



**UNIVERSITY OF NAIROBI
SCHOOL OF COMPUTING AND INFORMATICS**

**USING ICT TO IMPROVE ACCESS TO EDUCATIONAL
RESOURCES BY MARGINALIZED COMMUNITIES: A
KENYAN EXPERIENCE**

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P54/6463/2017

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A research project report submitted to the School of Computing and Informatics in partial fulfillment of the requirements for the award of Master of Science in Information Technology Management of the University of Nairobi

August 2020

DECLARATION

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

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This project report has been submitted for examination with my approval as university supervisor.

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DEDICATION

To my parents and family.

ACKNOWLEDGEMENT

I thank God for all that I have and wish to express my sincere gratitude to my supervisor, Christopher A. Moturi for his support, time and invaluable contribution throughout the entire project.

ABSTRACT

Educational provision is a critical ingredient necessary for the development of any nation. Many of the secondary school graduates in Kenya are not guaranteed placement within the available university slots in the country. The vocational and technical colleges in Kenya could support such students. The technical colleges are not enough to absorb all the students ready to join technical colleges do not offer enough (Chege & Kariuki, 2016).

Students living among the marginalized communities in Kenya continue to experience limited access to current and relevant educational resources (TVETA Strategic Plan, 2018). Limited access to educational resources denies the youth the necessary hands-on skills required to secure employment in the ever-changing labor market (Miriti et al., 2014).

This study aims to develop an enhanced educational resources access model for the marginalized communities. The study objectives were to determine factors limiting access to educational resources, identify suitable educational resources access solutions and develop an ICT enhanced educational resources access framework for the marginalized communities.

The study was carried out in selected technical and vocational colleges in marginalized zone in Kenya employing descriptive survey for the research design. The study collected data from college managers, ICT lecturers, and ICT support staff. Data analysis process generated frequencies, percentages, and means.

The study finding showed that financial-related factors greatly affected educational access followed closely by physical factors. The study finding indicated that suitable educational resources access solutions included appropriate and relevant content, improved access opportunities and quality reviews.

The study findings supported multi-mode delivery channels, innovativeness and flexibility as suitable access solutions. The developed models significantly reduced the physical, technological, financial and human access challenges when access to educational resources challenges was moderated with PRIMER Enablers.

The research presents the necessary apparatus required to improve access to educational resources within the marginalized zones in Kenya. The research highlights the need to improve the state of technical colleges within the rural areas in Kenya which would enable more students to enroll in technical colleges. Through the use of ICT in education technical colleges can offer a stimulating learning experience to the students which could improve the negative perception these colleges have experienced over the years.

The study was undertaken in Tharaka Nithi county one of the 14 marginalized counties in Kenya, hence needs for further research focusing on many more marginalized or rural zones.

The study duration of two months could not allow the detection of all technical, cultural, and social factors in education. The study could not employ an online questionnaire due to low internet connection in some areas of Tharaka Nithi County.

The study concluded that finance-related factors heavily affected educational access in the marginalized communities. Other challenges affecting educational access for the marginalized communities were technology-related factors. ICT modeling and policy solutions were identified as the most suitable solutions to enhance educational resource access. In the development of the ICT educational model, the PRIMER enablers could make it possible to address the physical, technological, financial and human resource challenges. In verifying the model, the study concluded that ICT infrastructure including virtualization, thin clients, web servers and content management accounted for the effects of the PRIMER enablers leading to enhanced access to educational resources by the marginalized communities.

The government needs to provide financial capital required to mitigate the funding challenges facing the technical colleges. The government should support initiatives geared toward setting up physical infrastructure. The training of technical college teachers should be a priority. The county office should promote ICT related policies in schools. The private sector involvement through the development of ICT based solutions that would promote educational access in the marginalized areas is important.

Keywords

ICT, Educational Resources, Marginalized Communities.

TABLE OF CONTENT

DECLARATION	i
DEDICATION	ii
ACKNOWLEDGEMENT	iii
ABSTRACT.....	iv
LIST OF FIGURES	8
LIST OF TABLES.....	ix
ABBREVIATIONS	x
CHAPTER 1	1
INTRODUCTION	1
1.1 Background to the Problem	1
1.2 Problem Statement.....	2
1.3 Research Objectives.....	2
1.4 Research Questions.....	2
1.5 Significance of the study.....	3
1.6 Limitations of the study	3
CHAPTER 2	4
LITERATURE REVIEW	4
2.1 Educational Resources	4
2.2 Factors limiting access to educational resources by marginalized communities.....	5
2.3 Solutions for improving access to educational resources	8
2.4 Role of ICT for the Marginalized	11
2.5 Relevant ICT Policies	11
2.6 ICT in Education.....	12
2.7 Theoretical frameworks	13
2.8 Conceptual Framework.....	19
CHAPTER 3	21
RESEARCH METHODOLOGY.....	21
3.0 Introduction.....	21
3.1 Research Design.....	21
3.2 Target Population.....	21
3.3 Sampling Design.....	21
3.4 Sample size	21
3.5 Data Collections.....	21
3.6 Data Analysis	22
3.7 Ethical Issues	23

CHAPTER 4	24
DATA ANALYSIS, INTERPRETATION AND DISCUSSION	24
4.0 Introduction.....	24
4.1 Demographic Characteristics.....	24
4.2 Factors Limiting Educational Resource Access for Marginalized Persons	24
.....	28
4.3 Suitable Educational Resources Access Solutions for the Marginalized.....	28
4.4 Programs that enable educational resources sharing by the marginalized in Kenya	33
4.5 Integral Modules of the ICT Educational Resources Access Framework	36
4.6 Inferential Data Analysis	38
4.7 Discussion.....	45
CHAPTER 5	47
CONCLUSION AND RECOMMENDATIONS	47
5.1 Summary of Achievements.....	47
5.2 Recommendations of the Study	48
5.3 Research Assessment	49
5.4 Research Limitations	50
REFERENCES	51
APPENDICES	58
Appendix I: Introductory Letter.....	58
Appendix II: Questionnaire.....	59

LIST OF FIGURES

Figure 1 Model for ICT Rural Education	14
Figure 2 Framework for poverty alleviation with ICTs.....	15
Figure 3 E-CLRC Framework	16
Figure 4 FORE Framework	17
Figure 5 National Framework for Rural and Remote Education.....	18
Figure 6 Conceptual Framework	19
Figure 7 Other Educational Resource Access Challenges.....	28
Figure 8 ICT Model Attributes	32

LIST OF TABLES

Table 4. 1 Demographic Characteristics	24
Table 4. 2 Factors Limiting Educational Resource Access for Marginalized Persons	26
Table 4. 3 Other Educational Resource Access Challenges	27
Table 4. 4 Suitable Educational Resources Access Solutions	30
Table 4. 5 Major ICT Attributes that the ICT Model should provide.....	31
Table 4. 6 Handling Infrastructural Challenges to make Access Model Functional	33
Table 4. 7 Virtualization Role in Enhancing Educational Resources Sharing	33
Table 4. 8 Thin Client Role in Enhancing Educational Resources Sharing	34
Table 4. 9 Web Server Role in Enhancing Educational Resources Sharing.....	35
Table 4. 10 Content Management System Role in Enhancing Resources Sharing	35
Table 4. 11 Integral Modules of the ICT Resources Access Framework	37
Table 4. 12 ANOVA on Model Factors Limiting Educational Access	38
Table 4. 13 Model Summary on Moderating Effect	40
Table 4. 14 ANOVA for Goodness of Fit Test on Moderation	40
Table 4. 15 Moderated Regression of Factors Affecting Educational Access	42
Table 4. 16 Summary of Moderating Effect	43
Table 4. 17 Significance of Mediation (Model Verification)	44

ABBREVIATIONS

EPUB - Electronic Publication

GSM - Global system for mobile communication

HTML - Hypertext Markup Language

ICT - Information and Communication Technology

KNEC - Kenya National Examination Council

MoE- Ministry of Education

MOOCs – Massive Open Online Courses

OER - Open education resources

PRIMER-Personnel, Relevant Curriculum, Information Communication Technology,
Multimode, Delivery, Environments, Resourcing

RIC - Resource in Common

SDG - Sustainable Development Goals

TVETA -Technical and Vocational Education and Training Authority

UNESCO - United National Education, Scientific and Cultural Organization

UNICEF - United Nations International Children's Emergency Fund

WAP - Wireless Application protocol

WCAG - Web Content Accessibility Guideline

CHAPTER 1

INTRODUCTION

1.1 Background to the Problem

Educational provision is a critical ingredient necessary for the development of any nation. Many countries have invested greatly in their education programs with the desire of uplifting the lives of its people.

The introduction of free primary education in Kenya resulted in increased enrollment in primary schools. The primary schools have subsequently enabled many students to transit to secondary schools, with a huge number graduating from secondary school each year. Many of these secondary school graduates are not guaranteed a placement within the available university slots within the country. The alternative educational channel available for these students is the Technical colleges found in many counties in Kenya, however, the available slots within the technical colleges to accommodate the secondary school graduates are limited (Chege & Kariuki, 2016).

The Kenyan government in order to provide education to the youth started enrolling students in technical colleges (Unterhalter, 2019). The enrollment, however, did not achieve the desired goal of equitable and quality education equal due to educational resources access challenges.

The Kenyan government created the technical institution's authority which formulated the strategic plan for the period 2018 to 2022. The authority indicated that there were no clear institutional and national legal frameworks to guide the sector. The authority expressed the need for more research in technical institutions due to the limited research services being currently offered by the authority (TVETA Strategic Plan, 2018). The technical institution's authority stated the need for other players like academia to support research-based engagements within the technical colleges sector (TVETA Strategic Plan, 2018).

The limited access to educational resources especially by the marginalized communities remains an inhibitor that requires immediate solution and ICT can be used to improve educational access (Saina, Mukwa & Kyalo, 2018).

This study aims to develop an enhanced educational resources access model for the technical and vocational colleges within marginalized communities in Kenya (Novak & Tjoa, 2018).

The development and adoption of this enhanced model will improve access to educational resources by students and teachers living within the marginalized zones of this country.

1.2 Problem Statement

Students living among the marginalized communities in Kenya continue to experience limited access to current and relevant educational resources (Chege & Kariuki, 2016; TVETA Strategic Plan, 2018). Limited access to educational resources denies the youth the necessary hands-on skills required to secure employment in the ever-changing labor market (Miriti et al., 2014).

Integrating ICT in Education will allow the youth who are on the move to learn whenever and wherever they want to learn (Abuya, 2014; Novak & Tjoa, 2018). ICT will reduce the cost of education by offering alternative and affordable learning platforms like free and open-source software and open educational resources (Rekha & Adinarayanan, 2014).

1.3 Research Objectives

- i. Determine factors limiting access to educational resources by the marginalized communities.
- ii. Identify suitable educational resources access solutions for the marginalized communities.
- iii. Develop an ICT educational resources access model for the marginalized communities.
- iv. Verify the developed ICT enhanced educational resources access model for the marginalized communities.

1.4 Research Questions

- a. Which issues inhibit access to educational resources by the marginalized communities?
- b. How can access to educational resources challenges be reduced?
- c. What programs enable educational resources sharing by the marginalized communities in Kenya?
- d. What are the integral modules of an ICT enhanced educational resources access framework for the marginalized communities?

- e. Which are the suitable strategies for the development of access model within the educational sector for the marginalized?
- f. What methods can be employed to verify an enhanced ICT educational resources access framework for the marginalized communities?

1.5 Significance of the study

The research output will provide guidelines on the provision of quality education to the marginalized community. Providing better educational opportunities will ensure that the marginalized communities secure the necessary digital skills required to fully contribute to the digital world today (Novak & Tjoa, 2018). A change in the living condition of the marginalized communities will promote their social interaction with the entire citizenry of the country this will foster peace and stability within the nations (Mammon, 2017).

1.6 Limitations of the study

The study was conducted in Tharaka Nithi one of 14 marginalized counties in Kenya. The findings may not apply to all counties in Kenya. The study duration of two months could not allow intensive and extensive research which could reveal technical, cultural and social aspects of the society. Respondents in some areas were unable to use tools online-based Questionnaire due to internet connectivity challenges.

CHAPTER 2

LITERATURE REVIEW

2.1 Educational Resources

Teachers should develop educational materials capable of conveying the necessary idea or concept to the student (Al Azri & Al-Rashdi, 2014). The teaching materials owned by the teachers are able to captivate the students and have a positive impact on students.

The introduction of ICT in Education promised great gain, however, cost consideration is critical in picking which ICT investment to engage in. The selection of educational ICT projects must be done with caution for the achievement of desired goals (Piper, Zuilkowski, Kwayumba & Strigel, 2016). The teaching and learning process requires many and different digital educational resources.

The learning environment can benefit from various learning tools if well organized and availed to the students.

Open education resources are educational resources that are available for free for educational purposes (Al Abri & Dabbagh, 2018). *E-journals* contain research findings written by and for the faculty in a scholarly format and are a critical part of library subscription for scholarly literature (Kenchakkanavar, 2014).

E-book or electronic book are educational materials presented via electronic mediums and availed to the students. The electronic components includes text, audio and video (Bozkurt & Bozkaya, 2015).

2.1.1 Marginalized communities

The challenge of identifying and working with the marginalized community is a common problem project manager's encounter (Malek, Gatzweiler & Von Braun, 2017). Marginalized communities refer to people whose access to quality and sustainable education remains elusive. The marginalized people operate with little or no resources at all which continues to impoverish their lives and those of their children (Okilwa, 2015).

The definition of a marginalized community enables project leaders to indicate the project intensions, monitor the project and indicate if the project transformed the community (Prilleltensky, 2014).

2.2 Factors limiting access to educational resources by marginalized communities

1. Financial limitation

Many students within the marginalized zones are not able to access educational resources due to the high cost of these educational resources. The cost of textbooks is high and solutions required to handle these high costs (UNESCO, 2016). The cost challenge affects primary, secondary and tertiary levels of education (Kimani & Gitahi, 2017). Computing devices cost are prohibitive making students unable to access and use the devices (Hori, Ono, Yamaji, Kobayashi, Kita & Yamada, 2016). The students from the marginalized groups are not able to access other online resources like journals which require internet access to access them (Bailey, Scott, & Best, 2015; Kibuku, Ochieng & Wausi, 2020)

2. Lack of schools

Thought the provision of necessary educational facilities in Kenya by the government, the marginalized zone continues to suffer from the lack of basic learning structures in schools (Koissaba, 2017). In some marginalized areas the government does not build and support schools but only provide police stations, military base and other administrative bases (Okilwa, 2015). The schools in these marginalized areas require consistent and deliberate acts of funding because the schools within the marginalized zones lack necessary supporting tools (Plessis & Mestry, 2019). The schools continue to experience or lack important components like libraries and laboratories required for quality education (Afework & Asfaw, 2014).

3. Lack of teachers

The teacher role is consistently changing where both the students and teacher require close interaction (Nathenson & Henderson, 2018). In marginalized communities, the lack of enough teachers is a serious challenge affecting access to quality educational resources (Hlalele, 2014). The marginalized communities have to contend with a few numbers of qualified teachers challenges (Plessis & Mestry, 2019). Teachers within the marginalized groups are made to handle tasks beyond their domains like store and inventory management of educational resources which leads to low morale among teachers (Afework & Asfaw, 2014). Access to important resources like libraries is limited due to the lack of qualified librarians to manage school libraries (Mojapelo & Fourie, 2014). The requirement for teacher training in ICT should be implemented for the education sector to realize the required growth (Kibuku, Ochieng & Wausi, 2020).

4. Lack of clean water and proper sanitation

The communities in marginalized zones lack water and have to keep moving from one place to another. This means that the children are not available to attend schools when learning opportunities are presented to them (Okilwa, 2015). The marginalized groups are seen from the veil of long walk to schools. Critical services like water and sanitation are not available affecting the health conditions of children making them fail to attend schools (Hlalele, 2014). The lack of toilets and clean water affects teacher's performance because the majority of the teachers offering their services in these schools are uncomfortable hence low morale and motivation by both students and teachers (Plessis & Mestry, 2019; Lumby, 2015).

5. Power connectivity and roads network challenges

The schools within the marginalized areas are not close together making students trek for many hours. The roads in rural areas are in poor states with some lacking bridges, this leads to increased absenteeism when the rainy seasons start (Hlalele, 2014).

Learning tools like desktop computers, laptops, radios, and other devices that require power cannot function in these areas which then limit the possibilities of children accessing any educational resources using these devices (Plessis & Mestry, 2019; Okilwa, 2015). Lack of electricity in schools continue to reduce the possibility of accessing important educational resources which can only be operated if schools were connected to electricity or other energy sources (Mojapelo & Fourie, 2014).

6. Legislation and Political challenges

Countries educational policies have not supported the growth and development of education within the marginalized zones. The government has introduced what can be termed as discriminative policies that do not improve the quality of education (Orodho, 2014). This means that discriminative policies have made many marginalized people lack access to educational resources necessary for their educational development. Many governments have to put in-place policies that support the cause and needs of teachers (Plessis & Mestry, 2019). The policies or legislation used like when determining the acceptable non-academic criteria limits access to education by the marginalized people. These policies undermined instead of reinforcing education access especially for the rural poor (Orodho, 2014). The available mechanism to address the challenges of bad policies can be addressed through the proper judicial process (Lumby, 2015). The lack of policies is evident even in universities which

could have formed the foundations upon which technical institutions could have developed their ICT based policies (Kibuku, Ochieng & Wausi, 2020).

7. Insecurity challenges

The tribal tension between the various groups living within the marginalized areas leads to continuous fighting. The tribal tension and fighting affect the education sector because children are not able to stay in schools and learn (Okilwa, 2015). The long term impact on these children is huge with great influence on their social and emotional wellbeing which affects them and the society (Ullucci & Howard 2015). Many attacks that have happened in these marginalized areas have made students and teachers to leave these zones (Okilwa, 2015).

8. Language, Social and cultural limitations

The marginalized people will not be willing to access or share educational resources if the resources do not support their language or culture. The marginalized people will only use the resources if opinion makers in the society agree to use the resources (Shiratuddin, Smeda & Wong, 2014). The organizational, cultural and teacher's belief and willingness to change to new technology limits to a great extent access to educational resources (Hori et al., 2016). The use of educational devices like electronic books will depend on the perceived good or utility which the teachers and students can derive from them (Zhang, Niu & Promann, 2017). Teachers using English alone limits access to educational resources by excluding those within the marginalized group who cannot use English (Orodho, 2014). The practices of segregation practiced by various people do limit children from accessing important educational resources (Ullucci & Howard 2015).

9. Libraries licensing policy challenges

Vendors of electronic-books put limits on the allowed number of circulations in libraries (Sewell & Link, 2016). The circulations limit is at a time set on titles or on loan duration where a library cannot circulate out a book beyond the set number of times. The limit on the titles restricts the number of titles that the marginalized community libraries could receive. The limits are either per e-book page or per entire e-book (Maceviciute, Borg, Kuzminiene & Konrad, 2014). The agreements in some libraries are more rigid limiting printing to only 20% of any book (Walters, 2014). The students within the marginalized communities are negatively affected by these libraries business models. The no or libraries within the

marginalized communities are few and the libraries open for a few hours which limits access to educational resources (Ullucci & Howard 2015).

10. Stakeholders' identifications

In developing ICT based solutions, participant selection is critical for project success. The participants in educational resource access projects need to be selected with caution by the people managing such projects. The project could have the best financing model with a good plan however, the stakeholders to execute the project and benefit from the project must be identified properly (Butler & Adamowski, 2015).

The use of crowd sourcing is an effective mechanism of getting the requirements and avoids conflicts with the stakeholders (Hosseini, Phalp, Taylor & Ali, 2014). The use of the bottom-up mode of operations and teachers can help resolve such conflicts (Wang, Yang, Shi, Zhou & Zhang, 2015; Ullucci & Howard 2015).

2.3 Solutions for improving access to educational resources

1. The libraries sharing model

The library sharing initiative allows libraries to share the books that they have to increase the total number of books available to its patron. Libraries allow other libraries to access some of their books hence helping resolve the access to textbooks challenge. The libraries from the marginalized communities do benefit from this sharing model which enables them to expand their book collection. The libraries do experience resource sharing challenges hence the need to develop a resource-sharing model to help them extend their resources (Prakashe & Tayade, 2015). The other sharing aspect is based on the resource in common (RIC) model. The model is based on the fact that libraries have some common resource which can be shared by putting all the common books together for use by a larger group of users (Acadia, 2016).

2. Chilo Book model

The Chilo book solution was developed to address the connectivity challenge and serves in places where internet connection is a challenge. The model relies on the advantages offered by mobile devices and the advancement of e-book file formats. The Chilo based e-book framework is one of the leading solutions in improving access to e-books through its advanced text manipulations and access capabilities.

The chilo framework allows the content and both the EPUB3 and HTML5 file format. The EPUB3 format offers access to content in areas where no internet is available while the HTML5 format offers access to those in areas with internet connection. Studies conducted on

the use of Chilobook model indicated that 47% of the people who used the Chiloe-book were from developing counties where connectivity challenges are prevalent (Hori et al., 2016).

3. Bring your own device Initiative

This initiative is allowed in organization by allowing users or students to bring computing devices to schools and use them as learning tools. Bring your own device project allows students to access learning content on their devices with little restriction from school management (Afreen, 2014). This model can be used by marginalized communities to bring the cost of education down because students own the devices so the cost of securing the device is met by the students or the parents. The initiative allows students to continue learning even when away from schools. Students receive instruction from teachers through the use of instructional tools like Skype which is used to guide the students at a specific time when assistance is required. Skype and Zoom are useful educational tools in areas where teachers are not enough (Dharma, Asmarani & Dewi, 2017)

4. Provision of free primary and secondary education

In Kenya, the government support for quality education initiatives is evident through the provisioning of free primary education since 2003 (Lelei, Weidman & Sakaue, 2015). The government introduced cost-sharing and bursaries models in education which have expanded education access opportunities in Kenya (Orodho, 2014).

The provision of university bursary has provided an opportunity for students from marginalized communities to access university education in Kenya. The number of students in marginalized areas receiving these help is low compared to other zones (Okilwa, 2015).

5. Open Education Resources

Open education resources denote educational materials that users can access freely and can amend them (Zancanaro, Todesco & Ramos, 2015). The students can legally copy, use, modified, reused and shared with others hence increasing access to equity educational resources by many learners (Kourbetis & Boukouras, 2014). The material includes text, audio, video, animations, assignments and projects.

6. Nomadic schools

Nomadic schools keep migrating to different locations because the communities migrate to different areas (Okilwa, 2015). The movements by parents especially those in marginalized zones make the children unable to access school. The nomadic schools help such students to

access schools even when parents migrate to new areas (Ullucci & Howard, 2015). Studies have indicated that the cost of nomadic schools is quite high and joint partnership is required between government and other stakeholders in the education sector to make the nomadic school a reality (Okilwa, 2015).

7. Community Radio

The marginalized communities can secure learning lessons through the use of community radio. The community radios offer broadcasts to the marginalized communities. The radio stations offer educational broadcasts to the marginalized in matters health, agriculture and other spheres of life (Khan, Khan, Hassan, Ahmed & Haque, 2017).

The community's radios have in some cases provided educational resources specifically targeting the women in the marginalized zones (Nirmala, 2015).

The radio though seen as an outdated means of communication can supplement other options like the ICT based solutions to offer educational resources to the marginalized groups. The radio is used for many purposes from education to health-related training (Yasunaga, 2014).

8. Partnership

For real development in the marginalized zones to happen in the educational sector partnerships are solutions that can be explored. The partnership can be in many formats and between different stakeholders.

Schools engage in various partnerships with private and public partners. The link among science teachers and technology partners enable school to improve curriculum and offer relevant learning materials (Tytler, Symington, Williamns, White, Campbell, Chittleborough & Dziadkiewicz, 2015)

In education, public-private partnership can enable the partners to optimize resources because the partners are enablers and contribute a wide range of expertise and technology necessary to make education successful (Sharma, Gupta, Chowhan & Srivastava, 2015)

9. Virtualizations

System virtualization is considered in cases where performances versus cost options are under consideration. System virtualization is a concept that enables a physical computer to run several operating systems in controlled virtual machines under the management of a hypervisor (Pousa & Rufino, 2017). Virtualization brings with it the advantages of availability and enhanced performance with the flexibility and cost-saving benefits (Savaglia & Wang, 2017).

The advantages of virtualization can support the marginalized zones due to the cost demands facing the marginalized communities. Virtualization offers various types including desktop virtualization which conceals the main computer system and other computer software's from the users. This type of virtualization is also called client virtualization (Michael, 2015). This model offers computing resources to users at a lower cost and less power allowing each student to secure a personal computing session (Michael, 2015).

2.4 Role of ICT for the Marginalized

Marginalized communities refer to a group of people who are systematically excluded from participating in meaningful economic, political, and social life (Maitland, 2018).

ICT has the potential to address to a great extent the development needs of the marginalized communities in various aspects of the marginalized people. The use of ICT in creating solutions for the marginalized requires an understanding of the role ICT can play to bridge the digital gap.

The provision of connectivity to the marginalized will to a great extent offers far-reaching benefits to the marginalized people including education and health care sector benefits (Maitland, 2018; Dunn, 2016). ICT4Education promises to improve access even among the marginalized communities, though challenges related to design and pedagogy are key issues that require to be resolved before such promises become a reality (Kamal & Diksha, 2019).

In Agriculture, ICT is used to empower farm workers by improving access to information that is necessary for economic, social, and political empowerment. ICT offers the marginalized group health, educational services not forgetting the capacity to digitally link them to a network of many possibilities e.g. new markets (Nakasone & Torero, 2016).

Technology is used to unite those under social segregation and help them reach the outside world. Technology remains the only option for such people to reach their families and help keep other relationships active (Almohamed & Vyas, 2016; Khorshed & Imran, 2015).

ICT can be used by the government to improve the political engagement of the marginalized people by building tele centers and providing internet access to the marginalized to enable them to participate in their civil duties (Nemer & Tsikerdekis, 2017).

2.5 Relevant ICT Policies

The introduction of ICT in education will help expand the skills base hence transform the country. ICT offers great opportunity for development and growth more so in the education sector due to the fact that it's a key enabler required for the digital economy in Kenya. The need for investment in network infrastructure which will facilitate research in tertiary colleges is in line with local and international standards. The lack of ICT skills among the

youth can be resolved through curriculum review use of mentorship sessions, retooling and use of massive online open courses (MOOCs) among the youths (Digital Economy Blueprint,2019).

The National Quality Assurance framework by the Technical and vocational Authority plays a critical role when designing programmes in education by the technical colleges in Kenya. The framework demands for continuous improvements achieved through input and output monitoring and evaluations. The framework requires for quality and strong research which will facilitate lifelong learning among the youths in Kenya (TVETA Quality Assurance framework, 2019).

The lack of concentration to broadband issues in the national ICT policy and specifically the regulatory framework requires immediate action by actors in the communication sector. The Broadband Strategy posits the need to address broadband access (National Broadband Strategy, 2017)

The Technical and vocational Authority Strategic plan aims to alleviate the challenges within the technical colleges including unqualified trainers and substandard infrastructure that cannot support quality training. The high cost in technical training and lack of awareness are challenges affecting in youth in Kenya who wish to join the technical colleges (TVETA Strategic Plan, 2018).

The Kenya ICT policy calls for the inclusion of technologies in vocational training systems to ensure that the youth are prepared to work seamlessly within a digital workplace. The development of a innovation hub close to each technical and vocational center will help realize the digital transformation agenda (Kenya ICT policy, 2019).

2.6 ICT in Education

The study endeavors to improve the educational standard among the rural and remote students and more so those enrolling in Technical colleges in Kenya.

The integration of ICT in education should consider both formal and informal settings which offer great opportunities and challenges (Chinapah & Odero, 2016).

In providing access to educational resources a well thought out strategy must be put in place to ensure success which is the primary goal for any ICT development initiatives. The strategy must consider and make the community members a key component (Atieno & Moturi, 2014). The integration of ICT in education is hampered by many challenges including lack of the necessary infrastructure for ICT integration and high maintenance cost required to sustain the project (Njoka, Githui & Ndegwa, 2020).

This study aims to develop an ICT model that will improve access to educational resources levels among the marginalized communities. To undertake this process the study reviewed relevant literature concerned with ICT use in improving learning.

ICT-Based frameworks should have the principles of good practice which include support for teachers, real partnerships, relevant and local content and sustainable funding model (Kundu, 2019).

The development of ICT based frameworks for educational purposes must adhere to the educational context and consider various factors. The factors include pedagogical alignment, teachers' skills and confidence (Chinapah & Odero, 2016).

Studies have supported the idea that ICT integration should not be addressed separately but it is an interdisciplinary affair that required efforts from multiple sectors (Becuwe, Roblin, Tondeur, Thys, Castelein & Voogt, 2017)

2.7 Theoretical frameworks

The proposed model was developed after a review of various frameworks, models and related theories of ICT Enabled education in rural areas.

The frameworks provided the variables this study used in the technological, economic and social aspects of the marginalized communities and more so the technical colleges in marginalized zones.

ICT-Based Education should have technological requirements, social aspects and cultural contexts of stakeholders (Alkhaldeh, Olimat & Al-Rousan, 2015).

The ICT-based framework envisages the environments and participants in the environments. ICT-Based education models will have a lasting impact on the rural population if all stakeholders are considered in the design (Chinapah & Odero, 2016). The various models and frameworks are reviewed in the preceding section.

2.7.1 Rural Kiosk Machine for ICT Rural Education Model.

The model various components are geared toward providing education and other social services to the community.

The rural community center consists of Rural Kiosk Machine and the ICT-Training Centre all housed in a rural school that provides twenty-four-hour access to different people. The center offers a location for training and discussion after the training.

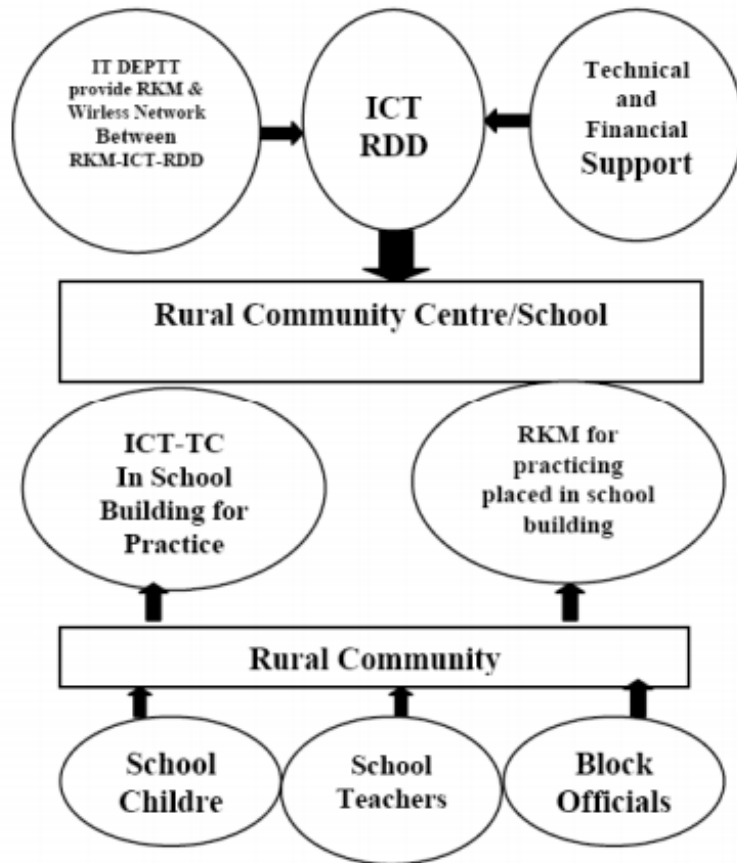


Figure 1 Model for ICT Rural Education

The Rural Kiosk Machine contains information in text, audio and video format and in different languages. The information is updated regularly by the use of wireless connection by the ICT –Rural Development Department.

ICT–Rural Development Department is responsible for getting the latest information and updating all the Rural Kiosk Machine and provides training to instructors.

The ICT Training Centre provides basic education on how to get services from this facility. The training is provided in every school where the facility is established. The model for ICT for rural Education proposes training, management support, quality content development, improved and multiple access channels, community inclusion and partnership as key ingredients for ICT integration in rural areas (Roy, 2012).

This research borrowed from the above model the concept of community inclusion, partnership and management, multiple channel access, online update for offline use and training to be a key component for rural ICT for educations models.

2.7.2 A framework for poverty alleviation with ICT

The framework for poverty alleviation indicated that technology can be used to improve the living standards of the poor by first understanding the various dimensions of the digital divide

experienced by the marginalized. The framework supports other studies that have indicated that educational policies are critical for the success of such engagements (Kozma, 2005).

The model key components include appropriate strategies that can be used to ensure ICT delivers the desired goal in education and other aspects of people’s lives. The framework for poverty reduction using ICT tries to reduce the digital divide gap by employing strategies that are sensitive to the wish of the poor (Harris, 2002).

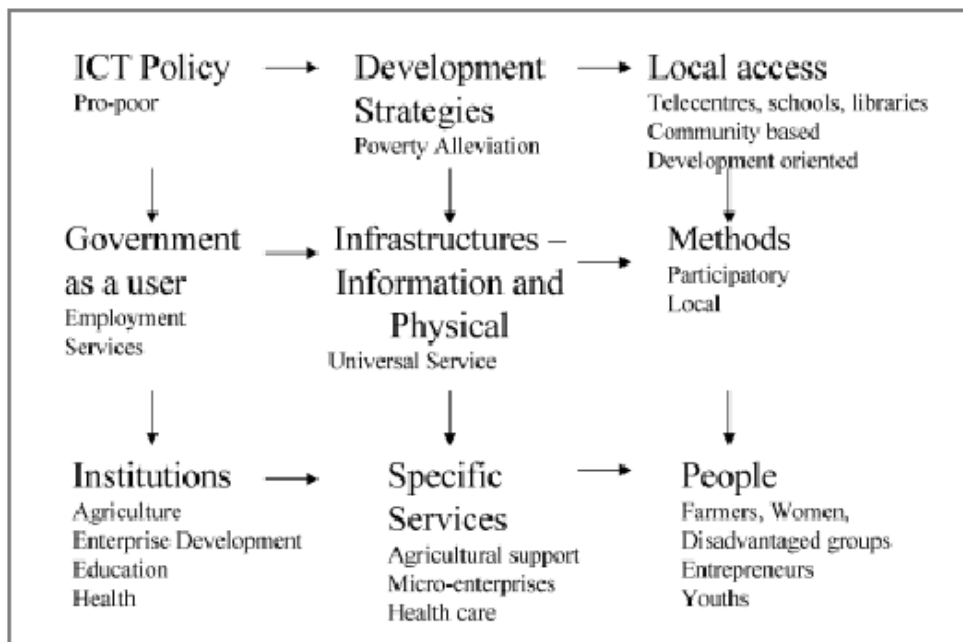


Figure 2 Framework for poverty alleviation with ICTs

The Poverty Alleviation Framework equipped this research with the concept that research in ICT integration in rural areas should think about the poor, embrace government and other partners in building local access centers. The development of local educational initiatives should have the community member’s involvement which ensures that local members support such projects.

2.7.3 E-CLRC Framework

The Community Learning and Resources Center (CLRC) framework promotes Education by supporting the following objectives among the rural and remote areas.

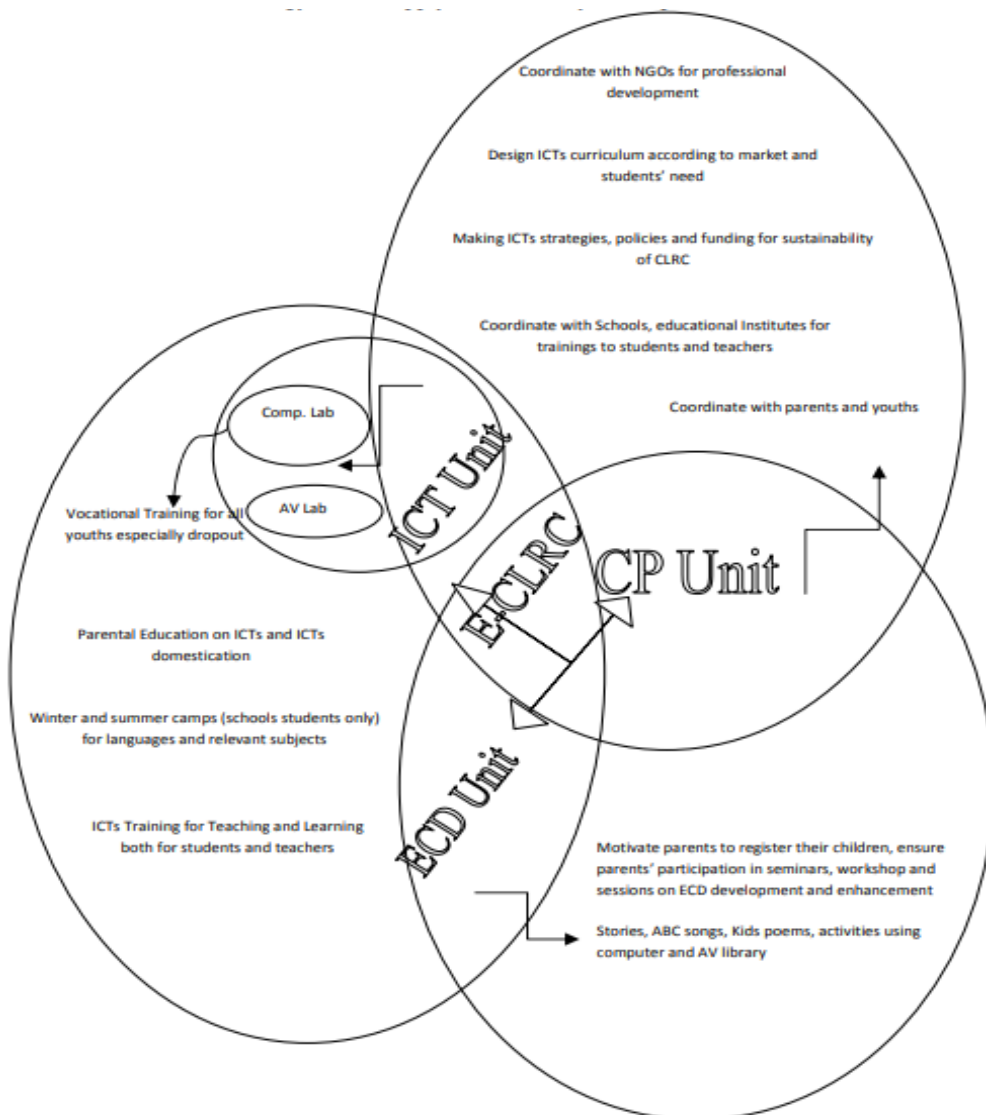


Figure 3 E-CLRC Framework

The objectives include; raising ICT skills for lifelong learning, improving academic performance among rural students, develop a desire to learn using ICT that goes beyond school, expand literacy to parents and the community members, and the use of IT to increase creative thinking in youths.

The Community Learning and Resources Center framework is made of the following Units. The ICT unit, this consists of ICT training for teachers and learners, parental education on ICT and ICT domestication, vocational training for all youths. The ECD unit motivates parents to register students, ensure parents participate in seminars and workshops in ECD development and the use of computers for stories and other learning activities. The third part

is the CP unit which deals with ICT Curriculum design according to market needs, promoting and marketing, ICT strategies and policies, coordination of NGOs, and educational institutes for professional development and training of teachers and students (Rahim, Tie & Begum, 2014).

2.7.4 FORE Framework

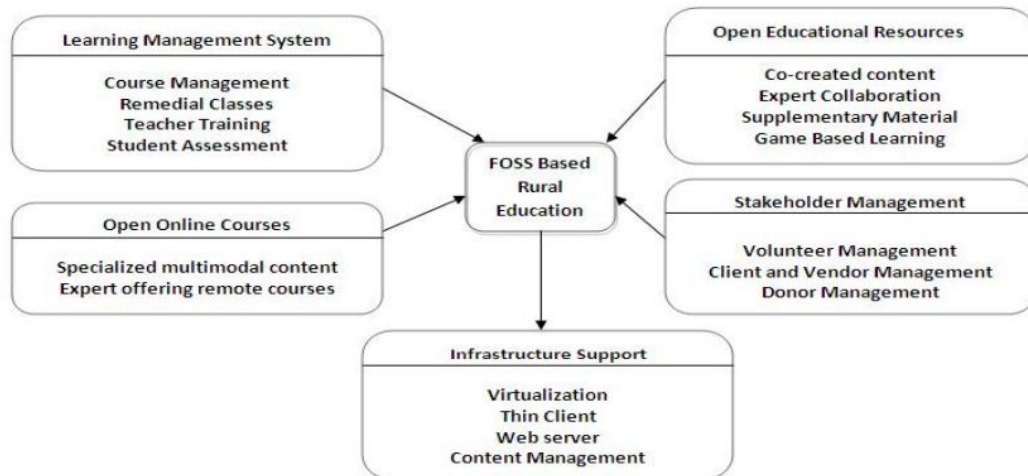


Figure 4 FORE Framework

The framework addresses the challenges of access to quality education materials in rural schools by incorporating the various open-source software and open education resources and other critical components like management in a learning center (Rekha & Adinarayanan, 2014).

The FORE framework considered what the necessary parts for provisioning education are among the rural poor. The framework suggested that cost was a major hindrance to quality education. The Fore framework proposed an alternative and affordable solution driven by free and open-source software, open educational resources, content management solutions, management and local support and supporting infrastructure.

The Fore framework proposed solutions to address the ICT infrastructure cost challenge which are major impediments in integrating ICT in education among the marginalized communities (Pringle & David, 2002).

The Fore frameworks bring to this research the concept of free and quality open education resources, open-source software, appropriate hardware, and software and management necessary components in improving educational resources access for the rural poor.

2.7.5 The National Framework for Rural and Remote Education in Australia

The Framework is made up of three components. The vision of the framework is to provide education to people in the rural area or the remote sections of the community. The other

components are principles and enablers. The framework borrows strongly the concept of ICT Enabled Education and as such includes ICT as one of the Enablers in improving Education in rural areas.

The framework identified teacher training, management support, relevant content, improved access channels, multiple access channel, community inclusion and partnership as key ingredients for ICT integration in rural areas (Spring, 2001).

The PRIMER model supports this study by pointing out what to consider if ICT is to be used in addressing the challenges of the rural poor. From the model ICT and other social aspects of the people must be combined to bring desired results among the rural communities (Alkhaldeh et al., 2015).

NATIONAL FRAMEWORK FOR RURAL AND REMOTE EDUCATION						
Vision	By age 18 each young person residing in rural or remote Australia will receive the education required to develop their full potential in the social, economic, political, and cultural life of the nation.					
Principles	<ul style="list-style-type: none"> Students and families living in rural and remote Australia have specific needs which are the direct result of living in particular geographic locations. The needs of rural and remote students should be met through local commitment and ownership as well as through predictable and sustained government funded initiatives. 		<ul style="list-style-type: none"> There is a high degree of variability in the characteristics of rural and remote communities, both within and between states and the Northern Territory. The provisions of education in rural and remote Australia requires creative and flexible approaches that utilize leadership capacity at all levels, innovative technology and methodology, and whole of government approaches. 			
Essential Enablers	P ersonnel	R ellevant Curriculum	I nformation Communication Technologies	M ultimode Delivery	E nvironments	R esourcing
Key Challenges and Requirements	Training & Development Leadership/Succession Recruitment/Retention	Pathways Standards Outcomes	Quality Access Content	Flexibility Innovation Structures	Cultural Sensitivity Partnerships Community	Predictability Assuring Quantity Building Capacity
	Diverse & reliable supply Success plans Incentives Family assistance	Programs consistent with national goals Articulated planning for life-long learning Access to VET Enterprise Education	Broadband provision Affordability and accessibility Reliable infrastructure	Support of current modes ICT Training and Development for staff Broadening of best practice networks	Support of industry, civic, education, government and nongovernment collaboration Identification and use of local expertise and leadership	Support for local for social capital building Funding for equitable access Disseminate best practice Whole of government approaches

Figure 5 National Framework for Rural and Remote Education.

The study conceptual model was derived from the National Framework for Rural and Remote Education framework. The proposed model (Figure 1) depicts the relationship between the challenges independent variable, the Primer model enablers which are moderators, the ICT infrastructure, and access to educational resources the dependent variables.

2.8 Conceptual Framework

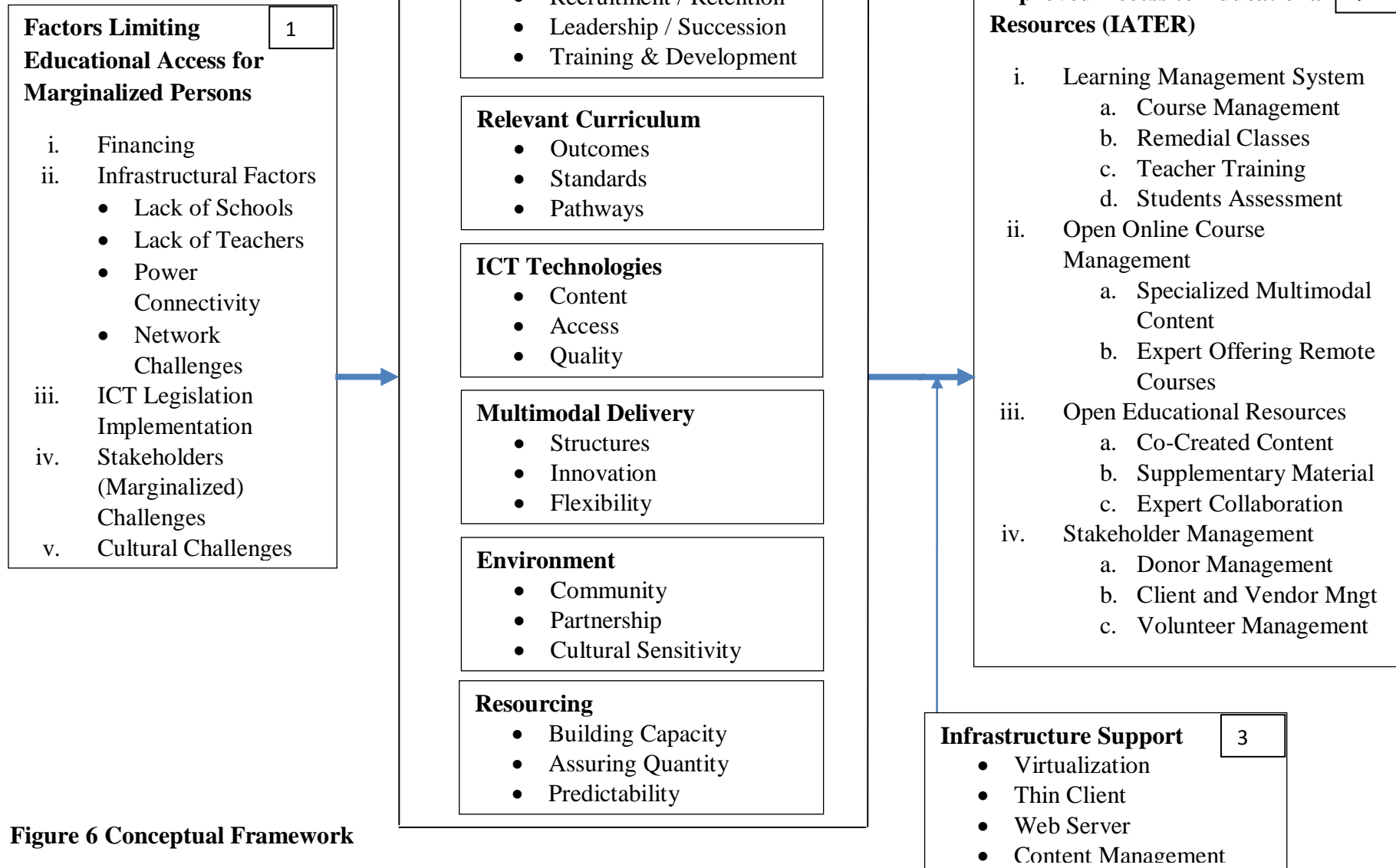


Figure 6 Conceptual Framework

2.8.1 Conceptual Framework Components

The framework addresses the challenges of access to quality education materials in rural schools by incorporating the various open-source software and open education resources and other critical components like management in a learning center.

The framework recommended the use of the PRIMER framework to address access challenges. The framework posits that the key ingredients for ICT integration in rural areas are teacher training, management support, relevant content, improved access, multiple access channel, community inclusion and partnership (Alkhaldeh et al., 2015). The PRIMER model was used in this research to point out what to consider if ICT is to be used in addressing the challenges of the rural poor. The PRIMER enablers are the moderators in this research.

The improved Access to Educational Resources or the resulting platform represents the vision and principles of the PRIMER model. The vision for rural education calls for creative and flexible methods. The Primer model calls for leadership and innovative technologies. This research proposes that free and open-source software, open educational resources, management support, supporting infrastructure to be the desired outcomes that improve access to educational resources forms such requirements. These form the desired access platforms or the dependent variables in this research.

This mediated by the infrastructural support which addresses concerns of cost and expensive infrastructure which are major impediments in integrating ICT in education and more so when dealing with the rural poor. This is possible through, Virtualization, Thin Client, Web Server, and Content Management technologies which mediators in this research.

CHAPTER 3

RESEARCH METHODOLOGY

3.0 Introduction

The section spells out the steps the study followed in preparing for the data collection and the actual data collection and analysis.

3.1 Research Design

This study used a descriptive survey due to the desire to understand the correct state of affairs in as far as access to educational resources is concerned in Tharaka Nithi County.

3.2 Target Population

The study objective was to study educational access in marginalized zones. The study selected Tharaka Nithi County which was identified as a marginalized county by the Commission on Revenue Allocation (Commission on Revenue Allocation, 2018).

The target population refers to a collection of individuals or items that a scientific study will focus on (Mugenda & Mugenda, 2003). The study maximum available total population from the above individual study groups was 510.

3.3 Sampling Design

The study employed stratified random sampling procedures in selecting the technical colleges required. The reason for this was to avoid picking colleges very close to major towns in Tharaka Nithi which could affect our research results.

3.4 Sample size

This is part of the target population that is placed under investigation to enable the study to draw scientific conclusions. Scientific research work demands that the sample size selected should be at least thirty per cent of the target population (Mugenda & Mugenda, 2003).

The sample included one college principal, one deputy principal, two heads of department, two ICT lecturers, two ICT support staff and one community leader selected from each of the 25 technical and vocational colleges. This brought the total number of respondents to 225.

3.5 Data Collections

Data collections refer to the process of gathering information to be used to understand a topic under investigation during a study. The study used guided questionnaires having open-ended and closed questions. See appendix II.

A pilot test of the questionnaires was conducted in selected schools in Nairobi to enable modification if errors were found before actual data collection in Tharaka Nithi County.

The test was done by an experienced researcher who could ensure the testing process was done successfully. Reliability testing is about obtaining the same results after several similar examinations.

Validity checking in research is about the accuracy of output from the research this includes.

Face validity

Face validity checks the clearness and unambiguity of the research instrument items. This calls for simple to answer items, understandable items with clear purpose (McElroy & Esterhuizen, 2017). The test will verify if a given instrument e.g. a good receipt note can be used for research by checking its face value. The test checked for completeness of the questionnaire among other details.

Construct Validity

The construct validity was used to test if the resulting data accurately reflects a theoretical concept. The test used statistical analysis of the instruments structure and the relationship of the response and the different terms or parts under study.

Content Validity

Test if the data collected maps to the content of the study. This involves expert judgment if the items do reflect material the questionnaire is investigating (McElroy & Esterhuizen, 2017). This test is non-statistical and carried out systematically to show if the items in the instrument represent the area or domain under review or study purpose.

Reliability testing is about obtaining the same results after several similar examinations.

3.6 Data Analysis

The analysis was done after checking for errors and evaluating the impact of the errors on the research. Then corrections were done without modifying what the respondent meant.

The management of blank responses was another major activity and a determination done on blank responses.

The coding phase was next to establishing a retrieval mechanism. The coding entailed the establishment of critical attributes or concepts or ideas. The coding process leads to patterns and themes development, the themes and pattern represented key ideas or concerns that occurred frequently or were noted by respondents as main features.

The design of every question was to aid in getting feedback on each objective and research questions. The areas under scrutiny in the conceptual framework were challenges in accessing educational resources, access solutions and an integral part of an access model. The open-ended questions required coding the results into themes, and then SPSS was used to

analyze the quantitative data with measure of central tendency carried out and results presented by way of graphs and tables.

3.7 Ethical Issues

The Data collection process was a key part of the study and the success realized depended on proper planning of the entire data collection exercise.

The ethical considerations which this research observed included.

Cost and cost consideration

The respondents were not subjected to any activity which could have made them incur any expense. Time consideration was key on the part of the respondents this was achieved by consultation with principals on what was the best time to administer the questionnaire

Power misuse by researcher

The researcher took great caution not to misuse the authority awarded to him by any means. The researchers respected all the respondents and treated them with great respect.

Failure to acknowledge other people work in research.

The researcher ensured that works from other sources were acknowledged and full citation recorded.

Confidentiality and anonymity

This research ensured that the respondents were protected by having the information they give treated with utmost care and confidentiality. We excluded the name to increase the confidentiality levels and allow the respondent to respond freely.

CHAPTER 4

DATA ANALYSIS, INTERPRETATION AND DISCUSSION

4.0 Introduction

This chapter shows the data analysis approach employed in the study in order to achieve the study objectives. The chapter concludes with the presentation of the findings and discussion of the study.

4.1 Demographic Characteristics

Examination of the data representing 218 responses showed that 143 were male while 75 females. This constituted 65.6% women and 34.4% men in regards to gender distribution.

Majority of the respondents who formed 83.0% were aged between 18-35 years, while 12.8% were between 36-50 years and 4.1% were aged above 50 years.

The study findings indicated that most of the respondents had reached some level of education with 57.8% of the participants having diploma level of education.

These findings indicate that the data collected was not biased on the demographics of the respondents as respondents of different genders, ages and education levels were sought.

Table 4. 1 Demographic Characteristics

Feature	Classification	Frequency	Percent
Gender	Male	143	65.6
	Female	75	34.4
	Total	218	100
Age Category	18 - 35	181	83
	36 - 50	28	12.8
	Over 50	9	4.1
	Total	218	100
Educational Level	Diploma	126	57.8
	Bachelors degree	81	37.1
	Masters degree	11	5
	Total	218	100

4.2 Factors Limiting Educational Resource Access for Marginalized Persons

The study sought to establish factors limiting educational resource access for marginalized persons.

The study findings indicated that 89.4% of the respondents agreed that the cost of educational material was out of reach to many students with 77.5% of the respondents approving that nearly all students could not afford computing device while only 4.6% of the respondents strongly agreed that schools have sufficient number of textbooks. The ratio of respondents who strongly approved that the internet and mobile network was not a problem in the region was only 16.5%. Based on this, it was apparent that access to educational material was hampered by the low purchasing power of the marginalized groups with textbooks, computers and the internet noted as some of the key requirements the marginalized groups require which concurs with (Kimani & Gitahi, 2017; Hori et al., 2016).

Further, 45.4% of the respondents agreed that the region had an insufficient number of schools, while 27.9% of the respondents agreed that schools in the region were unreachable by most of many pupils. In addition, the study findings had 20.6% of participants strongly agreeing that most schools in the region had a power connection while 19.3% of the respondents strongly agreed that classes had sufficient power plug-ins. These findings imply that the marginalized groups require enough school with proper infrastructure, a finding shared by (Koissaba, 2017).

The study findings indicated that the participants who strongly agreed that the teacher-pupil ratio was below the nationally accepted standard were 36.2% while the participants who strongly agreed that some schools in the region lacked teachers to teach in some classes were 71%. The findings signify the need for enough well-motivated teachers to teach the students within the marginalized groups, a position shared by (Hlalele, 2014).

The study findings indicated that stakeholders participation in the running of school activities received only 3.7% of the respondents, while only 30.2% of the respondents agreed that legislations developed by education ministry like ICT usage were promoted in the school. Additionally, the study finding reported that 92.2% of the respondents agreed that despite government fee subsidy, some schools still charge development fees. The study findings are in agreement with earlier studies that have called for sound policies in educational management (Orodho, 2014).

The study findings indicated that 30.3% of the respondents agreed that school pupil's absenteeism in the region was very high, while 39.4% of the respondents strongly agreed that cultural aspects heavily influenced school learning in this region. Social and cultural issues must be addressed if success is to be realized in educational management typical in similar other studies of education management (Ullucci & Howard, 2015).

Table 4.2 help demonstrate these findings.

Table 4. 2 Factors Limiting Educational Resource Access for Marginalized Persons

Feature		SA	A	UD	D	SD	Mean	Std
Cost of educational material is above reach for many students	Fre	74	121		23		4.11	0.861
	%	33.9	55.5		10.6			
Near all students cannot afford computing device for use in school	Fre	84	85		45	4	3.90	1.178
	%	38.5	39.0		20.6	1.8		
Despite fee subsidy, some schools charge development fees which some students cannot afford	Fre	106	95	3	8	6	4.31	0.892
	%	48.6	43.6	1.4	3.7	2.8		
There region has an insufficient number of schools	fre	53	46	9	54	54	2.91	1.569
	%	24.3	21.1	4.1	24.8	25.7		
Schools in the region are far from reach of many pupils	fre	22	39	6	63	88	2.29	1.412
	%	10.1	17.9	2.8	28.9	40.4		
Teacher pupil ration is below national accepted standard	fre	79	78	10	26	25	3.74	1.349
	%	36.2	35.8	4.6	11.9	11.5		
Some classes/subjects have no teachers hence schools improvise	fre	71	85	7	9	46	3.57	1.501
	%	32.6	39.0	3.2	4.1	21.1		
Schools have sufficient number of textbooks	fre	10	78	8	25	97	2.44	1.46
	%	4.6	35.8	3.7	11.5	44.5		
Most school in the region are power connected	fre	45	47	17	67	42	2.92	1.458
	%	20.6	21.6	7.8	30.7	19.3		
Classes have sufficient power plugins	fre	42	33		82	57	2.60	1.487
	%	19.3	15.1		39.4	26.1		
Internet and Mobile network is not a problem in the region	fre	36	38	2	45	97	2.42	1.585
	%	16.5	17.4	9	20.6	44.5		
Stakeholder participate in the running of activities of this school	fre	8	88	18	66	38	2.83	2.32
	%	3.7	40.4	8.3	30.3	17.4		
ICT usage is promoted in the school as defined by the Ministry legislations	fre	21	45	15	99	38	2.61	1.258
	%	9.6	20.6	6.9	45.4	17.4		
School pupils absenteeism in the region is very high	fre	15	51	13	60	79	2.37	1.359
	%	6.9	23.4	6.0	27.5	36.2		
Cultural aspects heavily influence school learning in this region	fre	40	46	11	55	66	2.72	1.529
	%	18.3	21.1	5.0	25.2	30.3		

Key: SA: Strongly Agree, A: Agree, U: Undecided, D: Disagree, SD: Strongly Disagree, Fre: Frequency, %: Percentage

4.2.1 Other Challenges of Educational Resource Access for Marginalized Persons

The study endeavored to get other challenges the respondents felt were limiting access to educational resources by the marginalized communities.

Table 4.3 help display these findings.

Table 4. 3 Other Educational Resource Access Challenges

Feature		Yes	No	Mean	Std
Physical Infrastructure	fre	55	163	0.25	0.435
	%	25.2	74.8		
Technological infrastructure	Fre	36	182	0.16	0.37
	%	16.5	83.5		
Financial Infrastructure	fre	27	191	0.12	0.33
	%	12.4	87.6		
Human Resource Infrastructure	fre	33	185	0.51	0.359
	%	15.1	84.9		
Natural Calamities	fre	27	191	0.12	0.330
	%	12.4	87.6		
Social Factors	fre	38	180	0.17	0.38
	%	17.4	82.6		

Key: Fre: Frequency, %: Percentage

The study findings indicated that 25.5% of the respondents believed that physical infrastructures was a challenge facing education access in the region whilst 16.5%of the respondents thought that technological infrastructures were challenges affecting educational access in the region. Educational expansion required in the marginalized areas requires addressing first the physical infrastructure like schools and roads these findings are supported by (Lelei, Weidman & Sakaue 2015;Okilwa, 2015)

Financial challenges were reported by 12.4% of the respondents while 15.1% of the respondents cited human resource infrastructure challenges. Education access in the region was partially affected by natural calamities this was supported by 12.4%of the respondents while 17.4% of the respondents believed that social factors were affecting educational access in the region.

These findings are represented graphically in figure 6.

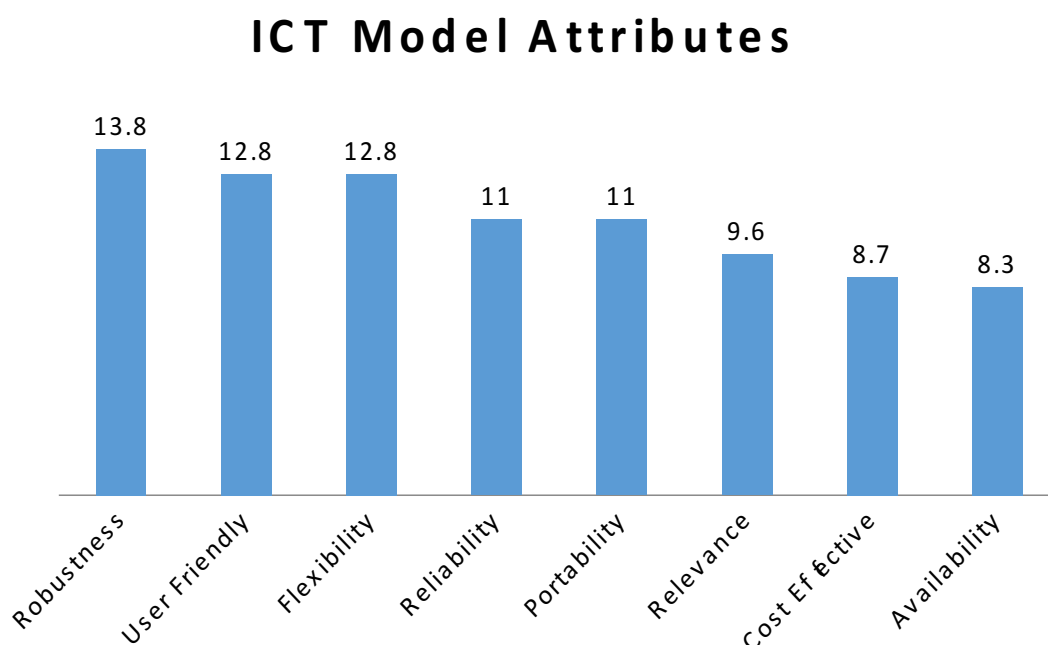


Figure 7 Other Educational Resource Access Challenges

4.3 Suitable Educational Resources Access Solutions for the Marginalized

The study sought to enumerate the Suitable Educational Resources Access Solutions for the Marginalized Communities through ICT utilization that have a bearing on ICT access models.

The study findings indicated that personnel management was an important aspect of solving access to education. Recruitment, leadership and training were crucial aspects of personnel management in education with 85.7% of the respondents showing that training had the biggest impact as a solution in providing access to education. This is advocated for and supported by related studies in education (Kibuku, Ochieng & Wausi, 2020).

The study findings showed that the relevant curriculum was a vital aspect in addressing access to education challenges. Relevant curriculum encompassed well-defined outcomes, appropriate standards and relevant pathways. The study showed that in providing access to education appropriate standards was supported by 95.4% of the respondent these findings are supported by (Miriti et al., 2014).

The study findings showed that Information Communication Technology was a vital aspect in addressing access to education challenges. The study showed that Information Communication Technology supported appropriate content, access opportunities and quality

reviews. Content was reported by 49.1% of the respondent as having the greatest impact in mitigating access challenges these findings are supported by (Kundu, 2019).

The study findings showed that multiple delivery channels were a vital aspect in addressing access to education challenges. In resolving access to education challenges, multi-mode delivery advocated for innovativeness, flexibility and diversified structured methods of education management. The study showed that 93.6% of the respondent viewed diversified structured methods of education management as having the greatest impact in mitigating access challenges. Managers of access solutions must diversify their educational solutions, these findings are supported by (Myers, Blackman, Andersen, Hay, Lee & Gray, 2014).

The study findings indicated that provisioning access to education required environmental consideration. In managing educational projects environmental considerations included community aspect considerations, partnerships and cultural characteristics must be considered. Community aspect considerations had 85.7% of the respondents indicating their importance in providing access to education (Atieno & Moturi, 2014).

The study findings indicated that provisioning access to education required sufficient funds targeted to specific educational projects in rural areas. Funding should be directed towards capacity building, assuring quality and predictable projects. In managing educational projects capacity building had 95.4% of the respondents indicating of its importance in promoting access to education, this concurs with (Pompa, 2014).

Table 4.4 help disclose these findings.

Table 4. 4 Suitable Educational Resources Access Solutions

Feature		SA	A	UD	D	SD	Mean	Std
Recruitment and retention of personnel including teachers and support staff is lacking for support ICT educational access models	fre	88	86	2	21	21	3.91	1.290
	%	40.4	39.4	9	9.6	9.6		
There is no leadership succession policy for schools in the region to enhance ICT capacity	fre	50	77	19	46	26	3.36	1.354
	%	22.9	35.3	8.7	4.1	11.9		
Training and development for teaching staff is inadequate to support ICT educational access	fre	74	113	2	19	10	4.00	1.075
	%	33.9	51.8	0.9	8.7	4.9		
Curriculum outcomes through ICT Model use can only be enhanced not compromised	fre	44	129	10	17	18	3.76	1.110
	%	20.2	59.2	4.6	7.8	8.3		
Customized standards in ICT models use need to be developed for resource accessibility	fre	101	107		10		4.41	0.580
	%	46.3	49.1		4.6			
Learning pathways are easier to follow by use of ICT models	fre	61	101	17	32	7	3.81	1.097
	%	28.0	46.0	7.8	32	14.7		
ICT models are capable of covering all educational content	fre	25	82	8	65	38	2.94	1.354
	%	11.5	37.6	3.7	29.8	17.4		
ICT models are accessible in the region despite infrastructural challenges	fre	36	47	2	90	43	2.75	1.424
	%	16.5	21.6	0.9	41.3	19.7		
Quality of education is not compromised by ICT models	fre	35	67		63	53	2.86	1.483
	%	16.1	30.7		28.9	24.3		
ICT platform must develop various delivery structures of content including mobile and web based	fre	88	116	1	8	5	4.25	0.840
	%	40.4	53.2	0.5	3.7	2.3		
Innovation be prioritized over content to ensure the platform adds value and flexibility	fre	76	116	2	13	11	4.05	1.046
	%	34.9	53.2	0.9	6.0	5.0		
It is easy to achieve platform flexibility to education resources using ICT access models	fre	51	95	10	37	25	3.52	1.317
	%	23.4	43.6	4.6	17.0	11.5		
Community can provide practical information on kind in ICT model they think is practical for them	fre	66	125	8	12	7	4.05	0.921
	%	30.3	57.3	3.7	5.5	3.2		
The ICT education access model has to be developed and supported by partners	fre	59	123		15	21	3.80	1.217
	%	27.1	56.4		10.1	9.23		
The ICT model must be intelligent and sensitive to the region's culture	fre	6.2	114		22	20	4.43	0.581
	%	28.4	52.3		10.1	9.2		
ICT models for education access need more capacity development if they are to be successful	fre	104	104	10			2.29	1.352
	%	47.7	47.7	4.6				
Quantity management cannot be an issue for ICT educational access models	fre	79	86	4	33	16	3.82	1.265
	%	36.2	39.4	1.8	15.1	7.3		

Key: SA: Strongly Agree, A: Agree, U: Undecided, D: Disagree, SD: Strongly Disagree, Fre: Frequency, %: Percentage

4.3.1 Major ICT Attributes that the ICT Model should have to enhance Educational Access

The study sought to assess the major ICT attributes that the ICT model should have to enhance educational access.

Table 4.5 discloses the study findings.

Table 4. 5 Major ICT Attributes that the ICT Model should provide

ICT Attribute		Yes	No	Mean	std
ICT Reliability					
	fre	24	194	0.10	0.308
	%	11.0	89.0		
ICT Availability		Yes	No	Mean	std
	fre	18	200	0.09	0.283
	%	8.3	9.7		
ICT Robustness		Yes	No	Mean	std
	fre	30	188	0.14	0.345
	%	13.8	86.2		
ICT Cost Effective		Yes	No	Mean	Std
	fre	19	199	0.08	0.282
	%	8.7	91.3		
ICT Portability		Yes	No	Mean	std
	fre	24	194	0.11	0.313
	%	11.0	89.0		
ICT User Friendly		Yes	No	Mean	std
	fre	28	190	0.12	1.333
	%	12.8	87.2		
ICT Relevance		Yes	No	Mean	std
	fre	21	197	0.09	0.295
	%	9.6	90.4		
ICT Flexibility		Yes	No	Mean	std
	fre	28	190	1.13	0.335
	%	12.8	87.2		

Key: Fre: Frequency, %: Percentage

The study findings indicated that 11.0% of the respondents thought that ICT reliability was the major ICT attribute that would enhance educational access while 8.3% of the respondents believed that ICT availability was the main ICT attribute that would enhance educational access.

Additionally 13.8% of the respondents believed that ICT robustness was the main ICT attribute that would enhance educational access supported by (Wallet & Melgar, 2015). ICT cost-effectiveness had 8.7% of the respondents indicating that it was the major ICT attribute that would enhance educational access.

The study finding showed that 11.0% of the respondent indicated that ICT portability was the main ICT attribute that would enhance educational access (Wallet & Melgar, 2015). ICT

user-friendliness is a key component with 12.8% of the respondent indicating that it was the main ICT attribute that would enhance educational access (Mtebe, 2015).

The study finding indicated that 9.6% of the respondents stated that ICT relevance was the main ICT attribute that would enhance educational access (Garbutt & Wanami, 2017).

The study finding indicated that 12.8% of the respondents noted that ICT flexibility was the major ICT attribute that would enhance educational access (Barnett, 2014).

These findings are represented graphically in figure 7.

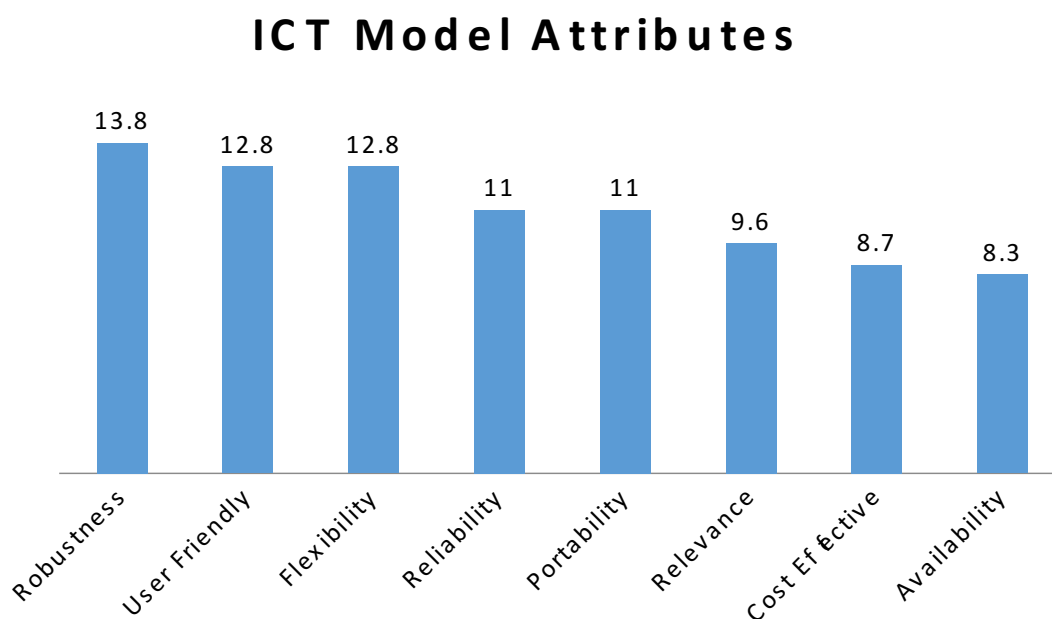


Figure 8 ICT Model Attributes

4.3.2 Handling Infrastructural Challenges for Functional Access Model

The study finding showed that 13.3% of the respondents were of the opinion that innovative measures would enable ICT educational access model to function with 47.7% of the respondent gave the opinion that infrastructure support by the institution would enable ICT educational access model to function. The infrastructure support by institution finding is a position shared by other studies on ICT integration in education (Mukundi & Njuki, 2019). The study findings indicated that 16.5% of the respondent noted that government support would enable ICT educational access model to function, the finding is supported by (Saina, Mukwa & Kyalo, 2018). Additionally, 14.2% of the respondents believed that private sector support would enable ICT educational access model to function.

Table 4.6 help demonstrate these findings.

Table 4. 6 Handling Infrastructural Challenges to make Access Model Functional

Feature		Yes	No	mean	Std
Government Support	Fre	36	182	0.17	0.372
	%	16.5	83.5		
Private Sector Support	Fre	31	187	0.14	0.350
	%	14.2	85.8		
Innovate Measures	Fre	29	189	0.13	0.340
	%	13.3	86.7		
Infrastructure Support by Institution	Fre	104	114	0.53	0.645
	%	47.7	52.3		

Key: Fre: Frequency, %: Percentage

4.4 Programs that enable educational resources sharing by the marginalized in Kenya

The study analyzed several programs that would enable education resource access sharing by the marginalized communities in Kenya.

4.4.1 Virtualization Role in Enhancing Educational Resources Sharing

The study findings indicated that 73.9% of the respondents believed that virtualization would support education resource sharing by availing resources in the region, additionally,64.7% of the respondents indicated that virtualization would support group operations in accessing educational resource sharing in the region. Virtualization was thought to offer enhanced educational resource sharing in the region through a synergistic computing system by 23.4%of the respondents while 37.6% of the respondents held the view that virtualization would enhance educational resource sharing by providing reliability and robust system.

Table 4.7 discloses the study findings.

Table 4. 7 Virtualization Role in Enhancing Educational Resources Sharing

		Yes	No	mean	std
Avail Resources	Fre	161	57	0.73	0.440
	%	73.9	26.1		
Supports Group	Fre	141	77	0.64	0.479
	%	64.7	53.3		
Synergistic Computing System	Fre	51	167	0.23	0.424
	%	23.4	76.6		
Reliability and Robust System	Fre	82	136	0.38	0.486
	%	37.6	62.4		
Others Reasons	Fre	42	176	0.19	0.395
	%	19.3	80.7		

Key: Fre: Frequency, %: Percentage

Virtualization when properly implemented in educational setup offers many of the desired benefits. The identified roles by this study are supported by other studies in virtualization

which have indicated that group sharing, resource sharing, robust and reliable systems are possible through virtualization (Michael, 2015).

The majority of the respondent appreciates the importance of virtualization but cannot specifically indicate its specific place in computing, this calls for more training on virtualization.

4.4.2 Thin Client Role in Enhancing Educational Resources Sharing

The finding indicated that 83.0% of the respondents that indicated that thin client would provide individualized access which would enhance educational resource sharing in the region 61.9% of the respondents thought that thin client would enhance mobile access that would enhance educational resource sharing in the region, and 63.3% were of the response that thin client would provide cost-effective access which would enhance educational resource sharing in the region.

Table 4.8 reveals the study findings.

Table 4. 8 Thin Client Role in Enhancing Educational Resources Sharing

		Yes	No	mean	std
Individualized Access	fre	181	37	0.83	0.376
	%	83.0	17.0		
Mobile Access	fre	135	83	0.61	0.486
	%	61.9	38.1		
Cost Effective Access	fre	138	80	0.63	0.483
	%	63.3	36.7		

Key: Fre: Frequency, %: Percentage

Studies in education have advocated for individualized access in learning setups (Aris & Orcos, 2015), the finding by this study supports this position. The management of education in marginalized zones should provide for thin clients as one way of promoting individualized access to content by students.

4.4.3 Web Server Role in Enhancing Educational Resources Sharing

The study findings indicated that 63.3% were of the respondents believed that web servers would lead to more content storage hence enhance educational resource sharing in the region, 72.5% were of the opinion that search capability of the web server would enhance educational resource sharing in the region, 52.8% were of the respondents believed that remote accessibility would enhance educational resource sharing in the region while 42.7% of the respondents thought that web server would introduce cost-effectiveness enhancing educational resource sharing in the region.

Table 4.9 reveals the study findings.

Table 4. 9 Web Server Role in Enhancing Educational Resources Sharing

		Yes	No	Mean	Std
More Content Storage	Fre	138	80	0.63	0.483
	%	63.3	36.7		
Search Capability	Fre	158	60	0.72	0.448
	%	72.5	27.5		
Remote Accessibility	Fre	115	103	0.53	0.500
	%	52.8	47.2		
Cost-Effectiveness	Fre	93	125	0.42	0.495
	%	42.7	57.3		

Key: Fre: Frequency, %: Percentage

Knowledge sharing is a critical component in education and technical colleges are no exceptions (Hashim, Judi, Wook & Meriam, 2016). The search capability offered by web server technologies will be a critical component in advancing the educational goals of technical colleges hence such technologies should be prioritized.

4.4.4 Content Management System Role in Enhancing Educational Resources Sharing

The study findings indicated that 83.0% of the respondent thought that content management system would enhance user-generated content, 10.6% believed that update capability of the content management system would enhance educational resource sharing in the region, 62.4% thought that user access control would enhance educational resource sharing in the region and 34.9% of the respondents were of the opinion that modular organization of data through content management systems would enhance educational resource sharing in the region.

Table 4.10 presents the study findings

Table 4. 10 Content Management System Role in Enhancing Resources Sharing

		Yes	No	mean	std
User Generated Content Support	Fre	181	37	0.83	0.376
	%	83.0	17.0		
Update Capability	Fre	112	51.4	0.51	0.501
	%	10.6	48.6		
User Access Control	Fre	136	82	0.61	0.487
	%	64.2	35.8		
Modular Organization of Data	Fre	76	142	0.35	0.477
	%	34.9	65.1		

Key: Fre: Frequency, %: Percentage

The study findings vindicate the importance of user-generated content in learning management systems. Technical colleges need to enable the youth to participate in learning by employing web 2.0 technologies that promote personalized learning leading to a stimulating learning experience.

4.5 Integral Modules of the ICT Educational Resources Access Framework

The study sought to assess the Integral Modules of an ICT Enhanced Educational Resources Access Framework for the Marginalized Communities.

The study findings indicated that the learning management system was an integral part of the enhanced access framework. Course management was reported by 74.8% of the respondents while 74.3% of the respondents agreed the remedial classes modules were an integral module. The other integral part was the teacher Training which was viewed by 95.4% of the respondents while 71.2% of the respondents agreed that student assessment was an integral module. The study findings have pointed that teacher training is the importance and must be addressed, this concurs with previous findings where teacher training is viewed as a critical component required for improving access to education (Wallet & Melgar, 2015; Chinapah & Odero, 2016).

The study findings indicated that Open Online Course Management was an integral part of the enhanced access framework. Specialized Multimodal Content was reported by 49.5% of the respondents while 68.4% of the respondents agreed the Expert Offering Remote Courses was an integral module. Open Online courses are gaining momentum with students using them to learn a new course thereby bridging the digital divide experienced by students in marginalized zones (Rekha & Adinarayanan, 2014). The study finding indicated that the inclusion of experts who can offer the courses remotely will greatly assist the students, this is a position shared by (Hodges, Moore, Lockee, Trust & Bond, 2020). The use of experts in education would play a positive role in times of pandemic like Covid-19 which demands for remote learning approach among students (Bansal, 2020).

The study findings indicated that Open educational resource was an integral part of the enhanced access framework. Co-created content was championed by 67% of the respondents while 61% of the respondents agreed that Supplementary Material management was an integral module. Expert Collaboration was reported by 73.4% of the respondent who supported in importance. The ability to reuse and distribute open educational resources allows experts either from industry or academia to infuse their knowledge and transform the technical colleges by creating and sharing the free and open learning materials.

The study findings indicated that Stakeholder’s management system was an integral part of the enhanced access framework. Donor management was reported by 70.6% of the respondents while 76.6% of the respondents agreed that client and vendor management was an integral module. The marginalized community projects require proper client and vendor relationship management for the success of such projects, if not well managed the institutions could end up in a vendor lock-in situation.

Table 4.11 reveals the study findings

Table 4. 11 Integral Modules of the ICT Resources Access Framework

			SA	A	UD	D	SD	mean	std
Learning Management System	Course Management	fre	69	94	6	17	32	3.71	1.365
		%	31.7	43.1	2.8	7.8	14.7		
	Remedial Classes	fre	66	96	15	15	26	3.75	1.277
		%	30.3	44.0	6.9	6.9	11.9		
	Teacher Training	fre	89	119			10	4.27	0.866
		%	40.8	54.6			4.6		
	Students Assessment	fre	65	92	4	27	30	3.63	1.375
		%	29	42.2	1.8	12.4	13.8		
Open Online Course Management	Specialized Multimodal Content	fre	51	57	16	38	56	3.02	1.552
		%	23.4	26.1	7.3	17.4	25.7		
	Expert Offering Remote Courses	fre	42	107	9	13	47	3.39	1.421
		%	19.3	49.1	4.1	6.0	21.3		
Open Educational Resources	Co-Created Content	fre	63	83	16	21	35	3.54	1.411
		%	28.9	38.1	7.3	9.6	16.1		
	Supplementary Material	fre	48	85	23	30	32	3.38	1.360
		%	22.0	39.0	10.6	13.8	14.7		
	Expert Collaboration	fre	51	109	23	16	19	3.72	1.154
		%	23.4	50.0	23	16	19		
Stakeholder Management	Donor Management	fre	67	87	17	20	27	3.66	1.342
		%	30.7	39.9	17	20	27		
	Client and Vendor Management	fre	50	117	18	15	18	3.74	1.143
		%	22.9	53.7	8.3	6.9	8.3		
	Volunteer Management	fre	39	105	29	9	36	3.46	1.299
		%	17.9	48.2	13.3	4.1	16.5		

Key: SA: Strongly Agree, A: Agree, U: Undecided, D: Disagree, SD: Strongly Disagree, Fre: Frequency, %: Percentage

4.6 Inferential Data Analysis

The study sought to model the ICT enhanced educational resources access framework for the marginalized communities. This was modeled through the use of the moderation model where the model aimed to predict access to educational resources in the marginalized areas by use of the independent variables which were the factors limiting educational access for marginalized persons moderated by enablers of the PRIMER model. The study sought to verify the ICT enhanced educational resources access framework for the marginalized communities.

This was verified by the use of the mediated model which explains the predictor values. The ICT Infrastructural Support represents the mediator in the model and indicated how the PRIMER model was able to influence Access of Educational resources eliminating the Challenges affecting educational access to the marginalized communities.

Before this could be done the major challenges affecting educational access were identified using the ANOVA model.

Table 4.12 reveals the study findings results.

Table 4. 12 ANOVA on Model Factors Limiting Educational Access

Feature		Sum of Squares	df	Mean Square	F	Sig.
Physical Infrastructure	Between Groups	6.913	2	3.457	4.231	.010
	Within Groups	175.660	215	.817		
	Total	182.573	217			
Technological infrastructure	Between Groups	4.602	2	2.301	1.786	.000
	Within Groups	277.072	215	1.289		
	Total	281.674	217			
Financial Infrastructure	Between Groups	43.843	2	21.921	18.211	.000
	Within Groups	258.799	215	1.204		
	Total	302.642	217			
Human Resource Infrastructure	Between Groups	3.223	2	1.612	.683	.004
	Within Groups	507.290	215	2.359		
	Total	510.514	217			
Natural Calamities	Between Groups	10.496	2	5.248	3.033	.070
	Within Groups	372.073	215	1.731		
	Total	382.569	217			
Social Factors	Between Groups	10.549	2	5.274	2.231	.110
	Within Groups	508.318	215	2.364		
	Total	518.867	217			

The study findings indicated that four of the factors limiting educational access had significant variations to educational access in the marginalized region ($p < 0.05$).

The factors were human infrastructure ($p=0.004$), technological infrastructure ($p=0.000$), financial infrastructure ($p=0.000$) and physical infrastructure ($p=0.01$). These were all included in the development of the ICT model for educational access.

However, two of these factors had no significant variation ($p>0.005$) to educational access. These were, natural calamities ($p = 0.070$) and social factors ($p = 0.110$). These factors were therefore eliminated in the development and verification of the ICT based model to be used for educational resource access.

4.6.1 Development of an ICT enhanced educational resources access framework for the marginalized communities.

The study sought to model the ICT enhanced educational resources access framework for the marginalized communities. This was modeled through the use of the moderation model where the model aimed to predict access to educational resources in the marginalized areas by use of the independent variables which were the factors limiting educational access for marginalized persons moderated by enablers of the PRIMER model.

The value of adjusted R² should be as close to the value of R². The model summary of the moderating effect presented in table 4.13 involved all the Factors Affecting Educational Access as the only independent variable and PRIMER Model as the moderator. The outcome 0.596, represented the coefficient of determination (R square).

The model explained only 59.6 percent of the variation or change in the dependent variable. The remaining proportion of 40.4 percent could be explained by other factors other than the independent or moderating variables. Adjustment of the R square did not change the results substantially, having reduced the explanatory behavior of the predictor from 59.6 percent to 58.6 percent.

As a general rule, the R Square value should be above 50% showing that over half the data used in computation of the model was relevant enough and was used to compute the model. Consequently both the R Square values before and after moderation 0.579 (57.9%), and 0.596 (59.6%) respectively were over 50% which indicated that the data used in computation of the model was sufficient hence the model outcome could be relied upon. This meant that the model was fit to be used to generalize the findings.

Table 4. 13 Model Summary on Moderating Effect

Model Summary				
Model	R	R Square	AdjustedR Square	Std. Error of the Estimate
1	.761 ^a	0.579	0.570	0.34307
2	.772 ^b	0.596	0.586	0.33692
a. Predictors: (Constant), Human Resource Infrastructure, Physical Infrastructure, Financial Infrastructure , Technological infrastructure				
b. Predictors: (Constant), Human Resource Infrastructure, Physical Infrastructure, Financial Infrastructure , Technological infrastructure , PRIMER Model				

Analysis of Variance (ANOVA) or the Goodness of Fit test measures for the moderated effect was computed to determine that the data used to compute the regression model was not computed by chance. The results with a p-value of 0.000 being less than 0.05 indicate that the model was not computed by chance hence its statistically significant. The results were presented in table 4.14.

The significance in the Goodness of Fit Test indicates that despite the data collected being random, the data has a ‘good fit’ or has relationships within itself that can compute a model which relates different variables showing their influences on the dependent variable using coefficients. This is the case before and after moderation ($p < 0.000$)

Table 4. 14 ANOVA for Goodness of Fit Test on Moderation

ANOVA for Goodness of Fit Test on Moderation						
Moderated Regressions		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	30.628	4	7.657	65.058	.000 ^a
	Residual	22.244	189	0.118		
	Total	52.872	193			
2	Regression	31.532	5	6.306	55.555	.000 ^b
	Residual	21.341	188	0.114		
	Total	52.872	193			
a. Predictors: (Constant), Human Resource Infrastructure, Physical Infrastructure, Financial Infrastructure , Technological infrastructure						
b. Predictors: (Constant), Human Resource Infrastructure, Physical Infrastructure, Financial Infrastructure , Technological infrastructure , PRIMER Model						
c. Dependent Variable: Access to Educational Resources for Marginalized Communities						

The study moderated regression and the analysis results of Factors Affecting Educational Access, PRIMER Model and Access to Educational Resources for Marginalized Communities are presented in Table 4.15.

With a constant of 0.638, the study concluded that even without factors affecting educational access, marginalized community students seemed to display some form of access to educational resources. Nonetheless, the coefficient of 0.341 indicated the extent to which a unit change in Physical Infrastructure caused a change in Access to Educational Resources for Marginalized Communities. In this case, a unit change in Physical Infrastructure leads to 34.1% units of positive change in Access to Educational Resources for Marginalized Communities Students.

The coefficient of 0.231 indicated the extent to which a unit change in Technological infrastructure caused a change in Access to Educational Resources for Marginalized Communities. In this case, a unit changes in Technological infrastructure leads to 23.1% of positive change in Access to Educational Resources for Marginalized Communities of Marginalized Community Students.

The coefficient of 0.310 indicated the extent to which a unit change in Financial Infrastructure caused a change in Access to Educational Resources for Marginalized Communities. In this case, a unit change in Financial Infrastructure leads to 31.0% units of positive change in Access to Educational Resources for Marginalized Communities of Marginalized Community Students. The coefficient of 0.313 indicated the extent to which a unit change in Human Resource Infrastructure caused a change in Access to Educational Resources for Marginalized Communities. In this case, a unit change in Human Resource Infrastructure leads to 31.3% units of positive change in Access to Educational Resources for Marginalized Communities.

Therefore, the Factors Affecting Educational Access and Access to Educational Resources for Marginalized Communities model after moderation can now be presented as follows:

$$\underline{Y = 0.638 + 0.341X_1 + 0.231X_2 + 0.310X_3 + 0.3130X_4 + 0.288 (\text{error}).}$$

Table 4. 15 Moderated Regression of Factors Affecting Educational Access

Coefficients ^a						
Moderated Regression Results		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.35	0.275		1.273	0.205
	Physical Infrastructure	0.077	0.044	0.097	1.758	0.08
	Technological infrastructure	0.299	0.049	0.374	6.124	0.000
	Financial Infrastructure	0.147	0.079	0.109	1.857	0.065
	Human Resource Infrastructure	0.388	0.062	0.364	6.264	0.000
2	(Constant)	0.638	0.288		2.213	0.028
	Physical Infrastructure	0.341	0.103	0.431	3.310	0.001
	Technological infrastructure	0.231	0.054	0.289	4.312	0.000
	Financial Infrastructure	0.31	0.097	0.229	3.199	0.002
	Human Resource Infrastructure	0.313	0.066	0.293	4.71	0.000
	PRIMER Model	-0.364	0.129	-0.358	-2.821	0.005

a. Dependent Variable: Access to Educational Resources for Marginalized Communities

Before moderation, the results of multiple regressions, indicate that Physical Infrastructure had no significant relationship ($p = 0.080$) at 5 percent confidence with Educational Resource Access for Marginalized Communities while Technological Infrastructure had a significant relationship ($p = 0.000$) at 5 percent confidence with Educational Resource Access for Marginalized Communities. Financial Infrastructure had no significant relationship ($p = 0.065$) at 5 percent confidence with Educational Resource Access for Marginalized Communities and Human Resource Infrastructure had a significant relationship ($p = 0.000$) at 5 percent confidence with Educational Resource Access for Marginalized Communities.

The results of the moderated hierarchical regressions, indicated that Physical Infrastructure had a significant relationship ($p = 0.001$) at 5 percent confidence with Educational Resource Access for Marginalized Communities when moderated with PRIMER Enablers and Technological Infrastructure had a significant relationship ($p = 0.000$) at 5 percent confidence with Educational Resource Access for Marginalized Communities when moderated with PRIMER Enablers. In addition, Financial Infrastructure had a significant relationship ($p = 0.002$) at 5 percent confidence with Educational Resource Access for Marginalized Communities when moderated with PRIMER Enablers. Further, Human Resource Infrastructure had a significant relationship ($p = 0.000$) at 5 percent confidence with Educational Resource Access for Marginalized Communities when moderated with PRIMER Enablers.

This results in to the following equation.

$$Y = 0.638 + 0.341X_1 + 0.231X_2 + 0.310X_3 + 0.313X_4 + 0.288 (\text{error}).$$

From the equation therefore after moderation physical infrastructure (X_1) has the greatest effect on access of education in the marginalized areas (34.1%) followed by Human Resource Infrastructure (X_4) at 31.3%, Financial Infrastructure (31%) and finally technological infrastructure (23.1%).

Interpreting the Impact of Primer on Access to education

Table 4. 16 Summary of Moderating Effect

	Hypothesis	P Value Before Moderation	P Value After Moderation	Decision	Beta Value Before Moderation	Beta Value After Moderation	Overall Change in Beta Value
1	Physical Infrastructure	P = 0.080	p=0.001	Significant	0.077	0.341	0.264
2	Technological infrastructure	p = 0.000	p = 0.000	Significant	0.299	0.231	-0.068
3	Financial Infrastructure	p = 0.065	0.002	Significant	0.147	0.31	0.163
4	Human Resource Infrastructure	p= 0.000	p=0.000	Significant	0.388	0.313	-0.075
	Overall Beta Effect	0.284					

The summary of the moderated effect of PRIMER for factors affecting access education and educational access is interpreted to mean that PRIMER has great influence on structural factors. These include physical and financial factors. PRIMER has been shown to have significantly influenced physical and financial factors. The items were not significant before moderation but have been showed to be significant on moderation with PRIMER. The beta value have also been positively affected to imply that PRIMER is a good remedy to educational access. Overall, because of PRIMER, education access has been enhanced by 28.4% in the marginalized areas.

4.6.2 Verify the developed ICT Enhanced Educational Resources Access Framework for the Marginalized Communities.

The study sought to verify the educational resources access framework done by the use of the mediated model which sought to explain the nature of the predictor values. The mediator in the model was the ICT Infrastructural Support which indicated how the PRIMER model was able to influence access to educational resources eliminating the educational resources access challenges.

The model was verified by testing if mediation had occurred by use of Sobel test which measured the amount of indirect effect that had occurred (Preacher & Leonardelli, 2001).

A sobel test evaluates the indirect effect of the mediation by the use of an estimate on the standard error (Namazi, & Namazi, 2016). The inclusion of the mediator together with the independent variable in the regression analysis leads to reduced effect of the independent variable. The identification of statistical significance of the indirect effect requires statistic data based on the indirect effect be evaluated against the provided null sampling distribution (Namazi, & Namazi, 2016).

The findings regarding this were summarized and presented in Table 4.17.

Table 4. 17 Significance of Mediation (Model Verification)

Significance of Mediation			Significant
Sobel z-value	5.528265		$p = < 0.000001$
95% Symmetrical Confidence Interval			
	Lower	0.13022	
	Upper	0.27327	
Unstandardized indirect effect			
	a*b	0.20174	
	Se	0.03649	
Effect size Measures			
	Standardized Coefficients		R ² Measures (Variance)
	Total:	0.679	0.461
	Direct:	0.497	0.110
	Indirect:	0.182	0.351
	Indirect to Total Ratio:	0.267	0.761

The generated value of indirect effect was 5.528 which is the sobel z-value which produced a p-value of less than 0.01. This shows that significant partial mediation occurred with an association between factors affecting educational access in marginalized communities and educational access for marginalized communities having significantly decreased.

This is due to the inclusion of the mediating variable which is ICT infrastructural support. The decline from 0.679 to 0.497 in the subsequent regression and the small standard error (se) of 0.036 which measures the precision of the estimate of the coefficient indicates the improved access to educational resources by uses in the remote areas. The total effect 0.679 is the correlation between factors affecting educational access in marginalized communities on educational access for marginalized communities.

4.7 Discussion

The study discussion was based on the study objective.

- i. Determine factors limiting access to educational resources.

The research identified that cost of educational resources heavily affected educational access within the marginalized communities. The cost of educational materials like textbooks is prohibitive and many students cannot afford the textbooks. The case is not only in marginalized areas even students in developed countries are experiencing the same problem. Textbooks are one of the basic items students need hence if the cost is high then solutions must be found to deal with the situation. These study findings are supported by other studies whose findings indicated the need to develop other alternatives that can help students overcome the textbook challenge (McGowan, 2020). The proposal developed by McGowan (2020) is in support of other solutions this study has proposed. This study proposes to have varied delivery channels used to deliver educational content. The alternative channels include open educational resources as an alternative a finding supported by (Kourbetis &, Boukouras, 2014). The audience of this research will be interested in the cost-cutting mechanism hence OER provides a channel educational managers can use to reduce the cost burden in marginalized areas. The support for OER cannot be made without mentioning the challenges of OER sustainability due to unsuitable business models which at times are not well thought out (Basken, 2016). The challenge of access in areas where computing devices are a challenge must be thought out before OER solutions are fully implemented. The study proposes the introduction of smart devices in learning however, the devices bring other challenges and education managers need to be aware of the challenges. The devices require some form of energy source while battery replacement is to be undertaken after some time.

The devices if not well configured will afford the students access to unauthorized content not forgetting disruption which occurs when lessons are going on (Chartrand, 2016).

- ii. Identify suitable educational resources access solutions.

The study findings noted that ICT based models and policy were the most suitable solutions. This position is shared by many under different themes of ICT for education, the idea is to allow for a multi-mode delivery channels (Myers et al., 2014).

The various modes ensure that different students will have at least an option available within their locations. Mobile devices are some of the solutions which can transform the rural and remote locations in improving access to education which is the aim of this study. The mobile phone is suitable in this context due to its low cost, mobility and connectivity capability. The mobile device requires power and network connectivity, this means that the solution might not work in all parts of a country (Okilwa, 2015).

The study finding pointed out that human capital plays a critical part in education. The teachers who are responsible for the change required in technical colleges must be empowered and recognized for the desired change to occur. The study by Schmitt (2015) explains that mobile connectivity is great but puts emphasis on the need to recognize the value of teachers within the education system. Similar studies suggest that teacher training is a critical component required for improving access to education (Wallet & Melgar, 2015; Chinapah & Otero, 2016).

The study indicated that lack of schools affects the marginalized students and that the government of the day needs to be convinced to invest in schools. Related studies have shown that governments do not consider schools first when financial decisions are made. In developing countries, the leadership will consider projects with short term benefits like roads as opposed to schools (Atolia, Li, Marto & Melina, 2017). The development in schools requires visionary leaders, community leaders and huge capital investment. This results in high risk and no immediate return which prevents many private entities from full participation. The private sectors can support through the provision of ICT based solutions or ventures in education. The private sector can make a serious contribution to education by providing agricultural-based training to farmers in remote locations through mobile phones (Batchelor, Scott, Valverde, Manfre & Edwards, 2014). This study implores ICT in education implementers to consider ICT solutions as part solution in solving the access challenges facing the underserved part of the country. This conclusion is supported by (Nkula & Krauss, 2014) who posit the need for implementation within integration but not implementation without integration.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Achievements

Objective1: Determine factors limiting access to educational resources by the marginalized communities.

The research identified that cost of educational resources heavily affected educational access within the marginalized communities. The educational materials like textbooks and computing devices were unaffordable to the majority of the students. The condition was exacerbated by fees charged by schools. Lack of physical infrastructure like schools and roads reduced the number of students in schools. Human resources challenges and technology challenges denied the student the desired access to educational resources opportunity.

Objective2: Identify suitable educational resources access solutions for marginalized communities.

The study findings noted that ICT based models and policy were the most suitable solutions to enhance educational resource access within the marginalized community. The development of standards in ICT could enhance resource accessibility. The study findings noted that the community could provide practical information on the best ICT solutions; the study noted that the developed solutions should be intelligent and sensitive to the people's culture and promote the aspirations of the local community.

Objective3: Develop an ICT enhanced educational resources access framework for the marginalized communities.

Physical, technological, financial and human Infrastructure had slight significant relationship with Educational Resource Access before any moderation on these factors. The results of the moderated hierarchical regressions indicated that physical, technological, financial and human Infrastructure had a significant relationship with educational resource access when moderated with PRIMER enablers. With a constant of 0.638, the coefficient of physical, technological, financial and human factors in the model after moderation become

$$Y = 0.638 + 0.341X_1 + 0.231X_2 + 0.310X_3 + 0.3130X_4 + 0.288 (\text{error}).$$

Using technology as an example, a unit changes in Technological infrastructure lead to 23.1% of positive change in Access to Educational Resources for Marginalized Communities.

Objective4: Verify the developed ICT enhanced educational resources access framework for the marginalized communities.

Results of the verification depicted a reduction in access to educational resources challenge.

The Sobel test indicated a reduction in access challenges indicating that significant partial mediation had occurred. The association between factors limiting educational access in marginalized communities and educational access for marginalized communities had improved. It was seen that the access challenge decreased from 0.679 to 0.497 in the subsequent regression after the mediation. The 95% confidence interval conclusively showed significant mediation had occurred.

5.2 Recommendations of the Study

To address the problem of limited access to relevant educational resources among the marginalized communities several measures must be taken to improve and sustain such initiatives.

The government should increase financial allocation to technical colleges this will enable them to undertake necessary procurement activities like the purchase of relevant library books.

The study noted the low number of technical and vocational colleges, hence more technical and vocational colleges should be set up within the marginalized zones. The training, recruitment, and retention of qualified teachers in technical colleges should be a priority to counter the low number of competent and motivated lecturers within the technical colleges in Kenya.

The study findings evidentially show that greater Public and Private sector involvement in addressing educational resource access challenges within the marginalized context. The study champions the need for involvements and participation of the donor community, other partners, together with the local community members in education projects within the marginalized communities.

The government should ensure that progressive ICT policies are developed and implemented within the technical colleges in Kenya.

The paper proposes the development and implementation of relevant curriculum within the technical colleges. The approved curriculum should adopt best practices in training which demands for appropriate content delivered through multiple educational channels.

To support students continue with learning during the Covid-19 pandemic, governments should provide affordable internet and avail digital devices to students (Jena, 2020). Students in remote and rural areas lack connectivity solutions hence the demand for remote learning continue to negatively impact their studies (Wang, Cheng, Yue & McAleer, 2020).

The Covid-19 pandemic continues to expand the digital inequality among the marginalized because digital literacy is required to access government services or education (Beaunoyer,

Dupere & Guitton, 2020). The study proposes that education should be considered a common good and availed to all. The study highlights that relevant curriculum and improved access to relevant educational materials can be implemented using Open Educational Resources, Open Online courses and appropriate stakeholder management strategies.

The study's practical implication is a suggestion to set up an affordable digital repository using free and open-source platforms which will auger well with the financial challenge of the marginalized communities. Further, the study recommends the need for developers of ICT educational access models to employ the proposed model in developing ICT based educational access systems.

5.3 Research Assessment

5.3.1 What is new? Does the research make a significant, value-added contribution to the current thinking?

Research in the vocational sector is critical if significant growth is to be achieved in Kenya more so, vision 2030 dream cannot be achieved if technical colleges are left out. The ICT blueprint 2019 made only one mention of technical and vocational training hence this research will make a valuable contribution to this important sector and more so move the thinking from formal only learning to even informal learning which is possible through mobile kiosks (Chinapah & Odero, 2016). The technical and vocational training authority requires to review and amend the technical colleges National Quality Assurance framework the finding of this study will form necessary input in the review of such quality framework (TVETA Strategic Plan, 2018).

5.3.2 So what? How will the research change the practice of ICT integration in education and more so for the marginalized communities?

The study proposes the need to move from classroom learning to informal or blended learning in the technical and vocational setup as the students are mostly learning on the job while others are learning on the go. The Kenya ICT blueprint 2019 calls for provisioning of basic mobile services to the unreached. The education Broadband project should now include technical colleges by providing internet bandwidth (Kenya ICT blueprint, 2019; Kibuku, Ochieng & Wausi, 2020). Teachers within the technical colleges need to adopt free and open-source learning tools which will significantly reduce cost requirements and help the marginalized access education. The trainers within the technical sectors will now be encouraged to produce and share open educational resources with their students and other lecturers across the globe reducing the digital divide and digital marginalization.

5.3.3 Why now? Is it of interest to the people?

This research is timely due to the demands by governments and global educational partners to have people and organizations align their efforts toward various SDGs. The output from this research will make a positive contribution to Sustainable Development Goal No 4 and more so technical education (Unterhalter, 2019). The transition from secondary schools to universities in Kenya is not 100 percent hence research in technical and vocational colleges will be timely. The government every year needs to provide a training platform for over half a million secondary school graduates who need to secure world-class training in technical colleges. The paper output will support the technical and vocational training authority to improve the TVET National Quality Assurance framework.

5.3.4 Who else including academic researchers are interested in this research?

Educational managers in Tharaka Nithi County and the educational partners especially donors, community-based organizations will find the results from this study worthwhile.

The Technical Vocational Educational and Training Authority has called academia to assist in researching educational related matters hence this will be of great help to the authority (TVETA Strategic Plan, 2018). The commission on revenue allocation will benefit from the finding of these research more so on what should be priority areas in matters education. The results from this study will inform debate about revenue sharing between senate and national assembly members in Kenya.

The technical colleges authority released the summarized distance learning guidelines, key among the requirements by the guidelines is selection of appropriate technologies. This research provides alternative and complementary technologies the industry can use to implement such guidelines (TVETA Summarized Guidelines, 2020).

5.4 Research Limitations

The proposed model needs to be subjected to further validation and test in other jurisdictions and contexts. The use of expert's opinion is one option that can be employed in future research to test the model. The study was undertaken in Tharaka Nithi county hence needs for further research focusing on a wider area by including more counties where technical and vocational education is happening and more so the marginalized zones. The study duration of two months could not allow intensive and extensive research which could help reveal deep cultural and social factors. The research does not concentrate on the physically challenged within the marginalized areas. The respondents were unable to use an online-based questionnaire as a data collection tool due to internet connectivity challenges.

REFERENCES

- Abubakar, D., & Adetimirin, A. (2015). Influence of computer literacy on postgraduates' use of e-resources in Nigerian University libraries.
- Abuya, T. K. (2014). Impacts of Adopting ICT Integration in Technical Training Institutions of Kenya
- Acadia, S. (2016). Books be gone! Reducing an academic library's print collection by half to meet strategic planning initiatives and participate in a joint library resource-sharing facility. *Journal of Library Administration*, 56(2), 144-157.
- Afework, T. H., & Asfaw, M. B. (2014). The availability of school facilities and their effects on the quality of education in government primary schools of Harari Regional State and East Hararghe Zone, Ethiopia. *Middle Eastern & African Journal of Educational Research MAJER Issue: 11*.
- Afreen, R. (2014). Bring your own device (BYOD) in higher education: opportunities and challenges. *International Journal of Emerging Trends & Technology in Computer Science*, 3(1), 233-236.
- Al Abri, M., & Dabbagh, N. (2018). Open educational resources: A Literature Review. *Journal of Mason Graduate Research*, 6(1), 83-104
- Al Azri, R. H., & Al-Rashdi, M. H. (2014). The effect of using authentic materials in teaching. *International journal of scientific & technology research*, 3(10), 249-254.
- Alkhalwaldeh, M. F., Olimat, E., & Al-Rousan, A. (2015). A Blended Theoretical Framework for Integration of ICT within Early Year Education: an Overview.
- Almohamed, A., & Vyas, D. (2016). Designing for the Marginalized: A step towards understanding the lives of refugees and asylum seekers. In *Proceedings of the 2016 ACM Conference Companion Publication on Designing Interactive Systems* (pp. 165-168).
- Aris, N., & Orcos, L. (2015). ICTs and school education. *IJIMAI*, 3(4), 13-18.
- Arshad, M., & Saeed, M. N. (2014). Emerging technologies for e-learning and distance learning: A survey. In *2014 International Conference on Web and Open Access to Learning (ICWOAL)* (pp. 1-6). IEEE.
- Atieno, L. V., & Moturi, C. A. (2014). Implementation of Digital Village Projects in Developing Countries-Case of Kenya. *British Journal of Applied Science & Technology*, 4(5), 793.
- Atolia, M., Li, B. G., Marto, R., & Melina, G. (2017). Investing in Public Infrastructure: Roads or Schools? *Macroeconomic Dynamics*, 1-30.
- Ayiro, L. P., & Sang, J. K. (2016). Provision of Education to the 'Hard to Reach' Amidst Discontinuity in Nomadic Communities in Kenya. In *FIRE: Forum for International Research in Education* (Vol. 3, No. 3, p. 2).
- Bailey, T., Scott, A. & Best, R. (2015). Cost differentials between e-books and print in academic libraries. *College & Research Libraries*. 76(1), 6-18.
- Bansal, S. (2020). Impact of the COVID-19 Pandemic on Education, Rise of Online Teaching Learning Process & Effects on Health of Kids. *Rise of Online Teaching Learning Process & Effects on Health of Kids* (May 8, 2020).

- Barnett, R. (2014). Conditions of Flexibility: Securing a More Responsive Higher Education System. *Higher Education Academy*.
- Basken, P. (2016). The U. of California's open-access promise hits a snag: The faculty. *The Chronicle of Higher Education*. Retrieved from: <http://chronicle.com/article/The-U-of-California-s/237044>
- Beunoyer, E., Dupéré, S., & Guitton, M. J. (2020). COVID-19 and digital inequalities: Reciprocal impacts and mitigation strategies. *Computers in Human Behavior*, 106424
- Becuwe, H., Roblin, N. P., Tondeur, J., Thys, J., Castelein, E., & Voogt, J. (2017). Conditions for the successful implementation of teacher educator design teams for ICT integration: A Delphi study. *Australasian Journal of Educational Technology*, 33(2).
- Birochi, R., & Pozzebon, M. (2016). Improving financial inclusion: Towards a critical financial education framework. *Revista de Administração de Empresas*, 56(3), 266-287.
- Bozkurt, A., & Bozkaya, M. (2015). Evaluation criteria for interactive e-books for open and distance learning. *The International Review of Research in Open and Distributed Learning*, 16(5).
- Butler, C., & Adamowski, J. (2015). Empowering marginalized communities in water resources management: Addressing inequitable practices in Participatory Model Building. *Journal of Environmental Management*, 153, 153-162.
- Chartrand, R. (2016). Advantages and disadvantages of using mobile devices in a university language classroom. *Bulletin of the Institute of Foreign Language Education Kurume University*, 23, 1-13.
- Chege, P. N., & Kariuki, J. N. (2016). Increasing Women Access In TVET Through ODL Programme: A Case Of Thika Technical Training Institute In Kiambu County, Kenya.
- Chinapah, V., & Odero, J. O. (2016). Towards inclusive, quality ICT-based learning for rural transformation. *Journal of Education and Research*, 5(2/1), 107-125.
- Commission on Revenue Allocation, (2018) SECOND POLICY AND CRITERIA FOR SHARING REVENUE AMONG MARGINALISED AREAS. Retrieved on March 1, 2020 from <https://www.crakenya.org/wp-content/uploads/2018/06/CRA-37-Second-Policy-on-Marginalised-Areas-June-16th-2018.pdf>
- Cybart-Persenaire, A., & Literat, I. (2018). Writing stories, rewriting identities: using journalism education and mobile technologies to empower marginalized high school students. *Learning, Media and Technology*, 1-16.
- Dawes, J. (2008). Do data characteristics change according to the number of scale points used? An experiment using 5-point, 7-point and 10-point scales. *International Journal of Market Research*, 50, 61–104.
- Dey, B., & Ali, F. (2016). A critical review of the ICT for development research. In *ICTs in Developing Countries* (pp. 3-23). Palgrave Macmillan, London.
- Dharma, H. R. C., Asmarani, D., & Dewi, U. P. (2017). Basic Japanese Grammar and Conversation e-learning through Skype and Zoom Online Application. *Procedia computer science*, 116, 267-273.
- Digital Economy Blueprint (2019) Powering Kenya's Transformation. Ministry of Information, Communications and Technology, Retrieved on July 25, 2020 from <https://www.ict.go.ke/wp-content/uploads/2019/05/Kenya-Digital-Economy-2019.pdf>
- Doshi, J. (2014). ICT based solutions for education in rural India-A case study. In *IEEE Global*

- Humanitarian Technology Conference (GHTC 2014) (pp. 302-306). IEEE.
- Dunn, H. S. (2016). Teleworking the mobile Caribbean: Enabling remote work among the marginalized in Jamaica and Trinidad and Tobago. *ICT Skills & Employability*, vol. 5, issue 2, Summer 2009.
- du Plessis, P., & Mestry, R. (2019). Teachers for rural schools—a challenge for South Africa. *South African Journal of Education*, 39(4).
- Garbutt, G., & Wanami, S. (2017). Challenges Facing Implementation of Distance Education in Kenya. *Africa Journal of Technical and Vocational Education and Training*, 2(1), 132-139.
- Haijun, Z. E. N. G., Weifeng, X. I. A., Jinghua, W. A. N. G., & Rong, W. A. N. G. (Eds.). (2015). *Approach of ICT in education for rural development: Good practices from developing countries*. SAGE Publications India.
- Hashim, H., Judi, H. M., WOOK, T., & MERIAM, T. S. (2016). Success factors for knowledge sharing among TVET instructors. *Journal of Theoretical & Applied Information Technology*, 85(1).
- Hlalele, D. (2014). Rural education in South Africa: Concepts and practices. *Mediterranean journal of social sciences*, 5(4), 462.
- Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020). The difference between emergency remote teaching and online learning. *Educause Review*, 27.
- Hori, M., Ono, S., Yamaji, K., Kobayashi, S., Kita, T., & Yamada, T. (2016, April). A Suitable m-Learning System using e-Book for Developing Countries. In *CSEDU (2)* (pp. 408-415).
- Hosseini, M., Phalp, K. T., Taylor, J., & Ali, R. (2014). Towards crowdsourcing for requirements engineering.
- IsikoStrba, S. (2014). A Model for Access to Educational Resources and Innovation in the Developing World.
- Jemni, M. (2014). Promoting the effective use of ICT for enhancing education in the Arab World. In *2014 IEEE 14th International Conference on Advanced Learning Technologies* (pp. 4-4). IEEE.
- JENA, D. P. K. (2020). Challenges and Opportunities created by Covid-19 for ODL: A case study of IGNOU.
- Kamal, M., & Diksha, D. (2019). Investigating ICTs for Education in Marginalized Communities.
- Kenchakkanavar, A. Y. (2014). Types of e-resources and its utilities in library. *International Journal of Information Sources and Services*, 1(2), 97-104.
- Khan, M. A. A., Khan, M. M. R., Hassan, M., Ahmed, F., & Haque, S. M. R. (2017). Role of community radio for community development in Bangladesh. *The International Technology Management Review*, 6(3), 94-102.
- Khorshed Alam and Sophia Imran. (2015). The digital divide and social inclusion among refugee migrants: A case in regional Australia. *Information Technology & People* 28, 2, 344-365.
- Kibuku, R. N., Ochieng, D. O., & Wausi, A. N. (2020) e-Learning Challenges Faced by Universities in Kenya: A Literature.
- Kimani, S., & Gitahi, D. (2017, September). Online Portal Requirements for Computer Science Researchers in Kenya. In *Proceedings of Sustainable Research and Innovation Conference* (pp. 42-45).

Koissaba, B. R. (2017). EDUCATION FOR ALL: PROSPECTS AND CHALLENGES OF MOBILE SCHOOLS, MOBILE EDUCATION, AND E-LEARNING FOR THE NOMADIC PASTORALISTS IN KENYA (2017).

Kourbetis, V., & Boukouras, K. (2014). Accessible open educational resources for students with disabilities in Greece: they are open to the deaf. In *International Conference on Universal Access in Human-Computer Interaction* (pp. 349-357). Springer, Cham.

Kozma, R. B. (2005). National policies that connect ICT-based education reform to economic and social development. *Human Technology: An interdisciplinary journal on humans in ICT environments*.

Kundu (2019), A. Towards a Framework for ICTs Integration in Teacher Education in India.

Lelei, M. C., Weidman, J. C., & Sakaue, K. (2015) Toward Achieving Universal Primary Education in Kenya: The Free Primary Education Policies.

Lumby, J. (2015). Leading schools in communities of multiple deprivation: women principals in South Africa. *Educational Management Administration & Leadership*, 43(3), 400-417.

Maceviciute, E., Borg, M., Kuzminiene, R., & Konrad, K. (2014). The acquisition of e-books in the libraries of the Swedish higher education institutions. *Information Research: An International Electronic Journal*, 19(2), n2.

Maitland, C. F. (2018). Now you see it, now you don't: Digital connectivity in marginalized communities. *Computer*, 51(6), 62-71.

Makura, A. H. (2014). Students' perceptions of the use of ICT in a higher education teaching and learning context: The case of a South African University. *Mediterranean Journal of Social Sciences*, 5(11), 43.

Malek, M. A., Gatzweiler, F. W., & Von Braun, J. (2017). Identifying technology innovations for marginalized smallholders-A conceptual approach. *Technology in society*, 49, 48-56.

Mamoon, D. (2017). Society case study: Why formal education is the common goal of human progress. *Journal of Economic and Social Thought*, 4(4), 433-436.

McElroy, C., & Esterhuizen, P. (2017). Compassionate communication in acute healthcare: establishing the face and content validity of a questionnaire. *Journal of Research in Nursing*, 22(1-2), 72-88.

McGowan, V. (2020). Institution initiatives and support related to faculty development of open educational resources and alternative textbooks. *Open Learning: The Journal of Open, Distance and e-Learning*, 35(1), 24-45.

Mburu, S. (2017). Effects of livestock herd migration on child schooling in Marsabit District, Kenya. *Compare: A Journal of Comparative and International Education*, 47(4), 545-560.

Michael, R. (2015). Acceptance of Desktop Visualization Technology in Education Sectors—A case study of Ncomputing in Tanzania. *The International Journal of E-Learning and Educational Technologies in the Digital Media*, 1(2), 81-91

Miriti, G. M., Mugambi, M. M., & Ochieng, R. J. (2014). The critical role of curriculum in addressing youth unemployment in Kenya: Opportunities and challenges.

Mojapelo, M. S., & Fourie, J. A. (2014). Library and information resources in rural schools of

- Limpopo Province: a small study. *Mousaion*, 32(2), 124-149.
- Mtebe, J. (2015). Learning management system success: Increasing learning management system usage in higher education in sub-Saharan Africa. *International Journal of Education and Development using ICT*, 11(2).
- Mugenda, O. & Mugenda AG (2003). *Research methods: Quantitative and Qualitative Approaches*. Nairobi: ACTS
- Mukundi, R. M., & Njuki, W. (2019). Enhancing Green Learning and Training in TVET Institutions through Digital Libraries in Nyeri County, Kenya. *Africa Journal of Technical and Vocational Education and Training*, 4(1), 13-23.
- Myers, T., Blackman, A., Andersen, T., Hay, R., Lee, I., & Gray, H. (2014). Cultivating ICT students' interpersonal soft skills in online learning environments using traditional active learning techniques. *Journal of Learning Design*, 7, 38-53.
- Nakasone, E., & Torero, M. (2016). A text message away: ICTs as a tool to improve food security. *Agricultural Economics*, 47(S1), 49-59.
- Namazi, M., & Namazi, N. R. (2016). Conceptual analysis of moderator and mediator variables in business research. *Procedia Economics and Finance*, 36(16), 540-554.
- Nathenson, M. B., & Henderson, E. S. (2018). *Using student feedback to improve learning materials*. Routledge.
- National Broadband Strategy (2017) Ministry of Information, Communications and Technology, Retrieved on July 25, 2020 from http://icta.go.ke/pdf/The_National_Broadband_Strategy.pdf
- National ICT Policy (2019). Ministry of Information and Communication Technology. Retrieved on July 25, 2020 from <https://www.ict.go.ke/wp-content/uploads/2019/12/NATIONAL-ICT-POLICY-2019.pdf>
- Nemer, D., & Tsikerdekis, M. (2017). Political engagement and ICTs: Internet use in marginalized communities. *Journal of the Association for Information Science and Technology*, 68(6), 1539-1550
- Nirmala, Y. (2015). The role of community radio in empowering women in India. *Media Asia*, 42(1-2), 41-46.
- Njoka, J. N., Githui, P., & Ndegwa, L. W. (2020). Analysis of Challenges facing ICT integration in managing Public Secondary Schools: A Comparative Study of Day and Boarding Secondary Schools in the South Rift Region, Kenya. *Budapest International Research and Critics Institute (BIRCI-Journal): Humanities and Social Sciences*, 3(1), 58-66.
- Nkula, K., & Krauss, K. E. (2014, November). The integration of ICTs in marginalized schools in South Africa: Considerations for understanding the perceptions of in-service teachers and the role of training. In *International Development Informatics Association (IDIA) conference* (pp. 03-05).
- Novak, N. M., & Tjoa, A. M. (2018, November). ICT as an Enabler for a Society where No One is Left Behind. In *Proceedings of the 20th International Conference on Information Integration and Web-based Applications & Services* (pp. 3-7).
- Nurjanah, S., Santoso, H. B., & Hasibuan, Z. A. (2017). An ICT adoption framework for education: a case study in public secondary school of Indonesia. In *Journal of Physics: Conference Series* (Vol. 801, No. 1, p. 012029). IOP Publishing.

- Okilwa, N. S. (2015). Educational marginalization: Examining challenges and possibilities of improving educational outcomes in Northeastern Kenya. *Global Education Review*, 2(4).
- Orodho, J. A. (2014). Policies on free primary and secondary education in East Africa: Are Kenya and Tanzania on course to attain Education for All (EFA) Goals by 2015. *International Organization of Scientific Research (IOSR) Journal of Humanities and Social Sciences (IOSR-JHSS)*, 19, 11-20.
- Piper, B., Zuilkowski, S. S., Kwayumba, D., & Strigel, C. (2016). Does technology improve reading outcomes? Comparing the effectiveness and cost-effectiveness of ICT interventions for early grade reading in Kenya. *International Journal of Educational Development*, 49, 204-214
- Pompa, C. (2014). TVET and skills training in fragile and conflict affected countries. EPS PEAKS, Overseas Development Institute (ODI).
- Poulova, P., & Simonova, I. (2014). The impact of ICT amongst the secondary school graduates towards higher education. In *2014 8th. Malaysian Software Engineering Conference (MySEC)* (pp. 371-375). IEEE.
- Pousa, D., & Rufino, J. (2017). Evaluation of type-1 hypervisors on desktop-class virtualization hosts. *IADIS-JOURNAL ON COMPUTER SCIENCE AND INFORMATION SYSTEMS*, 12(2), 86-101.
- Prakashe, V. A., & Tayade, S. (2015). Study of e-resources of Indian institute of management (IIM) libraries in India. *DESIDOC Journal of Library & Information Technology*, 35(3)
- Preacher, K. J., & Leonardelli, G. J. (2001). Calculation for the Sobel test. Retrieved January, 20, 2009.
- Prilleltensky, I. (2014). Meaning-making, mattering, and thriving in community psychology: From co-optation to amelioration and transformation. *Psychosocial Intervention*, 23(2), 151-154.
- Pringle, I., & David, M. J. R. (2002). Rural community ICT applications: The Kothmale model. *The Electronic Journal of Information Systems in Developing Countries*, 8(1), 1-14.
- Rekha, S., & Adinarayanan, V. (2014). A free and open source framework for rural education. In *2014 Seventh International Conference on Contemporary Computing (IC3)* (pp. 56-61). IEEE.
- Saina, A. K., Mukwa, C., & Kyalo, M. (2018). TVET in Driving Sustainable Development: Strategies for Mitigating Challenges Associated with the Integration of ICT in Instruction of Engineering Subjects. *Africa Journal of Technical and Vocational Education and Training*, 3(1), 229-237
- Savaglia, J., & Wang, P. (2017). CYBERSECURITY VULNERABILITY ANALYSIS VIA VIRTUALIZATION. *Issues in Information Systems*, 18(4).
- Schmitt, C. (2015). Why a mobile-technology revolution needs teachers. Retrieved from <http://www.dw.com/en/lifelinks-education-mobile-africa/a-18358008>
- Sewell, B. & Link, F. (2016). Developing workflows for short-term loans of e-books as an adjunct to ILL: part one. *Technical Services Quarterly*, 33(3), 240-250.
- Sharma, D., Gupta, D., Chowhan, D., & Srivastava, M. (2015). Role of public-private partnership in higher education. *Devesh and Chowhan, Dr. Sudhinder and Srivastava, Mr. Vishal, Role of Public-Private Partnership in Higher Education (January 17, 2015)*.
- Sharma, R. S., Goh, Z. H., Sun, G., & Ho, W. T. (2014). Does ICT effectively contribute to the delivery of mass education in developing countries?. In *2014 IEEE International Conference on Management of Innovation and Technology* (pp. 375-380). IEEE.
- Shiratuddin, M. F., Smeda, A., & Wong, K. W. (2014). Proposed framework of the adoption of e-

book amongst mathematics and statistics students at universities in Libya.

Spring, G. (2001). National Framework for Rural and Remote Education in Australia. *Journal of Research in Rural Education*, 17(2), 112-119.

TVETA Quality Assurance framework (2019) Retrieved on July 25, 2020 from

<http://www.tveta.go.ke/wp-content/uploads/2019/06/TVET-Quality-Assurance-Framework.pdf>

TVETA Strategic Plan (2018) http://www.tveta.go.ke/wp-content/uploads/2018/06/TIVETA-STRATEGIC-PLAN-2-e-pub_2-Compressed.pdf

TVETA Summarized Guidelines.(2020).<https://www.tveta.go.ke/odelsummarized/>

TVETA Institutions (2019). Institutions Retrieved from <https://www.tveta.go.ke/institutions/>

Tytler, R., Symington, D., Williams, G., White, P., Campbell, C., Chittleborough, G., ... &

Dziadkiewicz, M. N. (2015). Building Productive Partnerships for STEM Education

Ullucci, K., & Howard, T. (2015). Pathologizing the poor: Implications for preparing teachers to work in high-poverty schools. *Urban Education*, 50(2), 170-193.

United Nations Educational, Scientific and Cultural Organization (UNESCO). (2016). Every child should have a textbook. Global Education Monitoring Report, Policy Paper 23. Paris: UNESCO.

Retrieved 12 November 2018 from <http://unesdoc.unesco.org/images/0024/002433/243321E.pdf>

Unterhalter, E. (2019). The many meanings of quality education: politics of targets and indicators in SDG 4. *Global Policy*, 10, 39-51.

Wallet, P., & Melgar, B. (2015). Information and Communication Technology (ICT) in Education in Sub-Saharan Africa: A comparative analysis of basic e-readiness in schools. UNESCO Institute for Statistics

Walters, W. H. (2014). E-books in academic libraries: Challenges for sharing and use. *Journal of Librarianship and Information Science*, 46(2), 85-95.

Wang, C., Cheng, Z., Yue, X. G., & McAleer, M. (2020). Risk management of COVID-19 by universities in China.

Wang, X., Yang, H., Shi, M., Zhou, D., & Zhang, Z. (2015). Managing stakeholders' conflicts for water reallocation from agriculture to industry in the Heihe River Basin in Northwest China. *Science of the Total Environment*, 505, 823-832.

Yasunaga, M. (2014). Non-formal education as a means to meet learning needs of out-of-school children and adolescents. *Background Paper prepared for Fixing the Broken Promise of Education for All: Findings from the Global Initiative on Out-of-School Children*. Montreal: UNESCO Institute for Statistics, 120.

Zancanaro, A., Todesco, J. L., & Ramos, F. (2015). A bibliometric mapping of open educational resources. *The International Review of Research in Open and Distributed Learning*, 16(1).

Zhang, T., Niu, X., & Promann, M. (2017). Assessing the user experience of e-books in academic libraries. *College & Research Libraries*, 78(5), 578.

APPENDICES

Appendix I: Introductory Letter



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TO WHOM IT CONCERN

DAVID NTHIGA LEWIS (P54/6463/2017)

The above named is a student in the MSc in Information Technology Management of the University of Nairobi. As part of the requirements of the programme, the student is required to undertake a research project and write a report. The project title for the student is: **An ICT-Based Framework for Improving Access to Educational Resources**. The objective of the research is to improve access to educational resources by technical and vocational colleges among the marginalized communities.

Your institution has been identified as a source of data required for this project. I am therefore requesting that you assist the student, who is under my supervision, to obtain the required information. Your assistance will be highly appreciated

A handwritten signature in black ink, appearing to read 'Christopher A. Moturi'.

CHRISTOPHER A. MOTURI
SCHOOL OF COMPUTING AND INFORMATICS

Appendix II: Questionnaire
Questionnaire for ICT and Administrative Staff

Kindly answer the following questions by ticking or commenting in the spaces provided.

Your responses will be treated with at most confidentiality.

Section A: Demographic Information of Respondents

- i. Gender
 - a) Male []
 - b) Female []
- ii. Age
 - a) 18 – 35 Years []
 - b) 36 – 50 Years []
 - c) Over 50 Years []
- iii. Educational Background
 - a) Form Four []
 - b) College []
 - c) Undergraduate []
 - d) Post Graduate []
- iv. Area of Specialization / Department of Work _____
- v. Years in Employment
 - a) Less than 5 Years []
 - b) 5 – 10 Years []
 - c) 11 – 15 Years []
 - d) Over 15 Years []

Section B: Factors Limiting Educational Access for Marginalized Persons

1. Kindly indicate the extent to which you agree with the following statements on the factors limiting educational access in this region

SA: Strongly Agree, A: Agree, U: Undecided, D: Disagree, SD: Strongly Disagree

	Factors Limiting Educational Access for Marginalized Persons	SA	A	U	D	SD
EA1	Cost of educational material is above reach for many students					
EA2	Near all students cannot afford computing device for use in school					
EA3	Despite fee subsidy, some schools still charge development fees which some students cannot afford					
EA4	There region has an insufficient number of schools					
EA5	Schools in the region are far from reach of many pupils					
EA6	Teacher pupil ration is below national accepted standard					
EA7	Some classes/subjects have no teachers to teach them hence schools improvise					
EA8	Schools have sufficient number of textbooks					
EA9	Most school in the region are power connected					

EA10	Classes have sufficient power plugins					
EA11	Internet and Mobile network is not a problem in the region					
EA12	Stakeholder participate in the running of activities of this school					
EA13	ICT usage is promoted in the school as defined by the MoE legislations					
EA14	School pupils absenteeism in the region is very high					
EA15	Cultural aspects heavily influence school learning in this region					

2. What are the other challenges affecting the education access in the region

Section C: Suitable Educational Resources Access Solutions for the Marginalized Communities through ICT utilization

3. To what extent do you agree with the following statements on the suitable education resource access solutions for the marginalized communities through ICT utilization

SA: Strongly Agree, A: Agree, U: Undecided, D: Disagree, SD: Strongly Disagree

	Suitable Educational Resources Access Solutions for the Marginalized Communities	SA	A	U	D	SD
EAS1	Recruitment and retention of personnel including teachers, admin staff and support staff is lacking for support ICT educational access models					
EAS2	There is no leadership succession policy for schools in the region to enhance ICT capacity					
EAS3	Training and development for teaching staff is inadequate in the region to support ICT educational access models					
EAS4	Curriculum outcomes through ICT Model use can only be enhanced not compromised					
EAS5	Customized standards in ICT models use need to be developed to enhance resource accessibility					
EAS6	Learning pathways are easier to follow by use of ICT models					
EAS7	ICT models are capable of covering all educational content					
EAS8	ICT models are accessible in the region despite infrastructural challenges					
EAS9	Use of ICT models does not compromise quality of education					
EAS10	ICT platform must develop various delivery structures of content including mobile and web based					
EAS11	Innovation should initially be prioritized over content					

	to ensure the platform adds value to ease and flexibility of educational access					
EAS12	It is easy to achieve platform flexibility to education resources using ICT access models					
EAS13	Community can provide practical information on kind in ICT model they think is practical for them					
EAS14	The ICT education access model has to be developed and supported by partners					
EAS15	The ICT model must be intelligent and sensitive to the regions culture					
EAS16	ICT models for education access need more capacity development if they are to be successful					
EAS17	Quantity management cannot be an issue for ICT educational access models					
EAS18	ICT education access models must have predictive models to support learners of different strengths					

4. Kindly indicate major ICT attributes that the ICT model which would enhance educational access should have?

5. How can infrastructural challenges including power, network and ICT resources be handled to ensure the ICT educational access model is functional?

Section D: Programs that enables educational resources sharing by the marginalized communities in Kenya?

6. Kindly indicate the extent to which the following programs can enhance educational resource sharing in this region based on your understanding of these technologies

Virtualization:

Thin Client:

Web Server:

Content Management:

Section E: Integral Modules of an ICT Enhanced Educational Resources Access

Framework for the Marginalized Communities.

7. Kindly rate the following statements based on the extent to which you agree on the most important integral modules that the ICT educational resource management framework must have to address the needs of the this marginalized community.

		SA	A	U	D	SD
Learning Management System						
IM1	Course Management					
IM2	Remedial Classes					
IM3	Teacher Training					
IM4	Students Assessment					
Open Online Course Management						
IM5	Specialized Multimodal Content					
IM6	Expert Offering Remote Courses					
Open Educational Resources						
IM7	Co-Created Content					
IM8	Supplementary Material					
IM9	Expert Collaboration					
Stakeholder Management						
IM10	Donor Management					
IM11	Client and Vendor Management					
IM12	Volunteer Management					

Interview Schedule for Community Members (Administrators, Religious Leaders, Parents Representatives and Local Leaders)

1. Kindly comment on educational access situation in this region.

2. What are the challenges affecting the education access in this region?

3. In your opinion how do you think the use of ICT can assist increase educational resource access?

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4. How ready is the community in terms of ICT adoption and use to assist increase educational resource access

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5. Kindly indicate major ICT attributes that the ICT model which would enhance educational access should have?

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6. How can infrastructural challenges including power, network and ICT resources be handled to ensure the ICT educational access model is functional?

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7. How would you propose the e-based content be shared among the different learners in the region?

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8. What are some of the most important integral modules (activity support) that the ICT educational resource management framework should have to address the needs of this marginalized community?
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