ordinal scales measurements were in Likert scale of five (1 – strongly disagree to 5 – strongly agree) to determine the degree to which ICT has been integrated by science teachers in their teaching and learning process. Other questions had yes or no answers (nominal ones).

3.8 Reliability and Validity of Research Instrument

In the following two sub-sections, the concepts validity and reliability are unpacked. It will also be indicated how these concepts were ensured for this study.

3.8.1 Reliability

Reliability of instruments in research refers to the constancy to measure; the degree to which a measuring tool is free from random error, which can be obtained by using the internal consistency method through the use of Cronbach alpha (Clark & Creswell, 2015). Malhotra (1999) states that the nearer the reliability coefficient to 1.0, the better, *i.e.* the greater the internal consistency. Generally, Cronbach alpha value of 0.7

is regarded the lower limit of acceptability (Hair, Black, Babinanderson, & Tathem, 2006).

The Cronbach alpha was also determined (see Chapter 4, Table 4.1 for the Cronbach alpha values) in order to ascertain the internal consistency, *i.e.* measuring scale reliability indicating how close a set of items as a group are related to one another (Hair *et al.*, 2006). The Cronbach alpha was determined for the items (statements) associated with teachers' readiness which comprised of teacher attitude, facilitating condition, intrinsic motivation and behavioural intention, as well as for the items (statements associated with) ICT integration (implementation or usage). The statements associated with the various aspects indicated above are presented in Appendix IV and the questionnaire distributed in Appendix III. A Cronbach alpha value of 0.7 is regarded as acceptable, but Cronbach alpha values of 0.8 and higher are regarded as more than acceptable (Hair *et al.*, 2006).

The internal consistency for the measures as measured by Cronbach alpha values ranged from .803 to .969 and are presented in Table 4.3. According to Hair *et al.* (2006), a Cronbach alpha value of 0.7 is regarded as the lower limit of acceptability. As such, it can thus be concluded that the values of alphas in this study suggest that the scale reliability of the levels that were used in this study was more than acceptable (Table 3.1) as all the results were above .800. The results are summarized in Table 3.1.

Table 3.1: Reliability Results of raw data

Variable	Number of Items	Cronbach Alpha Coefficient
Integration of ICT	12	.969
Attitude Towards the use of ICT	4	.803
Motivation to use of ICT	7	.812
Facilitating Conditions	11	.954
Behavioural Intention to use ICT	8	.875

3.8.2 Validity

According to (Litwin, 1995) validity is the degree to which the data support the inferences that are made from the measurement. Validity refers to how well a data gathering tool measures what it is supposed to measure or intend to measure (Kvale, 1995) or as Hair, *et al.* (2006) state, validity is the ability of the instrument to evaluate what it is supposed to measure regarding the idea or constructs under study (Hair, *et al.* 2006). There are different forms of validity and the three forms of validity considered for this study were face validity, content validity and construct validity (Price, Jhangiani, & I-Chant, 2015).

Face validity is concerned with whether the construct to be measured is indeed measured by the statement or indicator (Price *et al.*, 2015). In order to ensure face validity, copies of the questionnaire were given to the supervisor and another expert to obtain their feedback regarding the questionnaire as data gathering instrument and their feedback informed changes to the questionnaire.

The second measure is the validity of the research instrument. According to Kimberlin and Winterstein (2008), validity is the precision or accuracy of a measuring instrument. This means that it is the consistency to which a measuring instrument yields similar results related to the validity of an individual to which a research questionnaire is administered repeatedly (Penniston, Antonelli, Viprakasit, Averch, Sivalingam, Sur & Nakada, 2017).Content validity refers to the sufficiency of indicators to measure the concepts, thus the representativeness of the concepts as statements related to the constructs (Ooko, 2016; Penniston, *et al.*, 2017) or as Sharma, Kumar and Kumar (2005) state, the magnitude of whether the level items are truly determining what they ought to measure. In order to ensure content validity, previously validated measures were pre-tested and the preliminary questionnaire was pre-tested on a pilot set of respondents to ascertain whether the questionnaire as data gathering tool was perceived as relevant and understandable to the participants. Respondents in the pre-test were drawn from schools in Trans-Nzoia County, Kenya.

As recommended by Malhotra and Galletta (1999), the questionnaire items were presented in the pre-test to the respondents in the form of personal interviews prior to the study in order to ascertain feedback from the respondents as a pilot to ascertain how they reacted to the data gathering tool. These include how they respond to the sequence of questions, wording, form and layout. The feedback received was used to amend the questionnaire before delivering it to this study's respondents. The questionnaire was also given to the supervisor and another expert, as indicated previously. The supervisor and another expert were asked to rate the relevance of research questions on a five-point scale: 1 Not relevant, 2 – Somewhat relevant, 3 – Quite relevant, 4 – Very relevant. The decision for determining the validity index of the research instrument was based on the scales mentioned above and this resulted in the final data gathering instruments conceptualized. Obtaining feedback from respondents by means of a pilot and from the supervisor and another expert hence assisted with the content validity process (Ooko, 2016; see also Price *et al.*, 2015).

Test of construct validity is a technique used to determine whether pattern of relationships exist among the variables (Cronbach & Meehl, 1955). Therefore, it ascertains an agreement between the theoretical ideas and the measuring tool. Creswell (2009) states that construct validity entails the usage of suitable or satisfactory terms (or definitions) measuring the variables. Construct validity is the most important and complicated type of validity used to set up the validity of a measuring scale (Sharma, Kumar, & Kumar, 2005) and it refers to the extent to which a study's measurements support the relevant literature and measure the ideas for which the tool was designed (Dhamuniya, 2013), thus concurring with Creswell (2012). According to Field (2005) factor analysis is a means to assess construct validity. The assessment offers an evaluation of the accuracy; correctness and validity of the scale, that is, the deviation between the real value and the measured value of the target construct (Hunter& Hunter, 1984). In other words, construct validity assist to evaluate the consistency of the scale structure with its theoretical assumptions and how the internal components of the obtained measurement results are consistent with the one's intention to measure the field (Venkatesh, & Davis, 2000).

In order to test for construct validity, hypothetical relationships to have been defined which have been empirically examined and factor analysis was determined (see Chapter 4). Furthermore, in order to assess the construct validity, the items were examined by principal maximize components extraction with varimax orthogonal rotation (Dhamuniya, 2015). The varimax orthogonal rotation and all subsequent measures and/or tests referred from this point onwards in th*is section will be unpacked in Section 3.12* (Data presentation, analysis and interpretation section) and also referred to again in Chapter 4.

Reliability of a measure, on the other hand, is thus an attempt to determine and indicate to what extent the data gathering tool is error-free and thus, consistent and stable across time and across the various items in the scale (Sekaran, 2000).

3.10 Collection Procedure

Once the instruments had been tested for validity and reliability, the fieldwork began. The researcher sought approval from the University. The letter from Moi University was used to acquire a research permit from National Commission for Science, Technology and Innovation (NACOSTI). Once the permit was issued, the researcher proceeded to County Director and County Commissioners officers to obtain authority to visit 30 public secondary schools in the West Pokot.

Thereafter principals of the 30 public secondary schools were contacted first and were presented with the permit letters to allow administration of research instruments in their schools. Before the science teachers were issued with the questionnaires (surveys), they were informed about the nature and purpose of the study after which they signed the consent form to participate in the research voluntarily. The teachers were later issued with the questionnaires (surveys) which were collected the same day. The duration of data collection was six weeks.

3.11 Data Analysis

Quantitative data collected from closed-ended questions (nominal, scale and ordinal) was coded and entered into electronic spreadsheets and Statistical Package for Social Sciences Version 22.0 (SPSS). As stated previously in Section 3.7 (Data Collection Tools), for the purpose of this study a five-point Liker scale was used for each of the Liker scale items. The five-point Likert scale's possible response for each item (statement) is presented in Table 3.2 by indicating the value as response code and what each value represents.

Table 3.2: Likert scale item response mean per statement

Response code	Response meaning in words
5	Strongly agree
4	Agree
3	Neutral or Undecided
2	Disagree
1	Strongly disagree

The response code from 1 to 5 was entered into SPSS for each item, depending on the code range. The data is presented in Chapter 4 by means of descriptive statistics in tabular format based on the results calculated by the software package from IBM SPSS. The results in these tables were presented as percentages, means, standard deviations and the number of respondents per item. All values of the various calculations pertaining to inferential statistics were also presented in tabular format in Chapter 4.

Okoo (2016, p. 98) suggests pertaining to the interpretation of a 1 to 5 Likert scale, that the calculated mean value per item can be interpreted as indicated in Table 3.3.

Table 3.3: Likert scale response overall mean value interpretation per item for 1 to 5 scale (Okoo, 2016, p. 98)

Response mean value	Response mode	Description	Interpretation
Above 3.75	Strongly agree	You agree without doubt	Very high level
3.00-3.74	Agree	You agree with some doubt	High level
2.60-2.99	Neutral or Undecided	You have doubt, not sure	Moderate
2.00-2.59	Disagree	You disagree with some doubt	Lower level
Below 2.00	Strongly disagree	You disagree with no doubt at all	Very low level

Table 3.3 illustrates that when the overall mean of an item (statement) calculated for the five-point Likert scale is 3.75 or higher, then one can claim that the mean value of the response indicates that the overall result is *‘strongly agree’*. When the overall result of the mean per item ranges from 3.00 (including 3.00), but less than 3.75, one can claim that the mean value of the response indicates that the overall result is *‘agree’*. On the other hand, when the overall mean response of an item is from 2.60 to 2.99, the mean value of the response indicates that the overall result is *‘neutral’* or ‘undecided’. Then again, when the overall mean of an item (statement) calculated for the five-point Likert scale is from 2.00 to 2.59, then one can claim that the mean value of the response indicates that the overall result is *‘disagree’*, while when the overall result of the mean per item it below 2.00, one can claim that the mean value of the response indicates that the overall result is *‘Strongly disagree’*.

As stated previously, Exploratory Factor Analysis (EFA) is used to discover the underlying structure of a fairly large set of variables (Hair *et al.*, 2006). A widely used form of factor analysis is one in which the investigator’s/researcher’s a priori hypothesis assumes that any indicator might be associated with any factor. In this form, the researcher does not involve prior theory but uses factor loadings to perceive the factor structure of the data (Field, 2005). In this way, the researcher examines things that already exist and ascertains if and in what way those things are related to each other. The reason for doing correlations is to enable the researcher to make a prediction about one variable based on what he/she knows about another variable (Vogt, 2011). In this particular study, the assessment of the correlation matrix of variables showed that the correlations between the independent variable and the dependent variables were between the acceptable value ranges of +1 to -1 and were all significant at p< 0 .05 signifying a linear relationship and hence the regression assumption of linearity was met (Hair *et al.*, 2006).

The Kaiser- Meyer - Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity were used to check for the adequacy of data for extraction of the principal components. The minimum values of the KMO statistic of the significant measuring of Sphericity and communalities should be a minimum value of 0.5. The KMO was applied after extraction and retention of factors with Eigen values greater than one as suggested by Tabachnick and Fidell (2011) and Field (2005), which includes determining the Chi-Square - a non-parametric test. The Chi-square ($\chi 2$) test is mostly applied to assess a relationship between two nominal or ordinal variables. Non-parametric tests are applied when hypothesis about normal distribution in the population cannot be encountered or when the level of measurement is ordinal or less (Hair *et al.*, 2006).

The Karl Pearson correlation was computed to analyze the relationship between independent variables (in ordinal form) against the dependent variable (Vogt, 2011).

The Likert scale used had a total of 42 items with the following statements per category: ICT integration had 12 items, attitude towards use had 4 items, intrinsic motivation to use ICT had 7, behavioural intention had 8 items and facilitating condition had 11 items. A t-test is utilised within inferential statistic as a means to ascertain to what extent there is a significant difference between the means of two groups, as these differences could be the result of certain features (De Winter, 2013). T-tests are referred to as t-tests, since the test results are all founded on t-values. From a statistician's perspective, T-value refer to test statistics, which according to De Winter (2013) refer to a standardized value derived from (calculated from) the sample data during a hypothesis test. He (De Winter, 2013), further states that the process that determines the test statistic matches the data to what is expected under the null hypothesis. De Winter (2013) argues that a t-value of 0 shows that the sample results precisely equal the null hypothesis. As the difference between the sample data and the null hypothesis increases, the absolute value of the t-value increases (De Winter, 2013).

The Kaiser-Meyer-Olkin (KMO) was also determined, as well as the Bartlett test, which includes determining the Chi-Square. The recommendation of Kaiser Mayor Olkin is that values between 0.5 and 0.6 are mediocre, values between 0.7 and 0.8 are good and values between 0.8 and 0.935 are very good Hahs-Vaughn (2017, with reference to Kaiser, 1974). The values between 0 and 1 are regarded as acceptable values of Bartlett's Test of Sphericity. However, values closer to 1 are considered better, while values of 0.6 are recommended as acceptable minimum (Williams, Onsman & Brown, 2010) (see section 4.2.3). In addition, a regression analysis was also completed (see Chapter 4). The analyzed data are presented in tables, graphical illustrations and narrations in Chapter 4.

3.12 Ethical Issues under Considerations

The researcher sought consent from the relevant institutions and respondents before carrying out the study. As stated previously, the researcher sought permission from Moi University School of Education and applied for a research permit at the National Council for Science and Technology (NACOSTI). After the research permit had been issued, the researcher presented the permit to the County Commissioner and County Director of Education (CDE) West Pokot County, Kenya. The researcher visited the sampled schools with introductory letters and seeks consent from the principals to allow the researcher to carry out the research study in their respective schools. After that, the researcher explained the importance of the study to the selected science teachers. Respondents who agreed to participate in the study signed consent forms which indicated to the respondents that the information to be provided was treated with the utmost confidentiality and only be used for the purpose of this study.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, INTERPRETATION AND DISCUSSION

4.1 Introduction

This chapter presents the results of data analysis on teacher readiness and ICT integration in teaching and learning of science subjects in selected public secondary schools in West Pokot County, Kenya. In this chapter, interpretation and discussion of the data is also presented in relation to the objectives of the study. The chapter presents descriptive and inferential statistics to answer the research questions and test hypothesis respectively. The chapter begins by describing the demographic characteristics of the respondents which are followed by the descriptive statistics of the Likert scale items (which include the mean, standard error, standard deviation and percentages), as well as frequencies and percentages. The descriptive statistics are followed by factor analysis, test of regression assumptions, regression test, test of hypotheses and lastly discussion. In order to orientate the reader, the objectives of the study are presented below:

1. To determine the relationship between the attitude towards the use of ICT and the integration of ICT in the teaching of sciences in public secondary schools in West Pokot County.
2. To determine the relationship between motivation to use ICT and the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya.
3. To determine the relationship between facilitating conditions and the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya.

4. To determine the relationship between behavioural intention to use of ICT and the integration of ICT in the teaching of science in public secondary schools in West Pokot County.

4.2 Results

The findings in terms of demographic information, descriptive statistics, factor analysis and regression are presented in the results section. In the discussion section, which follows the results section, the findings are discussed by referring to the descriptive statistics, hypotheses and literature.

4.2.1 Demographic Information of Participants

The study collected demographic information from teachers based on, for example, their subject specialty (major), level of education and age range, as well as computer and internet-related aspects, availability of electricity, *etc.* The results are presented in Table 4.1.

The sample of participants consisted out of 148 males (63.5%) and 85 (36.5%) females. The age bracket of teachers shows that 98 (42.1%) were in the age group 20-29 years, 95 (40.8%) were in the age group 30-39 years, 33 (14.1%) of teachers were in the age group 40-49 years and 7 (3.0%) were in the age group 50 years and above, which highlights that most of the participants, *i.e.* approximately 83% falls within the 20 to 39 years of age groups. The age range thus suggests that the majority of the participants were very young.

Table 4.1: Demographic Information

Variable	Category	Frequency	Percent
Gender	Male	148	63.5%
	Female	85	36.5%
	Total	233	100.0%
Age bracket	20-29	98	42.1%
	30-39	95	40.8%
	40-49	33	14.1%
	50 and above	7	3.0%
	Total	233	100.0%
Subject speciality	Biology	99	42.5%
	Chemistry	63	27.0%
	Physics	71	30.5%
	Total	233	100.0%
Education level	Diploma	54	23.2%
	Degree	147	63.1%
	Masters	25	10.7%
	Post Graduate Diploma	7	3.0%
	Total	233	100.0%

According to the study findings, the subjects in which the participants specialized were Biology 99 (42.5%), Chemistry 6 3(27.0%) and Physics 71 (30.5%). From the findings, Biology had the highest percentage related to speciality followed by Physics and then Chemistry. The level of academic qualification showed that 54 (23.2%) of the participants were diploma holders and 147 (63.1%) were undergraduate degree holders. Only a very small number of participants had a post-graduate diploma or a masters' level qualification (see Table 4.1). The above information indicates that the majority of participating teachers had a university degree qualification, either an undergraduate qualification or a post-graduate qualification in addition to their undergraduate degree.

Regarding the number of students or learners at school, the results showed that 122 (52.4%) of the schools had 0 to 299 students while 23 (13.7%) had 300 to 499 students and 79 (34%) had 500-600 and above students. It is clear that from the findings that the majority of schools with a population of 0- 299 formed a larger part of the population (52%). The findings also indicate that approximately one-third of the schools had a population of above 500 and above (33.1%).

Table 4.2: Information about Schools on Facilitating Conditions

Variable	Category	Frequency	Percent
Approximate number of students in your school	0-149	62	26.6%
	150-299	60	25.8%
	300-499	32	13.7%
	500-599	23	9.9%
	600 and above	56	24.0%
	Total	233	100%
Quality of electricity available at school rated from 1 to 5	1 Very poor	41	17.6%
	2 Unreliable	36	15.5%
	3Moderately reliable	45	19.3%
	4 Good	67	28.8%
	5 Very good	44	18.9%
	Total	233	100.0%
How many computers does your school have?	0-10	120	51.5%
	10-20	58	24.9%
	21-30	24	10.3%
	31-40	16	6.9%
	41 and above	15	6.4%
	Total	233	100%
School is connected to the internet	Yes	93	39.9%
	No	140	60.1%
	Total	233	100%
Internet speed	Very poor	13	14.0%
	Poor	15	16.1%
	Neutral	33	35.5%
	Good	18	19.4%
	Very good	14	15.1%
	Total of those who responded	93	39.9%
	No response	140	60.1%
	Total	233	100.0%

With reference to the electricity supply, the results showed that when the responses related to strongly disagree and disagree were combined, there were 77 (33.1%) such responses which indicated that it was not good, while when good and very good as responses were combined, the responses were 111 (47.7%) participants which stated that the electricity supply was good or very good.

Regarding the number of computers, the results showed that 120 (51.5%) of the respondents indicated that their schools had between 0-10 computers, 58 (24.8%) that their schools had between 10-20 computers, 24 (10.3%) indicated that their school had between 21-30 computers, 16 (8.4%) of the respondents indicated that their schools had between 31-40 computers, while a meagre 15 (6.9%) of the respondents responded that their schools had 41 and above computers.

With reference to the level of connectivity of their school, the participants responded as shown in Table 4.2. According to the results, only 81(34.8%) of the participants indicated that their schools were connected to the internet and those without internet connectivity were 140(60.1%).This implies that more than half of the schools in West Pokot are not connected to the internet.

When asked about the internet speed, the data shows those who indicated that they had poor internet access at school accounted for 28 (30.1%) when the responses of the very poor or poor as two categories were joined. Those who indicated neutral responses were 33 (35.5%) while 32 (34.5%) agreed that it was very good or good when responses were combined. A total of 140(60.1%) did not respond to this question item. The data also shows that internet speed is also a concern, as only 32 (34.5%) indicated that it was good or very good when the two categories were combined.

4.2.2 Descriptive Statistics

In the following subsections, the descriptive statistics for each of the statements related to the items associated with ICT integration, attitude towards use, intrinsic motivation to use ICT, behavioural intention and facilitating condition as variables are presented in terms of one table for each section. The table in each section contains the descriptive statistics related to each statement and include the number of participants, mean, standard error, standard deviation and the percentages related to strongly disagree to strongly agree.

For the purpose of this study, the agreed and strongly agreed will be combined in the text when it is reported and the same will be done for disagree and strongly disagree. The Cronbach alpha (see Table 3.1) was above .8 for all five variables with its associated items per scale statements, which indicates a high level of internal consistency within each factor (or each scale) such as the factors ICT integration (implementation or usage), teacher attitude, facilitating condition, intrinsic motivation and behavioural intention.

The descriptive statistics sections that follow from 4.2.2.1 to 4.2.2.5 have the following format: The section starts by indicating the number of items related to the aspect indicated in the sub-headings, as well as indicating the mean range of the items. This is followed by indicating in textual format of the findings from the table indicated in narrative format by firstly presenting the percentages per Likert scale item.

Next, an interpretation of what the mean values suggest are provided and a possible implication(s) are indicated. After this, an interpretation of the percentage related items by highlighting the expected and unexpected findings and relating it to literature where possible [significance and contradictions related to the literature. The means, standard error and standard deviation for each of the statements were automatically generated by the SPSS software referred to in Chapter 3.

4.2.2.1 ICT Integration

The section *'Integration in the Teaching of Science'* measured 12 items with a mean response ranging from 2.0 to 2.5 (Table 4.3).The descriptive statistics pertaining to *'Accomplish tasks more quickly '*indicated that when strongly disagree and disagree are combined, approximately 73% of the participants disagreed (Table 4.4) while only 23% of the participants agreed. This thus suggests that the majority of the participants thought that they will not be able to accomplish tasks quicker when utilizing ICT.

In addition, the majority of the participants or 68% disagreed that it would *'Enhance the quality of their work that they do'* whereas only 25% were of the opinion that it would improve the quality of their work. They were thus probably not realizing that their work can be edited and presented in various ways which could enhance their ways of presentation of their work to learners, colleagues, the principal or parents. With reference to *'Making it easier for one to do his or her job'*, approximately 62% of the participants felt that this will not be the case, as they disagreed with this. A small number of participants or 21% indicated that it would make their jobs easier. Again, this points to participants probably not being able to see the value of saving and re-using and editing previous saved documents when ICT is utilized.

Approximately 67% indicated that ICT will not enhance their effectiveness on the job while 21% were positive that it would make their job easier.

Table 4.3: ICT integration for the teaching of science

Descriptive Statistics Statement (Item)	Mean	Std. Devia.	1	2	3	4	5
			Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Accomplish tasks more quickly.	2.0215	1.34372	53.6%	19.73%	3.4%	17.2%	6%
Improve the quality of the work that I do	2.3948	1.31581	27.5%	41.6%	5.6%	14.6%	10.7%
Make it easier to do my job	2.3391	1.17850	28.8%	33.9%	15.9%	17.6%	3.9%
Enhances my effectiveness on the job	2.3906	1.36372	29.6%	37.8%	11.6%	6%	15%
Increases my productivity	2.3348	1.15946	28.3%	34.3%	15.9%	18.5%	3%
Research and access specific scientific information	2.4549	1.32251	28.8%	29.6%	22.3%	6%	13.3%
Developing lesson notes	2.2661	1.08577	24%	47.2%	9.9%	15.9%	3%
Teaching and learning during lesson time	2.3816	1.31712	32.6%	24.9%	21.5%	8.2%	10.7%
Assess students' academic progress	2.2704	1.35183	37.8%	29.6%	11.6%	9.9%	11.2%
Making class presentations	2.3433	1.32048	33%	31.3%	14.6%	10.3%	10.7%
Generating reports	2.4421	1.19169	27.9%	24.9%	27.9%	13.7%	5.6%
Communication with students in class	2.5193	1.28681	22.3%	36.9%	21.5%	5.2%	14.2%

With reference to *'Enhance my effectiveness on the job'*, roughly 67% disagreed or strongly disagreed with this statement when combining disagree and strongly disagree totals, whereas 21% indicated that they either agree or strongly agree. Similarly, more or less 62% also indicated that they disagreed with the statement that ICT *'Increases* *my productivity'* and again more or less 21% agreed or strongly agreed with this statement. With reference to the statement that ICT can assist with '*Research and access specific scientific information'* more or less 58% disagreed with the statement while 19% agreed. It appears thus that the participants have not yet experienced the possibilities internet access affords to themselves and their learners. Pertaining to *'Developing lesson notes'* a staggering 71% disagreed with this statement whereas approximately 19% agreed with this statement, thus indicating that making lesson notes for their learners were not a priority.

With reference to using ICT for *'Teaching and learning during lesson time'* more or less 57.5% disagreed with the statement, while 18.9% agreed with this statement. It is thus evident from this response that the possible positive promise that ICT affords, have probably not been thought about. Pertaining to *'Assessing student's academic progress'*, approximately 67.4% disagreed with this statement and a meagre 21.1% agreed with this statement, probably because the participants were not aware of how this could be achieved. With reference to *'Making class presentations'*, 64.3% disagreed or strongly disagreed with this statement whereas 21.0% roughly agreed with this statement, which again could be attributed either to the lack of knowledge regarding ICT usage and/or not wanting to use it in this manner. The responses to *'Generating reports'* revealed that 52.8% disagreed with this statement and a meagre number of participants or 19.3% indicated that they agreed with this statement as the participants are probably accustomed to hand-written reports.

With reference to *'Communication with student in class'*, 59.2% strongly disagreed or disagreed with this statement whereas 19.4% agreed with this statement. This could again be attributed to several possibilities, for example, learners not having internet access or participants not having internet access, or alternatively, either because the possibilities for the above have not been foreseen or it could even be not part of their current fit.

The responses for the 12 items referred to above relating to *'ICT integration'* had means of between 2.028 and 2.519. The average mean for the items was 2.34 and was calculated by adding all the means of all the items in this section together and then by dividing it by the number of items in this section; for instance, total of the means divided by 12 items. As such, the mean score per item and the average mean score of this section, based on the overall interpretation of means presented in Table 3.2 in Chapter 3, indicated that the respondents generally disagreed with the Likert scale statements related to the integration (implementation) of ICT with reference to the teaching and learning of science. The findings thus suggest that at this point in time that the participants did not have a positive inclination towards ICT integration or implementation for the teaching and learning of science.

Overall, the descriptive percentage related statistics and mean scores indicated that the majority of the participants disagreed with all of the statements related to *'ICT integration for the teaching of science'*. The data thus revealed that the majority of the participants did not realize that ICT implementation holds promise. It was interesting to see that nearly 73% of the participants (who disagreed) thought that they will not be able to accomplish tasks quicker while ICT usage offers opportunities to save documents such as tests, worksheets, letters, reported, *etc*. which will save time if one had saved it instead of redoing it from scratch.

It is thus evident that the participants did not foresee the relative advantage (Rogers, 2003) that ICT as innovation offers, for example quality enhancement, creating learning material, communicating and reporting, to name a few only. This is probably due to the fact that majority of the participants (Table 4.8 on facilitating conditions) indicated that they did not have the resources nor the required ICT knowledge. Additionally, findings from a number of studies (Gakuu & Kidombo, 2015; Kinuthia, 2009; Kiboss, 2002) have indicated that effective integration of ICT in secondary school curriculum was hampered, as integration is very much dependent upon the ICT literacy skills of the teachers.

4.2.2.2 Attitude

The aspects related to *'Attitude towards ICT use'* measured 4 items with mean responses ranging from 1.7 to 3.0 (Table 4.4).The descriptive statistics pertaining to *'using ICT is a good idea'* revealed that the large majority or 80.3% strongly disagreed or disagreed with this statement, whereas 21.5% strongly agreed or disagreed. Pertaining to *'using ICT is a wise idea'* the data indicated that 69.5% strongly disagreed or agreed with this statement, while 21.5% strongly agreed or agreed with this statement. With reference to the statement *'I like the idea of using ICT'*, 40.4% strongly disagreed or disagreed, while 48.5% strongly agreed or agreed with this statement.

Table 4.4: Attitude towards ICT use for the teaching of science

Descriptive Statistics Statement (Item)	Mean	Std. Devia.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree
Using ICT is a good idea.	1.7082	1.10671	64.4.%	15.9.%	4.3.%	15.5.%	6%
Using ICT is a wise idea.	2.3562	1.11694	20.6%	48.9%	9.0%	17.2%	4.3%
I like the idea of using ICT.	2.9871	1.31136	18.5%	21.9%	11.2%	39.5%	9.0%
Using ICT is a pleasant experience.	3.0730	1.49678	17.6%	26.6%	15.5%	11.6%	28.8%

Pertaining to the statement *'Using ICT is pleasant experience'*, 44.2% strongly disagreed or disagreed with this statement, whereas 40.4%, strongly agreed or agreed with this statement. The lowest neutral response related to attitude statements was 4.3% and the highest 15.5%.

The responses for the 4 items referred to above relating to *'Attitude towards ICT use for the teaching of science'* had means of between 1.70 and 3.07 and an average mean of 2.531 for the 4 items. Based on the overall interpretation of means per item and the average mean score of this section, the results indicated that the respondents strongly disagreed with one item *'Using ICT is a good idea* 'and disagreed also with another item, *'Using ICT is a wise idea'*. The statement *'Using ICT is a pleasant experience*' on the other hand had had a larger agreed response and strongly agreed response result part. It was interesting to note that the first two items' responses which started with the word *'Using'* were both within the strongly disagreed and disagreed range, whereas the third statement starting with *'I like'* resulted in a more positive agreement. The above can probably be attributed to the possibility that the two items *'I like'* and *'ICT is a pleasant experience'* could have been interpreted as an intention or inclination towards the future usage of ICT, while the first two *'Using ICT'* items could have been interpreted as using ICT right now. As such, it thus appears that using ICT right now is not such a good idea, probably due to a lack of facilitating conditions.

The overall response for the average mean of 2.51 for all items thus indicated an overall disagree values. These results thus suggest that at this point in time, the participants did not have a positive attitude towards ICT implementation in teaching and learning of science. This is different from Subramanien (2014) indicated that the *'self'* and attitude are key to ICT implementation, integration and adoption and as such without attending to the *'self'* as an individual, it is unlikely that there will be a positive attitude from the *'self'*. In addition, Ertmer *et al.* (2012) found out that teacher own beliefs together with attitude on technology relevance had a great influence on their success.

4.2.2.3 Motivation

The section regarding *'motivation towards ICT use'* measured 7 items with mean responses ranging from 2.4 to 3.0 (Table 4.5).The descriptive statistics pertaining to *'I find using ICT to be enjoyable'*, showed that 58.8% strongly disagreed or disagreed with this statement, while 18.9% strongly agreed or agreed with this statement. This could probably be attributed to not having ICT resources, as suggested by the findings in the facilitating condition section, section 4.2.2.5.

Table 4.5: Motivation to Use ICT for the teaching of science

Descriptive Statistics Statement (Item)	Mean	Std. Devia.	1	2	3	4	5
			Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I find using ICT to be enjoyable	2.483	1.18216	20.2%	38.6%	22.3%	9.9%	9.0%
The actual process of using ICT is pleasant experience.	2.836	1.28620	18.8%	23.2%	25.3%	20.6%	12.0%
I have fun using ICT.	3.025	1.12159	5.6%	32.3%	28.8%	21.0%	12.0%
ICT makes work more interesting	2.982	1.36447	18.5%	20.2%	24.0%	19.3%	18.0%
Working with ICT is fun.	2.888	1.38199	18.9%	26.6%	19.3%	17.2%	18.0%
I feel comfortable when using ICT in teaching and learning process	2.502	1.32653	27.0%	30.9%	19.7%	9.4%	12.9%
Once I start working on ICT I find it hard to stop.	2.751	1.28580	24%	18.9%	21.9%	28.3%	6.9%

With reference to *'The actual process of using ICT is pleasant experience'*, the results showed that 42% strongly disagreed or disagreed, whereas 32.6% strongly agreed or agreed with this statement and 25.3% or a quarter of the participants were undecided. Regarding the statement *'I have fun using ICT'*, 37.9% strongly disagreed with this statement while 33.0% agreed with this statement. Again, similar to the previous statement, 28.8% were undecided, thus just over a quarter. Similarly, regarding the statement *'ICT makes work more interesting'*, 38.7% strongly disagreed or disagreed with this statement and 37.3% of the respondents agreed with this statement, with nearly a quarter or 24% being undecided. Pertaining to *'Working with ICT is fun'*, the data indicated that 38.7% of the respondents disagreed with this statement whereas 35.2% of the respondents agreed with this statement.

The data revealed regarding the statement *'I feel comfortable when using ICT in teaching and learning processes'* that 57.9% of the respondents disagreed with this statement while only 22.3% agreed. A similar trend was noticed to the statement *'Once I start working on ICT I find it hard to stop'*, as 39.3% of the respondents indicated that they strongly disagreed or disagreed with this statement whereas 35.2% of the respondents strongly agreed or agreed with this statement once I start working on ICT I find it hard to stop.

From the findings above, there were a few unexpected findings related to motivation to use ICT on two statements, the first one pertaining to *'I find using ICT to be enjoyable'*. The responses to this item showed that 58.8% disagreed that they found using ICT as enjoyable. It was expected that teacher would find the use of ICT to be enjoyable, but then from the facilitating condition section, section 4.2.2.5, the findings showed that the participants did not receive the support, training or resources.

Secondly, in addition to the first statement, 57.9% of the respondents indicated that they disagree with the statement pertaining to *'I feel comfortable when using ICT in teaching and learning process.'* Again this could probably be attributed to lack of access to resources, support and training. Intrinsically wise, Chigona, Chigona and Davids (2014) acknowledge that recent studies have indicated that teachers are unlikely to integrate ICT in their teaching when they do not feel ready and confident (motivated) to use the technology.

Furthermore, the mean responses for the 7 items related to '*Motivation to use ICT'* resulted in means ranging from 2.483 to 3.025. The average mean for the 7 items were

2.8 which is in the neutral or undecided range. Based on the overall interpretation of means per item and the average mean score of this section, the mean results indicated thus that the respondents generally disagreed with the Likert scale statements related to the '*Motivation to use ICT for the teaching and learning of science'*. However, one item *'I have fun using ICT'* had a neutral mean. This might probably be attributed to the fun dimension when the participants utilized their smart phones, which is not the same when using a desktop or laptop device.

Two of the statements had means falling within the disagreement range, whereas five statements fell within the neutral range. As such, the findings suggest that at this point in time, the participants were neutral overall regarding a positive inclination towards motivation to use ICT for the integration and implementation of the teaching and learning of science. The overall mean average finding of 2.7, which is within the undecided or neutral range, could probably again be attributed to the fact that the facilitated conditions were not conducive and hence became a first-order (Ertmer, 1999), third order and fourth-order challenge or barrier to integration, implementation and adoption and influenced motivation. As such, it is quite possible that the undecided overall result could result in a positive motivational related result, should the facilitating conditions be met (see section 4.2.2.5) such as for example access to resources, training and support (Du Plessis & Webb, 2012a; Subramanien, 2014; Rogers, 2003).

4.2.2.4 Behavioural intention

The section with reference to *'Behavioural intention to use ICT'* in teaching science subjects measured 8 items (see Table 4.6) with mean response ranging from 2.1 to 3.0.

Table 4.6: Behavioural intention to use ICT for the teaching of science

Descriptive Statistics Statement (Item)	Mean	Std. Devia.	1	2	3	4	5
			Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I intend to use the system in the next two months	2.141	1.24970	43.3%	21.9%	17.6%	11.6%	5.6%
I predict I would use the system in the next two months	2.459	1.22098	21.5%	41.6%	16.0%	10.7%	9.9%
I plan to use the system in the next term	2.884	1.29633	19.5%	22.7%	17.6%	30.9%	9.4%
I have positive perception towards ICT	3.038	1.42432	18.0%	21.9%	21.5%	15.5%	23.2%
I am ready to participate in computer training	2.382	1.35029	38.2%	14.6%	29.6%	6.0%	11.6%
I have an understanding on how to integrate ICT into teaching	2.510	1.21808	25.3%	28.8%	21.0%	19.3%	5.6%
Lack of adequate computers	2.506	1.23218	26.6%	29.2%	14.6%	26.2%	3.4%
I have a plan for ICT use	2.485	1.27340	27.5%	31.8%	11.2%	24.0%	5.6%

The data revealed that regarding the descriptive statistics pertaining to the statement *'I intend to use the system in the next two months'* that 65.2% of the respondents disagreed with this statement, whereas 17.2% of the respondents agreed with this statement.

With reference to the statement *'I predict I would use the system in the next two months'*, the data indicated that 63.1% of the participants disagree with this statement, whereas a mere 20.6% of the participants' agreed with this statement. Pertaining to the *statement 'I plan to use the system next term'*, a large percentage of 42.2% of the respondents disagreed with this statement while 40.3% of the participants' agreed with this statement. The findings related to the behavioural intention related statements above can probably be attributed to the fact that the majority of the participants do not have access to ICT resources and the necessary ICT knowledge, as evident from the results in section 4.2.2.5, facilitating conditions.

Regarding the statement *'I have positive perception towards ICT'*, the data revealed that 39.9% of the participants disagreed with the statement, while nearly a similar response of 38.7% was to be found for agreed option, suggesting thus that there seems to be some hope for ICT usage in the future. However, this above could be problematic, as that data showed that 52.8% stated that they were ready to participate in training. This could probably either be because they do not want to participate at all or that they do not intend to participate as they do not have ICT resources. The above is also probably affirmed by the statement related to *'Lack of adequate computers'* as 53.8% indicated that this was indeed the case. Without adequate computers, it is thus evident that it is unlikely to have a behavioural intention to use ICT.

The statement *'I am ready to participate in computer training'* the data revealed that the majority or 52.8% of the participants disagreed with this statement, while a meagre 17.6% of the participants' strongly agreed or agreed with this statement. The lack of teachers with ICT competency skills is another challenge facing the education system, as without ICT proficient and knowledgeable teachers, the success rate of integration and the use of information technology in schools is minimal (Mndzebele, 2013), which could probably be attributed to why the participants felt not ready to participate in computer training.

With reference to the statement, *'I have understanding on how to integrate ICT into teaching'*, the majority again or 54.1% of the participants' disagreed with this statement, whereas 24.9% of the respondents agreed. Pertaining to the statement *'Lack of adequate computers'* it was found that 55.8% of the participants disagreed with this statement, which was again the great majority. According to Chigona *et al.* (2014), teachers find it difficult to use technology for teaching when schools lack or have inadequate computers for learners. On the other hand, a mere 29.6% of the participants agreed with this statement pertaining to *'Lack of computers*. Lack of knowledge and lack of access to ICT resources such as computers were thus inhibiting aspects. Similarly, with reference to the statement *'I have plans for ICT use'*, the data indicated that 59.3% of the participants disagreed with this statement while on the other hand 29.6% of the participants agreed with the statement *'I have a plan for ICT use'*. It is argued that it is quite impossible to have plans for ICT usage if one does not have access to ICT resources.

The responses regarding the 8 items referred to above namely, *'Behavioural intention towards ICT use for the teaching of science'*, had means of between 2.141 and 3.038, suggesting that the responses ranged from disagree to agree. The average overall mean result regarding the responses for the 8 Likert scale *'Behavioural intention'* items was 2.55. Of the eight items, one item *'I have positive perception towards ICT'* had an agree response, one item '*I plan to use the system in next term'* an undecided or neutral response while the remaining six items received disagree responses. Based on the overall interpretation of means per item and the average mean score of this section, based on the values indicated in Table 3.2 in Chapter 3, the overall results thus indicated that the respondents generally disagreed with the Likert scale statements related to *‘Behavioural intention to use ICT for the integration (implementation) of ICT with reference to the teaching and learning of science’,* albeit two items were not within this range. As such, the findings suggest that at this point in time, the participants did not have a positive inclination towards behavioural intention to use ICT for the integration and implementation for the teaching and learning of science. It was encouraging to see that the participants agreed to have had a positive intention related to ‘*I have positive perception towards ICT’* which presents the Department of Education of Kenya with something positive. The above concurs with Marcinkiewicz (1993) who contends that teachers’ use of ICT in the classrooms is dependent on their beliefs and attitudes towards technology, which probably also influence behaviour.

4.2.2.5 Facilitating conditions

The section related to *‘Facilitating Conditions for ICT use’ in teaching Science Subjects’* was measured by 11 items (Table 4.7) with mean response ranging from 1.7 to 2.5.

Table 4.7: Facilitating conditions for the use of ICT in teaching of science

Descriptive Statistics Statement (Item)	Mean	Std. Devia.	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree
I have the resources necessary to use the ICT.	2.390	1.36372	29.6%	37.8%	11.6%	6.0%	15.0%
I have the knowledge necessary to use ICT	2.334	1.15946	28.3%	34.4%	15.9%	18.5%	3.0%
The ICT is not compatible with other ICT systems I use.	2.454	1.32251	28.8%	29.6%	22.3%	6.0%	13.3%
I have control over using the ICT	2.266	1.08577	24.0%	47.2%	9.9%	15.9%	3.0%
I have resources, opportunities and knowledge it takes to use ICT	2.381	1.31712	32.6%	24.9%	21.5%	8.2%	10.7%
Guidance was available to me in the selection of the ICT.	2.270	1.35183	37.8%	29.6%	11.6%	9.9%	11.2%
Specialized instruction concerning ICT was available to me	2.343	1.32048	33.0%	31.3%	14.6%	10.3%	10.7%
A specific person is available for assistance with ICT difficulties	2.442	1.19169	27.9%	24.9%	27.9%	13.7%	5.6%
Using ICT is compatible with all aspects of my work.	2.519	1.28681	22.3%	36.9%	21.5%	5.2%	14.2%
I think that using ICT fits well with the way I like to work.	1.708	1.10671	64.4%	15.9%	4.3%	15.5%	0%
Using ICT fits into my work style.	2.356	1.11694	20.6%	48.9%	9.0%	17.2%	4.3%

Descriptive statistics pertaining *'Facilitating condition'* related statement *'I have the resources necessary to use the ICT'*, 67.4% of the respondents disagreed with this statement, whereas 21% of the participants agreed with this statement that they had the resources necessary to use the ICT. Access to resources is critical in order to proceed to possible adoption (Ertmer, 1999, Du Plessis & Webb, 2012a; Subramanien, 2014).

With reference to the statement *'I have the knowledge necessary to use ICT'*, the large majority or 62.7 % of the participants disagreed with the statement, whereas 21.5% of the respondents agreed or strongly agreed with this statement. Rogers (1995, 2003) has posited that knowledge and skills are paramount with reference to adoption, for instance innovation-decision process theory for an innovation, and the participants indicated that they lacked knowledge. However, he also indicated that even if one does have the necessary knowledge and resources, one can still reject adoption.

Regarding the statement *'The ICT is not compatible with other ICT systems I use'*, again and similar to the previous statement, the vast majority or 63.2% of the participants either disagreed with this statement, while only 19.3% of the participants agreed with the statement.

Pertaining to *'I have control over using the ICT'*, the results revealed again that even a larger majority or 71.2% of the participants strongly disagreed with the statement, whereas 18.9% of the participants agreed with this statement. With reference to *'I have resources, opportunities and knowledge it takes to use ICT'*, the data revealed that 57.5% of the respondents disagreed with the statement while 21.5% of the participants agreed with this statement. It appears thus that the participants felt that without access to ICT resources and without support and training, they do not have control over their usage for teaching and learning.

Another statement worded as *'Guidance was available to me in the selection of the ICT'*, the results showed that a large majority or 67.4% of the participants disagreed with this statement while only 21.9% of the participants agreed with this statement. With reference to *'Specialized instruction concerning ICT was available to me'* again a large number of participants or 64.3% disagreed or strongly disagreed with the statement, whereas 21.0% of the participants agreed.

From the statement *'specific person is available for assistance with ICT difficulties'*, the data indicated that 52.8% of the participants disagreed with the statement, while on the other hand, only 19.3% of the participants' either agreed with this statement. It is thus evident that guidance and support were also missing and hence this influenced current and future adoption.

The statement pertaining to *'Using ICT is compatible with all aspects of my work'* highlighted that 59.2% of the participants' disagreed with the statement, while about 19.4% of the participants agreed with this statement. With reference to *'I think that using ICT fits well with the way I like to work,'* a very large percentage was recorded, namely that 80.3% of the participants either disagreed with this statement and only 15.5% of the participants agreed with this statement. Pertaining to '*Using ICT fits into my work style'*, 69.5% of the participants disagreed, whereas 21.5% of the participants agreed with the statement. The lowest neutral response related to statements pertaining to facilitating conditions for the use of ICT for the teaching and learning of science was 4.3% and the highest 27.9%. The importance of compatibility for the adoption of an innovation has been alluded to by both Rogers (1995, 2003) and Venkatesh *et al.* (2003).

The mean responses for the 11 items related to '*Facilitating conditions to use ICT'* resulted in means ranging from 1.708 to 2.519. The average mean for the 11 items were 2.31, which is in the disagree range. Based on the overall interpretation of means per item and the average mean score of this section as per ranges of the values indicated in Table 3.2 in Chapter 3, the mean results indicated thus that the respondents generally disagreed with the Likert scale statements related to the *'Facilitating conditions to use ICT' for the teaching and learning of science'*. However, one *item 'I think that using ICT fits well with the way I like to work'* had a strongly disagreed response value in comparison with the disagreement overall value of the means. This might probably be attributed to the fun dimension when the participants utilized their smart phones, which is not the same when using a desktop or laptop device. The overall mean average finding of 2.31, which is within the disagree range, is thus attributed to the current facilitating conditions not being favourable for ICT implementation, integration and adoption, thus affirming Ertmer's (1999) position that first-order challenges are indeed a barrier that prevents integration, implementation and adoption.

In addition, it is was quite disturbing that the majority of the participants disagreed and strongly disagreed with the item *'I think that using ICT fits well with the way I like to work'*, as it had a mean of 1.708. The previous is troubling, as it appears that ICT does not fit with the participants' current and anticipated ways of teaching and learning. It is also evident from the findings that there was at the point in time when the questionnaire (survey) was completed a lack of resources, lack of knowledge, guidance, the lack of the availability of specialized instruction and lack of technical support when ICT difficulties were to be experienced.

The above possible influenced the disagreed and strongly disagreed responses related to the two ‘fit’ statements, namely *‘I think that using ICT fits well with the way I like to work’* and *‘Using ICT fits into my work style’* respectively. Venkatesh *et al.* (2003) have highlighted the importance of ICT facilitating conditions as conditions that assist with the adoption process of innovations. It is thus clear that if the necessary facilitated conditions are not being met, the chance of ICT integration, implementation and adoption is very slim.

4.2.3 Factor Analysis for Integration of ICT

The various forms of analysis for the variables are presented below as extracted from the data. In order to provide an overview of aspects related to Exploratory Factor Analysis (EFA), the following aspects are presented and highlighted in the paragraphs below:

Exploratory factor analysis is a statistical method that is utilized to condense data to a smaller set of variables and to investigate the basic hypothetical/theoretical structure of the phenomena (Osborne, *et al.*, 2008). It is utilized to distinguish the structure of the connection between the variable and the respondent (Osborne, *et al.*, 2008).Another aspect that has to be considered is the selection of factors to be extracted. According to Hahs-Vaughn (2017, with reference to Kaiser, 1960), theory is the principal criterion to decide on the number of factors to be extracted. From theory, we realize that if the objective of factor analysis is to attain a smaller number of variables that substantively capture the information within the original set of variables, the factors ought to be more information-laden than the original items Hahs-Vaughn (2017, with reference to Kaiser, 1960). Consequently, the Eigen value rule (Kaiser, 1960) affirms that factors with Eigen values less than 1.0 and, hence, comprising less information than the average item, should not be retained. Hahs-

Vaughn (2017, with reference to Kaiser, 1960) further states that the variance explained method and value of the percentage is also applied for exploratory factor analysis. The Scree test criteria can also be applied for the selection of factors (Hahs-Vaughn (2017, with reference to Kaiser, 1960). In this technique, factors are chosen after the Eigen value is plotted on a graph (Hahs-Vaughn 2017).

Orthogonal rotation is a technique where the axis is kept at 90 degrees, therefore the factors are uncorrelated to one another (Comrey, & Lee, 2013). Dhamuniya (2015) proposes the following three techniques are available in orthogonal rotation based on the rotation, namely (1) Quartimax, (2) Varimax and (3) Equimax. In quartimax, rows are cut down so that the variable is loaded on a single factor.Varimax is applied to simplify the column of the factor matrix so that the factor extracts are noticeably related and there ought to be some division among the variables. Equimax is obtained by combining Quartimax and Varimax. This technique simplifies row and column at a single time.

Factor loading: This can be categorized depending on their magnitude: where + .30 is at minimum consideration level; + .40 is considered more important and + .50 is considered practically significant (Hair, *et al.* 2006).Factor extraction involves making a decision on the kind of model and the number of factors to extract. Factor rotation is achieved when factors are extracted, with the goal of attaining simple structure so as to improve interpretability (Hair, *et al.* 2006). Rotation (Factor rotation) and Varimax orthogonal rotation: This is the scientific benefit of an analytic method over graphical rotating measures, as the turning round causes the factor loadings to be clearly differentiated, which is usually essential to ease interpretation

(Cattell, 2012). There are mainly two types of rotations that are available for use, these are, orthogonal (Varimax) rotation and Oblique rotation Mlambo, Rambe & Schlebusch, (2020 with reference to Kaiser, 1960).

Rotated component matrix: This is also referred to as the loadings which is the key output of main component and analysis (Abdi, & Williams, 2010). It comprises components of the variables and the estimated components (Hair, *et al.* 2006).

Communality: It is the degree to which an item correlates the entire items (Tinsley, & Tinsley, 1987). High communalities are recommended, if communalities for a certain variable are low (between 0.0 and 0.4), then that variable could struggle to load extensively on some factor (Hair, *et al.* 2006).

Total variance: As a descriptive statistic, sum variance performs a breakdown of the sample variance of the occurrence residuals into components related to downward frequency octaves (Greenhall, Howe, & Percival, 1999; Riley, 2008). Kaiser-Meyer-Olkin (KMO) Test: This test is a measure of how suitable the data is for Factor Analysis (Beavers, Lounsbury, Richards, Skolits, & Esquivel 2013). It is a measurement that shows the extent of change in the factors that may be brought about by hidden factors. KMO measures sampling adequacy for every variable in the model and for the complete model (Mlambo et al, (2020 with reference to Kaiser1960) High values (near 1.0) by and large show that a factor analysis might be valuable with the data. In the event that the value is under 0.50, the results of the factor analysis most likely won’t be very helpful.

The recommendation of Kaiser Mayor Olkin is that values between 0.5 and 0.6 are mediocre, values between 0.7 and 0.8 are good and values between 0.8 and 0.935 are very good (Mlambo et al, (2020 with reference to Kaiser, 1974. The following excerpt from ‘Statistics how to’ (Glen, 2016, paragraph 2 and 3) website states the following regarding the KMO test which provides a result value between 0 and 1:

"KMO values between 0.8 and 1 indicate the sampling is adequate. KMO values less than 0.6 indicate the sampling is not adequate and that remedial action should be taken. Some authors put this value at 0.5, so use your own judgment for values between 0.5 and 0.6.

KMO Values close to zero means that there are large partial correlations compared to the sum of correlations. In other words, there are widespread correlations which are a large problem for factor analysis. For reference, Kaiser put the following values on the results:

0.00 to 0.49 unacceptable.

0.50 to 0.59 miserable.

0.60 to 0.69 mediocre.

0.70 to 0.79 middling.

0.80 to 0.89 meritorious.

0.90 to 1.00 marvelous"

Bartlett's Test of Sphericity: Bartlett's test for Sphericity matches the correlation matrix to the identity matrix of data in a study, *i.e.*it examines the existence of redundancy between variables that can be summarized with some factors (Snedecor & Cochran, 1989; Changwong, Sukkamart & Sisan, 2017). These are tests used in statistics to establish if samples in an experiment come from the population with the same variances, or the whole range of values (Changwong, *et al.*, 2018). Bartlett's Test determines if the fairness, known as homo scedasticity or homogeneity, is across all populations and if it can be used to identify if a tested population has a non-normal allotment of persons (Williams, *et al.*, 2010). The values between 0 and 1 are regarded as the values to scrutinize and values closer to 1 are considered better while values of 0.6 are recommended as the acceptable minimum (Williams, *et al.*, 2010).

Chi-Square Goodness of Fit Test: The Chi-square test is mostly used to determine whether sample data are consistent with a hypothesized distribution, in other words, the Chi-square test is mostly used to check by what means an observed distribution could have occurred by chance (Field, 2005). It is useful when a researcher has one categorical variable from a single population Chi-square, also referred to as a 'goodness of fit' statistic, gauges how suitable the observed distribution of data suits the distribution that is anticipated if the variables are independent (Satorra & Bentler, 2001). Often, researchers choose significance levels equal to 0.01, 0.05, or 0.10; nonetheless any value between 0 and 1 can be used (Satorra & Bentler, 2001).

P-value: This refers to the probability of significance and is used in place of hypothesis tests as a means of giving additional information about the relationship linking the data and the hypothesis than does a simple rejection or not rejects decision (Hair *et al.*, 2006). When p is < Alpha (0.05, 0.01, 0.001 and 0.0001) the result of the findings is said to be significant and when is p>0.05 the result is considered to be non-significant (Riley, 1996; Riley, 2008).

Eigen values: These values are a unique set of scalars connected with a linear structure of equation, linear system of equations that are occasionally known as attribute roots or quality standards (Weisstein, 2002). The Eigen value is considered significant when the rotated components load into one or more components with a value of 1 and above (Weisstein, 2002).

Scree plot: This type of plotting normally shows a discrete break linking the steep slope of the bigger factors and the regular trailing off of the rest of the factors (D’Agostino & Russell, 2005).

For the purpose of this study, an EFA was conducted per scale. It was decided to extract one factor for each scale and as such, a one-factor solution was forced per scale. The researcher may use a ‘meaningfulness’ measure to choose which solution should be retained in case a solution culminates into a component that cannot be well defined (has none or few variables loading on it) or a component which does make sense (Hair et al., 2006). Consequently, the researcher may perhaps decide not to accept that solution (Hair et al., 2006). This was because there were two items loading on the second factor and therefore the factor solution was not identifiable. Therefore, in accordance with Hair et al.’s (2006) assertion that the number of items loading on a factor should be three or four, the factor loadings in this study were adapted to measure a single unidirectional construct variable or factor.

The presentation of the findings to determine whether a factor analysis could be conducted with reference to the items associated followed the following ‘steps’, namely: Firstly, the Kaiser-Meyer-Olkin (KMO) was determined. Secondly, Bartlett’s Test followed, which included determining the Chi-square. Thirdly, it was determined whether the KMO and Bartlett’s Test indicated whether one can continue with the factor analysis for the items. Fourthly, Bartlett’s Test of Sphericity followed to establish the data was appropriate for principal component analysis. Fifthly, the Eigen values were determined and presented by means of a table (Total Variance) and textual write-up, as well as the textual write-up of the Scree plot followed by an image of the Scree plot. Sixthly and lastly, the clustering and presentation as per the rotated component matrix and whether an item (statement) was retained or dropped, as well as why it was retained or dropped.

4.2.3.1 Factor Analysis for Integration of ICT

The factor analysis is a technique that is used to reduce a large number of variables to a smaller set or assess the degree to which items are tapping the same concepts and or components (Field, 2005). One technique is the Kaiser-Meyer-Olkin (KMO) which is used to check the adequacy of the data for the extraction of principal components (Tabachnick & Fidell, 2003). The recommendation of Kaiser Mayor Olkin is that values between 0.5 and 0.6 are mediocre, values between 0.7 and 0.8 are good and values between 0.8 and 0.935 are very good (Kaiser, 1974). Table 4.8 with a threshold of .935 thus shows that the KMO value is very good (Field, 2005). In addition, Bartlett's Test was also substantial with a Chi-Square=3178.551 (p-value< 0.05).

Table 4.8: KMO and Bartlett's Test related to ICT integration (implementation)

Kaiser-Meyer-Olkin measure of sampling adequacy		.935
Bartlett's Test of Sphericity	Approx. Chi-Square	3178.551
	Df	66
	Sig. (p-value)	.000

Therefore, with the KMO value of 0.935, it can be stated that the significance of Bartlett's statistic confirmed the appropriateness of the factor analysis for 'Integration of ICT' (implementation, adoption or usage). The Chi-square value indicates a good fit when the mean is less than the alpha $p<0.05$ and the integration of ICT data and that there exists an adequate correlation among the extracted variables. Bartlett's Test of Sphericity indicated that the data was appropriate for principal component analysis. The results are presented in Table 4.8.

With reference to the Eigen test, component 1 had an Eigen value exceeding 1.0, as it was 9.035, as indicated in Table 4.9.

Table 4.9: Total variance explained related to the integration of ICT

Comp	**Initial Eigen values**		
	Total	**% of Variance**	**Cumulative %**
1	9.035	75.292%	75.292%
2	.686	5.716%	81.008%
3	.492	4.104%	85.112%
4	.336	2.800%	87.912%
5	.289	2.411%	90.323%
6	.268	2.237%	92.560%
7	.226	1.881%	94.441%
8	.180	1.497%	95.938%
9	.165	1.377%	97.315%
10	.135	1.129%	98.444%
11	.109	.911%	99.355%
12	.077	.645%	100.0%

The researcher undertook a Scree plot test of the ICT integration items to visually illustrate the Eigen value related to the component number (Figure 4.1).

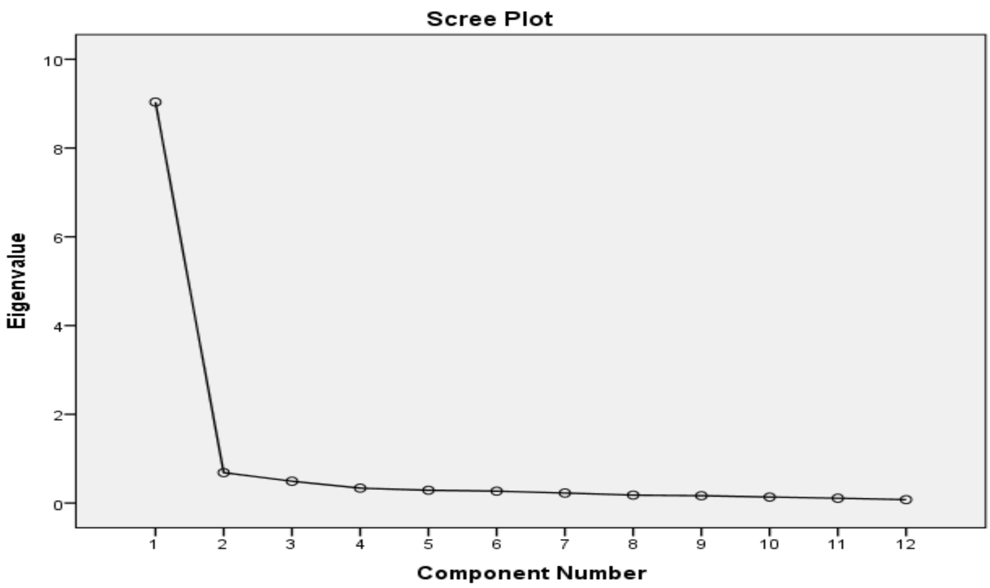

Figure 4.1: Scree plot for extracted components of integration (implementation, adoption) of ICT

The Scree plot test recommended by Cattel (1966) is a graph of the downward variance accounted for by the factor originally extracted. Wuensch (2004) posits that the Scree refers to the components that appear at the bottom of the sloping plot of Eigen values against the component number. He further states that the Scree plot enables a researcher to identify the factor to be retained. Ideally, this will be the factor(s) with an Eigen value greater than one and will lie before the point at which the Eigen values seem to become flat. In this particular study, one factor under the Component Matrix for ICT integration was retained as it had an Eigen value greater than one and lay before the point at which the Eigen values became flat as is presented in Figure 4.1. The component accounts for 75.2% of the total variance.

The results of the Exploratory Factor Analysis (EFA) for the integration of ICT as a variable showed that the 12 items clustered into 1 component, ‘Integration of ICT’ with an Eigen value of 9.035 which represents the amount of the total variance explained by that factor. This means that ‘Integration of ICT’ had only one factor extracted and hence it was not rotated. The results are presented in Table 4.10.

Table 4.10: Unrotated component matrix related to ICT integration (implementation, adoption, usage)

Comp	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Tot	**Var%**	**Cum%**	**Tot**	**Var%**	**Cum%**	**Tot**	**Var%**	**Cum%**
1	7.621	69.283	69.283	7.621	69.283	69.283	6.563	59.667	59.667
2	1.195	10.866	80.149	1.195	10.866	80.149	2.253	20.482	80.149
3	.574	5.221	85.370						
4	.329	2.989	88.359						
5	.273	2.486	90.845						
6	.226	2.050	92.896						
7	.194	1.768	94.663						
8	.186	1.691	96.355						
9	.155	1.410	97.764						
10	.128	1.166	98.930						
11	.118	1.070	100.00						

4.2.3.2 Factor analysis for attitude towards the use of ICT

Factor analysis for the four items measuring attitude towards the use of ICT resulted in a Kaiser-Meyer-Olkin (KMO) value of 0.595 which is above the threshold of 0.5 and is thus termed as mediocre (Field, 2005). The Bartlett's Test was found to be significant with a Chi-Square = 556.333 (p-value< 0.05). Therefore, as indicated in Table 4.11, with the KMO value of 0.595 and a significance of Bartlett's statistic confirmed the appropriateness of the factor analysis related to attitude towards use of ICT as an independent variable in this study. This implies that the KMO is measuring the variable that is linearly related to each other and is significantly related to the construct. It can thus be stated that Bartlett's Test of Sphericity indicated that the analysed data 'for attitude towards use' (which had a value of 66) met the measure of sampling adequacy and that it was adequate for principal component analysis. The results are summarized in Table 4.11.

Table 4.11: KMO and Bartlett's Test related to attitude

Kaiser-Meyer-Olkin measure of sampling adequacy		.595
Bartlett's Test of Sphericity	Approx. Chi-Square	556.333
	Df	6
	Sig.(p-value)	.000

As presented in Table 4.12, one component had an Eigen value exceeding 1.0, namely component 1 (2.459) and was retained according to the Kaiser criterion (Kaiser, 1974) and the Scree test (Cattel, 1966).

Table 4.12: Total variance explained related to attitude

Comp	Initial Eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.459	61.472	61.472	2.459	61.472	61.472
2	.680	16.990	78.462			
3	.468	11.703	90.166			
4	.393	9.834	100.000			

*Extraction Method: Principal Component Analysis

The researcher undertook a Scree plot test of the attitude items visually in order to illustrate the Eigen value related to the component number (Figure 4.2).

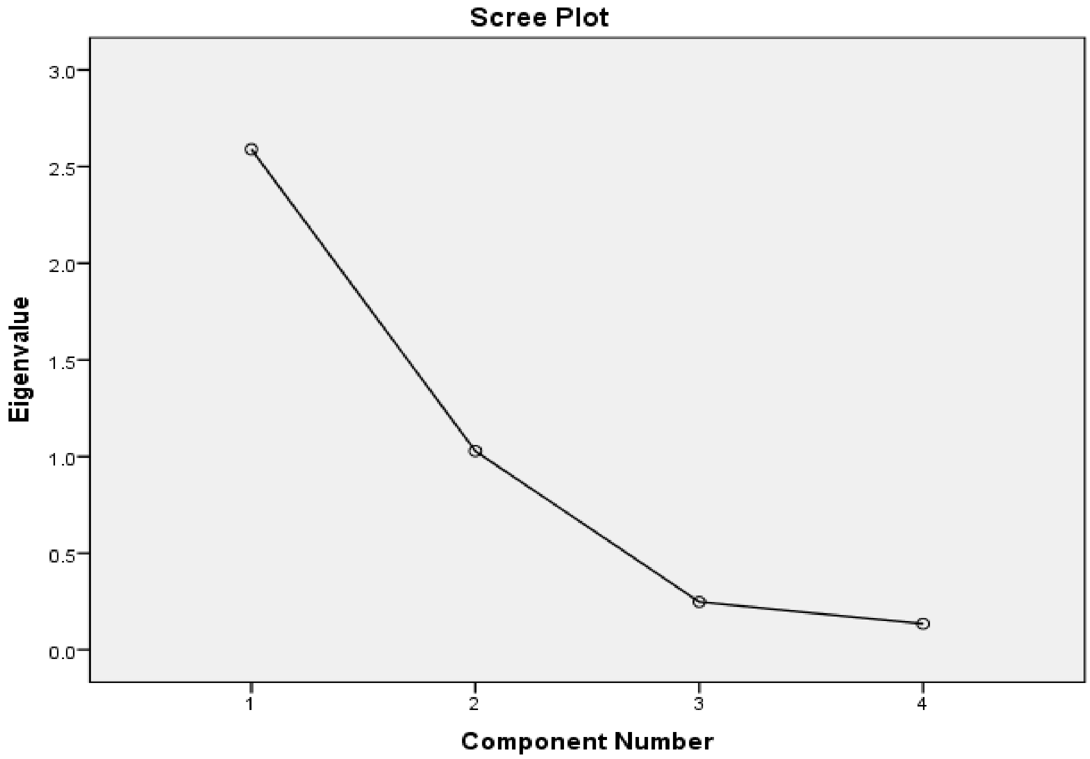

Figure 4.2: Scree plot for extracted components related to attitude towards the use of ICT

The Scree plot test recommended by Cattel (1966) is a graph of the downward variance accounted for by the factor originally extracted; the plot shows a break between the steep slope of the first factors and the gentle one of the later factors. The factors retained are the ones which lie before to the point at which the Eigen values seem to become flat. The results for the attitude towards use indicated a steady drop from the Eigen value to component one followed by insignificant changes of the remaining components (component two to component four). The results confirmed that the four components matrix accounts for one component (attitude towards ICT use) with an Eigen value of 2.459 and this component explain 61.472 % of the variance explained (see Table 4.12).

The statement from the variable on attitude towards use had four items coded as A1, A2, A3 and A4 loading onto two components each. A factor with two items loading onto it was unidentifiable and cannot be used for further analysis. Consequently, the researcher forced a single factor solution which resulted in all the four items loading onto one factor with reliability index of .803. This is consistent with the recommendation that factors should be constituted by at least three or more items. Moreover the study by Venkatesh *et al.* (2003),from which these questionnaire items were adapted, used all the 4 items to represent a one-dimensional variable called attitude as used in this study. No items were dropped.

Table 4.13: ***Rotated component matrix related to attitude***

Code	**Statement (Item)**	**Component**
		1
A1	I like the idea of using ICT	.824
A2	Using ICT is a wise idea.	.812
A3	Using ICT is a good idea	.763
A4	Using ICT is a pleasant experience	.734

*Extraction Method: Principal Component Analysis.
a. 1 components extracted.

4.2.3.3 Factor Analysis for Motivation towards the Use of ICT

The factor analysis results for the seven motivation related items to use ICT indicated that the Kaiser-Meyer-Olkin (KMO) was 0.811 (see Table 4.14), which is above the threshold of 0.5 (Field, 2005). The Bartlett's test was significant for motivation to use ICT with Chi-Square=478.213 (p-value<0.05) meaning that the variables are correlated and can, therefore, form a factor. Therefore, the KMO value of .811 and significance of Bartlett's statistic confirmed the appropriateness of the factor analysis for motivation to use ICT. The results are presented in The Kaiser-Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity was used to check for the adequacy of data for extraction of principal components. The KMO statistic of minimum values of 0.5, significant measure of Sphericity, minimum 0.5 for communalities after extraction and retention of factors with Eigen values greater than one was applied as suggested by Tabachnick and Fidell (2011) and Field (2005).Bartlett's test of Sphericity indicated data was appropriate for principal component analysis Table 4.14.

Table 4.14: ***KMO and Bartlett's Test related to motivation***

Kaiser-Meyer-Olkin measure of sampling adequacy		.811
Bartlett's Test of Sphericity	Approx. Chi-Square	478.213
	Df	21
	Sig.(p-value)	.000

As presented in Table 4.16 below, one component had an Eigen value exceeding 1.0, namely component 1 with a value of 3.320 which was thus retained according to the Kaiser criterion (Kaiser, 1974) and the Scree test (Cattel, 1966).

Table 4.15: ***Total Variance explained related to motivation***

Comp	Initial Eigen values			Extraction sums of squared loadings		
	Total	**Var%**	**Cum%**	**Tot**	**Var%**	**Cum%**
1	3.320	47.423%	47.423%	3.320	47.423%	47.423%
2	.935	13.360%	60.783%			
3	.807	11.534%	72.317%			
4	.664	9.479%	81.796%			
5	.495	7.072%	88.869%			
6	.429	6.126%	94.995%			
7	.350	5.005%	100.0%			

*Extraction Method: Principal Component Analysis

In order to confirm the figures in the table above, the researcher undertook a Scree plot test of the motivation items. The results indicated a steady drop from the Eigen value which to component one followed by insignificant changes of the remaining components (component two to component seven). The results confirmed that the seven components matrix accounts for one component (motivation) with an Eigen value of 47% (see Table 4.15) of the variance explained. The Scree plot for the factors described in Table 4.15 is depicted in Figure 4.3 for motivation section.

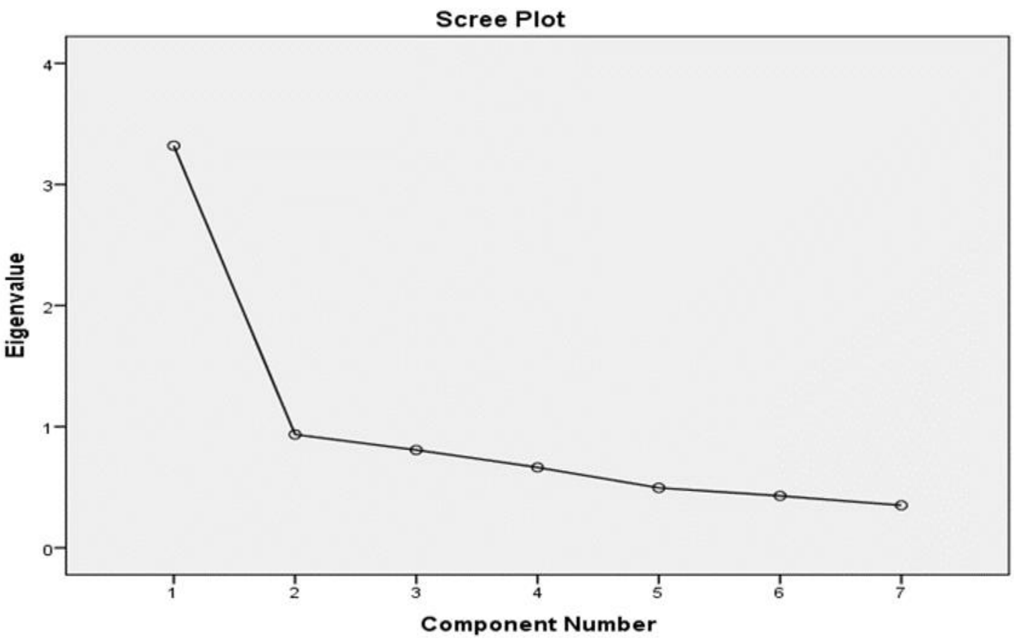

Figure 4.3: Scree plot for extracted component related to motivation to use ICT

The Scree plot test recommended by Cattel (1966) is a graph of the downward variance accounted for by the factor originally extracted; the plot shows a break between the steep slope of the first factors and the gentle one of the later factors. The factors retained are the ones which lie before to the point at which the Eigen values seem to become flat. The results for the motivation towards use indicated a steady drop from the Eigen value to component one followed by insignificant changes of the remaining components (component two to component three). The results confirmed that the 7 components matrix accounts for one component (motivation to use ICT) with an Eigen value of 3.320 and this component explains 47 % of the variance explained (see Table 4.15).

All the items for motivation to use ICT loaded onto one component since one factor was extracted. The rotated component matrix is given as Table 4.16. This implies that the items are substantially good to be used and it accounts for 47.423% of the variance.

Table 4.16: ***Rotated component Matrix related to motivation***

Code	**Item**	**Component**
		1
M1	I find using ICT to be enjoyable	.624
M2	The actual process of using ICT is a pleasant experience.	.629
M3	I have fun using ICT	.750
M4	ICT makes work more interesting	.676
M5	Working with ICT is fun	.718
M6	I feel comfortable when using ICT in teaching	.660
M7	Once I start working on ICT I find it hard to stop	.751

* Extraction Method: Principal Component Analysis

4.2.3.4 Factor analysis for behavioural intention towards the use of ICT

The eight items measuring behavioural intention to use of ICT were factor analyzed and the results indicated that the Kaiser-Meyer-Olkin (KMO) had a measure of 0.768, which is above the threshold of 0.5 (Field, 2005). The Bartlett's test is significant for structural bonds with Chi-Square=1325.209 (p-value< 0.05) as confirmed by Satorra and Bentler (2001), who indicates that p-values equal to 0.01, 0.05, or 0.10 indicate significant relationship. Therefore, the KMO value of .768 and significance of Bartlett's statistic confirm the appropriateness of the factor analysis behavioural intention and Bartlett's Test of Sphericity indicated that data met the measure of sampling adequacy and that it was adequate for principal component analysis. The measure of 0.768 is greater than acceptable minimum of 0.5 and loaded on one component. The results are presented in Table 4.17.

Table 4.17: ***KMO and Bartlett's Test Results related to behavioural intention to use of ICT***

Kaiser-Meyer-Olkin measure of sampling adequacy		.768
Bartlett's Test of Sphericity	Approx. Chi-Square	1325.209
	Df	28
	Sig.(p-value)	.000

As presented in Table 4.18 below, one component with Eigen values exceeding 1.0, namely component 1 with a total of 4.281, was retained according to the Kaiser criterion (Kaiser, 1974) and the Scree test (Cattel, 1966).

Table 4.18: ***Total variance explained related to behavioural intention to use of*** **ICT**

Comp	**Initial Eigen values**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
	Tot	**Var%**	**Cum%**	**Tot**	**Var%**	**Cum%**	**Tot**	**Var%**	**Cum%**
1	4.436	55.445	55.445	4.436	55.445	55.445	3.847	48.084	48.084
2	1.441	18.009	73.455	1.441	18.009	73.455	2.030	25.371	73.455
3	.818	10.227	83.681						
4	.522	6.530	90.211						
5	.301	3.760	93.971						
6	.225	2.812	96.783						
7	.142	1.773	98.555						
8	.116	1.445	100.000						

*Extraction Method: Principal Component Analysis.

The researcher undertook a Scree plot test of the behavioural items visually in order to illustrate the Eigen value related to the component number (Figure 4.4).The Scree plot test recommended by Cattel (1966) is a graph of the downward variance accounted for by the factor originally extracted; the plot shows a break between the steep slope of the first factors and the gentle one of the later factors. The factors retained are the ones which lie before to the point at which the Eigen values seem to become flat. The results for the behavioural intention towards use indicated a steady drop from the Eigen value to component 1 followed by insignificant changes of the remaining components (component 2 to component 8). The results confirmed that the eight components matrix accounts for one component related to behavioural intention with Eigen values of 73.5% of the total variance explained (see Table 4.18).

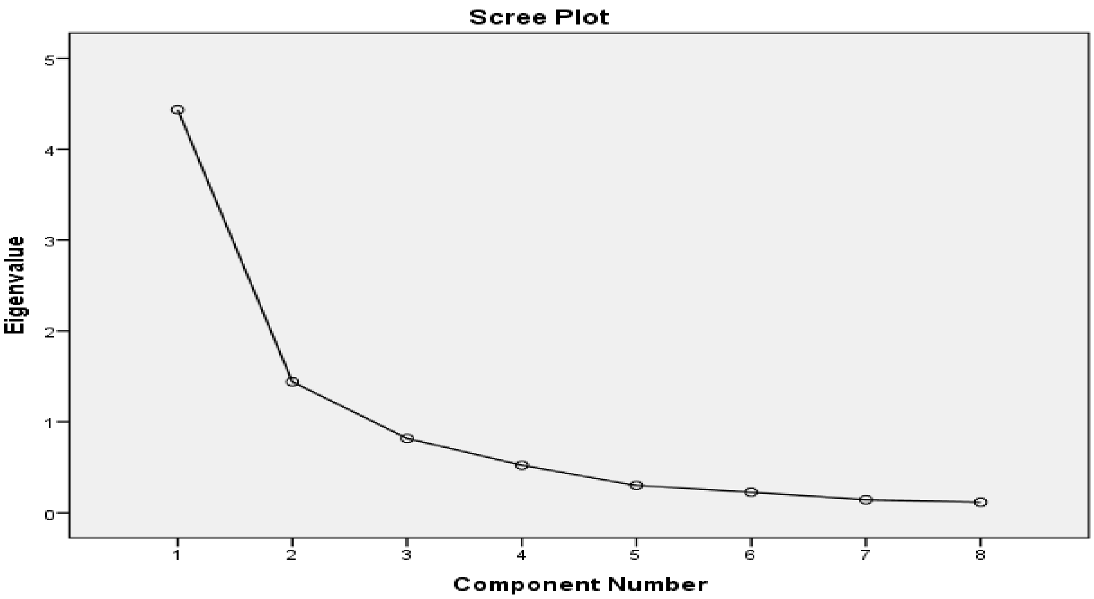

Figure 4.4: Scree plot for extracted component for behavioural intention to use of ICT

The results showed that the 8 items related to behavioural intention to use ICT loaded on two factors. The first factor that loaded with 1 item had Eigen value of 4.436 and 1,441. However, a factor with two items loading onto it is normally unidentifiable and cannot be used for further analysis.

Consequently, the researcher forced a single factor solution in which one item BI4 (I have positive perception towards ICT) dropped out as it had a low reliability of .444, and 7 items were retained which had an enhanced ‘new’ reliability of 0.891 from the initial reliability of .875 when seven items were being used. This is consistent with the recommendation that factors should be formed by at least three or more items. Moreover, the study by Venkatesh *et al.* (2003) from which these questionnaire items were adapted, used all the 8 items to represent a one-dimensional variable called behavioural intention as used in this study.

Table 4.1*9: Rotated Component Matrix related to the behavioural intention towards the use of ICT*

	Component
	1
BI1 I intend to use the system in the next two months	.704
BI2 I predict I would use the system	.823
BI3 I plan to use the system next term	.657
BI4 I have positive perception towards ICT [**was dropped]**	.444
BI5 I am ready to participate in computer training	.760
BI6 I have an understanding on how to integrate ICT	.791
BI7 Lack of adequate computers	.874
BI8 I have a plan for ICT use	.843

*Extraction Method: Principal Component Analysis with one component extracted

4.2.3.5 Factor analysis for facilitating conditions to use of ICT

With reference to facilitating conditions, the Kaiser-Meyer-Olkin (KMO) had a measure of 0.927 (see Table 4.20), which is above the threshold of 0.5 (Field, 2005). The Bartlett's test was significant for facilitating conditions with Chi-Square=2585.499 (p-value<0.05) meaning that the variables are correlated and can, therefore, form a factor. Therefore, the KMO value of 0.927 and significance of Bartlett's statistic confirmed the appropriateness of the factor analysis for facilitating conditions. The results are presented in The Kaiser-Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity was used to check for the adequacy of data for extraction of principal components. The KMO statistic of minimum values of 0.5, significant measure of Sphericity, minimum 0.5 for communalities after extraction and retention of factors with Eigen values greater than one was applied as suggested by Tabachnick and Fidell (2011) and Field (2005). Bartlett's test of Sphericity indicated data was appropriate for principal component analysis Table 4.21. The KMO statistic of minimum value of 0.50 is considered the lowest factor and a factor analysis value of .927 is good enough to be used. In this study the results are presented in Table 4.20.

Table 4.20: ***KMO and Bartlett's Test Results related to facilitating conditions***

Kaiser-Meyer-Olkin measure of sampling adequacy		.927
Bartlett's Test of Sphericity	Approx. Chi-Square	2585.499
	Df	55
	Sig. p-value)	.000

As presented in Table 4.21 below, two components with Eigen values exceeding 1.0, namely component 1 (7.621) and component 2 (1.195) were retained according to the Kaiser criterion (Kaiser, 1974) and the Scree test (Cattel, 1966).

Table 4.21: ***Total Variance Explained related to Facilitating Conditions***

Comp	**Initial Eigen values**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
	Tot	**Var%**	**Cum%**	**Tot**	**Var%**	**Cum%**	**Tot**	**Var%**	**Cum%**
1	7.621	69.283	69.283	7.621	69.283	69.283	6.563	59.667	59.667
2	1.195	10.866	80.149	1.195	10.866	80.149	2.253	20.482	80.149
3	.574	5.221	85.370						
4	.329	2.989	88.359						
5	.273	2.486	90.845						
6	.226	2.050	92.896						
7	.194	1.768	94.663						
8	.186	1.691	96.355						
9	.155	1.410	97.764						
10	.128	1.166	98.930						
11	.118	1.070	100.00						

In order to visually illustrate the figures in Table 4.21, the researcher undertook a Scree plot test of the motivation items. The results indicated a steady drop from the Eigen value which to component one followed by insignificant changes of the remaining components (component two to component eleven). The results confirmed that the eleven components matrix accounts for one component (facilitating condition) with an Eigen value of 69% (see Table 4.21) of the variance explained. The Scree plot for the factors described in Table 4.18 is depicted in Figure 4.5 for the facilitating conditions section.

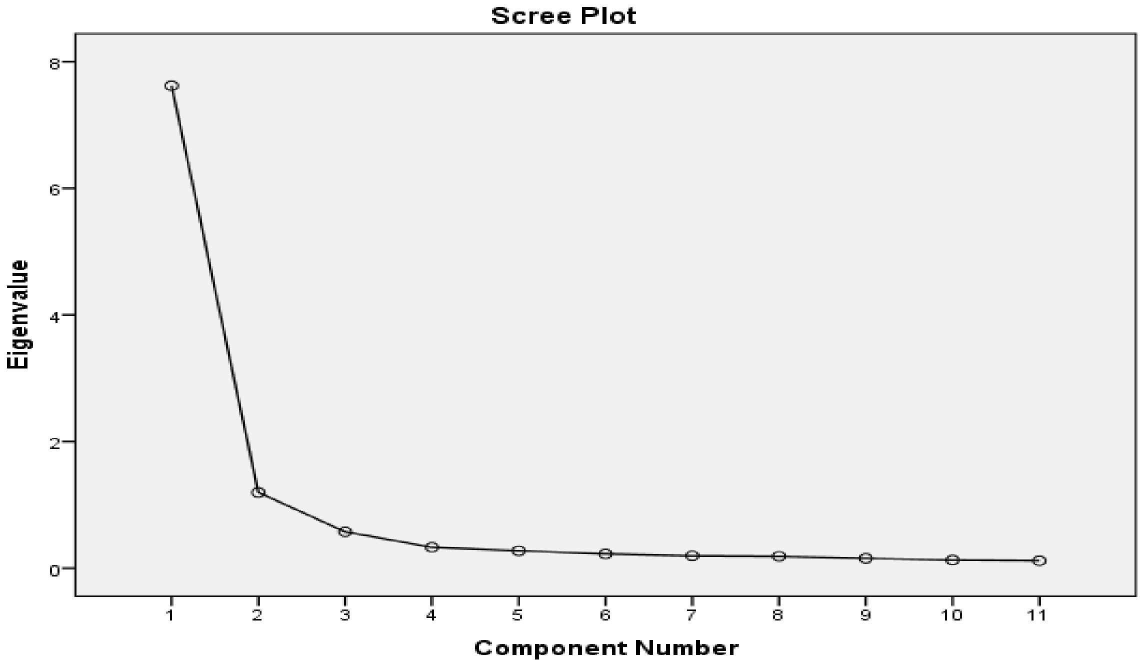

Figure 4.5: Scree plot for extracted component for facilitating condition

The results as shown in Table 4.22 represent a one-dimensional variable called facilitating condition as used in this study. Based on Kaiser Criterion (Kaiser, 1966) that proposes the retention of factors which have an Eigen value of greater than one, nine items FC1, FC2, FC3, FC4, FC5, FC6, FC7, FC8 and FC9 were loaded on component 1 which had an Eigen value of 7.621 with a variance of 69.283%, while the items that loaded into component 2 - which had an Eigen value of 1.195 with a variance of 10.866% - were FC10 and FC11.

The rotated Component Matrix related to Facilitating Conditions (Table 4.22) indicated that a factor with two items loading onto it is unidentifiable and cannot be used for further analysis. Consequently, the researcher forced a single factor solution which resulted in all the eleven items loading onto it. This is consistent with the recommendation that factors should be constituted by at least three or more items (Kaiser, 1974).

Table 4.22: Rotated Component Matrix related to Facilitating Conditions.

	Component 1
FC1 I have the resources necessary to use the ICT.	.892
FC2 I have the knowledge necessary to use ICT	.891
FC3 The ICT is not compatible with other ICT systems I use	.835
FC4 I have control over using the ICT	.890
FC5 I have resources, opportunities and knowledge it takes to use ICT	.875
FC6 Guidance was available to me in the selection of the ICT.	.883
FC7 Specialized instruction concerning ICT was available to me	.882
FC8 A specific person is available for assistance with ICT difficulties	.843
FC9 Using ICT is compatible with all aspects of my work.	.869
FC10 I think that using ICT fits well with the way I like to work.	.579
FC11 Using ICT fits into my work style.	.648

Extraction Method: Principal Component Analysis.
a. 1 component extracted.

4.2.4Test of Regression Assumptions

The data were tested to determine whether the assumptions of ordinary least square (OLS) are met. This is further elaborated in the subsequent sub-sections.

4.2.4.1 Test of Normality

Grand means per variable were computed by adding all the means of the various variables, namely, integration of ICT, attitude, motivation, facilitating conditions and behavioural intention, which were divided by the number of items. ICT integration had a grand mean 2.38, attitude a grand mean of 2.53, motivation a grand mean of 2.78, facilitating conditions a grand mean of 2.32 and behavioural intention a grand mean of 2.55 (Table 4.24) for data to be considered normal, it must fulfil the rule applied in inferential statics attain normality inferential (Field, 2005).

For data to be considered normal, it must have a base that looks like a bell or bell shape (Field, 2005). It thus assumes a symmetrical shape. When drawn, the scores will always concentrate at the middle very few score will always be at extreme positive and at extreme negative ends. Data can be described by using the level of skewness and kurtosis. While skewness is concerned with symmetry, kurtosis indicates the extent to which the data is peaked or flattened (Tabacknich & Fidell, 2007).

Based on the values of skewness and kurtosis the data can be described as reasonably normal. According to Hair, *et al.* (2010) the requisite range for normally distributed data is between -2.00 and +2.00. All the values of skewness and kurtosis the data 2.454 skewness fell in the range -2.00 and +2.00 and it appears that the data for the variables were normally distributed. The results are summarized in Table 4.23.

Table 4.23: Normality Test Results

Descriptive Statistics Statement (Item)	**Mean**	**SD**	**Skewness Statistic**	**SE**	**Kurtosis Statistic**	**SE**
Integration of ICT	2.3837	1.10	.844	.162	-.731	.322
Attitude	2.5311	1.01	.227	.159	-1.012	.318
Motivation	2.7823	.87	.073	.159	-.983	.318
Facilitating Conditions	2.3234	1.13	.877	.161	-.677	.321
Behavioural Intentions	2.5510	.93	.521	.159	-.958	.318

In order to ensure that the distribution of variables assumed was normal, the Kolmogrov-Smirnov Test was applied. The Kolmogrov-Smirnov test helps to compare scores from a sample normally distributed set of scores with the same standard deviation, mean and if the test is significant or not ($p>0.5$) (Woods, 2005).

The results of the K-S test as shown in Table 4.25 indicated that the Kolmogorov-Smirnov (K-S) test statistic for the variables was not significant (Sullivan, & Feinn, 2012). Hence a conclusion was arrived at affirming the normality of the variable to be used (Sullivan, & Feinn, 2012). This means that the data is safe for conducting statistical tests such as correlation and regression because it assumes the normality of the variables (Field, 2005). The variables for this study being integration of ICT, attitude, motivation, facilitating conditions and behavioural intention.

Table 4.24: One-Sample Kolmogorov-Smirnov Test Results

		Integration of ICT	**Attitude**	**Motivation**	**Facilitating Conditions**	**Behavioural Intentions**
n		233	233	233	233	233
Normal Parameters	Mean	2.3457	2.5311	2.7823	2.5977	2.5510
	SD	1.09933	1.00529	.87824	1.13377	.93887
Most Extreme Differences	Absolute	.221	.151	.122	.276	.194
	Positive	.221	.151	.122	.276	.194
	Negative	-.134	-.147	-.079	-.149	-.106
Kolmogorov-Smirnov Z		3.377	2.298	1.870	4.214	2.966
Asymp. Sig. (2-tailed)		.789	.562	.341	.451	.942

The figures on the table above show the mean and standard deviation, which implies that the mean average as seen above is between 2.3 and 2.8 the mean implies that the average of data statistics from computed from zero hence the data is normally distributed, while the standard deviation is between 0.87 and 1.09 this indicate the closeness and how far the data is spread. When a standard deviation is larger than the mean, the data is spread far apart from it and when the standard deviation is smaller than the mean, it indicates that the data set is close to it (Woods, 2005). Further, the absolute deviation, whether positive or negative, shows the amount of variation that occurs.

4.2.4.2 Test of independence of the error terms

The test of independence of the error terms was done using the Durbin-Watson test, which is a test that is used to detect the independence of error terms. The researcher used the test to confirm the presence of serial correlation within the residuals (Watson, 1971). The statement of the residuals or error in prediction of the independence of error does not follow a particular outline from one case to another. According to Hair, *et al.* (2010), the Durbin-Watson test statistic value ranges from 0 to 4 by the residuals and are not correlated if the Durbin-Watson statistic is approximately 2 and the acceptable range is 1.5-2.50. The Durbin-Watson statistic for the estimated model was 2.369 as shown in Table 4.28. It was, therefore, concluded that there was independence of the error terms. In particular it gives justification for the difference in the results of the model and actual observed outcome.

4.2.4.3 Multicollinearity Diagnostics

Collinearity means that two variable or more exploratory or independent variables in a regression have a linear relationship (MacNally, 2002). This causes the wrong translation of the regression results. As such, firstly an examination of the correlation matrix of the independent variables was done. The presence of high correlations in the region of r=0.9 and above is an indication substantial collinearity (McNally, 2002). Collinearity is a correlation linking predictor independent variables such that they articulate a linear relationship regression model due to the combination of two or more other independent variables, multi-collinearity arises when more than two predictors in regression are highly or moderately correlated (Field, 2005).When such scenario occurs it causes extreme problem on analysis, therefore, making the researcher draw a wrong conclusion (Field, 2005).

It is also important to note that collinearity is the efficiency of one variable to determine another variable and bring about a linear relationship. This could be attributed to the combination of two or more independent variables (MacNally, 2002).Multi-collinearity on the other hand influences the dependent variable (MacNally, 2002).The implication of multi-collinearity is that it will impact the variance by making it large hence leading to the acceptance or rejection of the null hypotheses (Rouder, Speckman, Sun, Morey, & Iverson, 2009). As a result, the ability of the researcher to determine an effect will be affected and as such, a second approach was utilized to address the above. This was done through multi-collinearity, *i.e.* the multi-co linearity was assessed using Variance Inflation Factors (VIF) (Field, 2005). A threshold of Variance Inflation Factor (VIF) of 10 or more appears not to be acceptable (Field, 2005). The variance inflation factor values for all the variables – integration of ICT, attitude towards use, motivation to use, behavioural intention and facilitating condition - of interest were in the range of 1.752 to 2.522 and are less than the set threshold of 10 which indicate that multi-collinearity was not an impediment. The results are presented in Table 4.25.

Table 4.25: ***Collinearity Statistic for variables - integration of ICT, attitude towards use, motivation to use, behavioural intention and facilitating condition***

Tolerance	VIF	
.547	1.828	Attitude
.571	1.752	Motivation
.450	2.224	Behavioural intention
.397	2.522	Facilitating conditions

The variance inflation factor (VIF) is the maximum number value or level allowed. Thus when one runs regression analysis and a VIF number between 1 and 9 is obtained, then the VIF model is within the acceptable limits, therefore it is free from multi-collinearity and is within acceptable limits (Field, 2005). The VIF above 10 means the data analyzed has indicators of presence of multi co-linearity. The tolerance value provides clear ideas of the problem (Field, 2005).

4.2.4.4 Correlation Analysis

A Pearson correlation analysis was conducted to examine the relationship between the variables (Wong & Hiew, 2005). According to Field (2005), the correlation coefficient should not go beyond 0.9 to avoid multi-collinearity. Since the highest correlation coefficient is .806 which is less than 0.9, it was found that there was no multi-collinearity problem in this research study with reference to the data gathering instruments. The results are presented in Table 4.26.

All the associated pairs of variables were significant at level 0.01, hence hypothesized relationships developed were found to be statistically significant at level $p < 0.01$. Attitude towards the use of ICT and integration of ICT had a positive significant relationship ($r=.541$, $p<.01$). Integration of ICT in teaching science correlated with motivation significantly and positively ($r=.495$, $p<.01$). There was a positive significant relationship between facilitating conditions and integration of ICT in the teaching of science ($r=.986$, $p<.01$) While integration of ICT in the teaching of science correlated with behavioural intentions significantly and positively ($r=.647$, $p<.01$). This means that none of the variables (ICT integration, attitude towards use, motivation, behavioural intention and facilitating condition) was excluded from the subsequent regression analysis. Furthermore, all the variables were positively related and significant at $p<.01$ with the lowest correlation of .424 between attitude and motivation and the strongest correlation of .986 facilitating condition and ICT integration in the teaching of science. The results are summarized in Table 4.26.

Table 4.26: ***Correlation Coefficients***

Correlation Coefficients	1	2	3	4	5
1. Integration of ICT	1				
2. Attitude	.541**	1			
3. Motivation	.495**	.424**	1		
4. Facilitating Conditions	.986**	.627**	.740**	1	
5. Behavioural Intentions	.647**	.608**	.636**	.680**	1

** Correlation is significant at the 0.01 level (2-tailed)

4.3 Regression Results and Test of Hypotheses

The study sought to investigate the relationship between teacher readiness for integration and integration of ICT in the teaching of sciences in public secondary schools in West Pokot County. The analysis involved investigating the effects of the independent variables (attitude towards the use of ICT, motivation, facilitating conditions and behavioural intentions) on integration of ICT in the teaching of sciences. To get the grand means of each variable –Attitude towards use Grand mean (AG), Intrinsic Motivation Grand mean (IMG), Facilitating Condition Grand mean (FCG), Behavioural Intention Grand mean (BIG) and ICT integration Grand mean (ICTG) -the researcher divided the mean of each variable with the number of items per variable as indicated in Table 4.27 that follows.

Table 4.27*: Regression Results - Model Summary*

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.974[a]	.948	.947	.25631	2.369

a. Predictors: (Constant), BIG, AG, IMG, FCG
b. Dependent Variable: ICTG

ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig. (p-value)
1	Regression	265.799	4	66.450	1011.515	.000[b]
	Residual	14.650	223	.066		
	Total	280.448	227			

a. Dependent Variable: ICTG
b. Predictors: (Constant), BIG, AG, IMG, FCG

Coefficients

Model	Unstd Coeff		Std Coeff	t-test	Sig.	Collinearity Stat	
	B	SE	Beta (β)			Tol.	VIF
(Constant)	-.552	.063		-8.800	.000		
Attitude	-.161	.023	-.146	-6.797	.000	.547	1.828
Motivation	.044	.026	-.035	-1.723	.086	.571	1.752
Facilitating Conditions	1.386	.031	1.054	45.435	.000	.450	2.224
Behavioural Intentions	.044	.029	.038	1.554	.122	.397	2.522

a. Dependent Variable: ICTG

The first hypothesis (H_{01}) stated that **attitude** towards use of ICT has no statistically significant effect on the integration of ICT in the teaching of sciences in public secondary schools in West Pokot County. To ascertain the above finding the researcher generated beta values, which are used to measure the strength of each predictor variable and how it influences the criterion (dependent) variable (Field, 2005). A beta value is measured in units of standard deviation. A higher the beta value denotes a bigger impact of the predictor variable on the criterion variable (Wong & Hiew, 2005). To interpret the direction of the relationship between variables in multiple regressions, one has to look at the plus or minus signs of the β coefficients. In cases where a β coefficient is positive (+) the relationship of the variable with the dependent variable is positive, that is, the greater the IQ the better the grade point average. The relationship is negative (-) if the β coefficient is negative, that is, the lower the class size the better the average test scores (Field, 2005). Consequently, there is no relationship between the variables if the β coefficient is equal to 0 Field, 2005). The results of the regression analysis indicated that attitude towards use of ICT had a statistically positive significant effect on integration of ICT in the teaching of sciences in public secondary schools in West Pokot County (β = -.146; p<.05) (Table 4.27). Hence the null hypothesis is not supported. The findings suggest that as the attitude towards use of ICT increases, so does the integration of ICT in the teaching of sciences in public secondary schools in West Pokot County (see Table 4.27).

For the second hypothesis (H_{02}) it was stated that **motivation** to use ICT has no statistically significant effect on integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya. The regression results indicated that motivation to use ICT had a weak negative effect (β = -.035, p=.086) which was not statistically significant on integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya (p>.05) (Table 4.28). Hence the hypothesis was accepted. The findings suggest that as motivation to use of ICT increases, the level of the level of integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya decreases.

The third hypothesis, (H_{03}), stated **facilitating conditions** has no significant effect on the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya. Regression results captured in Table 4.26 indicated that facilitating conditions had a positive statistically significant effect (β = 1.054, p = .000) on integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya ($p<.05$) (Table 4.27). Therefore, the third null hypothesis was rejected ($p<0.05$). This meant that facilitating conditions do play significant role in the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya.

The fourth and last direct effect hypothesis (H_{04}) stated that **behavioural intention** to use ICT has no statistically significant effect on integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya. The regression results indicated that behavioural intention to use ICT had a weak positive effect (β = 0.038, p= 0.122) which was not significant on integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya ($p>.05$) (Table 4.28). The fourth null hypothesis for the study was accepted ($p>0.05$). This implies that behavioural intention to use ICT does not enhance integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya.

The multiple regression results for testing the four direct ($H_{01,}$ $H_{02,}$ H_{03} and H_{04}) hypotheses are presented in Table 4.27. The coefficient of determination value of R^2=.948 means that 94% (Table 4.27) of the variation in integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya, can be explained by attitude towards use of ICT, motivation to the use of ICT, facilitating conditions and behavioural intention.

From the regression results in Table 4.27, the researcher constructed the following econometric model to capture the relationship between the independent variables of attitude towards use of ICT, motivation to the use of ICT, facilitating conditions and behavioural intention to use ICT and the dependent variable, integration of ICT in the teaching of science was constructed:

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon$

Where:

β_0 is a constant

β_1, β_2, β_3, and $\beta_4$are regression coefficients estimated

Y = Integration of ICT in the teaching of Science

X1 = Attitude towards the use of ICT

X2 = Motivation towards the use of ICT

X3 = Facilitating Conditions towards the use of ICT

X4 = Behavioural intention towards the use of ICT

ε = error term

The regression model can be written as:

$$y = -0.552 - 0.146x_1 - 0.035x_2 + 1.054x_3 + 0.038x_4$$

In summary: The data analysis thus suggests that attitude and facilitating conditions towards ICT had a significant effect on the integration of ICT in teaching science. However, motivation and behavioural intention towards the use of ICT did not have significant effect on the integration of ICT in teaching science in public secondary schools in West Pokot County, Kenya, as presented in Table 4.28. Two hypotheses were rejected while the other two were accepted.

Table 4.28: Summary of the Hypotheses Tests Results

Ho_1:	Attitude towards the use of ICT has no significant effect on the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya.	Rejected H_0
Ho_2:	Motivation to use ICT has no significant effect on the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya.	Accepted H_0
Ho_3:	Facilitating conditions has no significant effect on the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya.	Rejected H_0
Ho_4:	Behavioural intention towards the use of ICT has no significant effect on the integration of ICT in the teaching of science in secondary schools in West Pokot County, Kenya	Accepted H_0

4.4 Discussion of Findings

In this section, Chapter 4's findings are briefly presented as one whole by providing a brief overview of the findings employing a discussion about the integration of ICT (implementation, adoption and use). The discussion will follow the following format: The variables will be discussed by firstly referring to ICT integration (implementation, adoption and use), secondly attitude, thirdly motivation, fourthly behavioural intention and fifthly facilitating conditions. For each of the variables referred to above, the following format will be followed, namely: An overall summary of the descriptive statistics per variable, an overall summary of the mean average and mean of each of the variables, an overall presentation of the regression results and whether the hypothesis related to each variable is rejected (not supported, nullified, disproved) or not rejected (supported, true). Lastly, the results are interpreted by linking the results of each variable to the literature and/or theory.

The descriptive percentage statistics (Table 4.3) showed that the **ICT integration** (12 items) associated with (implementation, adoption and use) as variables or constructs had a Cronbach alpha coefficient of 0.969 (Table 3.1) which thus indicated that there is very good internal consistency within the group of items. The grand mean was 2.53 (Table 4.24). As is suggested by UTAUT (Venkatesh, *et al.*, 2003), the study identified that all the four independent variables (attitude, motivation, behavioural intention and facilitating condition) had a direct effect on the dependent variable. That is, an increase in the independent variable, for example, attitude towards use, had a greater increase in the dependent variable, ICT integration. Hence, it can be stated that all the independent variables had a significant influence on teachers' intention to integrate ICT (Venkatesh *et al.*, 2003) in teaching science in public secondary schools in West Pokot County, Kenya.

Secondly, the descriptive percentage statistics (Table 4.4) showed that under **attitude construct** (4 items) towards the use of ICT had a Cronbach alpha coefficient of .803 (Table 3.1) which thus indicated that there is very good internal consistency. The grand mean was 2.55 (Table 4.23). The variable attitude was the second most significant variable with a p-value of (p= .000) on the integration of ICT in science for Kenyan Science teachers in West-Pokot County. The findings suggest that attitude appears to be an important aspect to promote ICT integration in teaching among science teachers in public secondary schools in West Pokot County, Kenya (Table 4.28), thus, the hypothesis was rejected. As is suggested by UTAUT (Venkatesh, *et al.*, 2003), the study identifies attitude towards the use of ICT as having positive significance on the integration of ICT in the teaching of science in secondary schools in West Pokot County, Kenya. The above supports Copriandy's (2014) position (2014) that teacher readiness to adopt or explore ICTs is linked to teacher attitudes. Al-Awidi and Aldhafeeri (2017; see also Rogers, 1995, 2003) posit that readiness has to do with teachers' perceptions, knowledge, awareness, attitude and their competencies and skills related to ICT for technology integration and hence, this study suggests that enhanced teachers' attitude related to ICT integration will enhance ICT adoption related to the teaching of sciences in West Pokot County, Kenya.

Thirdly, the descriptive percentage statistics (Table 4.5) showed that under **motivation** towards the use of ICT (7 items) the intrinsic motivation construct had a Cronbach alpha coefficient of 0.812 (Table 3.1) which thus indicated that there is very good internal consistency within the group of items. The grand mean was 2.78 (Table 4.23). Motivation had no statistically significant ($p>0.05$) effect on ICT integration in science with a p-value of ($p=.086$) in public secondary schools in West Pokot County, Kenya (Table 4.28), thus, the hypothesis was accepted. Contrary to the suggestion by UTAUT (Venkatesh, *et al.*, 2003; Kyllönen 2018), the study identifies motivation towards the use of ICT had no statistically significant effect on the integration of ICT in the teaching of science in secondary schools in West Pokot County, Kenya. This is different from Copriandy (2014) who argued that that teacher readiness to adopt or explore ICTs is linked to teacher motivation but the teachers in West Pokot are not motivated. Siele (2006, as cited by Makanda, 2015) posits that availability, accessibility and effective use of teaching and learning resources (ICT technology included) improve the quality of education being offered. This calls for enhanced teachers' motivation on ICT integration in order to enhance ICT adoption in teaching of sciences in West Pokot County, Kenya.

Fourthly, the descriptive percentage statistics (Table 4.6) showed that the **behavioural intention** to use of ICT in teaching (8 items), the associated constructs construct had a Cronbach alpha coefficient of 0.875 (Table 3.1) which thus indicated that there is very good internal consistency within the group of items. The grand mean was 2.55 (Table 4.23). Behavioural intentions had no statistically significant contributions towards integration (p>0.05) with a significant value of (p=.122) with the integration of ICT in teaching of science in secondary schools in West Pokot County (Table 4.28), thus, the fourth null hypothesis was accepted. In the same way, as is suggested by UTAUT (Venkatesh, *et al.*, 2003), the study identifies behavioural intention as having positive significance on the integration of ICT in the teaching of science in secondary schools in West Pokot County, Kenya.

Lastly, the descriptive percentage statistics (Table 4.7) showed that the majority of participants felt that the **facilitating conditions** to use ICT (11 items) in teaching had had a Cronbach alpha coefficient of 0.954 (Table 3.1) and a grand mean of 2.32 (Table 4.24), which indicated that there is a very good internal consistency within the group of items. The most significant hypothesis is the one with a higher reliability (Malhotra, 1999). Hence, the significant variable for this particular study was facilitating condition which had a p-value of p=.000 and hence this variable (facilitating condition) is considered significant for Kenyan Science teachers in West-Pokot County. Facilitating conditions had thus statistically significant effects on the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya (Table 4.27); hence, the third null hypothesis was rejected. This suggests that the study identifies facilitating condition as having a weak positive effect which was statistically significant on the integration of ICT in the teaching of science in secondary schools in West Pokot County, Kenya. The above findings are different from UTAUT (Venkatesh, *et al.*, 2003) and Sonia (2012) who documented that teachers who are computer literate would realise in time that ICT as tool offers a number of benefits which their peers are not able to understand if these peers possess little or no computer knowledge and skill (Rogers, 1995; 2003). Additionally, as suggested by Venkatesh & Viswanath (2000) that teacher readiness to adopt or explore ICTs is linked to facilitating condition, the findings from this specific study suggest that organizational and technical infrastructure support could enhance ICT integration in the teaching of sciences in West Pokot County, Kenya and as such, this should be catered for by the Kenyan government.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The purpose of this quantitative study, underpinned by the positivistic paradigm, was to determine the readiness of ICT integration for teaching and learning of science for secondary science teachers residing in public secondary schools In West Pokot County. A total of 250 participants participated in this study by means of a questionnaire and 233 returned the questionnaire (survey). In order to orientate the reader, the researcher provides the objectives of the study again below:

1. To determine the relationship between the attitude towards the use of ICT and the integration of ICT in the teaching of sciences in public secondary schools in West Pokot County, Kenya.
2. To determine the relationship between motivation to use ICT and the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya.
3. To determine the relationship between facilitating conditions and the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya.
4. To determine the relationship between behavioural intention to use of ICT and the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya.

This chapter presents a summary of the findings based on the research objectives, indicates the possible contribution to knowledge and theory (including the possible significance of the study), implications and recommendations for further research. Finally, conclusions are drawn. The summary of the findings is presented first.

5.2 Summary of Findings

The descriptive percentage statistics showed that the majority of participants felt that at this point in time, **ICT integration (usage, implementation, adoption)** was not perceived as positive (Table 4.4). The means ranged from 2 to 2.7 for each of the statements related to ICT implementation and (or) integration for the teaching and learning of science. The percentages of these statements also ranged from strongly disagree to disagree.

The descriptive percentage statistics (Table 4.5) showed that the majority of participants indicated at this point in time that their **attitude** towards ICT integration was not perceived as positive. The means ranged from 1.7 to 3.0 for each of the statements related to teacher's attitude and ICT integration in teaching and learning of science. The percentages of the statements also ranged from strongly disagree to disagree. The first hypothesis (H01) stated that attitude towards Use of ICT has no statistically significant effect on the integration of ICT in the teaching of sciences. The results of the regression analysis indicated that attitude towards use of ICT had a statistically positive significant effect on integration of ICT in the teaching of sciences in public secondary schools in West Pokot County ($p = .000$ $p < .05$). Hence the null hypothesis was rejected. The data thus revealed that the majority of the participants had a negative attitude and did not realize that ICT implementation holds promise. This is probably due to the fact that majority of the participants did not possess the required ICT knowledge and training. Additionally, findings from a number of studies (Kiboss, 2002; Kinuthia, 2009; Gakuu & Kidombo, 2015) have indicated that effective integration of ICT in secondary school curriculum was hampered, as integration is very much dependent upon the ICT literacy skills of the teachers.

With reference to intrinsic **motivation** to Use ICT for the teaching of science, the percentages of the statements ranged from strongly disagree to disagree. The descriptive percentage statistics (Table 4.6) showed that the majority of participants felt that Motivation to Use ICT for the teaching of science was not perceived as positive with means ranging from 2.48 to 3.02 for each of the statements related to Motivation to Use ICT for the teaching of science. The second hypothesis (H_{02}) stated that **motivation** to use ICT has no statistically significant effect on integration of ICT in the teaching of science in public secondary schools, ($p=.086$) which was not statistically significant on integration of ICT in the teaching ($p>.05$). Hence the hypothesis was accepted. The findings suggest that as motivation to use of ICT increases, the level of the level of integration of ICT in the teaching of science in public secondary schools in West Pokot County. This means that the participants did not have a positive inclination towards the statement related to compatibility knowledge, skill and availability of resources. Celebi (2019) suggests that when the knowledge on the use of ICT technology is high, then the chances of integrating ICT into teaching is high. This indicates that teachers' knowledge plays an important role in the integration of ICT in education.

With reference to the intrinsic **behavioural intention** to use ICT in teaching of science, the percentages of the statements ranged from strongly disagree to disagree. The descriptive percentage statistics (Table 4.7) showed that the majority of participants felt that motivation to use ICT for the teaching of science was not perceived as positive with means ranging from 2.1 to 3.0 for each of the statements related to behavioural intention in the teaching of science. Teachers are the key persons that can promote ICT implementation or integration in a successful manner

(Ertmer, 1999; Fullan & Smith, 1999; Mouza, 2005; Prensky, 2008). The hypothesis (H_{04}) stated that **behavioural intention** to use ICT has no statistically significant effect on integration of ICT in the teaching of science in public secondary schools Kenya. The regression results indicated that behavioural intention to use ICT had a weak positive effect (p=0.122) which was not significant on integration of ICT in the teaching of science in public secondary schools in West Pokot County. The null hypothesis for the study was accepted ($p>0.05$). This implies that behavioural intention to use ICT does not enhance integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya. Hence, without access and knowledge, it is unlikely to have a behavioural intention to use ICT without adequate computers. At the same time, it is argued that teacher development related to ICT design skills as fourth-order barriers should also receive attention.

The above is necessary in order that schools from marginalized areas can benefit from the rich resources that are available online on the internet and which could then enable teachers and learners to benefit when teachers will integrate ICT in teaching and learning. This could thus also lead to learners having access to resources and enjoying world-class libraries and the latest information with regards to innovation and ICT use in schools. The lack of teachers with ICT competency skills is another challenge facing the education system, as without ICT proficient and knowledgeable teachers, the success rate of integration and use of information technology in schools is minimal (Mndzebele, 2013).

Facilitating conditions appear to be very important to promote ICT integration usage, implementation and adoption). With reference to **facilitating conditions** for the teaching of science, the percentages of the statements ranged from strongly disagree to disagree. The descriptive percentage statistics (Table 4.7) showed that the majority of participants felt that facilitating conditions for the teaching of science was not perceived as positive with means ranging from 1.7 to 2.5 for each of the statements related to facilitating conditions for the teaching of science. Hence, the findings showed that the majority of the participants did not have access to ICT resources and the necessary ICT knowledge. The hypothesis, (H_{03}), stated that **facilitating conditions** has no significant effect on the integration of ICT in the teaching of science in public secondary schools indicated, facilitating conditions had a positive statistically significant effect ($p = .000$) on integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya ($p < .05$). Therefore, the null hypothesis was rejected. The findings meant that facilitating conditions do play significant role in the integration of ICT in the teaching of science in public secondary schools.

Although the Kenyan government has ensured that the majority of schools in West Pokot County have electrified power connection through the rural electrification program as a result of the jubilee government campaign manifesto promise of one laptop per child programmes to all children joining class one (Chris, 2015), the results showed that internet connectivity is a problem, as many schools do not have internet access (Table 4.2). This thus calls for urgent measures from service providers like Telkom Kenya, Safaricom and Airtel to prioritize internet connection to all schools in rural areas in order that internet services can penetrate rural areas, as well as for governmental support related to this. As such, these companies should thus be supported by the Kenyan government, which will then assist with the eradication of the third-order barrier, *i.e.* support from outside the immediate school context. The fact that the facilitating conditions statements' means were low can thus be attributed to the lack of support and access to ICT as mentioned by Du Plessis and Webb (2012a, 2012b) and Subramanien (2014). These authors highlighted the importance of facilitating conditions related to ICT adoption. The current facilitating conditions are thus not favourable for ICT implementation (integration and adoption), thus affirming Ertmer's (1999), Du Plessis & Webb's (2012a) and Subramanien's (2014) position that first-order challenges external to the self are indeed barriers that prevent integration, implementation and adoption. Rogers (1995, 2003) has stated that training in the form of personal observability of how to use an innovation, the required knowledge and compatibility or fit, as well relative advantage are key aspects that influence adoption. From the results related to the facilitating conditions, it is thus evident that what Rogers (1995, 2003) has alluded to has not been addressed. It is thus clear that if the necessary facilitated conditions are not being met, the chance of ICT integration, implementation and adoption is very slim.

In conclusion, the findings showed that the two hypotheses (attitude and behavioural intentions towards the use of ICT) were rejected ($p<0.05$) whereas the other two (motivation to use ICT and facilitating conditions) were accepted ($p>0.05$).

5.3 Conclusion

The findings showed that attitude, motivation, facilitating conditions and behavioural intention towards the use of ICT have a significant effect on the integration of ICT in the teaching of science in public secondary schools in West Pokot County, Kenya.

It is also important to note that while the integration of ICT in teaching of science correlated with motivation significantly and positively, the model for this study may be able to account for 94.8% of the change in individuals' intentions to use a particular technology (Table 4.28). This is significantly higher as compared to the former theories and models that were applied in UTAUT. There was a positive significant relationship between facilitating conditions and the integration of ICT. This shows that teachers require adequate training in order to gain confidence and integrate ICT in teaching and learning this implies that Kenyan government should commit more resources in training of teachers and by doing so science teachers in secondary school will be able to integrate ICT in teaching and learning successfully hence improving curriculum content delivery.

As Du Plessis and Webb (2012, citing Hung & Koh, 2004) suggest, ICT integration ought to be undertaken through an all-inclusive approach which would take into consideration a socio-cultural view of the teachers and learners and all stakeholders involved. In essence for the motivation to integrate ICT among science educators' in public secondary schools Kenya, there should be consulted efforts by the government through Kenya Institute of Curriculum Development (KICD) to design ICT curriculum aimed at equipping teachers on knowledge skills and attitude through capacity building, seminars and workshops on the new technology and ICT integration in teaching and learning of science. Therefore, this particular study's finding could help inform the policymakers on areas relating to the technology acceptance model UTAUT by Venkatesh and Davis (2000) hence contributing to skills and knowledge on attitude, motivation to use and facilitating conditions with reference to technology adoption.

5.4 Recommendations

From the findings the study wishes to make the following recommendations in the subsequent paragraphs. The government, through the Ministry of Education, should consider allocating more funds to be used for the training teachers, for financing regular workshops and seminars and assistance to teachers should thus be provided by means of workshops and seminars. Teachers should also be provided with opportunities to share their ICT utilization with fellow teachers. The above is important as, it could enable teachers to use ICT for lesson planning, lesson development and searching for information from the internet.

It is argued that such training could improve teachers' attitudes towards the utilization of ICT for teaching and learning. Since ICT integration is very important in the classroom, the Kenya Institute of Curriculum Development (KICD) should make efforts to come up with ICT curriculum tailored plans in order to assist pre-service teacher and in-service teachers to enable them to obtain skills on *'how to'* use ICT for the facilitation of teaching and learning. This could then result in addressing and reducing second-order barriers (Ertmer, 1999) and fourth-order barriers (Tsai & Chai 2012; Subramanien, 2014).

The Kenyan government should prioritize the infrastructure improvement, by building modern computer labs, installation of fibre optics with high-speed internet and the supply of enough computers to schools to cater for a large number of students. These computers; which include desktops, laptops, interactive whiteboards, data projectors and all accessories; are the tools that will enable teachers to integrate ICT in teaching and learning of science in public secondary schools. Addressing the above could result in addressing and reducing first-order barriers (Ertmer, 1990; Du Plessis & Webb, 2012a, 2012b; Subramanien, 2014).

The government and well-wishers ought to allocate more resource to schools for the purchase of ICT instructional material and for in-service training of teachers to assist them to improve their knowledge, skills and attitude towards ICT implementation. The above could provide or establish them with confidence in the use of ICT, particularly towards lesson preparation and actual use in the classrooms.

Equally important, the government should connect all schools with high-speed internet by laying fibre optics to all government schools, fully paid free of charge. In order to achieve the above, government has to go into partnership with internet companies (providers). The school curriculum should also be tailored in such a way that teachers can use technology (ICT) in every aspect of lesson preparation presentation.

Learners should also be provided with access to ICT at school in order that they have opportunities to use technology when doing their assignments. The necessary time allocations and timetabling should thus be planned for. Teachers should also have access at home and at school to ICT resources (laptops and internet connectivity) in order that can have enough time to plan for the utilization of various teaching strategies in ICT integration.

Lastly, it is important to take note of the stages and heuristic of Du Plessis and Webb (2012a, 2012b) and Subramanien (2014), as their work resonates with providing the necessary facilitating conditions and supporting suggestions, as well as addressing attitude and motivating teachers. As their suggestions were based on their South African experience with marginalized schools and South Africa being part of the African continent, their localised ideas could thus be useful to implement.

5.5 Suggestions for Further Research

The present study only focused on teacher readiness to use ICT and ICT integration in teaching and learning of science in public secondary schools. As such, further research can be done in the following areas:

1. The research was done in West Pokot County and as such, the findings cannot be generalized to the whole country. Similar studies can thus be done indifferent counties such as Turkana, Samburu, Baringo, Garissa or the whole country in order to assess teacher readiness and ICT integration in other subject areas.
2. A study on learners' motivation and interest with reference to ICT could also be conducted in order to ascertain how positive learners are with reference to ICT implementation. A follow-up study could be conducted in schools where learners had been using ICT for teaching and learning to ascertain how ICTs are used and what their experiences are of ICT usage.
3. Since the study focused on the teachers' readiness and ICT integration for teaching and learning of science, research studies related to the readiness in different subjects in the curriculum like English, Kiswahili, Mathematics or readiness of teachers in general in all schools can be done in order to inform government of the current situational context pertaining to resources, readiness, motivation, attitude and behavioural intention.

REFERENCES

Abdi, H., & Williams, L. J. (2010). Principal component analysis. *Wiley interdisciplinary reviews: computational statistics*, *2*(4), 433-459.

Aduwa-Ogiegbaen, S. E., & Iyamu, E. O. S. (2005). Using information and communication technology in secondary schools in Nigeria: Problems and prospects. *Journal of educational technology & Society*, *8*(1), 104-112.

Afshari, M., Bakar, K. A., Luan, W. S., Samah, B. A., & Fooi, F. S. (2009). Factors affecting teachers' use of information and communication technology. *Online Submission*, *2*(1), 77-104.

Afshari, M., Ghavifekr, S., Siraj, S., & Jing, D. (2013). Students' attitudes towards computer-assisted language learning. *Procedia-Social and Behavioral Sciences*, *103*, 852-859.

Ajzen, I. (1991). The Theory of Planned Behaviour, *Organizational Behaviour and Human Decision Processes*, *50*(2), 179-211.

Al-Awidi, H., & Aldhafeeri, F. (2017). Teachers' readiness to implement digital curriculum in Kuwaiti schools. *Journal of Information Technology Education: Research*, *16*, 105-126.

Alazzam, A-O., Bakar, R., Hamzah, R. & Asimiran, S. (2012). Effects of Demographic Characteristics, Educational Backgroundand Supporting Factors on ICT Readiness of Technical and Vocational Teachers in Malaysia. *International Education Studies*, *5*(6), 229-43.

Albirini, A. (2006a). Cultural perceptions: The missing element in the implementation of ICT in developing countries. *International Journal of Education and development using ICT*, *2*(1), 49-65.

Albirini, A. (2006b). Teachers' attitudes toward information and communication technologies: The case of Syrian EFL teachers. *Computers & Education*, *47*(4), 373-398.

Albugami, S., & Ahmed, V. (2015). Success factors for ICT implementation in Saudi secondary schools: From the perspective of ICT directors, head teachers, teachers and students. *International Journal of Education and Development using ICT*, *11*(1).

Asiri, M.J., Mahmud, R., Bakar, K.A. & Ayub, A.F.M. (2012a). Factors influencing the use of learning management system in Saudi Arabian Higher Education: A theoretical framework. *Higher Education Studies*, *2*(2), 125-137.

Asiri, M.J., Mahmud, R., Bakar, K.A. & Ayub, A.F.M. (2012b). Role of Attitude in Utilization of Jusur LMS in Saudi Arabian Universities. *Procedia - Social and Behavioral Sciences*, 64(9), 525-534.

Atyang, F., Gathumbi, A., & Babusa, H. (2018). School Management and Technical Support to Teachers and Students in the Integration of ICT in Teaching/Learning English Language. Advances *in Social Sciences Research Journal*, 5*(7)* 249-258.

Badri, M. A., Mohaidat, J., Ferrandino, V., & El Mourad, T. (2013). The social cognitive model of job satisfaction among teachers: Testing and validation. *International Journal of Educational Research*, *57*, 12-24.

Badri, M., Al Rashedi, A., & Mohaidat, J. (2013). School teachers' technology readiness–An empirical study applying readiness factors and teacher type categorization. In *Proceedings of the 2013 International Conference on Information, Business and Education Technology (ICIBET 2013)*. Atlantis Press.

Badri, M., Al Rashedi, A., Yang, G., Mohaidat, J., & Al Hammadi, A. (2014). Technology readiness of school teachers: An empirical study of measurement and segmentation. *Journal of Information Technology Education Research*, 13, 257-275.

Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice Hall.

Bariso, E. U. (2003). The computer revolution: Friend or foe to FE college staff. *British Journal of Educational Technology*, *34*(1), 85-88.

Bariu, T. N. (2020). Status of ICT Infrastructure used in teaching and learning in secondary schools in Meru County, Kenya. European Journal of Interactive Multimedia and Education, 1(1), e02002. https://doi.org/10.30935/ejimed/8283

Barakabitze, A. A., William-Andey Lazaro, A., Ainea, N., Mkwizu, M. H., Maziku, H., Matofali, A. X., ... & Sanga, C. (2019). Transforming African education systems in science, technology, engineering, and mathematics (STEM) using ICTs: Challenges and opportunities. Education Research International, 2019.

Baya'a, N. F., & Daher, W. M. (2013). Mathematics teachers' readiness to integrate ICT in the classroom: The case of elementary and middle school Arab teachers in Israel. *International Journal of Emerging Technologies in Learning (iJET)*, *8*(1), 46-52.

Beavers, A. S., Lounsbury, J. W., Richards, J. K., Huck, S. W., Skolits, G. J., & Esquivel, S. L. (2013). Practical considerations for using exploratory factor analysis in educational research. *Practical assessment, research & evaluation*, *18*(6), 1-13.

Bingimlas, K. A. (2009). Barriers to Successful integration of ICT in teaching and learning environment: A review of the literature. *Eurasia Journal of Mathematics, Science & Technology Education*, *25*(3), 235-245.

Bonanno, P. (2011, September).Developing an instrument to assess teachers' readiness for technology-enhanced learning. In *2011 14th International Conference on Interactive Collaborative Learning*, 438-443.

Bozkurt, A. (2011).A classroom observation-based evaluation of elementary teachers' use of technology in the classrooms in Turkey. *Educational Research and Reviews, 6*(4), 367-373.

Buabeng-Andoh, C. (2012). Factors influencing teachersâ adoption and integration of information and communication technology into teaching: A review of the literature. International Journal of Education and Development using ICT, 8(1).

Cattell R. B. (1966). The Scree test for the number of factors. *Multivariate Behavioral Research*, *1*, 245–276.

Cattell, R. (Ed.). (2012). *The scientific use of factor analysis in behavioral and life sciences*. New York: Plenum Press.

Celebi, N. (2019). Teachers and ICT's in Secondary Education: The Turkish Case.*International Journal of Technology in Education and Science*, (1), 19-28.

Changwong, K., Sukkamart, A., & Sisan, B. (2018). Critical thinking skill development: Analysis of a new learning management model for Thai high schools. *Journal of International Studies*, *11*(2), 37-48. Doi:10.14254/2071-8330.2018/11-2/3.

Chigona, A., Chigona, W., & Davids, Z. (2014). Educators' motivation on integration of ICTs into pedagogy: case of disadvantaged areas. *South African Journal of Education*, *34*(3).

Chris, L. A. (2015). Barriers hindering implementation, innovation and adoption of ICT in primary schools in Kenya. *International Journal of Innovative Research and Development*, *4*(2), 1-11.

Clark, V. P., & Creswell, J.W. (2015). Understanding Research: A Consumer's Guide (2^{nd} ed.). Pearson: Boston.

Comrey, A. L., & Lee, H. B. (2013). *A first course in factor analysis*. Psychology press. El-Gayar, O., Moran, M., & Hawkes, M. (2011). Students' acceptance of tablet PCs and implications for educational institutions. *Journal of Educational Technology & Society*, *14*(2), 58-70.

Cornelissen, S. (2011). More than a sporting chance? Appraising the sport for development legacy of the 2010 FIFA World Cup. *Third World Quarterly, 32*(3), 503-529.

County Government of West Pokot (2017). *West Pokot County Integrated Development Plan 2018-2022*. Kapenguria: West Pokot County Government. Also available online at: https://www.cog.go.ke>cog-reports>caegory

Creighton, T. (2003). *The principal as technology leader*. Thousand Oaks, Calif: Corwin Press.

Creswell, J. W., Klassen, A. C., Plano Clark, V. L., & Smith, K. C. (2015). Best practices for mixed methods research in the health sciences. 2011. *Bethesda National Institutes of Health*, 1-37.

Creswell, J.W. (2009). Research Design: Qualitative, Quantitativeand Mixed Methods Approaches. SAGE: Los Angeles.

Cronbach, L. J., & Meehl, P. E. (1955). Construct validity in psychological tests. *Psychological bulletin*, *52*(4), 281.

D'agostino Sr, R. B., & Russell, H. K. (2005). Scree test. *Encyclopedia of biostatistics*, *7*.

Davis, F. D. (1989). Perceived usefulness, perceived ease of useand user acceptance of information technology. *MIS quarterly*, 319-340.

Davis, N. (2016). *What is the fourth industrial revolution?* World Economic Forum, Global Agenda, January 2016. Available from https://www.weforum.org/agenda/2016/01/what-is-the-fourth-industrial-revolution/

De Winter, J. C. (2013). Using the Student's t-test with extremely small sample sizes. *Practical Assessment, Research & Evaluation*, *18*(10).

Demir, S., & Bozkurt, A. (2011). Primary mathematics teachers' views about their competencies concerning the integration of technology. *Elementary Education Online*, *10*(3), 850-860.

Dhamuniya, S. (2015). E-Governance in Rajasthan State Universities: Impacts and Impediments. *International Journal of Social Sciences and Management*, *2*(1), 31-35.

Dong, C. (2018). 'Young children nowadays are very smart in ICT' – preschool teachers' perceptions of ICT use, *International Journal of Early Years Education*, DOI: 10.1080/09669760.2018.1506318

Du Plessis, A. (2016). Student-teachers' pedagogical beliefs: learner-centred or teacher-centred when using ICT in the science classroom? *Journal of Baltic Science Education*, *15*(2).

Du Plessis, A., & Webb, P. (2012a). Teachers' Perceptions about their own and their schools' readiness for Computer Implementation: A South African case study. *TOJET: The Turkish Online Journal of Educational Technology*, *11*(3), 312-325.

Du Plessis, A., & Webb, P. (2012b). A teacher proposed heuristic for ICT professional teacher development and implementation in the South African context. *TOJET: The Turkish Online Journal of Educational Technology, 11*(3), 312-325.

Durbin, J., & Watson, G. S. (1971). Testing for serial correlation in least squares regression. III. *Biometrika*, *58*(1), 1-19.

Earle, R. S. (2002). The integration of instructional technology into public education: Promises and challenges. *Educational Technology-Saddle Brook Then Englewood Cliffs Nj-*, *42*(1), 5-13.

Ely, D. P. (1999). Conditions that facilitate the implementation of educational technology innovations. *Educational Technology*, *39*(6), 23-37.

Ertmer, P. A. (1999). Addressing first-and second-order barriers to change: Strategies for technology integration. *Educational technology research and development*, *47*(4), 47-61.

Ertmer, P. A., Gopalakrishnan, S., & Ross, E. M. (2001). Technology-Using Teachers. *Journal of Research on Computing in Education*, *33*(5).

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers and Education*, *59*(2), 423-435.

Field, A. (2005). *Discovering statistics using SPSS*. Thousand Oaks, CA, US.

Fishbein, M., & Ajzen, I. (1975). Belief, Attitude, Intention and Behaviour: An Introduction to Theory and Research. Reading, MA: Addison-Wesley.

Ford, M., & Botha, A. (2010, May). A pragmatic framework for integrating ICT into education in South Africa. In 2010 *IST-Africa* (pp. 1-10). IEEE.

Fullan, M., & Smith, G. (1999). *Technology and the problem of change*.New York: Teachers College Press.

Gakuu, C.M. and Kidombo, H.J. (2010). Pedagogical integration of ICT in selected Kenyan secondary schools: application of Bennett's hierarchy. *Journal of Continuing, Openand Distance Education*, 1(1), 73-94.

Glen, S. (2016, May 11). *Statistics How To:* Kaiser-Meyer-Olkin (KMO) Test for Sampling Adequacy. Retrieved from https://www.statisticshowto.datasciencecentral.com/kaiser-meyer-olkin/

Godoe,P. and Johansen, T. (2012). Understanding adoption of new technologies: Technology readiness and technology acceptance as an integrated concept. *Journal of European Psychology Students*, *3*(1), 38-52.

Goktas, Y., Yildirim, S., & Yildirim, Z. (2009). Main barriers and possible enablers of ICTs integration into pre-service teacher education programs. *Educational Technology & Society*, *12* (1), 193–204.

Gray, T. (2011). *Barriers to integrating ICT into the UK primary school curriculum: a case study approach*. Doctoral dissertation, University of Nottingham,Nottingham, United Kingdom.

Hadley, M., & Sheingold, K. (1993). Commonalities and distinctive patterns in teachers' integration of computers. *American journal of education*, *101*(3), 261-315.

Hahs-Vaughn, D. L., Acquaye, H., Griffith, M. D., Jo, H., Matthews, K., & Acharya, P. (2017). Statistical literacy as a function of online versus hybrid course delivery format for an introductory graduate statistics course. *Journal of Statistics education*, *25*(3), 112-121.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate data analysis (6th ed.).*New Jersey: Pearson Prentice Hall.

Hamidah, A. R., Aziz, N., Mukheta, I., Fatimah, P., Faruk, M., Norazam, A. M., & Zurihahmi, Z. (2005, November). Teachers' competency in the teaching of mathematics in English in Malaysian secondary schools. In *Proceedings of the Eighth International Conference Reform, Revolution and Paradigm Shifts in Mathematics Education, Johor Bahru*.

Hanan, E. H., & Huwail, E. (2008). Malaysian Smart Schools: A fruitful case study for analysis to synopsize lessons applicable to the Egyptian context. *International Journal of Education and Development using ICT*, *4*(2), 117-143.

Hennessy, S., Harrison, D., & Wamakote, L. (2010). Teacher factors influencing classroom use of ICT in Sub-Saharan Africa. *Itupale online journal of African studies*,*2*(1), 39-54.

Herro, D., Kiger, D., & Owens, C. (2013). Mobile technology: Case-based suggestions for classroom integration and teacher educators. *Journal of Digital Learning in Teacher Education*, *30*(1), 30-40.

Hjørland, B. (2005). Empiricism, rationalism and positivism in library and information science. *Journal of documentation*, *61*(1), 130-155.

Holmes, W. (1999). The transforming power of information technology. *Community college journal.* 70 (2), 10-15.

Hunter, J. E., & Hunter, R. F. (1984). Validity and utility of alternative predictors of job performance. *Psychological bulletin*, *96*(1), 72.

Ifinedo, E., Rikala, J. & Hamalainen T. (2020). Factors affecting Nigerian teacher educators' technology integration: Considering characteristics, knowledge constructs, ICT practices and beliefs. *Computers & Education, 146,* 103760: https://doi.org/10.1016/j.compedu.2019.103760

Jimoyiannis, A., & Komis, V. (2006). Exploring secondary education teachers' attitudes and beliefs towards ICT adoption in education. *THEMES in Education*, *7*(2), 181-204.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational researcher*, *33*(7), 14-26.

Jonassen, D.H., Howland, J., Moore, J., Marra, R.M., & Crismond, D. (2008). Meaningful *Learning with Technology*. New Jersey: Merrill, Prentice Hall.

Jonassen, D.H., Myers, J.M., & McKillop, A.M. (1996). From Constructivism to Constructionism: Learning with Hypermedia/Multimedia rather than from it. In B.G. Wilson (Ed.), *Constructivist Learning Environments: Case Studies in Instructional Design* (pp. 96-106). Englewood Cliffs, NJ: Educational Technology Publications.

Jonassen, D.H., Peck, K.L., & Wilson, B.G. (1999). *Learning with Technology: A Constructivist Perspective*. New Jersey: Pearson, Merrill Prentice Hall.

Kaiser, H. F. (1958). The varimax criterion for analytic rotation in factor analysis. *Psychometrika*, *23*(3), 187-200.

Kaiser, H. F. (1960). The application of electronic computers to factor analysis. *Educational and Psychological Measurement*, *20*, 141–151.

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, *39*(1), 31-36.

Kanvaria, V. K. (2018). International Conference on ICT for Education: Glimpse and Highlights. A*sian Journal of Distance Education*, *13*(1), 152-174.

Katitia, M. D. (2012). *The Role of ICT integration into classroom in Kenya. A literature*. Retrieved on 13-06-2018 from www.academia.edu

Kaygisiz, G. M., Baglibel, M., &Samancioǧlu, M. (2011). Computer use of science teachers and their attitudes toward computer supported teaching: A sample from Turkey. *Journal of Turkish Science Education*, *8*(2).

Kenya National Bureau of Statistics (2020). *Kenya Population and Housing Census 2019*. Nairobi: KNBS.

Kenya national Examinations Council (2019). Report of KCSE 2019 Results. Nairobi: KNEC.

Kiboss, J. K. (2002). Impact of a computer-based physics instruction program on pupils' understanding of measurement concepts and methods associated with school science. *Journal of Science Education and Technology*, *11*(2), 193-198.

Kihoza, P., Zlotnikova, I., Bada, J., & Kalegele, K. (2016). Classroom ICT integraion in Tanzania: Opportunities and challenges from the perspectives of TPACK and SAMR models. *International Journal of Education and Development using Information and Communication Technology*, *12*(1), 107 – 128.

Kimberlin, C. L., & Winterstein, A. G. (2008). Validity and reliability of measurement instruments used in research. *American journal of health-system pharmacy*, *65*(23), 2276-2284.

Kipsoi, E. J., Chang'ach, J. K., & Sang, H. C. (2012). Challenges facing adoption of information communication technology (ICT) in educational management in schools in Kenya. *Journal of Sociological research*, *3*(1), 18-28.

Kirkland, K., & Sutch, D. (2009). Overcoming the barriers to educational innovation: A literature Review. Bristol: Futurelab.

Kisirkoi, F. K. (2015). Integration of ICT in education in a secondary school in Kenya: A case study. *Literacy, Information and Computer Education Journal*, *6*(2), 1345-1350.

Klassen, A. C., Creswell, J., Clark, V. L. P., Smith, K. C., & Meissner, H. I. (2012). Best practices in mixed methods for quality of life research. *Quality of Life Research*, *21*(3), 377-380.

Kozma, R., McGhee, R., Quellmalz, E., & Zalles, D. (2004). Closing the digital divide: Evaluation of the World Links program. *International Journal of Educational Development*, *24*(4), 361-381.

Krejcie, R.V.& Morgan, D. W. (1970). Determining sample size for research activities. *Educational and psychological measurement*, *30*(3), 607-610.

Kumar, N., Rose, R. C., & D'Silva, J. L. (2008). Teachers' readiness to use technology in the classroom: An empirical study. *European Journal of Scientific Research*, *21*(4), 603-616.

Kvale, S. (1995). The social construction of validity. *Qualitative inquiry*, *1*(1), 19-40.

Kyllönen M. (2018). *Applying Unified Theory of Acceptance and Use of Technology (UTAUT) to investigate teachers' perceived enablers and barriers for the ICT use in teaching*. Retrieved online on 19/01/2021 from https://www.researchgate.net/publication/324890139

Lawrence, J.E. & Tar, U.A. (2018). Factors that influence teachers' adoption and integration of ICT in teaching/learning process. *Educational Media International*, *55*(1), 79-105, DOI: 10.1080/09523987.2018.1439712.

Legris, P., Ingham, J., & Collerette, P. (2003). Why do people use information technology? A critical review of the technology acceptance model. *Information & management*, *40*(3), 191-204.

Litwin, M. S. (1995). *How to measure survey reliability and validity* (Vol. 7). Thousand Oaks, CA: Sage.

Lohr, S. L. (2009). *Sampling: design and analysis*. Toronto: Nelson Education.

MacNally, R. (2002). Multiple regression and inference in ecology and conservation biology: further comments on identifying important predictor variables. *Biodiversity & Conservation*, *11*(8), 1397-1401.

Malhotra, Y. (1999). Bringing the adopter back into the adoption process: a personal construction framework of information technology adoption. *Journal of High Technology Management Research*, *10*(1), 79-104.

Malhotra, Y., & Galletta, D. F. (1999, January). Extending the technology acceptance model to account for social influence: Theoretical bases and empirical validation. In *Proceedings of the 32nd Annual Hawaii International Conference on Systems Sciences. 1999. HICSS-32. Abstracts and CD-ROM of Full Papers* (pp. 14-pp). IEEE.

Manduku, J., Kosgey, A.K. & Sang, H. (2012). Adoption and use of ICT in enhancing management of public secondary schools: A survey of Kesses zone secondary schools in Wareng district of Uasin Gishu County, Kenya. Kabianga: Kabianga University.

Marcinkiewicz, H. R. (1993). Computers and teachers: Factors influencing computer use in the classroom. *Journal of research on computing in education*, *26*(2), 220-237.

Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative research: A guide to design and implementation*. San Francisco, CA: John Wiley & Sons.

Minishi-Majanja, M. K. (2007, August). Integration of ICTs in library and information science education in sub-Saharan Africa. In *World library and information congress: 73rd IFLA general conference and council* (Vol. 19, p. 23).

Mlambo, S., Rambe, P., & Schlebusch, L. (2020). Effects of Gauteng province's educators' ICT self-efficacy on their pedagogical use of ICTs in classrooms. *Heliyon, 6*, e03730. Https://doi.org/10.1016/j.heliyon.2020.e03730.

Mndzebele, N. (2013). Teachers Readiness in using ICT in the classroom: The case of a developing country. *International Journal of Information and Education Technology, 3*(4), 409-412.

Mndzebele, N., Gama, T., Mavuso, N., Ndzimandze, F., Nkambule, L., & Tfwala, S. (2014). Attitudes of non ICT Teachers. *International Journal of Innovative Research in Technology & Science (IJIRTS), 4*(6), 59-62

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information systems research*, *2*(3), 192-222.

Mouza, C. (2005). Using technology to enhance early childhood learning: The 100 days of school project. *Educational Research and Evaluation, 11*(6), 513-528.

Msila, V. (2015). Teacher readiness and information and communications technology (ICT) use in classrooms: A South African Case Study. *Creative Education*, *6*, 1973-1981. Retrieved from http://dx.doi.org/10.4236/ce.2015.618202

Mulambe, S. O. (2017). School Factors Influencing the Adoption of Physics SMASSE Teaching Skills by Physics Teachers in Secondary Schools in Kenya. *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)*, *35*(1), 274-283.

Munanu L.C. (2014). *Factors influencing teachers readiness to use ICT in Teaching In Public Secondary Schools In Gatundu North District, Kiambu County, Kenya*. MEd project, University of Nairobi, Nairobi, Kenya.

Mwaka, M., Wambua, B. K., Syomwene, A., & Kitainge, K. (2013). Monitoring of educational technology progress to enhance the quality of graduate teachers from the Kenyan universities. *European Scientific Journal, ESJ*, *9*(10), 1857 – 7881.

Mwendwa, N. K. (2017). Perception of teachers and principals on ICT integration in the primary school curriculum in Kitui County, Kenya. *European Journal of Education Studies*.

Nchunge, D. M., Sakwa, M., & Mwangi, W. (2012). User's Perception on ICT adoption for Education Support in Schools: A Survey of Secondary School Teacher's in Thika District Kenya.*International Journal of Humanities and Social Science*,*2*(10), 17-29.

Newby, L.S., Hite, J.M., Hite, S.J.& Mugimu, C.B. (2012). Technology and educaiton: ICT in Ugandan secodnary schools. *Educ Inf Technol,* doi:10.1007/s10639-011-9180x

Ngeze, L.V. (2017). ICT integration in teaching and learning in secondary schools in Tanzania: Readiness and way forward. *International Journal of Information and Education Technology, 7*(6), 424 – 427.

Obaydullah, A.K.M. & Rahim, M.A. (2019). Use of ICT for Primary science Teaching and Learning at the Primary Schools in Bangladesh. *IJARIIE, 5*(1), 642 – 651.

Ogula, P. A., & Onsongo, J. K. (2009). *Handbook on teaching and learning in higher education*. Nairobi: Catholic University of Eastern Africa (CUEA) Press.

Ojwang, C, O. (2012).*E-learning adoption among Secondary Schools in Kisumu County, Kenya*. Retrieved from http://erepository.uonbi.ac.ke/handle/11295/13251

Olasina, G. (2012). Perceptions, motivating and impeding factors of courseware development in Nigeria. *International Journal of Global Education*, *1*(4), 1-18.

Omare, W., Mwalw' S.a, & Mutisya, S. (2018). Challenges facing utilization of ICT in public secondary schools in Kajiado North Sub-County, Kenya. *International Journal of Social and Development Concerns, 3*(2/15), 18 – 38.

Ooko, M.A. (2016). *The adoption of technology to support teaching and learning in a distance learning programme at Africa Nazarene University*. Doctoral theses, University of South Africa, Pretoria, South Africa.

Osborne, J. W., Costello, A. B., & Kellow, J. T. (2008). Best practices in exploratory factor analysis. *Best practices in quantitative methods*, *10*(7), 1-9.

Ouardaoui,A., Legrouri, A., Darhmaoui, H. and Loudiyi, K. (2012). ICT integration into chemistry-physics classes in middle schools through a participatory pilot project approach. *Procedia: Social and Behavioural Sciences,* 55, 232-238.

Oyeronke, A. & Fagbohun, M. (2013). An Assessment of Computer and ICT Skills among Secondary School Teachers in Ota Ogun State.Library Philosophy and Practice (e-journal). Paper 846. Retrieved from http://digitalcommons.unl.edu/libphilprac/846

Özdemir, S. (2017). Teacher views on barriers to the integration of information and communication technologies (ict) in Turkish teaching.

Padayachee, K. (2017). A snapshot survey of ICT integration in South African schools. *South African Computer Journal*,*29*(2), 36-65

Pelgrum, W. J. (2001). Obstacles to the integration of ICT in education: results from a worldwide educational assessment. *Computers & education*, *37*(2), 163-178.

Penniston, K. L., Antonelli, J. A., Viprakasit, D. P., Averch, T. D., Sivalingam, S., Sur, R. L., & Nakada, S. Y. (2017). Validation and reliability of the Wisconsin stone quality of life questionnaire. *The Journal of urology*, *197*(5), 1280-1288.

Player-Koro, C. (2012). Factors influencing teachers' use of ICT in education.*Education Inquiry*, *3*(1), 93-108.

Prensky, M. (2008). The role of technology. *Educational Technology*, *48*(6), 1-3.

Price, P. C., Jhangiani, R.,& I-Chant, A. (2015). *Reliability and Validity of Measurement (licensed under a Creative Commons Attribution-Non-commercial-Share Alike 4.0 International License)*. Toronto: Quest University.

Raman, K., & Yamat, H. (2015). Barriers Teachers Face in Integrating ICT During English Lessons: A Case Study. *The Malaysian Online Journal of Educational Technology*, *2*(3), 11-19.

Republic of Kenya. (2006). *National information and communication policy*. Nairobi: Government of Kenya Printer.

Republic of Kenya. (2012). *Task force on the re-alignment of the education sector to the constitution of Kenya 2010 towards a globally competitive quality education for sustainable development. Report of the task force*. Nairobi, Ministry of Education

Republic of Kenya. (2016). *National information and communication policy*. Nairobi: Government of Kenya Printer.

Rieckmann, M. (2017). *Education for sustainable development goals: Learning objectives*. UNESCO Publishing.

Riley, W.J. (2008). *Handbook of frequency stability analysis*. Boulder, CO: NIST Special Publication 1065.

Rogers, E. M. (1995). *Diffusion of Innovations.* New York: Free Press

Rogers, E. M. (2003). *Diffusion of innovations*. 5th Edition. New York: Free Press.

Rouder, J. N., Speckman, P. L., Sun, D., Morey, R. D., & Iverson, G. (2009). Bayesian t tests for accepting and rejecting the null hypothesis. *Psychonomic bulletin & review*, *16*(2), 225-237.

Schoepp, K. (2005). Barriers to technology integration in a technology-rich environment. *Learning and Teaching in Higher Education: Gulf Perspectives*, *2*(1), 1-24.

Sekaran, U. (2000). *Research methods for business: A Skill building approach* (3rd Edn). New York: John Wiley & Sons.

Sharma, R. K., Kumar, D., & Kumar, P. (2005). Systematic failure mode effect analysis (FMEA) using fuzzy linguistic modelling. *International Journal of Quality & Reliability Management*, *22*(9), 986-1004.

Sherman, K. (2012). *Teachers' beliefs about first-and second-orderbarriers to ICT integration: Preliminary findings from a South African study*. University of Wollongong.

Sherman, K., & Howard, S. K. (2012). Teachers' beliefs about first-and second-order barriers to ICT integration: preliminary findings from a South African study. In *Society for Information Technology & Teacher Education International Conference*, pp. 2098-2105. Association for the Advancement of Computing in Education (AACE).

Simonson, M. (2008). Technology use of Hispanic bilingual teachers: A function of their beliefs, attitudes and perceptions on peer technology use in the classroom. *Journal of Instructional Technology, 31*(3), 257-266.

Singh, T. K. R.& Chan, S. (2014). Teacher readiness on ICT integration in teaching-learning: A Malaysian case study. *International Journal of Asian Social Science*, *4*, 874-885.

Snedecor, G. W., & Cochran, W. G. (1989). Statistical methods, 8thEdn. *Ames: Iowa State Univ. Press Iowa*.

Soanes, C., & Stevenson, A. (Eds.). (2004). *Concise oxford English dictionary* (Vol. 11). Oxford: Oxford University Press.

Subramanien, B. (2014). *Exploring teachers' perceptions of the barriers and solutions to using one laptop per class in a multigrade context: The case of Intel® Teach – ICT implementation*. Master's Thesis, Nelson Mandela Metropolitan University, Port Elizabeth, South Africa.

Sullivan, G. M., & Feinn, R. (2012). Using effect size—or why the P value is not enough. *Journal of graduate medical education*, *4*(3), 279-282.

Surry, D., Porter, B., Jackson, K., & Hall, D. (2004). Conditions for creating an innovation friendly environment in K-12 schools. In *Society for Information Technology & Teacher Education International Conference* (pp. 1418-1425). Association for the Advancement of Computing in Education (AACE).

Sympathonia, S. M. (2016). *Teachers' experience of Information and Communication Technology use for Teaching and Learning in Urban Schools*. Doctor of Education Thesis,University of South Africa.

Taylor, S., & Todd, P. A. (1995). Assessing IT Usage: The Role of Prior Experience, *MIS Quarterly*, *19* (2), 561-570.

Tella, A., Tella, A., Toyobo, O. M., Adika, L. O., & Adeyinka, A. A. (2007). An Assessment of Secondary School Teachers Uses of ICT's: Implications for Further Development of ICT's Use in Nigerian Secondary Schools.*Turkish Online Journal of Educational Technology-TOJET*, *6*(3), 5-17.

Tezci, E. (2009). Teachers' effect on ICT use in education: The Turkey sample. *Procedia-Social and Behavioral Sciences*, *1*(1), 1285-1294.

Thompson, R. L., Higgins, C. A., & Howell, J. M. (1991). Personal computing: toward a conceptual model of utilization. *MIS quarterly*, 125-143.

Tinsley, H. E., & Tinsley, D. J. (1987). Uses of factor analysis in counseling psychology research. *Journal of counseling psychology*, *34*(4), 414.

Tondeur, J. (2019). *Why Kenya is failing to integrate technology into secondary schools.* Retrieved online on 19th Jan 2021 from https://theconversation.com

Trilling, B., & Hood, P. (1999). Learning, Technologyand Education Reform in the Knowledge Age or We're Wired, Webbedand Windowed, Now What?. *Educational technology*, *39*(3), 5-18.

Tsai, C.-C., & Chai, C. S. (2012). The "third"-order barrier for technology integration instruction: Implications for teacher education.In C. P. Lim & C. S. Chai (Eds), Building the ICT capacity of the next generation of teachers in Asia. *Australasian Journalof Educational Technology, 28*(6), 1057-1060.

UNESCO, (2011a). *ICT Competency framework for teachers*. Paris: United Nations Educational, Scientific and Cultural Organization.

UNESCO. (2011b). *The hidden crisis: Armed conflict and education*. Paris: Unesco.

UNESCO (2019). *Improving quality and relevance of education through mobile learning in Rwanda: A promise to deliver*. Case study by the UNESCO-Fazheng project on best practices in mobile learning. Paris: UNESCO.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management science*, *46*(2), 186-204

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478.

Waema, M. (2005). A brief history of the development of an ICT policy in Kenya. *At the Crossroads: ICT policy making in East Africa*, 25-43.

Walsh V. & Farren, M. (2018). Teacher attitudes regarding barriers to meaningfully implementing iPads in a primary school setting. *Computers in the Schools,* 35:2, 152-170, DOI: 10.1080/07380569.2018.1462674

Watters, J. K., & Biernacki, P. (1989). Targeted sampling: Options for the study of hidden populations. *Social problems*, *36*(4), 416-430.

Williams, B., Onsman, A., & Brown, T. (2010). Exploratory factor analysis: A five-step guide for novices. *Australasian Journal of Paramedicine*, *8*(3).

Wilmore, D. & Betz, M. (2000). Information Technology and school: The Principal's role. *Educational Technology & Society*, 3(4), 12-19.

Wong, C. C., & Hiew, P. L. (2005). Diffusion of mobile entertainment in Malaysia: Drivers and barriers. *WEC (5)*, 263-266.

Wood, L. W. (2010). *Faculty Perceptions about Virtual World Technology: Affordances and Barriers to Adoption*. Dissertation,Georgia State University. Retrieved from http://scholarworks.gsu.edu/msit_diss/70

APPENDICES

APPENDIX I: Letter of Invitation

Francis Seurei
School of Education Moi University
P.O. Box 3900-30100
Eldoret- Kenya.
Dear Respondents,

RE: LETTER OF INVITATION TO TEACHERS

My name is Francis Seurei a postgraduate student pursuing Masters of Education Degree in Research at Moi University. I intend to conduct a study on **Teacher Readiness and ICT Integration for Teaching of Science in Secondary Schools in West Pokot County, Kenya**. The purpose of these latter is to request you to take part in this study. All the information given will be treated with utmost confidentiality.

The study will meet the requirements of the Research ethical committee of Moi University the study will involve the use of questionnaire; the researcher shall ask you to fill the questionnaire as means of generating data. Your participation in data generation process will be totally voluntary; your decision to decline, skip any question or withdraw from this study shall not attract any consequences. Information collected during withdrawal shall be discarded.

The information you give shall be treated with utmost confidentiality during and after the study, there is no anticipated risks associated with participating in this study all the responses you give shall be used only for the purpose of this study.

Thanks in Advance

Sign...

Date...

Francis Seurei EDU/PGR/1011/17

APPENDIX II: Consent Form

Francis Seurei EDU/PGR/1011/17

Master of Research in Education Student Moi University

I give my consent to participate in Research study

1.	I have read and understood the information about the project, as provided in the Information Sheet dated _________________.	☐
2.	I have been given the opportunity to ask questions about **Teacher Readiness and ICT Integration for Teaching of Science in Secondary Schools in West Pokot County, Kenya**	☐
3.	I voluntarily agree to participate in the research.	☐
4.	I understand I can withdraw at any time without giving reasons and that I will not be penalised for withdrawing nor will I be questioned on why I have withdrawn.	☐
5.	The procedures regarding confidentiality have been clearly explained (*e.g.* use of names, pseudonyms, anonymity of data, *etc.*) to me.	☐
6	The use of the data in research, publications, sharing and archiving has been explained to me.	☐
7	Select only **one** of the following: I would like my name used and understand what I have said or written as part of this study will be used in reports, publications and other research outputs so that anything I have contributed to this project can be recognised.	☐
	I do not want my name used in this project.	☐
8	I, along with the Researcher, agree to sign and date this informed consent form.	☐

Name of Participant_________________ Signature ___________Date_____________

Name of the Researchers _______________Signature __________ Date____________

APPENDIX III: Questionnaire for Teachers

Instructions

1. Please respond to all the questions.
2. Tick and give appropriate and correct response according to your experience.
3. Some items may be having more than one response
4. Your responses will be treated with confidentiality

Section A: Demographic Data

1. Which subject do you teach?
   Biology [ ] Chemistry [ ] Physics [ ]
2. What is your gender?
   Male [ ] Female [ ]
3. What is your highest level of academic qualification?
   Diploma [ ] Degree [ ] Masters [ ] Post graduate diploma [ ]
4. What is your age (in years) _______________
5. What is the approximate number of students in your school?
   0-149 [ ] 150-299 [ ] 300 – 449 [ ] 450 – 599 [ ] 600 and above [ ]
6. How many computers does your school have? ______________________
7. What can you say on the electricity supply in your school on the following scale?

1	2	3	4	5

Very poor ◄────────────────────► **very good**

8. (a) Are you connected to the internet in your school?
   Yes [ ] No [ ]

(b) If yes, what can you say on the internet speed using the scale below?

1	2	3	4	5

Very poor ◄────────────────────► **very good**

Section B: ICT Integration in Teaching of Science (Dependent Measure)

Indicate to what extent does you agree or disagree with the following statement with regard to use of ICT systems in teaching of science. Use the key: 1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly Agree

I use ICT to:						
ICT1	Accomplish tasks more quickly.	**1**	**2**	**3**	**4**	**5**
ICT2	Improve the quality of the work that I do	**1**	**2**	**3**	**4**	**5**
ICT3	Make it easier to do my job	**1**	**2**	**3**	**4**	**5**
ICT4	Enhances my effectiveness on the job	**1**	**2**	**3**	**4**	**5**
ICT5	Increases my productivity	**1**	**2**	**3**	**4**	**5**
ICT6	Research and access specific scientific information	**1**	**2**	**3**	**4**	**5**
ICT7	Developing lesson notes	**1**	**2**	**3**	**4**	**5**
ICT8	Teaching and learning during lesson time	**1**	**2**	**3**	**4**	**5**
ICT9	Assess students' academic progress	**1**	**2**	**3**	**4**	**5**
ICT10	Making class presentations	**1**	**2**	**3**	**4**	**5**
ICT11	Generating reports	**1**	**2**	**3**	**4**	**5**
ICT12	Communication with students in class	**1**	**2**	**3**	**4**	**5**

Section C: Attitude towards ICT Use (IV1)
Indicate to what extend do you agree or disagree on the following statements with regard to your attitude towards use of ICT in teaching of science subjects in school.
Use the key: 1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly Agree.

To Me:						
A1	Using ICT is a good idea.	**1**	**2**	**3**	**4**	**5**
A2	Using ICT is a wise idea.	**1**	**2**	**3**	**4**	**5**
A3	I like the idea of using ICT.	**1**	**2**	**3**	**4**	**5**
A4	Using ICT is pleasant experience.	**1**	**2**	**3**	**4**	**5**

Section D: Motivation to Use ICT in Teaching Science Subjects(IV2)
Indicate to what extend do you agree or disagree on the following statements with regard to your level of motivation in teaching of science subjects in school.
Use the key: 1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly Agree.

To Me:						
M1	I find using ICT to be enjoyable	**1**	**2**	**3**	**4**	**5**
M2	The actual process of using ICT is pleasant experience.	**1**	**2**	**3**	**4**	**5**
M3	I have fun using ICT.	**1**	**2**	**3**	**4**	**5**
M4	ICT makes work more interesting	**1**	**2**	**3**	**4**	**5**
M5	Working with ICT is fun.	**1**	**2**	**3**	**4**	**5**
M6	I feel comfortable when using ICT in teaching and learning process	**1**	**2**	**3**	**4**	**5**
M7	Once I start working on ICT I find it hard to stop.	**1**	**2**	**3**	**4**	**5**

Section E: Facilitating Conditions for ICT use in teaching Science Subjects (IV3)
Indicate to what extend do you agree or disagree on the following statements with regard to your level facilitating conditions in teaching of science subjects in school.
Use the key: 1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly Agree.

To Me:						
FC1	I have the resources necessary to use ICT.	**1**	**2**	**3**	**4**	**5**
FC2	I have the knowledge necessary to use ICT	**1**	**2**	**3**	**4**	**5**
FC3	The ICT is not compatible with other ICT systems I use	**1**	**2**	**3**	**4**	**5**
FC4	I have control over using the ICT	**1**	**2**	**3**	**4**	**5**
FC5	I have resources, opportunities and knowledge it takes to use ICT	**1**	**2**	**3**	**4**	**5**
FC6	Guidance was available to me in the selection of the ICT.	**1**	**2**	**3**	**4**	**5**
FC7	Specialized instruction concerning ICT was available to me	**1**	**2**	**3**	**4**	**5**
FC8	A specific person is available for assistance with ICT difficulties	**1**	**2**	**3**	**4**	**5**
FC9	Using ICT is compatible with all aspects of my work.	**1**	**2**	**3**	**4**	**5**

FC10	I think that using ICT fits well with the way I like to work.	**1**	**2**	**3**	**4**	**5**
FC11	Using ICT fits into my work style.	**1**	**2**	**3**	**4**	**5**

Section F: Behavioural Intentions to use ICT in teaching Science Subjects (IV4)
Indicate to what extend do you agree or disagree on the following statements with regard to your behavioural intentions to use ICT. Use the key: 1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly Agree.

To Me:						
B11	I intend to use the system in the next two months	**1**	**2**	**3**	**4**	**5**
BI2	I predict I would use the system in the next two months	**1**	**2**	**3**	**4**	**5**
BI3	I plan to use the system in next term	**1**	**2**	**3**	**4**	**5**
BI4	I have positive perception towards ICT	**1**	**2**	**3**	**4**	**5**
BI5	I am ready to participate computer training	**1**	**2**	**3**	**4**	**5**
BI6	I have understanding on how to integrate ICT into teaching	**1**	**2**	**3**	**4**	**5**
BI7	Lack of adequate computers	**1**	**2**	**3**	**4**	**5**
BI8	I have a plan for ICT use	**1**	**2**	**3**	**4**	**5**

The end
Thank you

APPENDIX IV: Questionnaire comparison

Venkatesh *et al.* (2003)		**This study**	
		Integration **I use ICT to:**	
		ICT1	Accomplish tasks more quickly.
		ICT2	Improve the quality of the work that I do
		ICT3	Make it easier to do my job
		ICT4	Enhances my effectiveness on the job
		ICT5	Increases my productivity
		ICT6	Research and access specific scientific information
		ICT7	Developing lesson notes
		ICT8	Teaching and learning during lesson time
		ICT9	Assess students' academic progress
		ICT10	Making class presentations
		ICT11	Generating reports
		ICT12	Communication with students in class
Performance expectancy			
U6	I would find the system useful in my job.		
RA1	Using the system enables me to accomplish tasks more quickly.		
RA5	Using the system increases my productivity.		
OE7	If I use the system, I will increase my chances of getting a raise.		

Effort expectancy			
EOU3	My interaction with the system would be clear and understandable.		
EOU5	It would be easy for me to become skilful at using the system.		
EOU6	I would find the system easy to use.		
EU4	Learning to operate the system is easy for me.		
Attitude toward using technology			**Attitude** **To me:**
A1	Using the system is a bad/good idea.	M1	Using ICT is a good idea.
AF1	The system makes work more interesting.	M2	Using ICT is a wise idea.
AF2	Working with the system is fun.	M3	I like the idea of using ICT.
Affect 1	I like working with the system	M4	Using ICT is pleasant experience.
Social influence			

SN1	People who influence my behaviour think that I should use the system.		
SN2	People who are important to me think that I should use the system.		
SF2	The senior management of this business has been helpful in the use of the system.		
SF4	In general, the organization has supported the use of the system.		

Facilitating conditions			**Facilitating conditions**
PBC2	I have the resources necessary to use the system.	FC1	I have the resources necessary to use ICT.
PBC3	I have the knowledge necessary to use the system.	FC2	I have the knowledge necessary to use ICT
PBC5	The system is not compatible with other systems I use.	FC3	The ICT is not compatible with other ICT systems I use
FC3	A specific person (or group) is available for assistance with system difficulties.	FC4	I have control over using the ICT
		FC5	I have resources, opportunities and knowledge it takes to use ICT
		FC6	Guidance was available to me in the selection of the ICT.
		FC7	Specialized instruction concerning ICT was available to me
		FC8	A specific person is available for assistance with ICT difficulties
		FC9	Using ICT is compatible with all aspects of my work.
		FC10	I think that using ICT fits well with the way I like to work.
		FC11	Using ICT fits into my work style.
Self-efficacy			**Self-efficacy**
I could complete a job or task using the system…			
SE1	If there was no one around to tell me what to do as I go.		
SE4	If I could call someone for help if I got stuck.		
SE6	If I had a lot of time to scomplete the job for which the software was provided.		
SE7	If I had just the built-in help facility for assistance.		
Anxiety			
ANX1	I feel apprehensive about using the system.		

ANX2	It scares me to think that I could lose a lot of information using the system by hitting the wrong key.		
ANX3	I hesitate to use the system for fear of making mistakes I cannot co		
ANX4	The system is somewhat intimidating to me.		
Behavioural intention to use the system			**Behavioural intention To me:**
BI1	I intend to use the system in the next <n> months.	B11	I intend to use the system in the next two months
BI2	I predict I would use the system in the next <n> months.	BI2	I predict I would use the system in the next two months
BI3	I plan to use the system in the next <n> months.	BI3	I plan to use the system in next term
		BI4	I have positive perception towards ICT
		BI5	I am ready to participate computer training
		BI6	I have understanding on how to integrate ICT into teaching
		BI7	Lack of adequate computers
		BI8	I have a plan for ICT use
Motivation			**Motivation To me:**
N/A		M1	I find using ICT to be enjoyable
		M2	The actual process of using ICT is pleasant experience.
		M3	I have fun using ICT.
		M4	ICT makes work more interesting
		M5	Working with ICT is fun.
		M6	I feel comfortable when using ICT in teaching and learning process
		M7	Once I start working on ICT I find it hard to stop.

APPENDIX V: Recommendation Letter

MOI UNIVERSITY

Office of the Dean School of Education

Tel: (053) 43001-8
(053) 43555
Fax: (053) 43555

P.O. Box 3900
Eldoret, Kenya

REF: EDU/PGR/1011/17 **DATE: 3rd April, 2018**

The Executive Secretary
National Commission for
Science, Technology & Innovation
P.O. Box 30623-00100
NAIROBI

Dear Sir/Madam,

RE: RESEARCH PERMIT IN RESPECT OF FRANCIS SEUREI KIPCHUMBA - (EDU/PGR/1011/17)

The above named is a 2nd year Masters (M.Ed) student at Moi University, School of Education, Department of Educational Management and Policy Studies.

It is a requirement of his masters Studies that he conducts research and produces a thesis. His research is entitled:

"The Status of West Pokot High Schools and Teacher Readiness for the Integration of ICT in the Teaching of Science in Kenya."

Any assistance given to enable him conduct research successfully will be highly appreciated.

Yours faithfully,

MOI UNIVERSITY
SCHOOL OF EDUCATION

PROF. J. K. CHANGACH
DEAN, SCHOOL OF EDUCATION

APPENDIX VI: Research Permit

THIS IS TO CERTIFY THAT:
MR. FRANCIS SEUREI KIPCHUMBA
of MOI UNIVERSITY, 0-30100 Eldoret,has been permitted to conduct research in *Westpokot County*

on the topic: *THE STATUS OF WEST POKOT HIGH SCHOOLS AND TEACHER READINESS FOR THE INTEGRATION OF ICT IN THE TEACHING OF SCIENCE IN KENYA*

for the period ending:
23rd April,2019

Permit No : NACOSTI/P/18/83854/22259
Date Of Issue : 10th May,2018
Fee Recieved :Ksh 1000

....
Applicant's Signature

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

CONDITIONS

1. The License is valid for the proposed research, research site specified period.
2. Both the Licence and any rights thereunder are non-transferable.
3. Upon request of the Commission, the Licensee shall submit a progress report.
4. The Licensee shall report to the County Director of Education and County Governor in the area of research before commencement of the research.
5. Excavation, filming and collection of specimens are subject to further permissions from relevant Government agencies.
6. This Licence does not give authority to transfer research materials.
7. The Licensee shall submit two (2) hard copies and upload a soft copy of their final report.
8. The Commission reserves the right to modify the conditions of this Licence including its cancellation without prior notice.

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No.A 18463

CONDITIONS: see back page

APPENDIX VII: County Commissioner Letter

OFFICE OF THE PRESIDENT

MINISTRY OF INTERIOR AND COORDINATION OF NATIONAL GOVERNMENT

Telegrams; DISTRICTER' Kapenguria
Telephone; kapenguria 054-62291
Radio call; kape 5ZRO
Email: westpokotland@rocketmail.com

The Deputy County Commissioner,
West Pokot Sub County,
P.o. BOX 1,
KAPENGURIA.

REF: OOP.CC.ADM.15/14 VOL.1/ 131

24TH MAY, 2018

TO WHOM IT MAY CONCERN

RE: RESEARCH AUTHORIZATION
FRANCIS SEUREI KIPCHUMBA

Reference is made to the letter Ref: No.NACOSTI/P/18/83854/22259 dated 10th May, 2018 on the above subject matter.

The above named student is from Moi University, he has been dully authorized to carry out research on the topic "***The status of West Pokot high schools and teacher readiness for the integration of ICT in the teaching of science in Kenya according to the research proposal*** for a period ending 23rd April, 2018.

The purpose of this letter, therefore, is to request you to accord him your cooperation and necessary assistance he may require during his research study within this County.

DEPUTY COUNTY COMMISSIONER WEST POKOT SUB-COUNTY 23 MAY 2018 P.O. Box 1-30600, KAPENGURIA

(KHALIF D. ABDULLAHI)
DEPUTY COUNTY COMMISSIONER
WEST POKOT SUB COUNTY

APPENDIX VIII: County Director of Education letter

REPUBLIC OF KENYA

MINISTRY OF EDUCATION, SCIENCE & TECHNOLOGY
STATE DEPARTMENT OF BASIC EDUCATION

-Email: elimu|cdewest pokot @ education.go.ke
Web: www.education.go.ke
-cdewestpokot@yahoo.com.
When replying please quote date S Ref.

SUB COUNTY EDUCATION OFFICE
WEST POKOT COUNTY
P.O. BOX 17
KAPENGURIA.

23RD May, 2018

REF: WPC/EDUC/ADM/15/20/VOL.1/68

Francis Seurei Kipchumba,
Moi University
P.O Box 3900-30100
ELDORET.

RE: RESEARCH AUTHORIZATION

Following your authorization from the National Commission for Science, Technology and innovation you are hereby permitted to carry out research on "***The status of West Pokot High Schools and teacher readiness for the integration of ICT in the teaching of science in Kenya.***" for a period ending **23rd April, 2019.**

Through this letter, therefore is to request you to accord him your cooperation and necessary assistance he may require.

SUB-COUNTY EDUCATION OFFICER
WEST POKOT SUB - COUNTY
P. O. Box 17
KAPENGURIA

(CHARLES MANYARA)
SUB COUNTY DIRECTOR OF EDUCATION
WEST POKOT COUNTY.

APPENDIX IX: Map of Study Area

Maps of Africa and Kenya (Google Maps, 2019 and Country Government of West Pokot