INTEGRATION OF INFORMATION COMMUNICATION TECHNOLOGY IN TEACHING AND LEARNING OF ENGINEERING COURSES IN KENYA: A CASE OF NATIONAL POLYTECHNICS

BY

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DECLARATION

Declaration by Candidate

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DEDICATION

I dedicate this work to my family members, my loving mother Grace, my father the late William, my dear wife Alice and our children Edward, Vincent and Beth for their patience, encouragement and prayers.

ABSTRACT

The dynamic changes in the education sector and the consistent demand for skilled personnel have necessitated the use of Information Communication Technology (ICT) as an important and innovative component for instruction. The workplace skills are changing significantly and there is high demand for new set of skills creating a skill gap between the development of human technical skills from technical Institutions and the emerging technological industrial skills. The purpose of the study was to investigate the status of ICT integration in teaching and learning as an innovative approach to address the challenge of engineering training in National polytechnics in Kenya. The objectives of the research were: to determine the adequacy of ICT infrastructure; examine the level of ICT knowledge and skills of trainers and the status of its application in teaching and learning of engineering courses. The study employed mixed method research approach which combines quantitative and qualitative techniques. The study was anchored on the constructivist and guided by technology, organization and environment theory. The study population comprised of managers and trainers in engineering departments in the national polytechnics. The study respondents' comprised 48 trainers selected by stratified simple random sampling, 15 managers of technical departments and 3 overall managers selected by Purposive sampling techniques. The research tools used for data collection were questionnaires, interviews and observations. The data collection tools were vetted by experts to guarantee reliability and a triangulation technique was applied for the assurance of validity. Descriptive statistics were used to analyse the quantitative data and the qualitative data were categorized under different themes and analysed using both narrative and discourse techniques. The findings revealed that over 75% of the trainers were competent in ICT basic knowledge and internet skills; 66% of the trainers were skilful in multimedia and advanced ICT skills while an average low of 20% could use ICT for teaching and learning in both theory and practical lessons. In lesson delivery observations, 40% of classes were in computer laboratory and were essentially computer based; exclusive of all the engineering based programs; a manager observed that smart classrooms were a reserve for trainers of predominantly computer technology**.** The study concluded that the trainers had positive perception towards ICT utilization but inadequate ICT infrastructure, and this could be attributed to the low ICT integration in teaching and learning of engineering courses. The trainers were competent; they had reservation in to using specialised media tools. This study therefore recommended that the trainers be up-skilled on pedagogical skills, digital content preparations and ICT infrastructure be improved.

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LIST OF ABBREVIATION & ACRONYMS

TVET:	Technical Vocational Education and Training
ICT:	Information Communication Technology
MOE:	Ministry of Education
MOEST:	Ministry of Education Science and Technology
MDG:	Millennium Development Goal
KESSP:	Kenya Education Sector Support Program
KICD:	Kenya Institute of Curriculum Development
DRC:	Democratic Republic of Congo
NICT4D:	National Information Communication Technology for Development Policy
NGICT:	National Government Information Communication Technology Policy
GOK:	Government of Kenya
UNESCO:	United Nation Education, Scientific and Cultural Organization
GDP:	Gross Domestic Product
GSMA:	Global System for Mobile Association (Communication)
DOI:	Diffusion of Innovation
TAM:	Technology Acceptance Model Theory
TRA:	Theory of Reasoned Action

TOE:	Technology Organization and Environment
ILO:	International Labour Organization
TTL:	Teaching Training and Learning
PBL:	Problem Based Learning
SSA:	Sub- Saharan Africa
ISTE:	International Society for Technology Education
ITE:	Initial Teacher Education
CPD:	Continuing Professional Development
CEPAK:	Computers in Education Project in Kenya
IDRC:	International Development Research Centre
TBL:	Technology Based Learning
TL:	Teaching and Learning
ELFE:	European E-Learning Forum for Education
NACTE:	National for Accreditation of Teacher Education
NP:	National Polytechnic
VL:	Virtual Laboratory
KNEC:	Kenya National Examination Council
TVETA:	Technical Vocational Education Training Authority

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CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

The Integration of Information Communication Technology (ICT) in teaching and learning is a concept of adopting new technologies in equipping trainees with knowledge, skills and attitudes needed in a variety of subjects. ICT is the application of an assorted array of technological tools and resources used to create, communicate, disseminate, store and manage information. The subject matter of this study was integration of ICT for teaching and learning engineering courses.

In turn engineering courses constitutes a curriculum that the content, the objectives and structure are of technical orientation. The term engineering can be described as a branch of science and technology that concerned with the design, invention, building, maintaining, and improving structures and processes, machines and devices. The application of engineering knowledge is important in everyday life in that the principles of science, technology and mathematical is used to research and develop economical solutions to technical problems.

The integration of ICT for teaching and learning of engineering constitutes the deployment of ICT infrastructure; tools and accessories as classroom instructional

resources. The application of ICT by integrating into teaching and learning promotes acquisition of engineering technological skills and it enhances knowledge attainment; however, the study focused on the application of ICT to facilitate transfer of knowledge.

In Kenya, population explosion has created tremendous pressure on enrolment in secondary education and subsequently the demand for technical training has gone up. The upsurge in enrolment consequently has compromised the quality of technical education due to the trainee-trainer ratio which calls for a variation of the teaching delivery methods. ICT today offers an opportunity to address many of these challenges and offers solutions for meaningful teaching and learning in technical education. ICT plays a very important role in teaching and learning as it provides flexible and timely information retrieval and facilitates learning without the limitation of distance, the class size and the trainee/trainer ratio.

For Kenya to achieve her Big Four Agenda as envisioned in Vision 2030 and Sustainable development goals, there is need to enhance quality engineering training. However, institutions are still grappling with shortage of equipment, inadequate trainers and out-dated instructional materials, a situation which can be alleviated by integrating ICT in Teaching and Learning to establish virtual laboratories. This has led to a mismatch between industry requirements and the skills technical graduates receives from training.

The knowledge in which engineering works is dynamic and how we understand the world and how to affect it continues to change and is ever becoming more comprehensive, complex and complete and therefore for any technician or technologist to carry out their work successfully, one must be well versed with new and emerging technologies. These knowledge and skills gap being experienced in the technical training institutions graduates and the world economy can be bridged by integration of ICT in the technical training institutions.

Therefore, this study seeks to explore the nature of teaching approach employed in national polytechnics. There is scanty information on technical trainer's adoption of ICT as a training tool. This is evident from the few studies conducted in Kenya on the application of ICT; more so in technical training institutions at the level of National polytechnics

Integration of ICT was the independent variable, whose effectiveness is influenced by various variables which included trainer's knowledge, skills and attitudes, availability and adequacy of infrastructure and pedagogical skills. The findings from this study is realized through cause effect as interpreted from the specific variables in establishing the strength of trainers in terms of knowledge, skills and attitudes, institutional resources and the approach to ICT utilization. The respondents who were fully immersed in the framework and set up of the institution enhanced the reliability of the outcome of the study. The study was carried out in three technical institutions; two National and College of equal status, purposely selected based on the approved

programs and the levels, management, staffing and funding structure, location and the years of existence.

1.2 THE BACKGROUND OF THE STUDY

The 21st Century has been identified the era of Information Technology (IT) and in every sector of economy the emphasis is on Information Communication Technology (ICT) application and operation compliance. This era has brought in functional transformation in all segments of the economy; business, education, transport, hospitality, medical, and manufacturing through the use of modern technology in training. It is therefore of principle importance that ICT is integrated in education and training and be strongly linked to lifelong learning to accommodate the current and the future technological innovations. It was the intention of this research to establish the practices and approaches adopted by trainers in integrating ICT in engineering content delivery.

The fundamental essence of the global economy is knowledge application with the aim of seeking solutions to challenges facing humanity. The renowned philosopher Drucker (1998) suggested that knowledge is the main factor of production and overrides both capital and labour. As in this research, there is need to study the methods of knowledge acquisition, availability of ICT equipment and the nature of interaction between the trainers' ICT competencies and the utilization of the equipment.

The objective of integrating ICT in the instructional delivery process is to improve quality, relevance and to provoke the desire of learners to continuously seek knowledge hence indulging lifelong learning. According to Maclean (2012) several developing and developed countries have undertaken to integrate ICT, which can be described as the incorporation of a variety of electronic tools that exchange information to enhance the quality of life that is not obstructed by location, time and distance. However, literature review presents studies undertaken in Europe and Asia with scanty data locally.

According to the researchers Gülbahar (2007), Kim and Hannafin (2011) using technology in educational settings benefits greatly the students. Practical skills can be delivered virtually via a well-organized ICT set up. The approach where practical skills were taught using hands-on learning only has changed over time. There is great need for ICT integration in TVET as the world of work according to Rojewski (2009) 'requires knowledgeable workers skilled in information technologies.

According to Zarini et al (2009) ICT facilitates the development and the strengthening of TVET around the world by enhancing networking and knowledge sharing opportunities. In the light of these facts, TVET institutions need to set up and strengthen their commitment towards training and produce ICT operation compliance graduates or products that will match up with industry trends in the modern workplace.

In order for institutions to effectively use technology to support trainee-centred learning, an agenda for technology that focuses on a common set of learning standards

and pedagogical strategy needs to be set up to connect to real situations. According to Moeller and Reitzes (2011) generally trainers that use technology do so primarily to present information rather than to provide hands-on learning for trainees. However, Pitan & Muller (2019a) asserts that education is to have computer class and to teach learners about the basic use of computer to exploit valuable services that ICT offers in improving the pedagogy of education.

The report of Inan and Lowther (2010) identified trainers' proficiency with technology as a key factor associated with restricted use of technology in the instruction rooms. For trainers to use technology effectively for educational purposes not only should they be familiar with how to operate equipment, but also understand how these tools are effectively used in their teaching and training fields; They also need to know how to incorporate ICT resources into classroom activities that accomplish important learning goals. It was observed by Kirimi (2014) that ICTs are rapidly changing technologies, and the best confident ICT trainers need to unceasingly upgrade their knowledge and skills, and be well-informed of the modern growths and top notch practices. Trainer nervousness over being substituted by technology or limiting their class authority in the classroom as the learning process becomes more learner –centred is a recognised obstruction to ICT adoption. Palagolla and Wickramarachchi (2019) asserts that trainers' ICT competency, ICT infrastructure, management backing and institutional planning are key components for operative integration of ICT in teaching and learning

Integrating technology in educational practices has proven to be a slow and complex process. The institutions' culture and structure do not support specific uses of Technology. More often than not, technology is not aligned with the methodology and curriculum and as a result there is no foundation in place to provide consistent access to and use of technology.

Trainers incorporate new technologies into existing practices when: they experiment on using technology to teach new ways and observe learning changes in their subjects as noted by Williams (2002) or when overall support and positive expectations from the institutions community and management influence trainers' beliefs, and willingness to integrate technology as reported by Inan & Lowther (2010). Zhao and Frank (2003) proposes that the process of technology integration evolve as the trainer's beliefs, pedagogy, and technology skills slowly build upon each other as the technology is introduced and assimilated into the institutions culture.

According to baseline survey by Hooker et al (2007), 15% of TVET institution does not have requirements for ICT use in coursework and 20% of lecturers do not use ICT as a tool for teaching and learning due to the absence of enabling environment; tools, structures and policies. The potential of ICT to facilitate the achievement of MDGs and Vision 2030 involves the handling of information to support all types of activities in the economy, training, work places and homes. This therefore, confirms that ICT is the key driver for socio-economic development. This study sought to establish this affirmation in the Kenya National Polytechnics context.

The Ministry of Education, expects TVET Institutions, National Polytechnics being among them, to adopt and integrate ICT in teaching and learning both in laboratories and workshops. Further, the institutions are expected to collaborate and interact with other organizations including industry as the potential market for graduates. A study by Higgins and Moseley (2011) revealed that inability of teachers to understand why they should implement ICT in teaching and how precisely to put into practice is an obstruction to its implementation. The results of this study will establish whether the trainers in technical institutions share the same characteristics as established in their study.

1.2.1 ICT Infrastructure and its Application

The equipment meant to store, transmit, manipulate information or animate processes is generally referred to as Information Communication Technology infrastructure, which comprises of computer, accessories and other related electronic equipment. MoE (2018) noted that trainers should have ICT proficiencies and instructional abilities to integrate ICT effectively in teaching and learning, whereas UNESCO (2011) resolved that successful integration of ICT in teaching and learning relies on trainers' aptitude to structure the learning environs in new ways, that blend new technology with new methodologies, develop informally dynamic instruction rooms, and inspire co-operative interface, cooperative learning and group work. A study conducted by Yildirim (2007) concluded that the access by trainers to ICT resources is one effective way of enhancing pedagogical use of technology in teaching and learning.

ICT provides teaching tools that are more effective in the learning process on the basis of virtual platform. Virtual laboratories aid the trainees when they are carrying out practical activities. According to UNESCO (2000), virtual laboratories are defined as a workplace for remote collaboration and experimentation aimed at doing similar activities, reporting and disseminating the results. The application of computer and its software in teaching and learning allows the trainees to collaborate. It also provides an opportunity to set up virtual laboratories to display the outcome of experiments and also to learn complex principles and processes.

The application of ICT is emerging as an essential element in this era of knowledge economy. Bryan and Slough (2009) recognized Computer technology and its accessories as cognitive tools. Virtual laboratories are based on simulation of real life situations; providing an enabling environment for learners to construct knowledge that is transferable in practical situations. The application of ICT in a cognitive-constructivist approach in teaching and learning is important to a supplementary, dependable, and productive learning. Bailey and Finkelstein (2009) argued that workers who have worked with computer simulation learn more successfully.

1.2.2 Trainers Perceptions of ICT Integration

The development of learning technologies has changed the approach to teaching and learning; it provided a proactive and easy access environment to content delivery. Institutions of higher learning such as universities and TVET colleges have made efforts

to provide ICT infrastructure. However, according to Albirini (2006) trainers do not maximize the usage of the infrastructure provided. According to findings by Zhang (2013), the perception of trainers on the use of ICT is a major barrier. Similarly, Cassim and Obono (2011) found that the correlation of teachers' belief and the use of ICT are high. The integration of ICT in teaching and learning is greatly influenced by trainers' attitude and acceptance of the usefulness of the technology as observed by Akbaba (2005). Mwalongo (2011) in his study on pedagogical teaching practices concluded that trainers did not use ICT to change the methodological practices, but instead chose to maintain the traditional teaching practices. In a study by Lubega (2017) on the role of ICT in Higher Education sector reported that Bill Gates asked a significant question "How can technology be used as a tool to re-form the entire college practice so as to deliver enhanced training to more people with less cost?''. Mahlangu (2018) asserts that the use of eLearning systems provides boundless opportunities on different topics for learning globally. While, Mikre (2011) explained eLearning as an education program that utilizes an information network- for instance the internet, an intranet (LAN) or extranet (WAN) be it whether entirely or partly, for content delivery, collaboration and or simplification. It was observed by Hamilton- Ekeke and Mbachu (2015) that ICT formulates a new pedagogical approach, changing recipient to being partakers of knowledge creation, and Olusanya and Oluwasanya (2014) listed the application of ICT to include computer-based learning, virtual classroom, video-conferencing and digital blending in which subjects matter are conveyed through the internet, in/extranet, video tape, satellite TV and CD-ROM. According to Murgor

(2015) ICT permits trainers secure the opportunity to muster knowledge from the entire world which augments efficient teaching, learning and research by reducing distance.

1.2.3 Trainers' Knowledge and skills in ICT

Information Communication Technology has brought revolution in the education sector both in learning and research. Education being a vehicle to training of human capital has continuously changed so as to cope up with the needs of the work place. In order to be in-line with the technological transformation taking place at the workplace, trainees need to be well prepared with ICT knowledge and skills and on how to continuously grow that knowledge, so as to cope with the rapidly new set of industrial skills required.

In order to integrate ICT in classroom trainers must be knowledgeable and skilful in ICT. ICT integration is defined by Lloyd (2005) as the use of ICT in classroom. The trainers being the agents of change need to be conversant with how to use the instructional software during the course, make presentations, or set and carry out practical activities in virtual laboratories or workshops. Crittenden (2009) emphasized the importance of ICT integration in technical and vocational education training and asserted that ICT is used to transmit, store, create or share information using various technologies. According to Cavas, Karaoglan & Kisla (2009) there are significant positive relationship between trainers' ICT skills and the frequency of the Technology use in instruction rooms. It is confirmed by Agyei and Voogt (2011) that ICT skills are

exclusively important for effective application of the technology and is the strongest predictor of ICT integration in the classroom or instruction rooms.

1.3 STATEMENT OF THE PROBLEM

The application of computer technology to manipulate information was described by Bryan and Slough (2009) as an avenue of knowledge transfer through simulations of processes and presentation of data in synthesized form for better comprehension. There has been a mismatch between the skills acquired by the graduates of National Polytechnics and the changing demand for new set of skills in the world of work as perceived by sessional paper (2005) number one. The Government has come up with comprehensive ICT policies and established several Polytechnics expected to produce competent technicians and technologists for the world of work, however the market castoffs them on the basis of deficits in the technical knowhow or lack of the expected competencies. This has created a lot of disquiets for the Governments, hence the formulation of ICT National policy (2009) the need to address the challenge by use of information communication technology. The wide gap between the development of relevant human skills and the emerging technological industrial processes is what this study investigated to establish the origin and possible solutions to therapy the situation. The emerging Information and Communication Technology to enhance skill training and provides an inducement for continuous learning in order to cope with the changing working environment.

Literature review has made it clear that computers have been used to impart technical skills to trainees elsewhere in the world. Computers are utilized pedagogically to simulate or animate specific scientific operations aimed at enhancing understanding and insight of philosophies and processes involved.

ICT has transformed the world into a technological village and Kenya in the ecosystem and as a developing country would need to keep with the pace. It is therefore unfortunate that the graduates from these middle level colleges lag behind in technological advancement as ICT has not been fully utilized to facilitate knowledge acquisition, thus, mismatching their skills with industry requirements and often rendering them incompetent for employment or even self-employment. The development of skills and competencies required in the workplace among trainees in technical training institution remains inefficient. Saud, Shu'aibu, Yahaya and Yasin, (2011) highly recommended that Information Communication Technologies (ICTs) be used to promote the development of employability skills. This overcomes the limitation of time and space and enhances transfer of knowledge. Integration of ICT in learning engineering and training fosters new experiences for the learning. The study investigated whether National Polytechnic trainers utilizes ICT in teaching and learning engineering practices.

1.4 PURPOSE OF THE STUDY

The purpose of this research study was to investigate the status of ICT integration in teaching and learning of engineering courses in National polytechnics in Kenya. The study investigated ICT Integration in teaching and learning engineering courses in National Polytechnics scrutinizing the mode of instruction with respect to availability of ICT infrastructure, trainers' ICT competence and attitude, the training environment and the utilization of ICT equipment.

1.5. THE OBJECTIVES OF THE STUDY

The objectives of the study were:

i. To establish the availability and the adequacy of ICT Infrastructure for ICT integration in teaching and learning of engineering courses in National polytechnics.

ii. To describe the perception of trainers on ICT integration in teaching and learning of engineering courses in National polytechnics

iii. To assess the level of ICT knowledge and skills of trainers with respect to teaching and learning of engineering courses in National Polytechnics.

iv. To determine the extent to which trainers utilize ICT knowledge, skill and ICT Infrastructure in teaching and learning of engineering in National Polytechnics.

1.6 RESEARCH QUESTIONS

i. Do the available ICT infrastructure adequate for integration in teaching and learning of engineering courses in National Polytechnics?

ii. What is the perception of trainers on the use of ICT integration in teaching and learning of engineering courses in National Polytechnics?

iii. To what degree do trainers' competent in ICT knowledge and skills for teaching and learning of engineering courses in National Polytechnics?

iv. To what extent do trainers' use of ICT knowledge, skills and infrastructure in teaching and learning of engineering courses in National Polytechnics?

1.7 JUSTIFICATION OF THE STUDY

Integration of ICT in teaching and learning is significant in that it provides broad base resources for trainers and trainees. This mode of teaching using integrated technology provides opportunities for creative thinking, knowledge construction, learning environment, problem solving skills and understanding concepts using various tools. Different forms of multi-media channels provide more information, understanding of different concepts, variety of approaches and expertise as asserted by Sharma (2005). This research was informed by the content of Sessional Paper one, 2005 and the general

outcry by industries that National Polytechnics graduates do not meet industry requirements both in skills and technology.

ICT integration in education and training settings requires an implementation plan to facilitate effective technology deployment and to produce enhanced learning environments as noted by Levine (1998) several years in the past, and the same applies in the current situation. This requires an elaborate plan comprising of trainers' competence and infrastructure provision. Cambell (2001) reported that ICT adoption is an indicator of economic development and enhancement of job opportunities. According to Gibson, O'Reilly and Hughes (2002) ICT is central in lifelong learning. The researchers' also noted that there is an immense challenge for educators and planners, whose role is to equip students with relevant and quality ICT experience in preparation for the modern workplace.

According to Bates (2001) a knowledge-based economy demands technology-ready workers. Governments and industry demands put enormous pressure on educational institutions to use ICT in their daily routine tasks. Technology has brought transformation in all areas of life; mechatronic and programming in motor vehicles and workshop equipment, electronic fuel systems, communication, meteorology, survey, business operation, sales and many more. This therefore calls for graduates from TVET institution to be ICT compliant in order to fit into the industries and entrepreneurial ventures. The outcome of this study will boost the integration of ICT in technical training institutions both locally and internationally.

Adomi and Anie (2006) described the importance of ICT in these words, “In this technology-driven age, everyone requires ICT competence to survive. Information and communication technology integration is to minimize the emerging digital divide which is becoming an issue in the current situation as technology continues to become more sophisticated”.

1.8 SIGNIFICANCE OF THE STUDY

The National ICT policy document of 2006 was reviewed in September 2019. Further, its implementation and impact in education and training has not been evidently demonstrated. The finding of this research will go a long way in providing essential data required in the appraisal. The study will also create awareness of the importance of effective integration of ICTs in engineering training. The planners and policy makers are expected to use the findings of this study as a basis for reviewing the current ICT policy in order to overcome the challenges hindering smooth adoption and integration of ICT in technical training institutes in Kenya and in particular the national polytechnics.

According to Sukri, Shu'aibu, Yahaya and Al-Muzammil (2011), there is distinguished need for additional literature on the integration of ICTs in TVET. Further studies by ICT-Technical Vocational and Education Training professionals around the globe, amongst them Kotsik (2009), Basu and Majumdar (2009), Kearns (2009) and Zarini, (2009) also agreed with this observation. Integration of ICT is increasingly attracting research in general education but not in Technical Education. However, this study adds

to the body of knowledge with respect to sub-Saharan Africa perspective. It is worth noting that studies on ICT integration in Technical training have been conducted mostly in West African countries such as Nigeria and Ghana and also in South Africa. Few case studies have been done in East Africa countries. The study will contribute to existing literature on ICT integration in Technical Training Institutions in Kenya.

This study was intended to collect, process and analyse data and formulate evidence based themes to help planners, policymakers and educationists, curriculum and instructional designers and e-learning experts set apart a framework for the appropriate and effective use of ICTs in their educational systems. The outcome of any empirical research is bound to assist decision makers in making informed conclusions. This research study is of interest to all key stakeholders involved in Technical and Vocational Training; first it provides a brief overview of the global perspective and the use of ICT and secondly, it addresses the five broad issues in the use of ICTs in education and training; effectiveness, cost, equity, relevance and sustainability. The findings and recommendations of this study are expected to provide a process or framework to assist senior administrators of technical training institutions when making decisions on how to adopt and use ICT in training.

1.9 SCOPE OF THE STUDY

Information communication technology (ICT) is a broad term with varied meanings. However, this study adopted Haddad & Draxler (2002) description that ICT is a diverse

set of technological tools and resources used to communicate, create, disseminate, store and manage information.

The term ICT skills in this study refers to acceptance of technology and pedagogical skills possessed by the trainers, whereas infrastructure considers equipment, software provided in instruction rooms' space as provided for training and communication devices.

The utilization of ICT goes beyond the traditional computer based technologies entailing word processing, spreadsheet, data software or presentation, but includes networked computers and use of internet to enable interactive and collaborative learning. The study surveyed the integration of ICT in teaching and learning engineering programs. The responses from the respondents relayed the understanding and interpretation of trainers on the integration of technology.

The integration of computers and communication devices was limited to the use in instruction rooms/classrooms, laboratories and workshops. The respondents were members of technical departments involved in the teaching and learning of engineering courses. The study focused on a total of three public National Polytechnics or equivalent offering technical programs at the level of certificate and diploma accredited by Technical vocational education and training Authority (TVETA) and examined by Kenya National Examination Council (KNEC). The survey covered observations of course delivery in classrooms, data collection on the availability of ICT infrastructure,

and the capacity of trainers' in terms of ICT knowledge and skills and the perception on integration of ICT in teaching and learning (TL). The study drew discussion heavily on the series of informative surveys of ICT use in developed and developing countries and any relevant studies in the education sector. The three National Polytechnics have been in operation for over ten years and are located in major urban areas of Kenya and offer engineering courses in the area of mechanical, automotive, electrical and electronics and building.

1.10 LIMITATIONS OF THE STUDY

The study assumed that respondents possessed the same characteristics and that all the trainers would give accurate and truthful information. The mode of teaching was also assumed to be the same in all selected technical areas. These limitations were dealt with by carrying out stratified simple random sampling to select the right respondents who were immersed in the training system. The study did not claim perfection due to the intricacies and limitations of the research designs; however, mixed method was used to generate several sources of data for relationship in an attempt to find the convergence of the outcome through triangulation techniques. The failure of some questionnaires to be returned or let-down to be duly filled, and the limitation to generate the expected responses was corrected by interviews scheduled with correlated questions for deeper understanding of the phenomenon. The researcher confined the study to public National Polytechnics (NP) operating under the directorate of technical education in the Ministry of Education (MoE), with the assumption that the institutions were under the same

funding policies. This limitation was surmounted by selecting institutions which fitted the criterion of size, equivalent environment, fairly equal years of existence and offering similar programs.

The study was uniquely crafted within a specific context – to investigate how far NPs had woven ICT integration into the different approaches required for practical lessons/subjects, keeping in mind the complexity entailed in replication as Creswell (2003) asserted. The length of service and the respondents' diverse experiences by virtue of their unprecedented transfers from one institution to the other provided them unique and different opportunities to work in several institutions; however, their experiences from the previous stations would infiltrate into the responses which were corrected once again by the research design.

Qualitative researcher's characteristics of reflexivity may have introduced his preconception into the analysis of the findings. The researcher being a lecturer in a technical training institute poses a limitation in that there is possibility for discrimination in the qualitative results interpretation.

Education and trainings objectives in technical training institutions were assumed to be similar, however, the period of existence of the institutions differs, so does the trainers experience. The ICT background of the users, leadership orientation, their technological maturity and exposure to science and technology amongst others may have posed a limitation in terms of their appropriateness to participate in the study. This became a

limitation when it came to generalizing and drawing up of conclusive statement regarding the level of ICT integration in national polytechnics.

In reviewing the literature and research for this study every effort was made to trace publications related to technical training institutions. However, publications focused on local general education were reviewed when no suitable engineering publications could be found. These publications had limitations in terms of scope; lacked in-depth investigation on the interactive, collaborative and in specialized application such as simulation and system design. The researcher minimized this limitation by researching into literature review from regional and international countries. This allowed the researcher to make suppositions looking upon the relevance of the information to technical training institutions, thus limiting the comparative analysis

1.11 ASSUMPTIONS OF THE STUDY

This study assumed that all the respondents were equally knowledgeable in their fields and conversant with the general institution teaching system. The study assumed that within the research period the dynamics of the Institutions and the development of ICT infrastructure would not have undergone any significant variation to the detriment of the project outcome. The study presumed that the results of the study would be beneficial in addressing the slow paced and low level of integration of ICT in engineering training. The study assumed that the cultures of the different institutions were of non-consequence in the responses.

1.12 THEORETICAL FRAMEWORK

This study was guided by two theories namely Tornatzky and Fleischer (1990) theory which is directed by Technology, Organization and Environment (TOE) and the Constructivist theory of learning by Vygotsky (1978) which is based on the idea that people actively construct and make their own knowledge, and that reality is determined by experience.

1.12.1 TOE Theory of Technology Adoption

According to Oliveira & Martin (2011), the adoption of technology by any enterprise is governed by external and internal characteristics of the organization. This study adopted the theoretical model by both Tornatzky and Fleischer (1990), which states that adoption of new technology is governed by Technology, Organization, and environment (TOE). TOE framework considers the organization setting in terms of organization and managerial structure, technological background both internal and external and technological practices exemplified by the available ICT equipment.

This study adopted TOE model which identifies three aspects of institution's context that influence the process by which it adopts and implements a technological innovation. The TOE models emphasizes that integration of ICT is influenced by individual characteristics, both the internal and external characteristics of the organization, and the technological context which focuses on technological practices and equipment, as drivers for organizational innovativeness. Nevertheless, TOE

framework additionally has a new and significant component, environment perspective. The environment context puts forward both opportunities and constraints that the institution faces as it integrates ICT; such as infrastructure and technological modernization.

This model was appropriate as it provided a useful analytical framework that could be used for studying the adoption and ICT integration as an innovation for teaching and learning. The theoretical framework adopted guided the study as its structure supported the purpose of the study. As outlined by the theoretical framework, the adoption of ICT integration is influenced by individual characteristics which according to this study were the trainers. The trainers play an important role as mediators of the transformation. The acceptance of the application of the technology infrastructure begins with the trainer coupled with the ICT knowledge and skills they possess.

There are other factors that influence the integration of technology in teaching and learning which centres on the environment. In this study the focus was to establish whether integration of ICT in teaching and learning is influenced by the availability of equipment. In order to Integrate ICT properly as a technological tool for supplementing the traditional teaching process there is need to have appropriate computer technology materials available and relevant knowledge and skills that can serve as the fundamental support for the new methods of teaching and learning.

1.12.2 Constructivist Theory of Learning

The constructivist theory of learning is associated with Piaget (1966) who advocated that out of procedures of acclimatization people construct new knowledge from their experiences. The word constructivism denotes the notion that learners are capable of acquiring knowledge as individuals. This theory newscaster on the objective of trainer readiness in using lifetime themes teaching as they are appreciated as a critical constituent of the teaching and learning process. According to this theory, reality does not exist in advance but it is constructed through human activity. Constructivism scope can be enriched by means of intellectual apprenticeship which concerns with the trainer modelling a cognitive process and with time reallocates the responsibility over to the trainees as they grow into skilled personnel. The constructivist learning theory emphasizes that knowledge is constructed, rather than inborn, socially invented and not discovered since learning is basically a course of constructing sense of the world and real-live situations. According to Woolfolk (2010) constructivist approach is conducive to trainee-centered teaching and learning.

Constructivism converts the student from an inactive to a dynamic participant in the learning progression and by integrating ICT tools knowledge construction is activated rather than just routinely consuming knowledge from the trainer observes Bharati (2018). He went on to state that the fundamental of constructivism is equally the application of theoretical input and practical knowledge. He further added that ICT integrated tools opens up the world, challenging human intellect to explore learning in a

diverse mode, converting just a learner to an expert learner; a characteristic essential for success in the real world. He went on further to explained that ICT integrated tools offer opportunities for collective learning by the provision of social network link such as Google Docs and Drive; a file storage and synchronization service provided by Google, which enables user cloud storage and file sharing, Social Bookmarking a provision for a centralized online service which allows users to add, annotate, edit, and share bookmarks of web documents amongst others. The use of ICTs in technical training has resulted to a major paradigm shift from the dependence on the theory that human knowledge is reached through logical reasoning but rather by understanding of knowledge, objectives and creation of new knowledge. This is by relating the existing knowledge and making sense of the experiences, referred to as constructivism by Thomas (2010). In constructivism, learners construct the knowledge and learn from their experiences - a phenomenon termed as cognition. It therefore acknowledges the learners' active role in creation of knowledge. In constructivism classroom, the trainer has a role to create a collaborative environment where the trainees are actively involved in their own learning.

Constructivism theory of learning believes that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. When one encounters something new, say the expectation of the trainer to integrate ICT in teaching and learning, the initial step in once mind is to reconcile it with previous ideas and experience; traditional methodology, changing to a new believe, there then actively creating new knowledge. This theory was relevant to

the study investigating the status of ICT integration in TL by exploring and assessing prevailing situation. In the classroom, constructivist view of learning points toward using a number of different teaching practices; encouraging trainees to use active techniques such as experiments and real world problem solving practices.

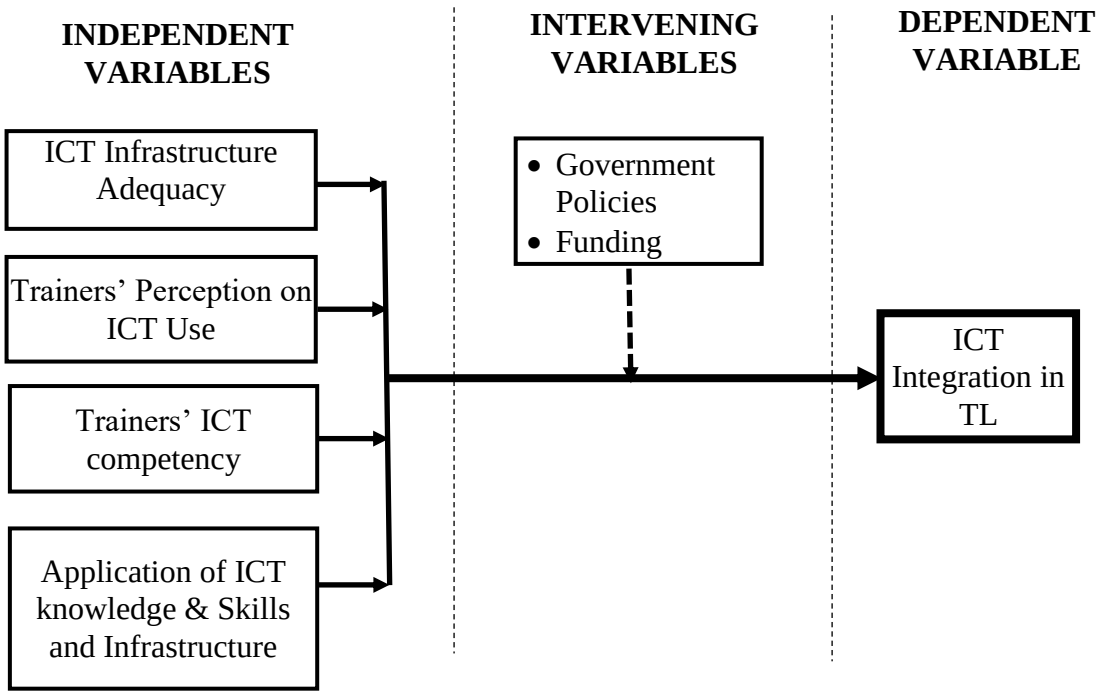
The two theories were selected by the researcher on the basis that both theories are based on constructivism which bears two aspects that is the constructivist perspective and the socio- cultural perspectives. The two theories emphasize that trainees were more liable to learn by aggressively partaking in the learning process.

1.13 CONCEPTUAL FRAMEWORK

The study considered ICT integration as the dependent variable. ICT integration relied on the independent variables namely ICT infrastructure; ICT infrastructure is the physical capital that at the individual level is targeted to improve the quality of life by giving that individual access to information and the exchanges of thoughts and aspirations which often occurs in all levels of economies asserts Bankole (2015). ICT facilitates content delivery and the process utilizes computer based technologies, digital imaging, internet, data storage devices, network infrastructure, desktop, laptop and broadcasting technologies not leaving out telephone which are used as instruction tools. Trainers' perception on ICT use, Trainers' ICT competencies and their utilization of ICT in conjunction with ICT infrastructure. The study conducted by Medeshova, Amanturlina and Sumyanova (2016) revealed that trainers' skills, perception and attitude were associated with the application of ICT for TL. The perception and attitude was considered as the forecaster

on the application of ICT in teaching simply because the trainers were seen as the key drivers of teaching and learning asserts Stiglitz (2016). Further, the author went on to state that the availability of Infrastructure did not equate to its effective use. The 'attitude towards ICT' was defined by Sang, Valcke, Braak, Tondeur and Zhu (2011) as the trainer's tendency to react in approval or disapproval to the integration of ICT in their instruction rooms as a consequence of the convergence of cognitive and emotional aspects. According to McShane & Glinow (2008) perception is the practice of getting information and constructing logic of the world about us by interpreting it, in the framework of the prevailing knowledge Mwendwa (2017) observed that this is occasioned by time, methodology and familiarity with computer accessories.

A study by Ojo and Adu (2018) revealed that trainers did not utilize ICT in teaching and learning regardless of the availability of infrastructure simply because of limited knowledge and skills, while Muslem, Yusuf, & Juliana (2018) asserts that trainers did not integrate ICT in teaching because they either lacked methodological skills or supporting facilities. The intervening variables were the Government policies and funding. These were variables relating the independent and dependent variables, but as non-figurative procedures; not directly observable or quantifiable in this study, its effect can only be inferred from the properties of the independent variables on the observed occurrence. Figure 1.1 below demonstrates the relationship between the variables.



Source: Conceptualized by the Researcher (2020)

Figure 1.1 Conceptual Framework Diagram

Globally, education and training has adopted new technologies to integrate ICT in the teaching and learning process, to prepare the trainees with knowledge and skills they require in their course subject matter.

The benefits gained by trainees were greatly dependent on the technological skills of the trainers and their attitude towards technology. Skills and attitude in turn largely dependent on the trainers' training. It was therefore clearly demonstrated that for effective integration of ICT in learning the major independent variables are knowledge, ICT skills, ICT infrastructure and how they are being utilized in practice. Effective ICT integration was the dependence variable. Therefore, integration of ICT in teaching and learning is a comprehensive interaction of instructional techniques and computer technologies with central and resultant objective of effective delivery of engineering principles and practices. The failure of a trainee to hold a fundamental discrete concept complicates the understanding of a system; however, integration of ICT through the interaction of all the components in the conceptual framework confronts the hurdle.

1.14 OPERATIONAL DEFINITION OF TERMS

Technical Vocational Education and Training (TVET): UNESCO and ILO (2002) defined TVET "as a comprehensive term referring to those aspects of the educational process involving general education, the study of technologies and related sciences, the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life."

Integration of ICT: According to Miller (1997), integration of ICT refers to the use of the computer and its accessories to facilitate teaching and learning in any subject area. In this study integration of ICT refers the application of computer, accessories and network, software and multimedia equipment for teaching and learning an engineering course.

Information Communication Technology (ICT): This refers to diverse set of technological tools and resources used to communicate, and to create, disseminate, store and manage information used for teaching and learning an engineering course.

Teaching and Learning: This refers to the process through which the trainer, organizes the curriculum, teaching aids and other variables are organized in a systematic manner to transfer technical knowledge and attain pre-determined competencies.

Competence: This refers to cluster of related abilities, commitments, knowledge, and skill that enable a trained person skillfully perform an engineering activity or operation or process.

ICT Policy: This refers to a well prepared document which is used as a regulatory framework and guide for directing the use of ICT as a vehicle for transforming teaching and learning with the purpose of enhancing quality teaching and lifelong learning.

ICT Infrastructure: This refers to the computer, its accessories and communications hardware and software used as instruction tools for teaching and learning,

Instructional/Educational Technology: This refers to the study and ethical practice of facilitating learning by creating, using, and managing appropriate technological process and resources.

Traditional Teaching: This refers to teaching where the learner listens to the trainer face to face. It is also referred to as "conventional teaching"

Perception: This refers to the attitude/opinion of the trainers about integration of ICT to facilitate teaching and learning.

ICT Skills: Refers to skills needed to efficiently use the elementary functions of a computer and its accessories to retrieve, access, store, produce, present and exchange information, and participate in collaborative networks via internet.

Engineering: This refers to a discipline that involves taking our scientific understanding of the natural world and using to invent, design, and build structures to solve problems to achieve practical goals.

Trainer: refers to a person whose occupations is to instruct people on skill building in various teaching fields and prepares them for a job. The term ‘trainer’ is being used interchangeably with ‘teacher’.

Vocational Education: It is the path of education that imparts the skills and knowledge needed in a given occupation

National Polytechnic: Refers to technical training institutions that were established under government orders in a gazette notice by the ministry of education or an equivalent.

1.15 THE CHAPTER SUMMARY

The chapter discussed the background of the study with focus on the importance of integrating technology in teaching and learning. The statement of the problem was discussed in view of the products of National polytechnic and perspective to the world

of work. The justification of the study was on the basis of the significance of significance in technical training. The general purpose of the study was to investigate the status of ICT integration in the teaching of engineering programs. The chapter also deliberated on the scope, justification, the theoretical and the conceptual framework of the study. The study was guided by two theories; Technology, Organization and Environment (TOE) and Constructivist Theory of Learning.

The findings and recommendations of this study were expected to provide a process or framework to assist managers of technical training institutions in when making decisions on how to adopt and use ICT in training.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discussed literature related to integration of ICT in teaching and learning engineering courses. The review particularly focused on the knowledge and skill capacity of trainers', ICT equipment and the approaches to delivery of curriculum content. It also gave the overview of the TVET concept in the transfer of practical knowledge, skills and attitudes in relation to industry practice and relevance. The recognition of virtual delivery of practical skills is also discussed in this chapter in view of ICT as a modern learning method that is expected to bridge the skill gap experienced between industry and training. The literature review identified distinctive features of TVET and application of ICT as a mandatory component that aims to achieve a sustainable and globally recognized workforce.

2.1.2 ICT Integration in Technical Training

Information Communication Technology (ICT), according to Munday (2012) is a branch of engineering dealing with the use of computers and telecommunication equipment to store, retrieve, transmit and manipulate data. ICT is the foundation of economies and a compelling force of social changes in the 21st century. In this era of knowledge economy, the driver is the technology and competent human capital in ICT is the gasoil energy as noted by Lynch (2000). This author went on to say "time to

competency" is the restricted access or considered advantage depending on how effective an organization is at finding and training knowledge workers.

In this period of aggressive economy, ICT makes knowledge a competitive resource as the economy depends on brains rather than muscles. This signifies that tangible benefits are realized by employing knowledge and competent technicians/workers and by engaging lifelong learning strategies. The economy is continuously undergoing regeneration through what may be termed as globalization which has led to free trade and limitless communication. ICT has unlimited influence in populace's lives, it has transformed virtually everything about how we do things on daily basis from the online shopping, card payments, social media, information sources asserts Atika & Awolusi (2019)

The growth and sustainability of the new economy as put forward by Artkinson (2000) relies on the fast transformation to the digital economy, heavy investment in research and innovation, and steady upgrading of skills and knowledge.

Technical training provides requisite knowledge and skills; however, due to the rapidly changing technology and the perpetually rising innovations a paradigm shift on the training approach is inevitable. Klug, Krause, Schober, Finsterwald and Spiel (2014) defined lifelong learning as a procedure that comprises a rapid transformation through which individual gain competencies in diverse areas throughout their existence. Lifelong aims to develop individuals' knowledge, skills and competencies. Ozdamli and

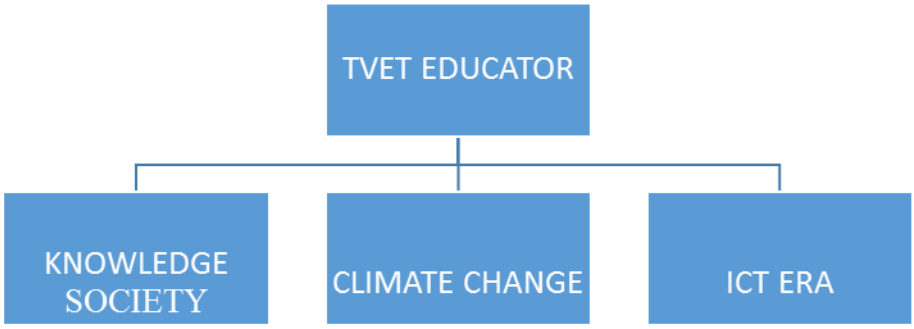
Ozdal (2014) observed that every individual desires lifelong learning for both work-related and singular needs. They further went on to proclaim that changing world conditions and developing technology makes lifelong essential for all individuals. A study by Imel (1998) identified four applications of ICT; as a Technology, mechanism for content delivery, instructional and complimentary tool. Technical Vocational Education and Training facilitates the transfer of skills and knowledge.

Teaching and learning in National polytechnics institutions is traditionally trainer based with learners entirely depending on trainers to provide learning content. ICT integration allows learners to be in involved in the learning process. In teaching and learning mechanical, electrical, and automotive and civil engineering related subjects, ICT is effective in aiding content delivery. According to Mwinyeria (2009) ICT integration is the use of all manner of ICTs across curriculum subjects. The integration of ICT in teaching and learning in technical training has not been fully utilized exhaustively; it is a perfect bridge between the in-use and emerging technology. Most concepts in mechanical, electrical, automotive, building and civil engineering are abstract in nature. It is through ICT that such concepts which are difficult to imagine can be simulated for ease of understanding.

2.1.3 Global Perspective of Information Communication Technology in Engineering training.

According to Rojewski (2009), the need for ICTs integration in Technical training institutions remains a great challenge, considering the impact ICTs makes in the world of work, and the need for knowledgeable workers skilled in information technologies. This researcher went further to state that the purpose of vocational education is to meet a country's workforce needs. Education therefore, should emphasize the importance of hands-on instructions and be delivered by persons with extensive experience. The market demands workers who are highly skilled, innovative, motivated and have higher order thinking skills such as problem solving, critical thinking, and teamwork and are committed to lifelong learning. With this in mind, trainers need to be conversant and committed to the integration of ICT in teaching and learning, in order to inculcate lifelong learning through critical thinking. Hollander and Mar (2009) observed that TVET is seen as an instrument for reducing extreme poverty as it prepares people for self-employment and is a medium through which relevant skills are inculcated to enable trainees effectively transit to the world of work. However, they noted that it is difficult to measure service quality as it is elusive and imprecise. This study looked at the provision of service on the basis of knowledge construct and transfer through effective integration of ICT in teaching and learning. Mohammed et al (2011) noted that effective integration of ICT eases the expansion and reinforcement of Technical Training by

enhancing networking and knowledge sharing opportunities as depicted in figure 2.1 below.



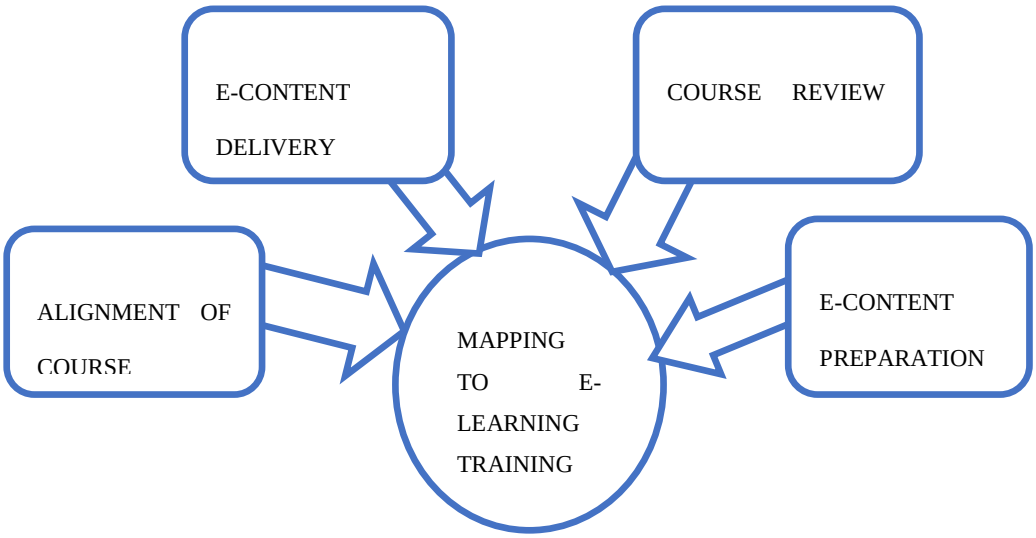
Source: UNEVOC (2011)

Figure 2.1 Global Trends Affecting TVET Educators

According to UNESCO (2003) technology is a key driver in economic growth and ICT is becoming a critical tool for preparing and educating trainees with the required skills for the global workplace. Thus, that the use of ICT in TVET can provide varied opportunities for developing more innovative ways to bridge the gap between institutional laboratories and the real practice of the workplace. The world, in which we are in, is changing rapidly with the influence of technology, from the way that knowledge is constructed to the way enterprises are performed. The labour market for those making initial entry or for those re-entering the market after in-service programs presents new challenges despite them being freshly trained and having acquired new skills. According to Saud et-al (2011) this challenge is brought about by the

development in the world of work that requires application of ICT in technical vocational education and training.

In summary, the development and delivery of e-learning content is feasible through what is provided in figure 2.2.



Source: www.hrmars.com/journals, (2001)

Figure 2.2 E-learning Components

2.1.4 Information Communication Technology Perspective in TVET in Africa

Most Sub-Saharan African countries have inadequate technological infrastructure. Menda (2006) noted that the major barrier to integration of ICT in the curriculum in learning institutions and community access to ICT are lack of hardware, software and

internet connectivity. Apart from the usual challenges of infrastructure, African countries are confronted by several external systemic factors such as lack of electrical power, poor transport systems and high import duties as articulated by Jensen (2005). Technical defects, internet connectivity and network configuration problems are also noted by Minishi-Majanja (2007) as key challenges.

The acquisition of ICT equipment is continuously gaining popularity amongst the population especially in areas where information transmission is being experienced as observed in table 2.1.

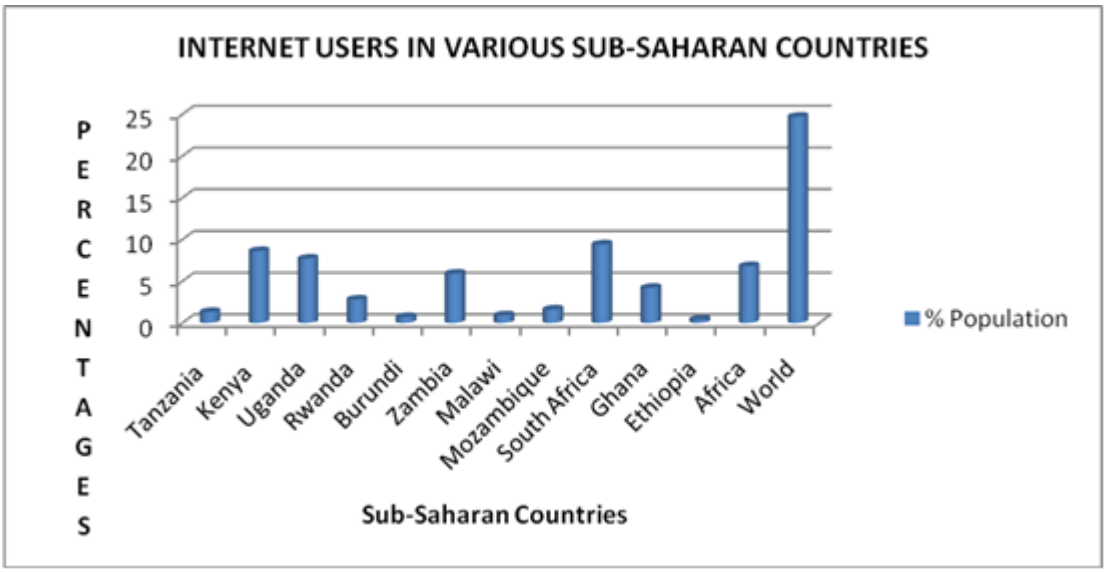
Table 2:1 ***Computer and Internet Access Statistics***

Infrastructure description	**% Population index**	**Current phenomenon (no statistics given)**
Population owning a Radio(1out of 4)	25	Increasing steadily
Pop. owning a TV	7.7	steady Growth
Pop. owning a phone	2.9	Increasing progressively
Pop. accessible to fixed telephone line	2.5	Decreasing
Pop. owning personal computer	0.7	Increasing gradually; inclusive of laptop
Pop. accessible to internet	0.6	Increasing steadily
Pop. accessible to pay TV	0.25	Increasing progressively

The digital divide is dominant across Sub-Saharan Africa (SSA) as a bandwidth divide stands out as noted by Unwin (2005). While good broadband connectivity is now taken for granted in most developed countries of the world, educational software is increasingly being developed to take advantage of this. On the other hand, access to the internet in SSA is rare and expensive due to dependence on expensive satellite connections. The use of ICT in education and training is hindered by the cost of bandwidth which is unaffordable for many learning institutions. The internet penetration in Africa is therefore still low ITU database (2013). The following statistics explain the narrative above: Internet Penetration in various Sub-Saharan African countries by June 2009 was 66 million making up about 4% of internet users globally, yet Africa hosts 14.6% of the world's population.

Information Communication Technology infrastructure development is the foundation and the first step towards making technology accessible to consumers. The prerequisite for infrastructure acquisition is determined by the ICT consumer populace. According to Were et al (2007) there were nine hundred and ninety-one million people in Africa in 2009. Statistics indicate that one in every four people had a radio, one in every 13 had a Television, one in every 35 had a mobile phone, 1 in every 40 had a fixed line telephone, 1 in every 130 had a personal computer, 1 in every 160 used the internet and 1 in every 400 had a pay TV. Though one of the richest countries in sub Saharan Africa, South Africa was included in this statistics and was therefore not exceptional. The data generally presents an overall dismal picture of computer and internet access in Africa.

Figure 2.3 summarizes percentage users in thirteen African States. Ethiopia trails in internet use. The whole of Africa has an average use of approximately six percent while the World's percentage was approximately 24% indicating a huge gap between the two Worlds.



Source: Internet World Stats 43

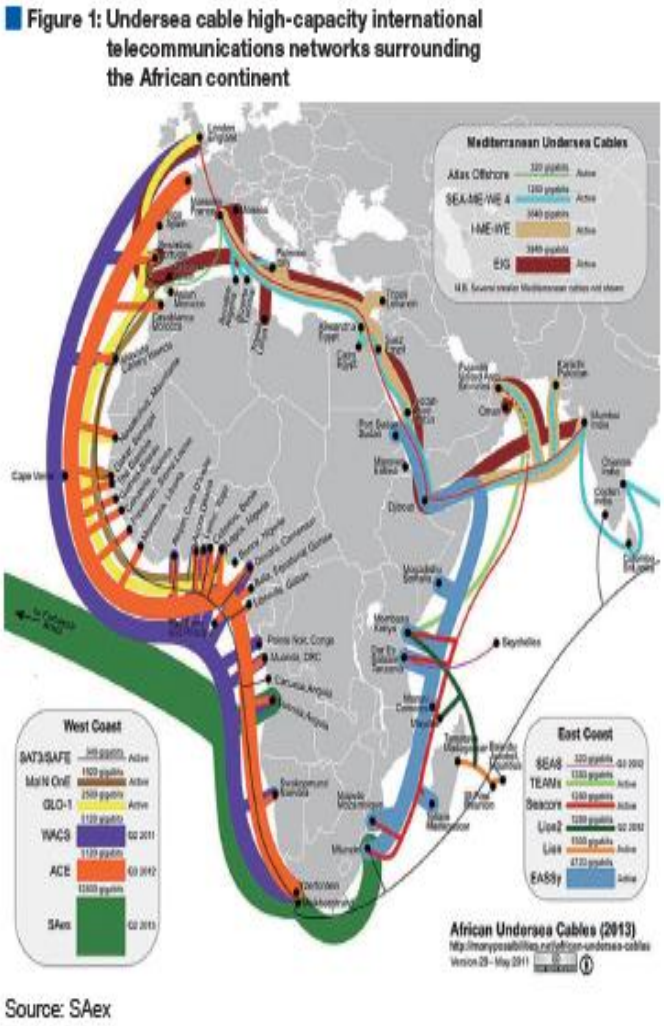
Figure 2.3 Users of Internet in Sub-Saharan Countries

The absence of landlines or fixed phone line access, and the popularity of mobile connectivity provide a dominant platform of internet connectivity in Africa. This is because over 90% of phones are now using digital technology. According to Van der Merwe (2003) observation in Africa, the wireless technology contributes to the rapid, low-cost level of a new wave of connectivity into rural areas not served by any other telecommunication providers. This was a paradigm shift in the world of information

communication. According to Peña-López (2009), the number of mobile phone connections in Africa increased sevenfold between 2002 and 2007 and the percentage of cell phones per inhabitant was 28% in contrast to 110% in Europe and 38% in Asia.

Traxler (2009) in the E-Learning Africa Conference argued that, for Africa, mobile learning was partly a way of dealing with the challenges of poor or virtual absence of internet connectivity, power, and access to computers. The expansive coverage of mobile phone network providers and large supply of mobile phones have greatly influenced the use of phones to access information

The African continent was receiving many international undersea cables to support information communication technologies resulting to a remarkable growth in the rapidly expanding mobile phone market and internet connectivity. The distribution of the undersea high capacity international telecommunication networks surrounding the African Continent is illustrated by figure 2.4 below:

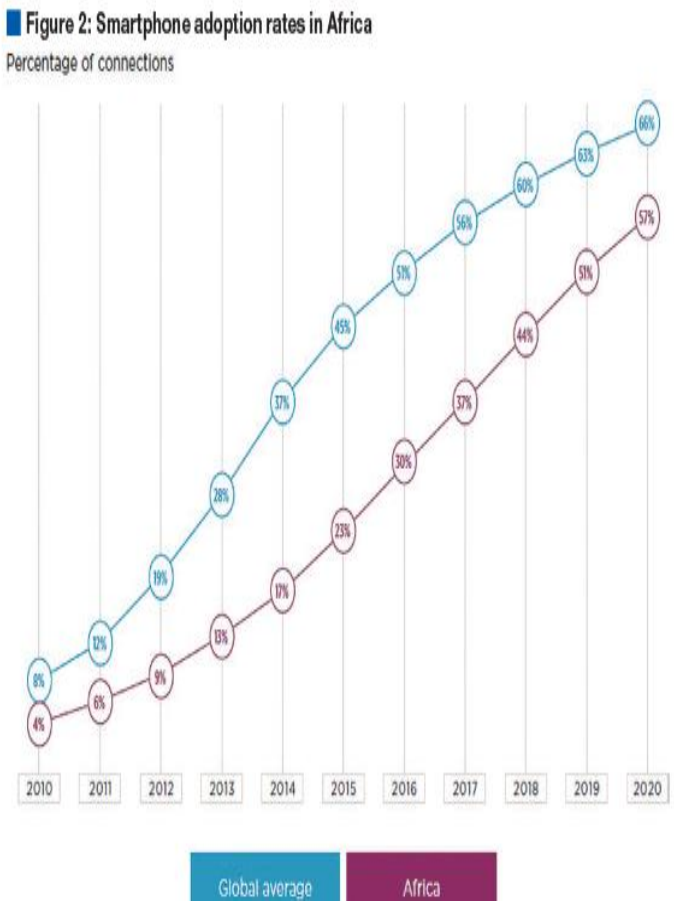


Source: GSM Report June, 2016

Figure 2.4 The Connection of East Africa and South Africa across the Indian Ocean

The cables on the eastern side connect East Africa and South Africa across the Indian Ocean. The lines on the western side connect countries on that side such as Britain and France amongst others, across Atlantic Ocean.

The introduction of ICT in all sectors of economy as the driving force under this background has boosted the digital economy causing a leap effect in Africa. The establishment of high capacity transmission cables had enhanced the adoption of smart-phones in Africa. Globally smart phones adoption was 51% in 2016 and 30% in Africa (GSMA) (2016). The difference was expected to reduce significantly in the future as illustrated here below.



Source: GSMA Report, 2016

Figure 2.5 Global Smart Phones Adoption

2.1.5 Information Communication Technology Perspective in East Africa

East Africa as is known today comprises of Kenya, Tanzania and Uganda but has widened its borders to include Burundi and Rwanda. These five countries constitute the East African Community a holistic and comprehensive framework within member countries which include infrastructure enhancement, development of ICT use in schools and large-scale professional development.

The available literature confirms the well-known fact that East African countries face a shortage of electrical energy supply. In Tanzania, the national electricity grid is limited to commercially viable areas missing out on most of the schools in the rural areas. This, together with frequent power breakdowns and power cuts, increase the cost of owning ICT infrastructure and makes it almost impossible for schools in the rural areas to access and use ICT in education Farrel (2007).

2.1.6 The Information Communication Technology Perspective in Kenya

In Kenya, the first comprehensive and stakeholders driven ICT policy was discussed and approved by the cabinet in January 2006 and an ICT policy document was then gazetted. In recent times, the Government of Kenya emphasised the importance of ICT by giving it recognition in Vision 2030 as a medium of development in line with the Sessional Paper No. 1 of 2005 and Millennium Development Goals (MDGs) (KIC) (2006). The MOEST (2006) ICT policy strategy was to integrate ICT in education and training for improved access, learning and administration.

Information Communication Technology in education in Kenya is a virtually new-found area of research. However, some useful publications are available, dating back to an evaluation of one of the original computer deployment projects in the country; the Computers in Education Project in Kenya (CEPAK). For society to be functional and prepared for a knowledge based economy and to cope with the competitive economy, human capital must be technologically oriented. In Kenya, the institutions that are mandated to provide skilled middle level manpower are Technical Training Institutions and National Polytechnics.

Raynaud (2018) in her speech in Kenya reported that ICT plays an important role in the implementation of the governments big four agenda in bridging the divides, sharing information and driving inter-operability across policy and regulatory landscapes.

2.1.7 National Policy Standpoint on Integration of ICT in Education and Training

The Government of Kenya developed a long term development blue print running from 2008 to 2030 commonly referred to as Kenya vision 2030. The development of Vision 2030 was informed by the tremendous growth realized after the implementation of rapid economic strategy for wealth and employment creation (ERS) (2002) where the economy recovered and resumed path to rapid growth at a rate of 6% in 2007 from 0.6% in 2002 as noted in Vision 2030 (2008). The strategy is to implement the vision 2030 blue print in five successive terms each of a period of five years. The vision is anchored on three pillars-social, economic and political. The social pillar embraces

eight key transformation sectors, one of which is education and training. The aim of Vision 2030 is to transform Kenya into a new industrializing, middle level country providing high quality of life for all citizens by 2030. In the same document it is stipulated that other levels of education and training such as Technical, Vocational and Education will play a crucial role in transforming the country into a middle income economy by the provision of high standards trainers' and learners' skills. The technical and vocational education courses are important in the perspective that they are able to cope with technology transformation, thus providing opportunities at the global market. This undertaking supports Brandsford et al (2000) view that ICT can help the students to cope with globalization. According to Grabe (2007) ICT facilitates the students to develop the skills, boost their motivation and widen their knowledge information. Vision 2030 emphasized the application of science, technology and innovation to raise production and efficiency across all the three pillars. It envisages that more resources would be devoted to scientific research, technical capabilities of work force and in raising quality of teaching in mathematics, science and technology in schools, polytechnics and universities. In terms of curriculum review, the universities and technical vocational education and training sector was to include more science and technology. This created a provision to integrate information communication technology in teaching and learning in the institutions of higher learning. It was at this point in time that the objective to review and appraise the national ICT policy of 2006 was referenced to be examined and analysed in light of vision 2030.

The Kenya Vision 2030 caused the development of new strategies for promoting science, technology and innovation and promotion of learning of technical skills. The Vision 2030 had in mind that Kenya has a small pool of inadequately trained skill workforce ready and relevant to be integrated into the job market in response to economy demands. It was envisioned that during the development of this blue print, Technical Institutions would be transformed into technologies that would provide proven technical knowledge acceptable by industries and a system of national recognition would be established to honour innovators.

The review of the National ICT policy was carried out in September 2019 with the objective of carrying out capacity development for ICT in Education and Training in order to establish a framework for ICT integration in education and facilitating integration of ICT in special needs education of all those involved, particularly learners and the trainers. In order to keep abreast with the development of the emerging technologies the government recognized that ICT would create a competitive advantage in the global job market. The policy noted that approximately one million youth enter the market NGICT (2019) every year. ICT is identified as enabler for social transformation and especially in the modern economy in which knowledge plays a pivotal role in inspiring wealth creation, social welfare and international competitiveness. The policy is expected to encourage Integration of digital technologies into educational and vocational systems at all levels to ensure that our current and future workforce is prepared for the changes that are happening both in the service and

industrial sector. The policy stated that the government position was that all Kenyans should be proficient users of appropriate digital technology so that they can benefit from the deep change that is continuously evolving. In view of this policy direction the government, having in mind that in the recent past there was migration from analogue to digital broadcasting, recognizes that ICT has great impact in globalization and rapid change in technology.

It was therefore, prudent to provide in the policy that the technology shall facilitate knowledge diffusion framework for institution of higher learning and industry. In the light of this the government aims to provide support to focus on incubation Laboratories on computer generated animations and film production.

On the Annual ICT week held on May 16 2018 at Nairobi, the Cabinet Secretary in charge of ICT, in his address on the theme "use of emerging Technologies in driving the big 4 agenda for Kenya" noted that:

> ICT will be the driving force in realization of Government Big 4 agenda all the way through the emerging technologies which includes artificial intelligence supported by data storage capacity, cloud computing and block chain technologies; a structure that stores transaction records-payment transfer/monitor supply chain et cetera, where every transaction is authorized by digital signature of the owner, which authenticates the transaction and safeguards it from tampering. It is therefore critical that government, industry and academicians work together to evaluate opportunities that these technologies present in order to ensure the entire human race benefits

In view of these highlights, the importance of ICT cannot be over-emphasized in improving the economic well-being of citizens. This is because technology has no

limitations for students and trainers' accessing different sources of information and ways to learn a concept.

Raynaud in addressing the same annual ICT week at Nairobi on the key note speech entitled "On how the implementation of ICT can empower business and entrepreneurship of Africa" noted that apart from equipping population with skills and knowledge, there was need to innovate and leverage on digital tools, promote investment and market entry to attain greater coverage of networks. This includes the need for food security through preservation of large perishable goods by setting up control systems to provide intuitive automation and maintenance solutions to ensure hygienic environments.

The emergence of technology has changed the learning environment such that the learning at the moment is more of Hands-on. When trainers effectively integrate technology into subject areas, the trainer grows into roles of adviser, content expert and coach.

2.1.8 The Status of National Polytechnics in Kenya

The National polytechnics in Kenya are domiciled in the Ministry of Education, State Department of Vocational and Technical Training. These institutions were established through a legal order by the cabinet secretary of education in exercising the powers conferred by section 26, article 2 of Technical Vocational Education and Training (TVET) Act 2013.

The functions and objects of polytechnics is to take part in technological innovations in addition to the discovery, transmission and enhancement of knowledge and to inspire intellectual life in economic, social, cultural, scientific, and technological advancement amongst others. The polytechnics are mandated to offer courses at Artisan, Craft, Diploma and higher diploma levels. These institutions train middle level human resource that is well equipped with technical and business skills required by industry. The institutions produce technicians and technologists who are expected to play a major role towards the attainment of the Kenya vision 2030.

Polytechnics are managed by governing councils appointed by the cabinet secretary. The day to day management is done by a Principal, Deputy Principal and Heads of Departments. UNESCO (2003) upholds that TVET trainers have constantly been initial adopters of innovations associated to ICT tools, equipment, and logic controls. This applies to the use of ICTs for enhancing the delivery of TVET curriculum. However, there is limited information on the degree to which ICT-supported learning is being integrated in TVET class experiences. There is evidence that the developed world especially in Canada, USA and Australia, has successfully implemented ICT-mediated learning to an extent that appears to have reached a more advanced level of integration. This study seeks to interrogate and constitute hard evidence on the ICT integration in Technical training in Kenya and in particular engineering courses in National polytechnics.

2.2 INTEGRATION OF ICT THRUST THEORIES

There are many definitions of integration of technology to teaching and learning. As defined by Hughes (2013), it is the application by a teacher or a student of digital ICTs that supports the constructivist teaching and learning process. In stimulating the factors essential for integration of technology in teaching and learning, several theories can be considered.

2.2.1 The Theory of Reasoned Action (TRA)

This theory of reasoned action (TRA) was developed by Ajzen and Fishbein (1975). This theory suggests that a person's behaviour is determined by their intentions to perform and that intention in turn, is a function of their attitude towards the behaviour and subjective norms. The theory aims to explain the relationship between attitudes and behaviour within human action. In this theory, the behaviour is ultimately determined by ones underlying belief. As a matter of fact, hanging behaviour is viewed first and foremost as a matter of changing the underlying cognitive structure.

The individual performance of a given behaviour is first and foremost determined by the person's intention to perform that action. This intention is influenced by two factors; the individual's attitude towards the behaviour as characterized by the belief about the outcome of the behaviour and the value of the outcome; Secondly, the influence of the person's societal or environment or subjective norms which rely on the belief about what other persons are perceived to interpret.

According to Atieno et al (2016) TRA model has been adopted only across consumer disciplines; dieting and consumption of engineered foods; however, it has not been employed in innovation technology.

2.2.2 Technology Acceptance Model (TAM)

The technology acceptance model is an information system theory that fashions how users come to accept and use technology. This model was developed by Davis et al (1989). TAM argues that external influences such as system characteristic, development process and training has great influence on the perceived usefulness and perceived ease of use and the development of positive attitude towards the technology. They argued that where users find a technology useful and easy to use, they then become positive to its use leading to behavioural intention to use, and finally the actual use of technology. The scholars Teo et al (2008) and Moon and Kim (2001) concurred with the spirit of the theory framework that the teacher who believes that ICT is useful and was enthusiastic to use it would have positive attitude towards integration of ICT in TL. According to Chuttur (2009) most of the studies had focused on only voluntary environments with little consideration for mandatory settings thus leaving a gap to be filled.

2.2.3 Technology-Organization-Environment Framework

Tornatkzky and Fleischer (1990) developed Technology-Organization-Environment (TOE) framework which theorized that the decision to adopt technology as the main variable was influenced by three principal elements: the technology element which

describes the internal and external technologies relevant to the organization and third was what Starbuck (1976) observed to be inclusive of current practices and equipment internal to the institution.

The organization context refers to the descriptive measures about the organization such as the scope, size and the managerial structure. The environmental context is the surrounding-arena in which the organization conducts its business. This theory was used by Leung (2015) to explore ICT initial and continued adoption in hospitality industry, and the outcome indicated the complication of technology adoption in the industry. Baker (2012) reviewed studies that had used the TOE framework and asserted that, there was limited development to the framework with the exception of enumeration of the different factors that are relevant to technology adoption. He saw the reason as being that the theory is highly adaptable and therefore scholars have had little to refine. Bakers' research carried out further analysis of the framework and developed a refined version that is simpler with the least assumptions and variables broadly applicable.

2.2.4 Technology Pedagogical Content Knowledge Framework

According to Mishra and Koechler (2006) the framework states that a teacher depends on three domain of knowledge for integration of ICT into TL. The domains are: content knowledge, pedagogical knowledge and technological knowledge. The two scholars went further to explain that content knowledge is the actual subject matter, thus, one must understand the central facts, concepts, theories and procedures to be able to

integrate in teaching. On pedagogical knowledge, it claims that one must understand deeply the process of teaching which includes planning, classroom management and student evaluation. As concerns technology knowledge, one must understand the standard technologies, for instance internet, digital video and how to operate the technology equipment. In general terms a teacher needs to know deeply the subject matter one teaches and also the manner in which the subject content can be changed by the application of the technology. Having established the importance of integration of ICT in TL by other researchers', Muyinda et al (2017) suggested that further research is required to investigate the strength of the theories, in order to identify other factors which may be manipulated to enhance positive influence and integration of ICT in TL.

2.3 MODELS OF ICT INTEGRATION IN TEACHING AND LEARNING

The growth and versatility of computers has transformed the interaction of the people. In addition, the power, diversity of information, and the speed have allowed trainees to access information beyond the classroom set up as notes Kankaanraata (2005). The computer culture has assisted the users to interact and share ideas conveniently in a multimodal communication system. The use of computers requires different learning strategies to accomplish, basically referred to as pedagogical approaches. The application of computer technology requires strategic pedagogy in technology integration and ensuring synchronisation of activities as teaching and learning are closely interconnected.

Under the sunshade of ICT blended learning, education has been transformed from the traditional learning procedures through presentation of facts, drills, rules and practices, to problem solving, inquiry and designs, discovery and inventions, and creativity and diversity. Majumbar (2006) posited that the role of a teacher or rather trainer is transformed from a knowledge transmitter to that of a facilitator and that of the trainee, from dependent learner to autonomous learner and from solidarity learner to collaborative learner. The responsibilities of a teacher demand a new mode of thinking and understanding of the new visionary learning. The learner is given new responsibilities to seek knowledge, synthesize and share it.

2.3.1 Innovative Philosophy of Learning

The philosophy of learning translates into fusing ICT with pedagogy in order to enhance learning. This strategy is brought about to promote or improve learning, motivate and engage learners, foster enquiry and exploration. This strategy creates a new culture for both trainees and trainers. Traditional educational approaches have resulted in a mismatch between what is taught to the student and what the industry needs. Problem based learning is becoming increasing famous in training institutions as a tool to address the inadequacies of traditional training.

According to Teo and Wong (2000), the traditional approach does not give trainees confidence to interrogate what they learnt. It was observed by Boud and Feletti (1999) that ICT is seen as an innovative measure to encourage students to learn how to gain

knowledge via real life problems. Innovative methods use text, audio, video and animation to provide the information. Thus, multimedia learning process is more interactive and student engagement is higher. The process is a mix between the student, teacher and multimedia resources, observes Damodharan and Rengaranjan (2007). The principles of innovative learning are to understand the course content and develop students' ability and beyond that, to have access to new sources of information, to apply learning in new and real situations. According to Dumont et al (2010) the principles that help to sustain innovative learning include: learners being at the centre of what happens in the classroom, recognizing that emotions are an integral part of learning and seeing learning as a social practice that cannot happen with a lone student, but happens best among students in groups.

There are several types of innovative learning methods, just to name a few: flipped classroom, which according to Strayer (2007) is delivering instructions online outside of class and 'moving' into classroom, which involves voice threads. This is an innovative method in which educators use voice for extending and documenting classroom conversation, online tutoring, virtual classes. Another innovation is Kahoot, an innovative learning technique according to Hussein and Ortega (2015) that requires a browser and internet connectivity to allow operation of an online platform at the outset of each lecture as an interactive way to revise and summarize important concepts and definitions explained in the previous lecture.

Finally, we have multimedia technologies which are available and capable to create innovative and interactive multimedia applications such as Adobe Photoshop, Premier and Sound Forge and 3D Studio Max observes Neo (2001). In this innovation the trainer can modify the content by converting it into digital format and customize it for presentation.

2.3.2 Pedagogical (Instructional) Practices Using ICT

In the recent past, there has been exponential growth in the application of ICT and has made great impact on the society. The trainees in this information age will require not just a larger set of statements or a larger range of specific skills, but capacity to readily acquire new knowledge, solve fresh problems and employ creativity and critical thinking in the development of innovative approaches to solutions of new and flourishing problems. Institutions are expected to support trainees develop life-long learning abilities and equip them to cope with the challenges of the 21st century. There are several pedagogical practices applicable in recent times.

2.3.2.1 Instructional Media

The application of ICT for teaching and learning constitutes pedagogy-technology integration. Preparing teaching and learning activities involves the traditional methods of getting teaching materials ready. However, by integrating technology the procedure

embraces the use of information communication technology equipment and processes. Therefore, Pedagogy-Technology integration is summarized in table 2.2 below:

Table 2:2 Pedagogy-Technology Integrated Chart

MEDIA	**LEARNING\ ACTIVITES**
Word processing	Drafting teaching materials
	Editing and Revising
	Publishing
Spreadsheet	Typed Student list
	Students performance records
	Planning content delivery instructions
Multimedia applications	Graphical diagrams
	Illustrations of concepts
	Animations
PowerPoint applications	Developing presentation and sequencing
Interactive multimedia applications	Interactive instructional materials
	Cognitive processes
Multimedia animation equipment	Drills and practices
	Simulation of complex concepts
	Individualized instructions
	Multimedia courseware
ICT Networking	Flexible Learning
	Distributed Learning
	Emails

Source: Adapted from Majumbar 2006

The preparation of teaching materials from the traditional teaching methods to the specialized educational software requires them to be equipped with the fundamentals of ICT tools and sufficient understandings of the integration of these tools in teaching and learning. The use of this equipment is critical for it calls for a change of mind set and development of positive attitude towards ICT application in TL. The role of the trainer from instructor to a facilitator and to learner centred instructions is significant for successful implementation of pedagogy-technology integration. The use of ICT satisfies the sundry needs of all learners and is epitomized by all kinds of socio-cultural situations in counting a range of intelligence.

The pedagogical strength of instructional media is identified by its ability to use natural processing abilities. The critical contest in designing instructions through multimedia is the selection of media and their application for most advantageous human learning with reference to the learning intentions. Multimedia is described by Rop (1997) as a systematic approach to the analysis, design, development, implementation and evaluation of learning materials. The multimedia instructional designs aim at effective learner centred as opposed to the traditional teacher centred approach. Keengwe et al (2008) observed that the application of multimedia technology is that which combines text, graphics, video, animations and audio in TL and ensures productive, interesting, motivating and interactive classroom activities. Stringer et al (2016) confirmed that using ICT in TL appropriately transforms the learning experience from teacher centred to learner centred.

2.3.2.2 Electronic Learning

Electronic learning is abbreviated as E-learning. In the case of E-learning according to Majumbar (2006), the instructional approach is achieved through a process whereby the trainer and the trainee are linked up via an electronic media or rather computer network. The phrase E-learning combines two concepts; focus on learning pedagogy and secondly, learning goes beyond the walls of the traditional classrooms.

The instructional method provides innovative educational resources and contemporary TL practices. The benefits of e-learning take account of anywhere-anytime learning, asynchronous and group collaborations. Algahtani (2011) affirmed that e-learning consists of the use of computer based and internet based platforms. He further elaborated that computer based e-learning comprises of the full use of a range of hardware and software that are available for use in ICT and each component can be used in either of two ways; computer managed instruction and computer assisted learning. The transition from the traditional face to face learning to full e-learning has created two learning systems, blended learning or hybrid learning. The phrases blended learning and hybrid learning are used interchangeably as posited by Ryan et al (2016. According to Benard et al (2014) blended learning is defined as the combination of instruction from two historically separate models of TL: face to face learning system and distributed learning system.

2.3.2.3 Pedagogical Content Knowledge

The application of ICT in teaching and learning combines methodology and content knowledge. The framework of pedagogy content knowledge encompasses two twin concepts. It is through science that concepts and principles are understood, concepts and relationships unified, and the process of investigation in science disciplines and application of mathematics in science research done. The second concept is pedagogy components involve actual strategies of teaching, class organization, evaluation and transformation of ideas into understandable experiences. According to Shulman (1987) pedagogy content knowledge is a blending of content and pedagogy in order to enhance the understanding of how particular topics, problems, or concerns are organized, represented, and adapted to the diverse interest and various levels of abilities of learners. The important skill that a teacher should possess is the capacity to transform the knowledge to be taught to the students in a way that could be understood. The scholars Achinstein and Fogo (2015) expressed pedagogy content knowledge as amalgamation of pedagogy and subject matter, mirror imaging how branch of learning, topics, concepts, and skills are organized and adapted for particular learners within specific learning contexts.

2.4 THE INFRASTRUCTURE FOR ICT INTEGRATION IN TEACHING AND LEARNING IN ENGINEERING

Information Communication Technology infrastructure is equipment meant to transmit or manipulate information or a variety processes. These operations cannot be possible without a computer and its accessories.

The developing economies are facing a competitive market since the accessibility of new technologies has not created any advantage to them to gain educational opportunities states Osang, Ngole & Tsuma (2013). However, the Republic of Kenya (RoK) (2018) asserts that ICT has the capacity to deal with the challenges of access, quality and relevance faced by Kenya's education system

The introduction of this interactive technology has brought about a paradigm shift in pedagogy making it constructivist and collaborative. Kotsik (2009) observed that the 21st century studies on integration of ICT into National Polytechnics learning system could be realized if focus is on-strategic readiness, the fit between ICTs and current teaching and learning practice, and the availability of ICT based infrastructure. ICT integration in Polytechnics education system complements the traditional knowledge transfer in engineering and science courses as it provides a means of simulating the processes or analysing the sections. This offers trainees individual learning which is capable of providing instantaneous practical learning experiences comparable to real life situations. ICT integration or instructional technology refers to the use of electronic

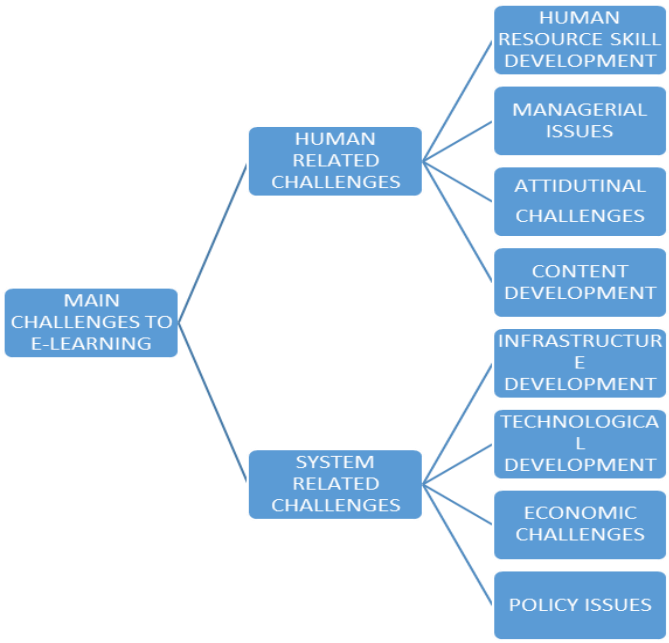
technology and media to deliver support and enhance teaching, learning and assessment. The working party of researchers Smith and Higgins (2006) noted that the preparation of electronic notes for classroom use is difficult, time consuming plus the required skills are tactful and hard to learn. The researchers concluded that the use of interactive boards enhance whole class teaching, less group work and a faster base but reduced student responses

According to Gupta (2002) e-learning has found application in engineering education in the delivery of hands-on activities. In this approach the environment is flexible and allows the development of course content by trainers into e-content, giving both the trainer and the trainees an opportunity to upload and download course material (interaction). The course material dealing with practical (hands-on) activities such as machining, processing and many more may be simulated for better understanding.

The use of interactive media in engineering training according to Karahoca et al (2010), has alleviated the shortage of staff and training content in the world of teaching and learning. However, this success is only possible when trainee's computer literacy and infrastructure is adequate and up to date. The challenges of implementation of ICT can be categorized into three broad groups: insufficient infrastructure; the unavailability of power and internet connectivity as was identified by Kozma et al., (2004).

The main challenges in the adoption of ICT integration in TVET training range from the digital divide, infrastructure development, acquisition of ICT equipment, provision of

software and internet connectivity to the development of policies for the utilization of equipment in teaching and learning. Pirani (2004) summarized the main challenges of e-learning in technical training in figure 2.6 below:



Source: Pirani (2004) and reviewed by the researcher, 2014

Figure 2.6 Analysis of E-learning Challenges

Effective adoption and integration of ICT into teaching in schools depends mainly on the availability and accessibility of ICT resources such as computers, screens, projectors and software among others. A study by Yildirim (2007) found that access to technological resources is one of the effective ways that influence teachers' pedagogical use of ICT in teaching. A strong ICT framework in education and training is an essential

tool for knowledge based development. Isman et al. (2010) remarked that deficiencies in ICT facilities and infrastructure in the workplace is significant barriers to ICT use.

According to Gibbons et al (2008), the benefits and advantages of using computer simulation soft-wares overweigh those of traditional laboratories. Gibson and his colleagues listed the advantages as flexibility of time and location (virtual laboratory can be located elsewhere other than the teaching laboratory) and control of learning pace. In addition, students can also control their learning speed and the use of simulation techniques leads to reduced infrastructure costs as cost of equipment is minimized. Thus, the virtual laboratory uses computer simulation as a training tool and is used as an educational aid permitting the self-training of students through their individual work by simulation and in effect, this reduces the gap between the theoretical information and hands-on in real laboratory. According to Martinez et al., (2003) information communication technology techniques solves the problem of overcrowding in lecture halls, and allows trainers to focus on the explanation of basic theories and reduces the time devoted to instrument operation and technique.

Kenya and Uganda amongst other East African Countries face similar electrification challenges. In these countries, hydro-power constitutes the bulk of energy supply. Alternate sources such as wind and solar energy options have not been exploited to their full capacity. However, small-scale funded projects are currently exploring alternate power supply options for schools in East African Countries. An erratic electricity supply with occasionally lengthy blackout limits the use of ICT in learning.

A study by Mwangi (2013) in two tertiary institutions in Kenya on the barriers to successful integration of ICT revealed that the major obstacles were: lack of telecommunication infrastructure, inadequate knowledge and ICT skills in both content and pedagogy. In a study that investigated the constraints to the integration of ICT in teaching and learning in a teachers' college in Kenya found out that infrastructure was inadequate. The researcher Rono (2015), reported that the inadequacies were in the areas of internet connectivity, competent human resource and ICT equipment. These findings correspond with the values of the theory that ICT adoption is influenced by the organization culture, the environment and the competency of human capital.

The failure of a learner to grasp a fundamental discrete concept complicates the understanding of a system. However, integration of ICT through the interaction of all the components in the conceptual framework confronts the experience. This research study was purposely designed to establish the reasons behind the slow and weak adoption of ICT in teaching and learning engineering courses. However, several studies agree with the theory that integration of ICT in teaching and learning engineering is influenced by the software and hardware infrastructure. While the above studies identified the factors influencing integration of ICT in learning engineering, they did not relate it to the environment. This includes the instruction rooms set up, the availability of ICT infrastructure and whether there was internet connectivity to facilitate preparations and support research undertakings. This study therefore sought to inter-

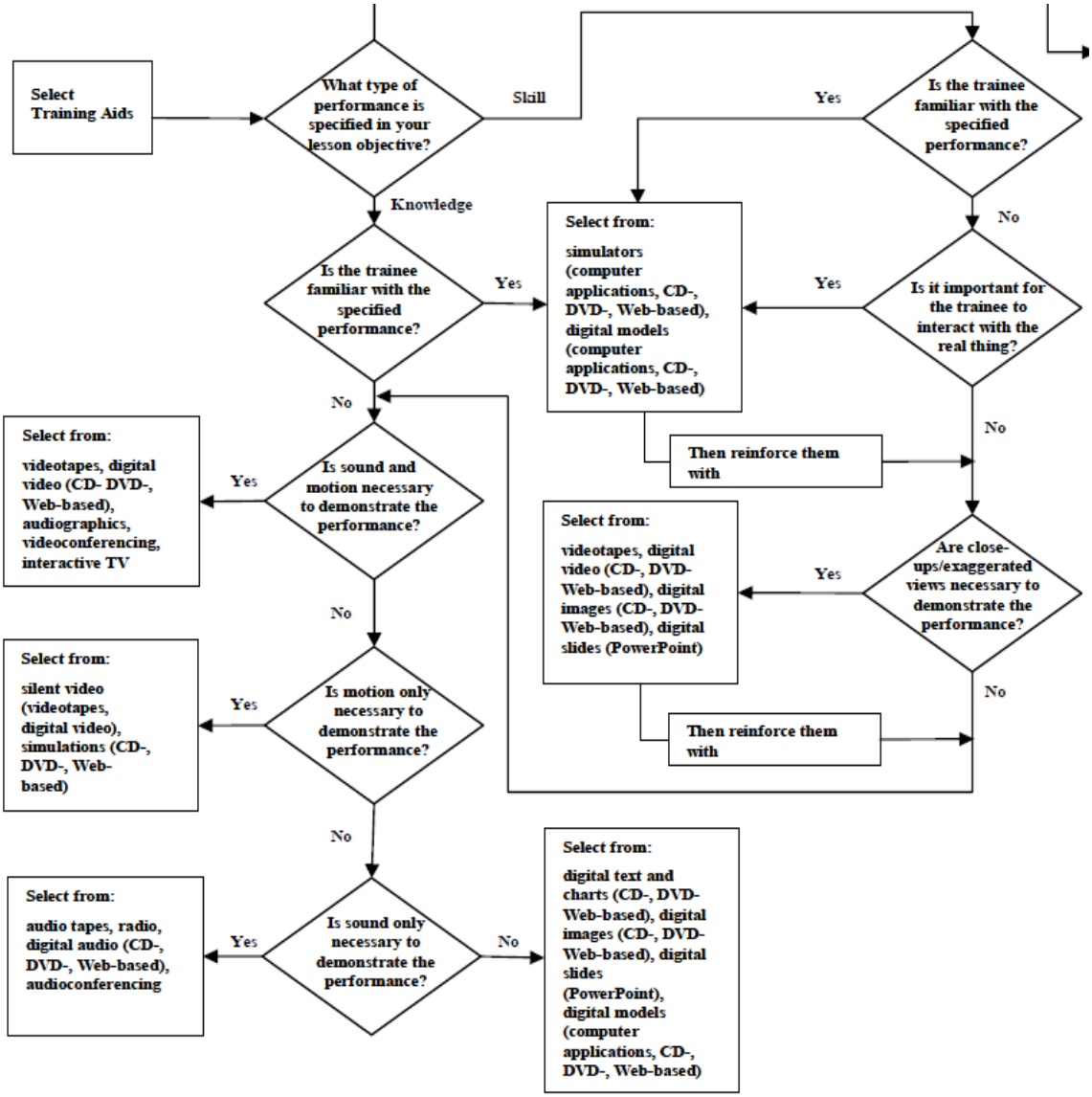
relate all these factors and draw conclusions as guided by theory that ICT integration is influenced by a combination of technology, organization and environmental factors.

2.4.1 Forms of Information Communication Technology Infrastructure

The availability of diverse technologies appeals to different learning stimulus. For instance, the audio tape petitions the ears to follow the deliberations step by step whereas the video tape combines the hearing and the sight. Therefore, the audio and video tapes present concepts and skills in a clear and succinct practical mode. According to Hampton (2002) compact disc or CD-ROM store information digitally in form of video, in animation form or in graphic format allowing multiple styles of learning.

Internet connectivity or web-based training presents a real time interaction between the trainees and the trainer. These technologies were presented by Cheong et al (2000) who observed that it provides an opportunity to set up a virtual laboratory, resource centre or virtual classroom. According to Nures and Gaible (2002) the technology to be used for teaching and learning depends on several factors which include the availability of ICT infrastructures, pedagogical constraints and trainers' competencies. The researchers went further to say the nature of technology in TVET is guided by the training chart figure 2.7 below. The chart was design by Sage and Rose (1985) to aid scheming for practical skills training programs.

The chart illustrates the diverse technologies which may be used in order to enhance knowledge and technical skills development. This is a clear demonstration that the many channels tell a lot on the significance of having competent trainers. The more the trainer is acquainted with the technology and proficient on the use of the infrastructure, the more efficient the transfer of knowledge and skills. The use of Information Communication Technology allows the user to query the methodology to be applied in order to ensure that the interaction is stable for learning and skill building.



Source: Adapted from Sage and Rose (1985)

Figure 2.7 Selection Chart for the Most Convenient Technology

The rapidly changing technology in this era of knowledge economy has outpaced the traditional face to face or the trainer knowing all concepts in teaching and learning. This

has created a huge gap in skills taught in school and the set skills demanded in the industry. The integration of Information Communication Technology in classrooms creates a model classroom that bridges the gap between the knowledge and skills most trainees learn in polytechnics and the knowledge and skills needed in the 21st century.

Information Communication Technology mediated systems present explorative and interactive opportunities as noted by Dillemans et al (1998). This view is shared by Morantis (2001) who observed that students can simulate the situations in the world themselves. The use of Information Communication Technology to teach knowledge and skills in the 21st century has been driven by the rapid growth of the global economy and the information age of the society today, as stipulated in the World Bank report (2004).

2.4.2 Virtual Laboratory in Teaching and Learning (Computer Simulation)

The new global economy being witnessed has been brought about by technological changes, fueled by information and driven knowledge creating globalization trends asserts Nnaekwe and Ugwe (2019). The evolution of the global economy together with information demanding society has pushed and the information based society has distressed the training sector worldwide to use ICT to teach theoretical knowledge and technical skills required observes UNESCO (2012. The rapid evolution of ICT has compelled education and training sector to use ICT to teach technical skills and for the learners requires this knowledge in the era of 21st century, in order to be accommodated in the in the universal job marketplace.

According to Shu'aibu, Bappah and Saud (2013) ICTs has several uses which includes employing it for teaching of safety rules and regulations, teaching technical skill, applying for virtual laboratories and workshop practices, at the same time used as e-learning tools and for online focus group discussion. Barrett (2012) asserts that the applying it for virtual realism enriches the safety of electrician in constructed environment. In the same study the three researchers noted that ICT can be utilized to teach technical skills, however Mumcu and Usluel (2010) observed that in technical training institutions ICT is mainly used for managerial than for instructional purposes. In comparative study (ibid) in Nigerian using it for teaching technical skills it still at infancy stage while in Malaysia the technology is at an average stages; being used to conduct workshop practices/laboratories especially in technical and engineering fields. According to Obaidah et al., (2012) ICT helps to simplify difficult concepts, apart from offering flexible mode of learning, and it also presents channels of abridging challenging learning experiences.

The use of ICT to establish Virtual laboratory has created an opportunity for trainers and trainees to work in a safe working environment at a cheaper cost while the processes can be recycled. According to Lei et al. (2012) virtual laboratory has found application with several advantages into engineering courses such as in electrical. Consequently, using the technologies with confirmed advantages, the integration of ICTs in engineering courses explicitly for virtual laboratories is supreme and well-intentioned for execution.

Computing infrastructure has created an essential story for the need for technological competencies and provision of education as the key agent for human resource skill building block. Integration of ICTs in teaching and learning has enabled well-informed transmission of knowledge and skills to learners. The technology has contributed immensely to fast-tracking of national economies as it tackles modest industry demand. According to Mbalamula (2016) therefore, integration of ICT in teaching and learning has becomes unavoidable and authoritative to lodge techno-based challenges so as advance construction of knowledge and in addition enhance identification of useful learning information for effective learning.

2.5 THE PERCEPTION OF TRAINERS' ICT INTEGRATION ON TEACHING AND LEARNING OF ENGINEERING COURSES

Teachers' or trainers' in this case are agents of change. However, change can only be effected if the facilitator of the change positively accepts it. Attitude is tendency to respond positively or negatively to an event or a stimulus. The successful integration of ICT in the engineering classroom depends entirely on the trainer. The strong relationship between computer related attitudes and computer use in education has been emphasized by researchers amongst them Tondeur et al (2008) and Sang et al (2010).

The attitude towards computers has great influence on trainer's acceptance of the usefulness of the technology, and also negatively influences trainers' willingness to integrate ICT into their classroom as noted by Huang et al (2005). There are varied

factors which affects the trainers from using ICT for teaching comprising of concerns related to facilities and technical expertise as noted by Mahdum, Hadriana, & Safriyanti (2019), absence of confidence in ICT use despite having adequate knowledge observes Wiranto (2014), they either deficient of methodological skills or supporting facilities asserts Muslem, Yusuf, & Juliana (2018) or have limitation on professional competency and unclear perceived benefits states Li, Yamaguchi, & Takada (2018). The mind-set of trainers touches on a number of areas which include the trainer's personality. It was noted by Paraskeva et al (2008) that individual characteristics have some dimension on the attitude of the personality towards computers and their use in teaching and learning. The outlook towards technology is expected to predict one's use of technology. Bai and Ertmer (2008) observed that teachers' attitude towards technology greatly influences his/her willingness to integrate technology and implement it effectively.

A theoretical study paper conducted by Abuya (2014) on impact of ICT adoption in TVET revealed that there were no clear national policy parameters for ICT integration into teaching and learning in TVET. The study found that teachers were not coping with the technology and recommended that learning institutions carry out continuous sensitization and training of teachers to update them with the current ICT technologies. It was also found that Internet access, software and digital content were wanting and needed more resources for upgrading.

The aim of ICTs is to facilitate the presentation of learning content and the communication between teachers and learners by providing instructional delivery

methods of TVET programmes amongst others. Tasir et al (2005) identified strategies necessary for effective integration of e-learning in problem based learning (PBL) for engineering and technical education as hereby recorded: The use of online techniques which have made it possible for trainers and trainees to interact through e-learning platform and also made it easy to access trainees easily and the use of online e-learning which also enables the trainer and trainees access e-learning materials and journals; provision of synchronous (interactive) and asynchronous sessions. Integration of e-learning approach in problem based learning has been used in engineering outside classroom to develop trainees reading and thinking skills and in articulation of ideas and team working.

A team of researchers found out that PBL should be seen as an approach that helps trainees to engage with and live in a complex world. The most prevalent barriers to successful integration include organizational support, trainer's attitudes and expectations, and the technology itself, agreeing with the theoretical model that ICT adoption depends on Technology, Organization, and the environment (TOE). The institutions culture and structure does not support specific uses of technology and often, technology is not aligned with the methodology and curriculum. As a result, there is no foundation in place to provide consistent access to and use of technology. Most trainers lack confidence in technology as well as technological skills. Those that use technology do so primarily to present information rather than to provide hands-on learning for trainees as declared by Moeller & Reitzes (2011).

The report by Inan and Lowther (2010) identified trainers' attitudes towards technology and expertise as key factors associated with technology use in the classroom or instructional rooms. It was observed by Peralta and Costa (2007) that trainers' competence relates directly to their confidence. They stated that trainers' confidence also relates to their perceptions of their ability to use computers in the classroom, particularly in relation to their trainee's perceived competence.

In another study at Walden University (2010) more than half of the teachers surveyed did not believe that their pre-service programs prepared them well in either basic technology or 21st century technological skills.

The research study conducted by Giordano (2007) affirms that teachers' perceptions of instructional technology integration in classroom revealed that teacher experience is significantly correlated with the actual use of technology. The study went further to explain that the effective use of computers was related to technological comfort levels and the liberty to shape instruction to teacher-perceived student needs. However, a study on, 'What facilitates teachers use of technology in the classroom?' revealed that experienced trainers' are less ready to integrate ICT into their teaching.

2.5.1 Trainers Perceptions on Instructional Technology Innovation

According to postman (2000) integrating technology into the classroom is not commonly accepted among scholars and teachers and, to a large proportion, this is due to the challenges posed by the digital divide in hindering ICT integration in the training

sector. The question one would ask is whether the perception of TVET trainers' is to the contrary. Several studies have been conducted on the users' perception of the instructional technology and this arises from the fact that a large percentage of trainers may have learnt pedagogy long before the technology was adopted for teaching and training.

According to Park and Thang (2017) digital divide is considered as a worldwide problem of uneven access to and uneven use of digital technologies in view of special benefits that can be gained from it. The digital divides encompass a series of continuous issues ranging from lack of resources and skills, low motivation to use the technologies and extends to lack of opportunities to use new digital tools asserts Lindgren (2017).

Technology it-self has been identified as a potential barrier to technology integration in teaching and learning by re-known researchers Lemke et al (2009). Teachers may not feel comfortable spending valuable instructional time dealing with equipment failures or slow Internet access.

The study conducted by Mewcha & Ayele (2015) found out that obstructions to technology application is lack of trainers' technical knowledge to formulate teaching resources based on technology, implying that the equipping the institution with ICT is not sufficient for achieving educational transformation. Further to that inadequacy and inaccessibility of resources and, lack of incentives for encouraging technology and lack

of training opportunities plays a role in obstructing the integration of ICT in the classroom.

According to Hatlevikr and Arnseth (2012) the trainers' beliefs and attitude influence them either to or not to integrate Information Communication Technology in teaching and learning.

2.6 UTILIZATION OF ICT INTEGRATION IN TEACHING AND LEARNING

The application of ICTs in TVET has initiated a major paradigm shift, from the dependence on the objectivist paradigm to fast developing cognitive and constructivist paradigms. The goal of constructivism is to cultivate learners thinking and knowledge construction skills. In this approach, the learner has a lot of control of her own learning and is given opportunity to negotiate content and deadlines; the learner is the expert, whereas objectivists believe in sequencing learning experiences with prescribed expected outcomes with the teacher as the authority and transmitter of knowledge.

According to Mwendwa (2017) several factors influence the application of computer used by trainers just to name a few; pedagogical problems, newness to computers, trainers' computer training, claims of limited preparation time and availability of hardware and software. This line of thought is supported by Hadriana (2017) who revealed that many factors influence the trainers' use of ICT such as limited skills and limited knowledge of ICT, the availability of ICT equipment in schools, and teaching overloads. In another study by Mirzajani, Mahmud, Ayub, & Luan (2015), trainers

remain incapable to apply ICT in the instruction rooms owing to unsatisfactory training, knowledge, skills, infrastructure, time and self-efficacy associated to the utilization of ICT. Similarly, a study by Amuko, Miheso, & Ndeuthi (2015) furthermore observed that the difficulties of ICT integration exists on the basis of limited ICT- linked competency and sustenance for technical support.

There is a growing awareness in Technology-Based Learning (TBL) described as the range of computer hardware and software used in the teaching and learning systems that comprises of computer-based training systems, multimedia and electronic systems, telecommunications, over and above the Internet with World Wide Web systems, across the world. According to Gonzalez & Louis (2008) Information Communication Technology is not an alternative means to teaching methodology but rather, an indispensable part of the modern learning environment. Omwenga (2004) affirmed that ICTs provide a window of opportunity for educational institutions and other organizations to harness and use technology to support the teaching and learning process. This paradigm shift has seen most developed countries embrace ICT and has influenced the Kenya government towards transformation thereby departing from the traditional approach to learning.

According to Muriithi (2005) in Kenya and majority of the developing countries, ICT use is limited to computer literacy training and the digital divide. The current ICT curriculum merely deals with ‘Teaching about Computers’ for most of the courses undertaken and not how the computers can be used to transform teaching and learning

in institutions. This study agreed with this observation and hence focussed on ICT integration in teaching and learning in national polytechnics. The “digital divide” in simple terms is the gap between people who have sufficient knowledge of ICT and access to technology and those who do not states Alam and Salahuddin (2015). The application of digital technologies in education and training needs to be embraced in all sectors as it is expected to strengthen the global village; there has been concerns that the economic emphasis and increasing use of these technologies would widen the digital gaps, which, accompanied by the ongoing socioeconomic polarization, could sharpen social inequality across the globe states Nieminen (2016).

2.7 TRAINERS’ ICT KNOWLEDGE AND SKILLS

Majumdar (2013) observed that to obtain the integration of ICT into the teaching-learning process, trainers, who are the agents of knowledge transfer, should acquire operational skills and understand how such educational technology can support pedagogy. For trainers to use technology effectively for educational purposes, not only should they be familiar with how to operate equipment, but also understand how these tools are effectively used in their teaching and training fields and how to incorporate resources into classroom activities with a view to accomplishing learning goals. In order to use technology effectively for educational purposes, teachers must not only be familiar with how to operate equipment, but also understand how these tools are effectively used in the subjects they teach and how to incorporate resources into classroom activities that accomplish important learning goals. While many teachers use

technology in their private lives and know how to operate it, they often lack some knowledge and skills required to support teaching and learning. Moreover, research into teacher learning in northern hemisphere contexts suggests that traditional, one-off external in-service workshops tend to be of limited value in developing sustained transformation of practice as observed by a team of researchers' Glazer and Hannafin (2006) and Muij and Lindsay (2008).

Hennessy et al (2010) in their research paper on Teacher Factors Influencing Classroom Use of ICT in Sub-Saharan Africa, identified a need for trainers and teacher educators to integrate ICT into subject teaching and learning using contemporary pedagogical approaches. In an ideal world teachers and trainers are assisted to work in partnership over time with colleagues, and to learn from one another's innovations and experiences. This requires prioritization of ITE and CPD that is pedagogically sound and aligned with wider policy objectives. This offers sufficient support and time for trainers to get enthralled with new technologies. These recommendations could be strengthened by the development of locally produced, contextually relevant course content for both trainers and trainees. This study established that the trainers training curriculum did not give preference to ICT as an alternate content delivery method and therefore agreed with the above recommendations. The study by Ghavifekr et al (2011) on management strategies for e-learning as the core component of systemic change in technology based education observed that the knowledge and skills about information communication technology

that trainers are equipped with encourages trainers to integrate ICT into teaching and learning process.

2.7.1 Trainer's ICT Competence

The study by Venezky (2004) revealed that there are two important approaches that support ICT integration into teaching and learning; one being effective Initial Teacher Education (ITE) and secondly Continuing Professional Development (CPD). Computer competence is a major predictor of trainer's ability to integrate ICT in teaching and learning. This is the ability to handle a wide range of varying computer applications for a variety of purposes. The outcome of the research went further to note that the majority of teachers who reported to have negative or neutral attitude towards the integration of ICT into teaching and learning processes lacked knowledge and skills that would allow them to navigate the application of computer knowledge as well as guide its use. Teachers with more experience with computers have greater confidence in their ability to use them effectively. This study sought to establish the level of trainers' competence and the level of integration of ICT in learning in Kenya's National Polytechnics, in order to make recommendation concerning the weak relationship between training skills and the industry skill demand. To this end, Aina (2009) and Sukri and Shu'aibu (2013) affirmed that the success of technology implementation for industrial development depends to a large extent on the ability of TVET to have competent and skilled human resource. The trainer is therefore, strategic to the development of education and training.

2.7.2 Trainers ICT Foundation

The experience of a trainer refers to the duration a teacher has in practising teaching in the regular classroom. Studies conducted by Wong (2008), Giordano (2007) showed that teaching experience influences the successful use of ICT in classrooms. In a similar reference, Giordano (2007) affirms that teachers' perceptions of instructional technology integration in classrooms revealed that teacher experience is significantly correlated with the actual use of technology. The study went further to explain that the effective use of computer technology was related to technological comfort levels and the autonomy to shape instruction to teacher-perceived student needs. However, a study on, what facilitates teachers use of technology in the classroom, found that experienced teachers are less ready to integrate ICT into their teaching.

2.7.3 Trainers' ICT pedagogy competence

A researcher HanneleNiemi (2003) described teacher competence as the nucleus in developing information society, while spellings (2005) observed that teachers are crucial for student's comprehension. In this context teachers play a fundamental role in integration of ICT asserts Zhao (2003). Zhao (ibid) asked significant questions regarding what goes into guaranteeing the competence of teachers to be able to handle ICT in an enriched learning environment. However, Pearson (2003) affirmed that apart from learning ICT topics, the focus is to enable the teacher to use these tools, skill related to the pedagogical use of ICT to support learning and teaching experiences.

According to Li (2002) teachers need a significant level of ICT skills to be able to use it for their instruction and learning, otherwise it is bound to cause unwillingness to use it. A- Panel of researchers Granger et al (2002) argued that teachers require empowerment with a level of autonomy and confidence in using ICT in classroom. The views expressed by Sabieh (2001) states that it is easy to teach how to use technology but relatively challenging to learn how to use technology as a pedagogical tool. It is clear from this argument that teachers need basic ICT skills, but on top of that they need knowledge and skills to enable them use ICT as pedagogy. The researchers Somekh and Davis (2005) cautioned that concentrating on technical skills which are not transferable to the classroom settings is fruitless to integration of ICT in TL. The knowledge and skills teachers received through their professional training should pay attention to how the acquired skills would be translated into classroom instructions. The 'isolated skills' acquired by teachers during workshops or conferences according to Granger et al (2001) do not guarantee their use by teachers when they return into their classrooms. A party of scholars Herman et al (2008) argued that for teachers to exceedingly merit ICT in teaching and learning, the integration approach be put to practice the right use of the technology in particular subject area; to emphasize on the topic introduced, for instance use of power point in a very innovative and creative style; to aid and support learning. Inadequate ICT knowledge and skills of the trainers limits its application in teaching and learning. According to Bingimlas (2009) the perpetual evolution of technology coupled up with the inadequate trainers' knowledge and skills aggravates the challenge

of integrating ICT in teaching and learning. In addition, some trainers are adapted to teaching without the use of ICT.

2.7.4 Institution Leadership Role on ICT Integration in TL Engineering

Deriving from a number of research sources, Leng (2008) asserts that effective leadership is a key element of success in any innovation and knowledge propagation. The finding further states that leadership is critical for successful Integration of ICT in teaching and learning. Effective leadership is therefore needed to take advantage of the potentiality of ICT in vocational education and training. This suggests that the success or failure of ICT integration in schools depends on the type of leadership practiced in respective schools. This could be because ICT integration involves many processes such as decision making, problem solving, sustained support of trainers and leader's role modelling in the use ICT. It was therefore being interesting to establish if leadership in National Polytechnics were supportive and the ways in which school leaders prepared for the integration of ICT in education and training.

The use of technology to support trainer-centred learning requires leadership and administration to collaborate and set up an agenda for technology that focuses on a common set of learning standards, and connects to real-world situations. According to Inan & Lowther (2010) trainers' use new technology when there is overall support and positive expectations from the institutions community and management. This helps to

influence trainers' beliefs about technology and enhances their willingness to embrace technology.

In a study by Oroma, Kiden, Maghendha & Ntiyani (2013) on the perspective on underutilization of ICT in East Africa the findings revealed that operative leadership is a significant component of accomplishment in any modernization and integration of ICT in education. The study on the concept and application of ICT to teaching and learning established that leadership in the process of integrating ICT in pedagogical innovation comes from three levels; principal setting the vision and expectation of the trainers', providing guidance to trainers in classroom and lastly be making decisions about resource mobilization states Nnaekwe & Kingsley (2019). The two authors went further to say the instructional leader described is important as far as facilitating the change and innovation as there was huge limitations on time, ICT infrastructure, space and connectivity. According to Kehdinga & Fomunyam (2019) Integration of ICT in teaching and learning intensify the admittance to contemporary learning practices which advances knowledge in this extremely modest period of globalization. ICT in its central role in African Technical Establishments carries learning nearer to trainees by posing virtual amenities. Education Administrators plays a key role in ICT integration in education. For ICT integration programs to be effective and sustainable, managers themselves must be competent in the use of technology, and they must have a broad understanding of the technical, curricular, administrative, financial, and social dimensions of ICT use in education observes Kirimi (2014).

As noted by Afshari et al. (2008), to achieve all this, school leaders need to appreciate, support and practice the idea of integrating ICT not only by providing computers but also transforming the approach to teaching and learning processes.

According to Badia et al (2013) the factors that influence the trainers perception on the integration of ICT in TL and closely associated with school leadership comprises institutional support for trainers to build their capacity in using ICT notes Mwawasi (2014), training related to methodological knowledge of integrating ICT into teaching asserts Hlasna, Klimova, & Poulova (2017), leadership support and school planning states Palagolla and Wickramarachchi (2019), technical problem such as fear for failure due absence of technical assistance asserts Buabeng-Andoh (2012) and professional competency states Li, Yamaguchi, & Takada(2018).

2.8 RELATED STUDIES

In the recent years there have been various studies, bearing in mind a variety of forms integration of ICT in TL. Consequently, preparation of trainers to face the challenges of an enriched teaching and learning environment is critical. The trainers' requirements are to be equipped with the basics of ICT tools and sufficient understanding of the integration of these tools in TL and secondly changing the mind set to distinguish teaching and learning as facilitation process rather than being recognized as the source of knowledge. Integration of ICT is an extension of traditional teaching and learning process that involves either one or more than one sensory system. However, Merrill et al (1996) considered a combination of ICT and traditional teaching process would enhance

learning- a phenomenon referred to as blended learning. In this configuration one form was to use ICT for experimentation, simulation or communication and the other form merely used as a tool to focus on the content notes observed Gros (2000). Information communication and technology is emerging as an essential element of the professed knowledge society. A panel of authors Tella et al (2007) examined a sample of 700 secondary schools using ICTs and the implications for further development of ICT use in schools. The findings showed that the teachers' lack of teaching support in schools and lack of expertise in using ICT were prominent factors hindering teachers' readiness and confidence of using ICT during lessons. This study postulates that the same conditions are prevailing with engineering trainers or it is no consequence in polytechnics.

In a study to identify the effectiveness of using ICTs in Technical Education in Bangladesh; Shamim and Raihan (2015) revealed that integration of ICTs in teaching and learning process makes TL very easy, exciting, and time saving than that of traditional way of teaching-learning. The study further stated that technical education teachers strongly agreed that ICTs are essential for enhancing the process of teaching and learning in the polytechnic institutions. The two researchers concluded that the major impediment of the teaching and learning activities is deficiency of ICT skills of instructional trainers', inappropriate instructional materials to meet the objectives of TL, inadequate motivational techniques to proliferate the curiosity to learn and also absence of training of the teachers on ICT.

In India a study by Kalyani and Rajasekaran (2018) on Innovative teaching and learning defined innovative teaching as creativity and originality of the teacher which changes the approach by redefining and reinventing the method of teaching to make it thrilling. A survey was conducted by Banday et al (2014) to examine adoption of ICT and e-learning tools in nine engineering institutions in India, and found out that not only learning but also performance of students in end-term examination satisfactorily improved by using e-learning tools in engineering education. The study further revealed that most of the students believed that the use of learning tools such as simulations; animations and virtualized demonstrations in laboratories were more productive than conventional classroom teaching. There is numerous such computer based tools that support engineering laboratories for each branch of engineering. Diverse experiments in engineering laboratories utilize direct or indirect use of computers; since laboratory equipment in recent times is operated via some computer based interface. E-learning can further supplement engineering education use of e-resources, online courses, blended learning, lecture management systems, and other communication and collaboration tools.

In the recent past, research studies by such scholars such as Potkonjak et al. (2010), Jara et al. (2011), Rojko, (2010), and Vivar, (2008) have illuminated that a number of institutions have created their own virtual and remote laboratories to support life-long learning and independent trainees' learning activities in various disciplines including electronics and microelectronics, power electronics and electrical drives, chemistry,

physics, and control and automation. Banday (2012) in another study has identified four groups of deficiencies in the conventional teaching and learning system followed for engineering education which included inadequate student-teacher interaction, complicated teaching and learning and weak collaboration and communication amongst others.

In Malaysia, ICT is well thought-out as one of the key essentials in transforming the country to the future development. A study by Ghavifekr and Rosdy (2015) to analyze teachers' perceptions on effectiveness of ICT integration to support teaching and learning process in classroom revealed that teachers' well-equipped preparation with ICT tools and facilities is the main factors in success of technology-based teaching and learning. In the same study (ibid), it was recommended that there is a call for consideration of other aspects of ICT integration, principally from administration point of view with respect to strategic planning and policy making.

In Tanzania a study examined teachers' and teacher trainees' individual characteristics to establish the opportunities and challenges facing them when implementing pedagogical ICTs. The evaluation specifically focused on technological knowledge, competences, skills, attitudes, beliefs, and readiness to integrate technology in classroom. The findings of this study indicated a low level of ICT usage by the teachers irrespective of their level of education. However, challenges of inaccessibility to computers, unsustainable power supply, lack of readiness to use ICTs among key users

and lack of Internet connectivity have continued to discourage the use of ICT in education.

In a survey to expose the existing problems that contribute to the slowness of using e-learning and computer based instructions to the growth and development of engineering education in Tanzania, Machumu (2016) described computer-based learning as any virtually kind of learning program using computers as a middle fastener. While, Mayer et al (2011) defined e-learning as instruction delivered on a digital device such as a computer or mobile device that is intended to support learning. This approach to learning takes advantage of the interactive elements of computer software, along with the computer's ability to present many different kinds of media. There are several potential advantages of computer-based learning programs, including the ability for people to learn from their homes and study without the assistance of an instructor. The survey noted that engineering teachers who are not-experts to use computer based instruction has led to the slowness of e-learning in engineering education in Tanzania. This is because most of engineering teachers are the "talk and chalk" products, it is difficult for them to prepare those materials for e-learning and computer based instruction in engineering education.

In the 21st century the world is entered into the digital era, and its economy being a knowledge economy highly reliant on ICT, engineers are going to take part in a major role in this gigantic transformation of the world's economy. Literature confirmed that the issue of ICT use in engineering education presently has started being adopted, but in

a remote manner, with each taking into account ICT in education of a particular engineering discipline, such as mechanical engineering, civil engineering or electrical engineering. In a paper entitled 'ICT in engineering educational content delivery', Ali (2013) established that the major challenges facing full implementation of ICT amenities in engineering educational content delivery are the need for hands-on experience in laboratories and inadequate training of trainers in pedagogical use of ICT in education. The UNESCO (2013) reported about the use of ICTs in Technical and Vocational Education and Training that selecting a technology or a combination of technologies for teaching and learning depends on many factors, such as available infrastructure, pedagogical constraints, learners' characteristics, subject matter, content, and time available to teach and learn. There is need for institutions to integrate ICTs through provision of appropriate resources, skills and infrastructure. The institutions need to explore creation of an efficient ICT division and sustainable formation as a driver for the integration of ICTs in the teaching and learning process should be implemented

2.9 THE CHAPTER SUMMARY

The literature review highlighted several elements that influence integration of ICT in teaching and learning. However, most of the studies reviewed have been conducted in developed countries. Integrating ICT in teaching and learning process is a global issue of the 21st century. The chapter enumerates the challenges of integrating ICT in teaching; leaving more questions in Kenyan situations. Integration of ICT in teaching

faces several challenges ranging from lack of skilful staff, lack of infrastructure and reluctance to accept the technology despite the many benefits it provides. The question was whether the same elements affect the situation experienced in Kenya. The study sought to establish the status of ICT integration in teaching and learning engineering courses in selected National Polytechnics in Kenya.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

This chapter presents the research methodology that was used in the study. It discusses the following: research philosophy, research design, target population, sampling procedure and sample size, research instruments, data collection procedure, validity and reliability of the instruments, data analysis and ethical consideration. A renown scholar Creswell (2007) described methodology as the overall approach to research design. It is a strategy or plan of action that links methods to outcomes.

3.2 PHILOSOPHICAL PARADIGM

The philosophical paradigm of the study was positivism. The term paradigm is used to describe a researcher's worldview notes Mackenzie and Knippe (2006); a school of thought or belief that informs the interpretation of research data observes Kivunja (2017). Positivism was used to express the scientific approach to the worldview observes Creath (2014). This scholar went further to state that science was the only source of facts for legitimate knowledge and the aim of philosophy was to find general principles common to all sciences. Positivism believes that knowledge stems from human experience and the principles of positivism research is to explain and predict the behavior of a phenomenon. Positivism philosophy research believes the truth exists and is independent of human perception and all the occurrence can be reduced to empirical

indicators. Positivism paradigm advocates the use of quantitative research methods as the foundation for researcher's aptitude to be accurate in the description of the factors and measurements in the data that are gathered, analyzed and interpreted so as to understand connection entrenched in the data analyzed states kivunja (2017).

This paradigm was suitable to this study in that the researcher believed in independence from the study and that the study was intended to be very objective. The study investigated the status of ICT integration in teaching and learning, particularly adaption in instruction rooms and establishing the understanding of the respondents through in-depth inquiries. The positivism philosophy research permits a mixed method technique; making it appropriate for the study. The multiple methodologies according to Burnett (2012) broaden the span of the study. In terms of validity and reliability of the outcome, this research philosophy emphasized the construction of knowledge on the basis of facts and information collected objectively, thus credible selection of the respondents was the goal of this study to use trainers who were immersed in the training, thus sampling techniques was employed to satisfy it. In view of the above the adoption of the positivism paradigm for the study infused the research questions', participants' selection, data collection instruments and collection procedures, as well as data analysis justifying the approach.

3.3 RESEARCH METHODOLOGY

This study used a mixed method research approach which is an integration of quantitative and qualitative research. This study adopted concurrent triangulation

approach where quantitative and qualitative data was collected concurrently and then compared to determine if there was convergence, differences or combination as asserts Creswell (2013). This is a method that involves broader or wider aspects of data collection through interviews, observation and surveys. Research scholars Kombo and Tromp (2016) noted that for effective use of this method the respondents and survey techniques should be identified objectively and questions construct be the spotlight of the information required.

Qualitative research arrived at the findings by analyzing social productions of issues or practices by collecting non-standardized data; the emphasis being on how people make sense of the environment as noted by Flick (2014). Quantitative research uses deductive methods and seeks regularities by separating social world in empirical components; variables which are represented numerically as frequencies can be analyzed by statistical techniques as outlined by Payne & Payne (2004). Quantitative research constructs knowledge by focusing on social aspects or behavior that can be quantified and patterned, objectively analyzed and conclusions deduced from empirical testing. The mixed method approach provides strengths that offset the weaknesses of both quantitative and qualitative research.

This method which combined the two techniques; ‘Qaun and qual’ ensured that the findings are grounded in participants’ experience, making it suitable for this study. This is further supported by the claim that no single research methodology is essentially better than the other methodology, the selected techniques should have more strengths

and less weaknesses asserts Teddlie and Tashakkori (2010). According to Connelly (2009) the goal of mixed methods research was to draw on the strengths and minimize the weaknesses of both types of research approach.

This method was suitable for this study in that the two approaches of collecting data complemented each other. Therefore, the mixed method research provided a more complete and comprehensive understanding of the research problem than the use of one approach.

The researcher combined quantitative and qualitative research techniques, methods, approaches, concepts, into a single study. The mixed method is an approach focussing on research questions that call for real-life contextual understanding, multilevel perspectives, and cultural influences. This is a research approach that blends both approaches quantitative and qualitative within or across the stages of the research process as was observed by Johnson and Onweuegbuze (2004). The most persuading rationale to engage the two methodologies was on the basis that both can utilise common techniques for data collection thus harmonizing the use of data to deeply understand and interpret the phenomena.

The collection of quantitative and qualitative data concurrently was permissible by this research method and equally the data was merged in order to provide comprehensive analysis, and the information was integrated for overall results interpretations as observed by Creswell (2013). The concurrent mixed method data was employed to

validate one form with the other and to transform data for comparison and address the different types of questions.

The application of mixed method techniques permitted the employment of several data collection tools and aligning and allowing the two techniques on methodological triangulation. Triangulation is described by Noble and Heale (2019) as a technique that facilitate validation data through cross verification from two or more sources; combining the information or data by way of cross validation. Triangulation was one step that made the research results bias free, valid by increasing the rate of certainty and neutrality; it authenticated the data and also assisted in the explanations of the results. The process of triangulation strengthens validity and credibility by checking consistency of the findings from the different techniques asserts Honorene (2017).

Lois & Brown (2010) argued that structured questionnaires and structured interviews are frequently used in mixed method studies to generate confirmatory results. They further assert that if 'confirmatory' results are being sought, researchers must create tightly aligned and structured instruments.

In consideration of the complexity of human perception about the real world, and the intensity of this study, the mixed methodology was deemed best suited and in line with the objectives of the study.

This method of both qualitative and quantitative data provided an opportunity for data to be collected concurrently. Furthermore, a mixed method approach is suitable to be

used for purposes of achieving triangulation; thus increasing validity and interpretability and effectively manages overlapping of the two techniques as was noted by Rocco, Bliss, Gallagher and Perez-Prado (2003).

The quantitative data that was collected and measured statistically entailed the variables; trainers' ICT skill, knowledge, perception and infrastructure as were objectively targeted. The quantitative data for the objective on skills, knowledge and infrastructure was extracted by survey questionnaires. The qualitative data was collected by carrying out observations and conducting interviews on the independent variables; trainers' ICT skills, knowledge and infrastructure.

The research methodology employed in the research is summarized in the diagram below

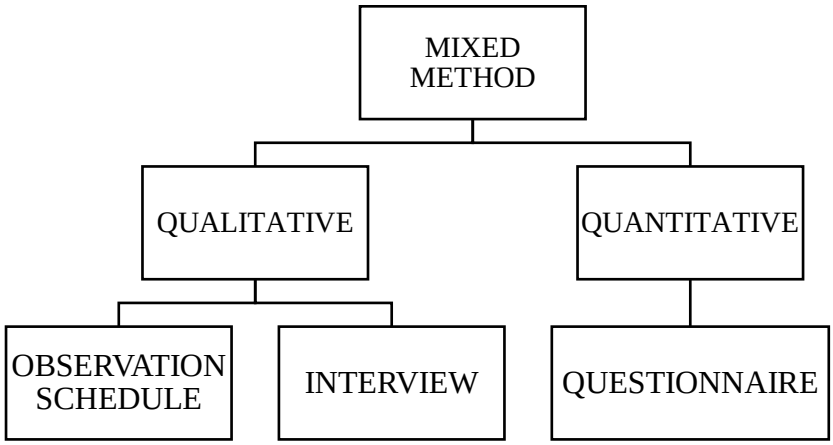


Figure 3.1 Summary of the Research Method

3.4 THE RESEARCH DESIGN

According to Creswell (2007) research design is a systematic organization of data collection and analysis. It consists of the purpose, theory or conceptual framework, research objectives, methodology and data analysis procedure. Orodho (2008) defines a research design as the arrangement of conditions for collection and analysis of data in a manner that aims to combine significance to the research purpose with economy in the procedure.

Survey research techniques were used to collect the data that attempted to answer the research questions. A survey is a research method used for collecting data from a given sample that has been selected to represent a population through the use of standardized procedures whose purpose is to ensure that each respondent is able to answer the questions at a level playing field to avoid biased opinion that could influence the outcome of the study. The quantitative and qualitative methods were integrated at the time of developing the instruments and selecting the participants based on the predictive variables identified during the discussion of the outcomes of the study.

Research survey describes research that involves administering questionnaires and interviews state Leedy and Ormrod (2014). Questionnaires or interviews are used in educational research to collect data about a phenomenon that is not directly observable, for example inner experience, opinions, values and interests as observed by Gall et al., (2003) as in this study.

3.5 THE LOCATION OF THE STUDY

The study was carried out among National Polytechnics in Kenya. There are 11 National Polytechnics established through Legal orders in accordance with the TVET Act Section 26(1)(c) with the mandate to offer Diplomas, Higher National Diplomas as well as Degrees in collaboration with Technical Universities under Section (26) (3) of the TVET Act. This mandate makes the National Polytechnics different from other tertiary TVET institutions; however, training programmes in all TVET accredited institutions are approved by TVETA. It is important to find out the status of ICT Integration in these institutions on the basis of ICT infrastructure, trainers' ICT knowledge and skills, and the perception of the trainers and trainees on ICT integration in teaching and learning.

3.6 TARGET POPULATION

The total population that the researcher specifies in this study is referred to as the target population according to Mugenda (2011). Quantitative studies focus on relatively few respondents who have the ability to describe their experiences and knowledge with respect to the phenomenon observes Baskarada (2014), whereas quantitative claims the participation of fairly a large population notes Creswell (2013). The population in this case was a group of individuals that had one or more characteristics in common that were of interest to the researcher and relevant to the study. The target population in this study were trainers and managers involved in teaching and managing engineering

courses. The trainers in National Polytechnic were the implementers of the training programmes as per the curriculum, while the managers are charged with the overall role of managing institution resources to ensure that the institution meets its objectives. The targeted population was 63 engineering trainers and managers appropriately selected using specifics sampling techniques to ensure the right respondents with relevant experiences were selected to participate in the study, as a reassurance of valid and reliable outcome.

3.7 SAMPLE SIZE AND SAMPLING PROCEDURE

A sample is a section of the total population that has been methodically identified to represent the entire population asserts Kirui (2015). This proportion was carefully selected to be a representative of the whole population with the significant characteristics. The researcher used a multi-stage sampling procedure involving purposive and stratified simple random method to select the research sample units. This was done to enhance credibility of the results. According to Amin (2003) purposive sampling method is a technique used to select sample cases that have the required information with respect to the objectives of the study. The purpose was to select respondents who possessed the required characteristics and information. While stratified sampling method is a technique used to identify sub-group in the population and their proportions and select from each sub-group to form a sample. This study used stratified sampling so that a sub-group was formed that was homogenous; the identified subgroup is referred to as strata notes Alvi (2016). The respondents were selected from each

stratum randomly and the techniques used to allocate sample from strata was on equal proportion. This sampling technique was applied to obtain a representative sample that captures the diversity of engineering programs which otherwise was likely to be undermined if simple random was used to select the trainers.

This study applied purposive sampling to select the three (3) national polytechnics based on their geographical location, year of existence and size in terms of infrastructure and the similarities in the training programs. The National Polytechnic or equivalent which were selected and symbolized as NP1, NP2 and NP3 for ethical considerations, have similar characteristics; located in urban centers, offers same technical programs, have been in existence over a decade, receives funding directly from exchequer and manage under the same system. The study stratified the engineering courses based on the areas of specialization which included Mechanical Engineering, Automotive Engineering, Electrical Engineering and Building and Civil Engineering. Thereafter the study applied simple random sampling to select four (4) trainers; (this was to give meaning to sampling as one section from the initial survey had five trainers), in each engineering field and in each of the three national polytechnics; this gave a total of 48 trainers. The study applied purposive sampling method to select managers in each of the engineering training sections and each National Polytechnic. The targeted population was 63 engineering trainers, inclusive of managers from a sampling frame of 140. According to Ary et al, (2002), a study sample of between 10%

-20% representatives is appropriate for any study. The sample size in this study was 45% way above the threshold.

Table 3:1 ***Sample Frame***

Sampled Institutions	Trainers Populace	Purposive Sampling Of Managers	Sampling Strata for trainers	Simple random Sampling of trainers/respondents
NP1	67	5	(M1)	4 Samples X3(NP1,NP2,NP3)= 12
			(A1)	4 Samples X 3(NP1,NP2,NP3)=12
NP2	39	5	(E1)	4 Samples X 3(NP1,NP2,NP3)=12
			(B1)	4 Samples X 3(NP1,NP2,NP3)=12
NP3	34	5		
Three	Frame=140	Respondents: 15	Four Stratus	Total Respondents: 48

Key: The National polytechnics selected symbolised as NP1, NP2 and NP3.

Table 3:2: ***Sampling Statistics Table***

Category	Institutions	Population	Sample	Sampling Methods
Trainers	NP1	67	16	Stratified Simple Random Sampling
	NP2	39	16	
	NP3	34	16	
HOD's	NP1	4	4	Purposive Sampling
	NP2	4	4	
	NP3	4	4	
Principal	NP1	1	1	Purposive Sampling
	NP2	1	1	
	NP3	1	1	

3.8 RESEARCH INSTRUMENTS

The purpose of a tool or instrument in research is to measure the variable of the study observes Mugenda (2011). According to Aina (2004), research instruments were significant for gathering data which later was analysed to answer research questions in all types of research methods. Research instrumentation formed a critical portion of the study where the tools were used to collect data that demonstrate validity, reliability and match with research objectives states Creswell (2013). This study used questionnaires, interview schedule and observation schedule in-line with the research methodology.

This instruments were suitable for the study, for it provided in-depth information and understanding about the phenomenon, balanced and free bias information essential for triangulation. The questionnaires were used to collect quantitative data while interview and observation schedule was employed to collect qualitative data as guided by the research objectives. According to Young (2016) the survey methodologies should match the paradigm, research questions and the instruments. Alshenqeeti (2014) stated that researchers/scholars should choose the method that answers their question best, taking into consideration that the more accurate the researchers were when conducting and analyzing the data, the more accurate the findings would be,

3.8.1 Questionnaires

A questionnaire is a survey research instrument that according to Siniscalco and Ariat (2005) is used to collect data from individuals about themselves and about social units such as institutions. Johnson & Christenson (2017) observed that survey techniques employs questionnaire tools or interviews (face-to-face) or observation for gathering cross-sectional data; data collected at a solitary point in time. According to Ogula (2005), questionnaires can reach a large number of respondents within a short time. The scholar also urged that it gives the respondents ample time to respond to the items, offers a sense of security and confidentiality to the respondents and lastly it tends to be objective since there is no bias resulting from the personal characteristics.

The development of these research instruments was guided by the objectives of the study to elicit information from the sampled respondents that would answer the research questions. The questionnaires were developed and subjected to validation process; with supervisors' approval. The Content Validity of the questions which refers to the extent to which the questions characterize all features of the social concept, was secured by subjecting it to expert judgement and supervisors' views. Face to face validity was also considered during the design of the questions in accordance to Rust, Golombok, Kosinski and Stillwell (2014) views that the questionnaires should appear to the user to examine what it is meant to test. The reliability of the questionnaire according to Kivunja (2017) refers to the extent to which results were consistent over time was assured by establishing the Cronbach coefficient which measures the internal consistency; that the items were eighty-seven percent (87%) interrelated in a set of 39 items. The study preferred to use questionnaires because of its capacity to generate sufficient large information and also aligned to the philosophical perspective.

The questionnaires were used to collect quantitative data about the level of ICT knowledge and skills, the nature of equipment available and the extent to which they were being used for Teaching and Learning.

Likert Scale was used in questions to test on the degree of respondents' agreements with particular variables under investigation. The questionnaires were divided into sections: Section A was on the bio-data information of the respondents. Section B covered the extent to which ICT has been integrated in teaching and learning of engineering courses

by the trainers, Section C was on the integration of ICT in teaching and learning, section E was on trainers' perception on ICT integration in teaching and learning of engineering and section D was on the trainers' understanding on the role of ICT as learning and teaching tool in the classroom.

3.8.2 Interview Schedule

According to Mugenda & Mugenda (2003) interviews are questions asked orally by researcher to get the information from respondents. Leedy and Ormrod (2014) argued that survey research mostly employs face-to face interview or a telephone interview. The preference in this study was face to face approach as observations was also conducted at the same time. The structured face-to-face interview yielded the highest response rates in this survey research, because of its apparent advantage of facilitating the researcher to set up understanding with respondents and therefore secure their partnership. According to Berg (2007) apart from interviews building a holistic snapshot it also allows the interviewees to verbalize their views and express their own thoughts and feelings. In a similar manner according to Schostak (2006) the interview adds an extendable conversation between partners that aims at having in-depth information about the subject under investigation. The personal interviews carried out allowed the researcher to clarify ambiguous answers and appropriately seek follow-up information. However, the drawback was that it was not easy to homogenize the interview state of affairs in such a manner that the interviewer does not manipulate the respondent to answer questions in a certain mode. The challenge was that interview was time

consuming and at the time of the interview the institutions were on session making the interviewer exercise a lot of patience.

The interview schedule was used to support and verify the information from the questionnaires. It was also used to collect data on the objective about the level of trainers' ICT knowledge and skills, ICT infrastructure and its application of ICT in the process of teaching and learning engineering. The data collected from interview schedule was analysed and used to validate information obtained from quantitative data.

The interview included such questions as "As a manager", what is your considered opinion on the use of integrated ICT in teaching and learning?

The interview questions were asked in a non-intrusive way to avoid making the Interviewee developing an attitude that one was being arbitrated because of the regime as was noted by Canals (2017). The researcher conducted the interviews with a clear mind on the impact of psychological factors as noted by Kombo & Tromp (2016) that such factors may prompt responses that may misrepresent the true reflection of the situation.

The interviews were recorded where the interviewee agreed to the request with a view to capturing data on opinions for analysis. The actual names of the interviewees were not revealed for the sake of confidentiality and validity. The respondents were interviewed as follows: the managers on leadership, equipping culture, policies and on the use of ICT infrastructure. The managers were also interviewed on the utilization of

ICT infrastructure and their perception on integration of ICT in teaching and learning. The qualitative data collected was categorized into themes perception, laboratory schedule for engineering theory and practical lessons and ICT infrastructure utility.

3.8.3 Observation Schedule

The quantitative and qualitative data for the objective on the use of ICT equipment for teaching and learning engineering was observed in the instruction rooms as the trainers delivered the course content. Lesson observation schedule was used to monitor the trainers in all the areas where knowledge transfer was being implemented; where trainers and trainees were interacting. The trainers were observed in the classroom performing various aspects of lesson presentation from introduction, development, use of software resources, and how they integrated it in their teaching and learning activities to the conclusion of the lesson. The quantitative and qualitative data collected was in reference to the research questions on trainers' knowledge and skills, ICT infrastructure and its application during the process of integrating ICT in teaching and learning. Trainers' behaviour in handling of ICT resources and challenges were also observed. An observation guide was also used to collect data in the computer laboratory and to ascertain availability and adequacy of ICT facilities.

This observation technique was used to collect qualitative data to answer specific questions on trainers' knowledge and skills, availability of ICT infrastructure and the actual application. The observation was in two sections; infrastructure and lesson

observation, sections H and G respectively. This survey method of data collection was used to gain in-depth understanding of the phenomenon and to compliment the outcome data and findings from the questionnaires, facilitate the formulation of themes and finally strengthen triangulation.

3.8.4 Observation Checklist of ICT Infrastructure

The observation checklist was used to ascertain the availability of ICT infrastructure in the sampled NPs that support trainers to integrate ICT in teaching and learning. The observation was carried out at the venues used for lesson preparation as well as venues where lessons delivery was conducted out. These venues included the staffroom, library, instructional rooms, workshops and laboratories. The data collected was based on the objective addressing the availability of ICT Infrastructure for ICT integration in teaching and learning of engineering courses in National polytechnics. The data collected was analyzed to determine the adequacy of ICT infrastructure that support effective ICT integration. This study used the survey techniques with the objective of putting the conduct of the participants in the context of the research and also used qualitative data corroborate the quantitative findings.

3.9 VALIDITY AND RELIABILITY OF RESEARCH INSTRUMENT

Stringent measures were undertaken to ensure the questionnaires were both valid and reliable. Validity was measured through focus on internal, external and content validity.

Reliability was also measured by examining the major aspects of equivalence, stability, consistency and reliability coefficient of the research instrument.

3.9.1 Validity of Research Instrument

The term validity of a test is a measure how well a test measures what it was supposed to measure states Kombo and Tromp (2016). According to Robson (2011) validity of a research instrument measures the degree to which the tool assesses what it is intended to measure. It is the extent to which the results are truthful. A scholar Pallant (2011) explained simply that any study requires research questionnaires to accurately measure the concepts under the investigation.

In any research, validity has two critical aspects, on one hand there is the question of credibility; whether the results would be genuine because of the information given by selected respondents and if so then it confirms whether the study can be reproduced asserts Willis (2007). The researcher took precaution over internal validity by considering the appropriate strategy of triangulation. The second essential aspect - external validity shows whether the results given by the study could be transferable to other sets of interest as asserted by Last (2001). The researcher increased external validity by ensuring full representation of population through diverse selection of respondents; one set respondents selected through stratified simple random sampling and another set by purposive sampling. According to Kombo and Tromp (2016) the

power of purposive sampling criteria lies in choosing information rich cases for in-depth analysis related to the central subject being studied.

A research instrument is deemed valid depending on how effective the data collected in answering the items and how well it covers significant aspects of the purpose of the study. The research instrument thus, should provide adequate coverage of the topic. Validity was also established through close consultation and expert judgment by the supervisors who verified the validity of the research instruments used in the study. The researcher prepared the instrument in consultation with the research supervisors to ensure that the specific areas or objectives were covered by the instruments. Instrument validity was established by pre-testing of data collection tools through a pilot study. Expert judgment enabled the researcher to identify areas of weakness of the instruments and make the appropriate corrections which were incorporated in the instruments to increase its validity.

3.9.2. Pilot Testing of Research Instrument

In broad-spectrum, pilot testing comes before a closely correlated larger study and it refers to an assessment of the practicality of a proposed method designed to test measures and procedures that are under consideration for use in the subsequent larger study observes Eldridge et al (2016). Kombo and Tromp (2006) stated, ‘the aim of pilot research is testing the validity of research instruments as well as to check the occurrence of vagueness and investigator’s bias’. The questionnaire was therefore subjected to pilot

testing to verify that the respondents supplied relevant and expected data. The statements' describing every situation to be evaluated by the respondents was scrutinized to eliminate any vagueness and enhance common meaning.

Pilot testing was carried out by administering questionnaires to five trainers from one institution of an equivalent status; size, courses offered, trainers background- Rift Valley Institute of Science and Technology in Nakuru County. Three mangers from relevant departments were sampled for the pilot study. Participants in the pilot test were chosen according to Mugenda and Mugenda (2003) who argues that a pilot sample of 1% for a large sample and 10% for a small sample would be adequate.

Pilot testing was conducted in order to detect any deficiencies and difficulties that respondents were likely to face when responding to the items. The purpose was to establish if any questions would make respondents feel uncomfortable or check areas of confusions and creating errors as a way of ensuring that all the participants in the sample understood the questions in the similar way, as well as provide an average estimate time each survey question will require for an appropriate answer.

at the same. Moreover, the researcher was able to find out how long it would take to complete the survey hence regulate it. The findings of the pilot study were used to determine the validity of the research instruments.

3.9.3. Reliability of Questionnaire

The term reliability refers to the extent to which results are consistent over time Kivunja (2017) or a measure of how consistent the results from a test are or rather how the procedure produces the same results on repeated trials asserts Kombo and Tromp (2016). Leedy and Ormrod (2001) describe the reliability of a measurement instrument as the extent to which it yields consistent results when the characteristic being measured has not changed or been altered. The two scholars went further to explain that reliability of a questionnaire depends on what is described as equivalence which refers to amount of agreement between two or more instrument that are administered at nearly the same point in time.

The internal consistency reliability which refers to the extent to which items on the test or instrument are measuring the same thing is measured by as reliability index-coefficient alpha as stated by Cronbach (1951).

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A reliability test was carried out to check the internal consistency of the data collection tool. One of the most popular reliability statistics in use today is Cronbach's alpha. This determines the internal consistency or average correlations of items in a survey instrument to gauge its reliability. The reliability test was run through Statistical Package for the Social Sciences (SPSS) and reliability coefficient was found to be 0.873

over 39 items that used to measure user response using Likert Scale. This suggested that the tool developed by the researcher was reliable.

High reliability does not guarantee valid results, but there can be no validity results without reliability. However, the researcher believes that the questionnaires in this investigation were valid and were completed with the necessary honesty and sincerity required to render maximum reliability. Frankness in responding to questions was enhanced by not requiring the respondents to affix their identification in the questionnaire

3.10 ETHICAL CONSIDERATIONS

The ethical secret code concerns the responsibility of researcher to respect each respondent as person capable of making an informed decision regarding participation in research study. According to Wassennar (2006) ethical research considerations have become an essential component of typical worldwide research practice. Wassenaar (2006) and Gall et al (2005) concur that the search for knowledge and scientific development should be concerned with assurance to respect human modesty and protection of participants from human rights infringements. To ensure the safety and rights of the participants, they were first informed about ethical rights as they were issued with questionnaires or before the interview.

The degree of considerations on ethical conduct of all the players and during research activity has both increased and widened in rejoinder to culture's expectancy of greater

accountability asserts Zegwaard, Campbell, & Pretti (2017). In view of this declaration the study sought approval from the University and the Ministry of Education, Department of Science and Technology and the institutions as demonstrated in appendix F and G.

The researcher also anticipated seeking the endorsement of the research instruments, the questionnaire survey and interviewing questions, from experts prior to the commencement of data collection. In light of the fundamental rights and protection of the respondents, measures were undertaken by the researcher to ensure the participants were assured of individual privacy and confidentiality in accordance to Cohen et al (2007).

The individual rights anticipated to be considered in this study entailed protection from physical and psychological harm or discomfort, confidentiality and anonymity, and academic integrity. The researcher provided non-coercive disclaimer that participation was voluntary and no penalties were involved in refusal to participate.

The questionnaires were serialised for purposes of accounting the questionnaires issued and received. The participants were prevailed upon not to submit or provide their identity at all as an assurance of secrecy and confidentiality. The Institutions were represented by NP1, NP2 and NP3.

The study was designed to use a survey technique which involved interviewing of the respondents. This was face to face interaction where the anonymity of the respondent

was assured. The participants were assured that their identity and information would not be disclosed to any one and the information was solely for the intended purpose between the researcher and the University.

The keystone of ethical research is “informed consent” asserts Denzin & Lincoln (2011). In terms of information the respondents were requested to supply the data required without threats or coercion, but out of free will and the respondents consented as verified in appendix ‘J’.

The rights and freedom of expression were guaranteed in that the information supplied was accepted and used for its rightful purpose and intent. The information gathered from either one respondent or Institution was not shared with any other respondents or reader whatsoever in order to protect the integrity of the concerned parties.

The information collected was used with dignity in accordance with the decorum it was acquired. In the course of the administration of the survey, a consent letter and a letter of confidentiality were presented to each respondent together with the questionnaire, explaining the purpose and the details of the study. The research findings were compiled objectively and accurately in order to meet the purpose and the significance of the study. The respondents were protected through the use of unbiased language; using language that is sensitive to labels and also acknowledging the participants APA (2001) as reported by Creswell (2013). The respondents were informed before the beginning of data collection the rationale of the study and be assured that the information they

provided was set aside as classified, off the record and unidentified and would not be used for any other use other than the intended purpose.

3.11 DATA COLLECTION AND ANALYSIS PROCEDURES

Data collection is the process of gathering and measuring information on the variables. In this study the variables were ICT knowledge and skills, availability of infrastructure and the perception of the trainers on integration of ICT in teaching and learning in engineering. Data analysis procedure is a process of systematically applying logical techniques to describe or condense entire data and synthesize to answer specific research questions. The methods were considered upfront as data collection was geared towards the mix evidence needed to make appropriate judgement about the phenomenon. The importance of ensuring accurate and appropriate data collection was to maintain the integrity of data, and this was achieved by setting up standardized protocol and communication structure alongside clearly defined instructions. The data collection and analysis methods were chosen to complement each other's strengths and weaknesses.

3.11.1 Data Collection Procedures

The researcher secured an introductory letter from the Board of Postgraduate Studies, Moi University to act as an identity and obtained a research permit from the National Commission for Science, Technology and Innovation (NACOSTI).

The researcher then visited the institutions on different days to seek consent from college management to conduct the research as the managers were briefed about the purpose of the study. The dates for carrying out the data collection was identified and each institution was give at least two days, but not more four days apart, this was to maintain consistency in the exercise. The trainers and managers sampled, on the day of data collection were asked to read and sign the informed consent letter as the first step before they were individually requested to respond to questionnaire items as honestly as they could. They were assured of confidentiality and protection from any maltreatment for participating in the exercise. The questionnaires which comprised of thirty-nine items were distributed by the researcher to the trainers purposely selected in the engineering sections and specifically the one who teaches engineering core subject areas. The respondents were given sufficient time to complete the questionnaires and research assistant assisted in gathering the questionnaires after the given response time. The researcher work closely with the assistant to ensure adequate control of the process. The trainers were readily available since they were found at their work station.

The quantitative data was collected at the same time through observation and interview schedule. The interview was conducted one on one at a venue where the trainers were comfortable; in a natural setting. The interview was structured and followed closely the format of the questionnaires.

The observation schedule was carried out by making visits to the workshops, classes in sessions and laboratory. The researcher took field notes in a structured manner, as

enquiry target activities closely related to ICT application in classroom and workshop practices. The researcher also undertook to collect data was not captured in the interview and observation schedule such as whether ICT was considered as a factor to enhance engineering training, what was the culture of the institution in regards to the subject matter. The interview atmosphere was favourable, relaxed and a non-threatening for all respondents. The quantitative data collected by use of interview and observation was essential to implore for information which may not have been easy to access through the questionnaires and this enriched the findings.

3.11.2 Data Analysis Procedures

The primary quantitative data was collected through questionnaires, whereas the qualitative data was collected using interviews and observations. The two sets of data were crisscrossed for oversights, clarity and consistency before being coded for analysis. It was coded and keyed into a statistical package for the social sciences (SPSS). Qualitative data generated from the interview schedule and observation was organized according to objectives and categorized through content scrutiny in themes Data collected was analyzed quantitatively and qualitatively. The quantitative data that was derived from the demographic and Likert scale questions were analysed using descriptive statistics. Descriptive Analysis delivered detail breath that fully captured the phenomenon, mirrored crucial perception, offered a diversity of perspective and methods that does not falsify data or give room for misinterpretations and it is characteristically acceptable by researchers, practitioners and policy makers because it

reflects real globe observations states Loeb, Dynarski, McFarland, Morris, Reardon, & Reber (2017). The common practices of descriptive explorations are for establishing the characteristics of a place, the populace, procedures and processes and also for explaining how systems and its integral mechanisms function asserts Loeb et al (2017).

Descriptive analysis was done to show the frequencies, percentages different items in the study and it was presented using and tables and bar graphs to display diagrammatically. In the description by a renowned philosopher of technology; Kelly (2010) graphical representation is evolvement of the mind structuring the fragments of information, ‘generating order’ that forms the reality - giving meaning to cognition. According to Marco (2017) graphical representation of scientific data is to utilise the power of visual display to preserve, understand and communicate efficiently information while circumventing dishonesty. The data collected by observation and interview was categorized into topical themes. The results of the two phases of data collected were integrated in order to confirm or otherwise, cross-validate and gain in-depths understanding as argued by Creswell (2003). The findings from the analysis of data from the different tools were triangulated at the discussion phase.

The table below shows the data analysis of the questionnaires used in the study.

Table 3:3*: Data Analysis of the Questionnaire*

Objective	**Type of Data**	**Tools/ Instruments**	**Data Analysis**
Demographic data	Methodology	Questionnaires numbered 1 to 5	Descriptive
To assess the level of ICT knowledge and skills of trainers with respect to teaching and learning of engineering courses in National Polytechnics	Qualitative/ Quantitative	Interview Schedule Questionnaire No 15	Thematic analysis/ Descriptive statistics
To determine the availability of ICT Infrastructure for ICT integration in teaching and learning of engineering courses in National polytechnics.	Qualitative	Questionnaire no 6, Observation schedule (section H)	Content/ Narrative Thematic analysis
To examine the level of ICT knowledge and skills of trainers with respect to teaching and learning of engineering courses in National Polytechnics	Qualitative/ Quantitative	Interview schedules (section F) Questionnaires' No. 9 to 12, 7	Narrative analysis/Descriptive Statistics
To describe the perception of trainers on ICT integration in teaching and learning of engineering courses in National polytechnics	Qualitative	Qs 20, Interview Schedules (section F)	Narrative analysis

3.12 UNIT OF ANALYSIS

The unit of analysis are those entities about which we collect data and about which we intend to generalise. In this study the unit of study comprised of the trainers. In accordance to Teddlie and Tashakkori (2009) mixed method analysis involved QUAN-Qual, adopted from Creswell et al (2003) who asserted that data analysis using statistical as qualitative data was integrated at the discussion/interpretation stages. In this study mixed data analysis involved QUAN analysis of data using statistical

technique appropriate to the variables; descriptive statistics, whereas QUAL analysis of data using qualitative analysis approaches appropriate for the data and research question. The two set of questionnaires on the basis of the mixed methods provided two phases of analysis which mainly utilised descriptive frequency and narrative analysis to generate themes accordingly. The investigation was about the integration of ICT and its adoption in teaching and learning engineering in Tertiary TVET institutions.

3.13 THE CHAPTER SUMMARY

The chapter discusses the research designs and methodology, various research instruments; questionnaires, interviews and observation schedule and the precautions considered to ensure the validity and reliability of the data. The chapter also discusses sample size and methods of sampling used to select the respondents, data collection and analysis procedures'. The instrument of the research was outlined in the chapter and it entailed questionnaire, interview, observation schedule, and observation checklist. The chapter concludes with a discussion on ethical considerations. The research design and methodology, in a nutshell, is a plan, structure, and strategy of the investigation so conceived so as to obtain answers to the research question by controlling the variance under study, thus increasing the reliability of measures.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, INTERPRETATION AND DISCUSSION

4.1 INTRODUCTION

The chapter discusses the findings and discussion of study results. The study sample comprised 48 trainers of the sampled three National Polytechnics drawn from the engineering departments and 15 mangers. The trainers considered as the appropriate respondents were those who teaches the trade core subject areas such as Technical drawings, automotive engineering and excreta. The trainers were issued with questionnaires using drop and pick approach. All the 12 managers were interviewed.

4.2 RESPONSE RATE

The researcher administered questionnaires which were administered to the trainers of engineering departments by dropping at the offices of the heads of departments and were picked after they had been filled. The respondents were given adequate time to answer the stated items in the research tool. A total of 42 questionnaires were properly filled and returned. This represented a response rate 93%. A total of 10 heads of engineering departments were interviewed. The interview schedule was administered by the researcher at the respondents' office. The number of those interviewed represented 67% of the sample size. Response rate of 50% can be considered to be adequate to establish the research objectives and answer the research questions according to

Mugenda & Mugenda (2003). Therefore, the response rate in this study was considered adequate.

4.3 FINDINGS AND DISCUSSION

4.3.1 Demographic Analysis

Table 4:1 ***Demographic Data***

Demographics		**No.**	**Percent**
Gender of the Trainer	Male	37	88
	Female	5	12
Age Bracket of Trainers in Years	21 - 30 Years Old	11	26
	31 - 40 years old	17	41
	41 - 50 years old	8	19
	51 and above years old	6	14
Education Level of Trainer	Diploma	1	2
	Higher Diploma	5	12
	First Degree	25	60
	Masters and Above	11	26
Duration in Teaching Service	0 - 5 years	18	43
	6 -10 years	10	24
	11 - 15 years	4	10
	16 - 20 years	1	2
	Over 20 years	9	21

Table 4.1 shows the generated analysis of the demographics data of the trainers. 88% of the respondents were male while 12% are female. This is an indication that engineering

teaching fraternity is dominated by males by more than three quarters of the total trainers. The table also shows that 67% of the trainers are 40 years and above (21 and 30 years old - 26%; between the ages 31 and 40 years – 41%). Over 80% of the trainers in the engineering have at least a bachelor's degree in their trade area. Furthermore, 43% of the respondents have teaching experience of more than 6 years, 24% between 6 and 10 years, 10, 11 to 15 years, 2% between 16 and 20 years and finally 21% have teaching experience of over 20 years

Table 4:2 *Disciplines*

Course Areas	**No. of Trainers**	**%**
M1	12	28.6
M2	11	26.2
M3	7	16.7
M4	12	28.6

The table 4.2 shows the distribution of sampled trainers in the different engineering course areas in the three National Polytechnics. The data collected revealed that M1 and M4 Engineering registered the highest number of respondents accounting for 28.6% of the respondents. The M3 area had the least number of respondents. The researcher thus deduced that the number of staff teaching M4 engineering in National Polytechnics is

low. It was inferred from these results that automotive engineering course was understaffed.

4.3.2 Objective 1: To establish the availability of ICT infrastructure for teaching and learning of engineering courses in National polytechnics

4.3.2.1 ICT Infrastructure: Findings from Questionnaire

Table 4:3 ***Location of Internet by the Trainers***

Location of Internet Access	**No.**	**%**
Personal Mobile Phone	23	54.8
Staffroom	19	45.2
Computer Laboratory	11	26.2

Table 4.3 show the location where the trainers access internet while within the precinct of the institution. The results showed that 54.8% of the trainers' access internet through their phones while 45.2% access it from the staffroom and 26.2% access it from the computer laboratory. This is an indication that institutional internet access points are few; more than half of the trainers' access internet using mobile service providers. It can be surmised from the results that a small numbers of trainers use institution infrastructure to access internet which implied that the National Polytechnics had inadequate internet infrastructure. This inadequacy could be in terms of low internet bandwidth thus limiting the number of access points.

Table 4:4 ***Location of Accessing of Computer***

Location of Accessing of Computer	NO		YES	
	No.	%	No.	%
Computer Laboratory	34	81.0	8	19.0
Managers Office	26	61.9	16	38.1
Staff preparation room	36	85.7	6	14.3
Library	41	97.6	1	2.4
Personal Computer	15	35.7	27	64.3

Table 4.4 shows where trainers access computers while within the institution. 64.3% of the respondents use their personal computer. 97.6% of the trainers reported that they do not access computers from the library. The high percentage of trainers utilizing their personal computer is an indication that national polytechnics have inadequate number of computers that the trainers can use for the purpose of teaching and learning engineering courses.

4.3.2.2. ICT Infrastructure: Findings from Observation of ICT Checklist

The researcher made observation in 18 different lessons in venues where engineering subject content was delivered to the trainees. 10 of these observations were carried in the computer laboratories or smart classrooms which represent 56% of the observed lessons. The laboratories where the lessons were observed had desktop computers, printer, interactive whiteboard and software relevant to the lessons being conducted.

The proportions of the lessons carried out in the computer laboratories constituted 40% ICT based comprising Introduction to basic ICT software and Computer Assisted Mapping. The other 60% involved drawing and design subjects using arch CAD. The researcher observed that there were inadequate numbers of computers to accommodate the huge number of trainees within a given lesson. It was also observed that the computer desktops available did not have the capacity to handle the resource demanded software required for the teaching and learning engineering (that is CPU speed, RAM and Hard disk capacity). It was also observed that most of the ICT tools could only be accessed while inside the computer laboratories. This presented the challenge of accessing these tools while out the computer laboratory; an indication that learning was only confined within the computer laboratory. The trainers observed were using their personal laptops and/or mobile phones while conducting lessons in the lecture rooms; to access lecture notes. These ICT tools were also used to access reference materials stored in the devices or in the World Wide Web. The lecture rooms had non-functional sockets due to vandalism. This was an indication that the lecture rooms did not have sufficient physical security. There was only one workshop that ICT was being utilized. In this particular workshop, the trainer was using an overhead projector for demonstration and simulation of concepts in an M4 engineering practical lesson.

Table 4:5 ***ICT infrastructure observed and recorded***

EQUIPMENT TYPE	**Department**			**No's of equipment**	**Type used for lesson delivery**	**Utilization of the equipment**
	M 2	**M4**	**M4**	**TOTAL**		
Desktop computers	20	21	20	61	Laboratory computers	Production of Power Point slides and displayed thro' projector.
Laptops	15	0	1	16	Used by trainers for preparation	Preparation and delivery of learning content
LCD Projectors	1	2	2	5	Class used	Display of power point slides
Optical disk-CD/DVD	12	21		33	Computer lab	Backup of the assignments and arch CAD projects
Ordinary printers	1	3	2	6	Trainers for printing assignment and projects	Printing of the student's projects. broad sheet Paper size A3 & A4
Interactive whiteboard-	2	2	2	6	Two smart classroom.	Delivery of class content
Application computer software e.g Arc-CAD	21	20	20	61		Preparation of Arc-CAD training content. Simulation software was missing

4.3.2.3 ICT Infrastructure: Findings from Interview Schedule

The interviews conducted with the managers revealed that engineering departments within the institution had an average of one computer laboratory that was being shared among them. The managers in the interview put it in plain language that the provision of ICT were meant for demonstration; 'technology exposure' one manager referred to that as 'Extech' while several observed that the use of ICT for teaching was not even regarded as an option 'strategy' for teaching and learning.

The list of audio-visual aids used to enhance teaching and learning technical areas include computers, projectors and interactive boards among others. The items listed in table 4.5 were observed in the NPs as part of the teaching aids. In terms of technical drawings, the software found to be in use was Arch CAD and it was being used across the departments. These audio-visual aids according to Imel (1999) were used to shift the emphasize from teaching to learning and to redirect the focal point away from low-level cognitive assignments to higher array of thinking skills. This study found out that the use of these technology equipment was only limited to the terms' timetable schedules thus minimizing the exposure period. Apart from word processing, spreadsheets and AutoCAD, the software for simulation was predominantly missing. As noted by Dean (2002) technical training institution must adopt the use of technology or emerging new ways of teaching such as simulation of real life situations. These technologies complement each other in teaching and learning; the Audio-Cassette Tapes provides information step by step notes opines Perraton et al., (2002) and is supplemented by

video tapes which provide real-life situations that is best presented and described using text or audio as opposed to only audio states Nunes and Gailbe (2002). This study found out that interactive boards had been embraced by the three polytechnics; however, the numbers are limited since not every instruction room had been equipped with it. In the application of simulation hardware, a paltry 7% indicated that they had the capacity to use the software, though this study couldn't establish whether this was on the basis of limitation of initial training or simply because of unavailability of the software.

All these give an indication that the national polytechnics lack adequate ICT infrastructure to be in a position to integrate ICT in teaching and learning. It was observed that there was limited access of ICT resources for use by trainers during their assigned lesson hours. These results concurred with Yildirim (2007) arguments that effective adoption and integration of ICT in TL were dependent on availability and accessibility of ICT resources. Isman et al. (2010) postulate that deficiencies of ICT infrastructure in workplace is a major contributor to barriers in the use of ICT; reflecting negatively on the integration of ICT in teaching and learning. The findings of this research study confirmed the results by Mwangi (2013) on research in tertiary institution in Kenya; that insufficient telecommunication infrastructure, inadequate knowledge and pedagogical methodology constraints ICT integration in teaching and learning. According to UNESCO (2003), the barriers that significantly hamper the integration of ICTs into teaching and learning in TVET includes infrastructure, availability of suitable materials, job threat, appropriateness of the methods, and

credibility of curriculum content. UNESCO (2003) reported that there were limited records of successful efforts associated with the use of ICT for effective teaching of practical skills. However, Gibbons et al (2004) concurred that ICT was effective in teaching practical skills. The use of virtual laboratories provided an easier method to perform practical classes with simulations as opposed to the traditional real laboratories. The results of this study affirmed that ICT integration in the teaching and learning in the NPs faces the same challenges experienced elsewhere, as noted in literature review.

4.3.2.4: ICT Infrastructure: Triangulation of Data Analysis

The term triangulation is defined as a process of combining of data from different sources to study a particular phenomenon. It is a strategy that proffers a diversity of data set to augment the subject matter under investigation. The objective of triangulation therefore is to combine reliable data to identify patterns and convergence; to achieve the most accurate conclusion. In view of the above, the quantitative and qualitative data collected were credible on the basis that the samples were a true representative of the population as the selection was through sampling, the data sets were collected concurrently and entirely ethical concerns were put under considerations.

The findings from qualitative data and quantitative were corroborated and the weakness or bias of any of the approaches or data sources was recompensed by the strengths of the other, thereby increasing the validity and reliability of the result. The step of triangulation validated the data and revealed that the managers thinking and belief on the ICT infrastructure provided were more of samples than tools for teaching and

learning. This notion forms the major reason for the provision of limited infrastructure observes the managers. Secondly the findings revealed that the use of ICT for teaching and learning engineering was least considered as educational aid, thus trainers resorted to self-equipping with personal lap-tops or advance cell-phones.

4.3.3 Objective 2: To describe the perception of trainers on ICT integration in teaching and learning of engineering courses in National Polytechnics

4.3.3.1 Findings from Questionnaire.

In order to find the significance of ICT use in the teaching and learning process the respondents were asked to assess it using five suggested importance of the technology using Likert scale and the results were recorded in table 4.6.

Table 4:6 ***Significance of ICT Use in the teaching and Learning Process***

Influence of ICT Use in the teaching and Learning Process	Strongly Agree	Agree	Disagree	Strongly Disagree
Enhance content delivery and understanding	66.7	28.6	2.4	2.4
Paves way for educational research	64.3	23.8	7.1	4.8
Enhance Innovative and integrated activities	57.1	31.0	7.1	4.8
Promotes pedagogical and organizational innovation	54.8	31.0	11.9	2.4
Provide new and diverse learning and teaching experiences	59.5	35.7	2.4	2.4
ICT provides greater positive influence to learning	69.0	31.0	0.0	0.0
Use of ICT enhances trainees critical thinking skills	42.9	52.4	4.8	0.0
Use of ICT in teaching and stimulates individual and group lifelong learning	50.0	47.6	2.4	0.0

The outcome of this study indicated that 95.3 % of the trainers were confident that ICT integration enhanced content delivery resulting in clearer understanding and greater positive influence towards learning. These results supported findings by Niederhauster and Stoddart (2001) that technology is a brand of instructive modernization. The use of ICT as teaching and learning strategy has introduced an innovative methods of sharing information between the trainers and trainees and amongst trainees alone. Several scholars have conducted research on the application of ICT in TL and found results which support this finding and identified major important areas to integrate ICTs in teaching and learning in technical and vocational training such as libraries and laboratories apart from classrooms.

Information communication technology has found a place in helping the populace to respond to new challenges and opportunities created by an increasingly global economy notes Kirimi (2014). According to Shu'aibu (2013) ICTs is significant as a teaching aid, it's an effective tool for content delivery where space and time becomes inconsequential factors. The overall widespread understanding of ICTs remained to be reliable resource and tools to enrich teaching and learning in all sectors of education states Mbalamula (2016). Integration of ICTs has facilitated construction of knowledge and transfer of knowledge and skills among the trainees, similarly important for identification of useful learning information for effective and acceleration of national economies and to address competitive labour markets (Ibid 2016). The studies conducted in developed and developing countries has concluded that the application of ICT has changed

melodramatically educational structures in the world especially the content, assessment and the mode of teaching and learning states Lee and Cerreto (2010)

The integration of ICT pedagogically has gain key prominence of ICT improving, motivating and promoting collaboration learning process (Wang, 2010), fostering enquiry and exploration, and creating an innovative learner centred culture asserts Nnaekwe**,** Uchenna, Ugwu and Patience (2019). However, Giordano (2007) asserted that the perception of the facilitators as change agents; trainers' on instructional technology integration in classrooms was further influenced significantly by the know-how. On the other hand, Mulwa et al (2018) stated that trainers easily acquired information communication technology skills to use only as a means of instruction. The approach at which one was exposed to computer skills according to Tully (2003) determined the flexibility to interact with information communication technology. The findings of this study revealed that technology provided new and diverse learning and teaching experiences that were in line with the concept of lifelong learning and according to Holmes and Gardner (2006) and that this technology was available at all times alongside the traditional ways of working. The results of this study further confirmed that ICT adoption was dependent on the theoretical model characteristics especially the technology aspect; the technology that was as identified by Zhao and Frank (2003) was a potential barrier to technology integration in learning and teaching. to integrate ICTs in teaching and learning in technical and vocational training.

The findings of the study revealed assertively that the trainers were understood that the use of ICT provided new and diverse learning and teaching experiences. The theory of constructivism learning upholds learner centered approach and that the trainers for this case essentially construct knowledge and attached meaning to the experiences argues Rampersad 2011). This theory and the finding of the study were in accord with the scholars Pitan and Muller (2019) that Information and communication technology has provided an avenue for transferring useful skills and knowledge needed to enter into the world of work. The findings also confirm that the theory of constructivism was relevant for the study as it encourages the trainees to be creative, learn from worldly experiences and actively creates new knowledge.

The application of ICT tools and simulation environment has found a place in technical and vocational training in teaching and learning technical content through virtual laboratories observes Lei et al (2012), and Barrett (2012) authoritatively stated that ICTs be utilized to establish ‘virtual laboratories’. According to scholar Yildirim (2007) ICT encourages modification of pedagogical teaching and learning techniques. The study revealed that 85.8% of trainers were equally convinced that the introduction and application of ICT in teaching and learning promotes pedagogical and organizational innovation.

Table 4:7: ***Respondent's Opinion on Trainers capacity to use ICT***

Respondent's Opinion on his/her capacity to use of ICT	Strongly Agree		Agree		Disagree		Strongly Disagree	
	N	%	N	%	N	%	N	%
I feel I am able to motivate students to use ICT in learning Engineering	17	40	21	50	4	10	0	0
I am willing to learn new ICT related stuff	26	62	13	31	3	7	0	0
I feel traditional method is more effective than the integrated method	3	7	3	7	22	52	14	33
I feel technology related teaching is more effective than the traditional method	15	36	14	33	8	19	5	12
I feel combining technology and traditional methods is more effective	20	48	18	43	3	7	1	2

52% of the respondents agreed with the statement that they could use ICT effectively to teach engineering courses, despite being de-motivated by the trainees. This implied that available time, attitude and number of trainees in a class as well as the trainers' level could contribute a significant effect on the ICT integration in teaching and learning. Lack of adequate resources could be attributed to the unwillingness of the trainers to integrate ICT in teaching and learning.

It was thrilling to note that 93% of the respondents were willing to acquire new ICT related knowledge and 91% expressed confidence that a combining the traditional and technological methods for TL would be an effective strategy to deliver course content to trainees. In addition, 90% of the trainers stated that they had the ability to motivate the trainees by of use ICT to learn engineering concepts. The willingness of trainers to

embrace new skills in ICT and ability to motivate the trainees to use ICT in learning was a clear pointer that the trainers had a positive attitude.

There was a general consensus among the trainers that integrated method of teaching was more effective than traditional methods. This perceived notion that technology had positive impact compared to traditional teaching was a good indication that trainers had positive attitudes toward technology use in teaching and learning of engineering courses. According to Ghavifer (2014) the positive attitude among the trainers plays an important role in the successful integration of ICT in teaching and learning. Despite this large number of trainers' agreeing that use of ICT technology for teaching was more effective than the traditional, however it was observed that there was low use of ICT among the trainers in the selected institutions.

4.3.3.2 Findings from Interview Schedule

On the perception of trainers on ICT integration in teaching and learning the managers opined that the trainers considered that technology was useful for those self-driven trainees who possessed inquisitive minds.

> The trainer conventionally, as the agent for the delivery of course content provided the understanding of concepts and the key guidelines on the scope of knowledge; ... ... the use of ICT technology provided an opportunity to search for deeper understanding of particular concepts and the setup of the practical components. The trainers believed that traditional teaching took first priority in new areas of learning and the successive knowledge construction could be enhanced by ICT integration in expounding the ideas; ... ...not unguided tour in the world of information. ....the instructive method expected to precede the technological method and not as unification techniques.

This conversation was against the fact that the needs of technical training in the 21st century was expected to be responsive to the fast changing technology landscape and its adoption by both trainers and trainees and the entire institutions as observed by Mead Richardson (2011). The study revealed that trainers' believed that new concepts could be introduced to learners using the traditional method rather than technology. The study further indicated that the trainers were of the opinion that the technology was a threat to their role as the only source of knowledge. In other words, trainer led teaching and learning cannot be replaced by trainee centred learning approach.

In an interview, Mead Richardson stated that: -

> *The critical success factor in integrating ICT in TL and well blended in course content delivery was the commitment and leadership of an Institution*

The opinion of Richardson put together with the trainers' perception that new knowledge or concepts must be introduced to the learner before an opportunity to use technology advance the learning, suggests that the managers must come up with proper guidelines or policies to directs blended learning and with well thought out teaching approaches as technology provide an opportunity for learners to forge ahead with learning even to new knowledge fields.

The findings agreed with Bai and Ertmer (2008) that the mind set of trainers toward technology influenced greatly the willingness to integrate technology; however, the trainers recognized the bearing of the technology and that it enhanced learning as the key dynamic point of reference'.

Further, in the interview with the managers of the engineering department revealed that eighty percent (80%)of trainers' used ICT to prepare and maintain their teaching records. The interview also established that ten percent (10%) of the trainers used ICT tools during lesson delivery. This implies that for every 10 trainers, only one would opt to use ICT tool(s) during lesson delivery. Trainers who consistently use ICT stated that it had made their work easier especially when teaching abstract content in their area of specialization. These trainers reported that the trainees were found to understand better difficult concepts when delivered through ICT.

The research results were found to be in-line with the findings of Postman (2000) that integrating technology in classroom is commonly not accepted among scholars because of lack of competence. TVET trainers in the engineering section had limited skills on how to integrate technology in teaching and learning. The findings concurred with research findings by Zhao and Frank (2003) which averred that trainers were willing to develop their skills in the use of technology to increase their confidence in integrating the ICTs in their lessons.

The conventional form of teaching considered face-to-face approach as a direct method of knowledge transfer. According to department managers and institution managers, the trainers were ever asking the following question: -

> *If teaching and learning was reversed from the trainer-centred to trainee-centred approach and ICT made the main source of learning, then what would be the role of a trainer? Is the trainer being reduced to an author of digital content/ material or class computer technician?*

It was the opinion of trainers that the curriculum being readily available with the trainer the traditional approach had a significant role of setting the scope and providing the learning framework. The key application of ICT is to simplify complex concepts through animations. Simulation provides room for turning information into knowledge and gives the trainees an opportunity to apply what they know the literature review reveals. This technology further allows the interactions of concepts and processes to be illustrated. The thoughts of Karahoca (2010) assert that the use of interactive media in engineering alleviates shortage of the staff and the training content; however, the trainers in the NPs were of a contrary opinion that technology reduced their teaching roles. The trainers aged over 31 years of the participants were 74%; from this numbers 33% had teaching experience of 15years and above. This figures accounts for about two thirds of the teaching population was and on the basis of ICT usage as argued above reveals that adoption to integrate ICT in teaching and learning was low in NPs. The question one would ask “does teaching experience affects the adoption of ICT use in the instruction rooms?” The findings agreed with the study outcome of Giordano (2007) which stated that experienced trainers were less ready to integrate ICT into their teaching. The interview with the managers confirmed that trainers were reluctant to adopt new technologies since it was not supportive of what had always been on practice. This concurred with the study of Lemke et al (2009) that technology was very likely to be adopted by trainers and institution if it championed the existing practices. The championing of ICT adoption for use in teaching therefore calls for policies and guidelines, and commitments from the leadership in terms of infrastructure provision.

4.3.3.3. Triangulation of Data Analysis on Trainers' Perception

In triangulation of the data the study revealed that integration of ICT in teaching was significant to teaching and learning. The technology influences the teaching methodology and it provides diverse ways of gaining learning experiences through virtual laboratories to access 'real life situations', as one constructs new knowledge. However, the trainers had questions about their future role and the impact on the changing from teacher centred learning to students centred learning. The perception of trainers on the use of ICT for TL was positive, however the long experienced trainers were slow to cope up with the application of the technology in class, despite recognizing the importance of ICT integration. The trainers were of the opinion that the technology will assist learners progress with learning but not for gaining knowledge in new sphere where the trainers acclaimed that traditional approach was more convenient.

4.3.4 Objective 3: To assess the level of ICT knowledge and skills of trainers with respect to teaching and learning of engineering courses in National Polytechnics

4.3.4.1 Findings from Questionnaire

The respondents were asked to rate the level of competency on various skills and knowledge application on Likert scale; skillful or not skillful. The findings are recorded in table 4.8 to 4.12 and table 4.1.

Table 4:8: *Computer Proficiency*

Trainer Computer Proficiency	Frequency	Percentage
Good	27	64
Moderate	15	36

Table 4.8 shows that 64% of the engineering trainers reported that their computer proficiency was good while 36% reported to be moderately proficient in the use of computers. Computer proficiency is the ability to use digital technology, communication tools, and/or networks to define access, manage, integrate, evaluate, create, and communicate information ethically and legally in order to function in a knowledge society. This implies that for every 100 trainers in engineering courses, 60 were computer literate. Despite this high percentage of computer proficiency, there was still low integration of ICT in teaching and learning among the engineering trainers in National Polytechnics. The low integration could be attributed to the computer literacy acquired by the trainers having no relationship with their role of teaching in their respective area of specialization.

The researcher categorized the ICT Skill Levels of the trainers into three; that is Basic ICT Competency Skills, Online/Internet Skills, Multimedia Skills and Advanced Skills as shown in table 4.9. Basic ICT Competency Skills were a group of ICT skills in the most widely used applications such as word-processing, spreadsheets, and presentation. They are skills necessary for generating textual, organization and presentation of digital information. Online/Internet Skills would refer to a group of skills related to

transmitting and exchanging ideas and working with others remotely through technology while Multimedia Skills were group of skills that involve creation and manipulation of digital images and videos which entail developing, editing, and publishing them. Advanced ICT Skills on the other hand were skills that related to creating ICT software, database management, and analysis of research data. The study drew inferences from the trainers' ICT skills levels analysed as per these categories.

Table 4:9: ***Trainers Basic ICT Skills Level***

ICT SKILLS	Very Skilful		Skilful		Less(Semi) Skilful		Unskilful	
	N	%	N	%	N	%	N	%
Using word processor	23	55	18	43	1	2	0	0
Using Microsoft Excel	12	29	19	45	8	19	3	7
Using Presentation	16	38	18	43	8	19	0	0

The results indicated a total 98% of the trainers reporting that they were either very skilful (55%) or skilful (43%) in Word processor application. A total of 74% (29% very skilful and 45% skilful) of the respondent reported that they were either very skilful or skilful in using Spreadsheet application (Microsoft Excel). Very skilful and skilful in the use of Presentation application had a total frequency of 34 representing 71% of the respondents. Skills in basic ICT applications were perceived to be minimum

competence in ICT. The implication of these finding was that a majority of the trainers had acquired basic skills to perform common operations using a computer.

Table 4:10: ***Trainer Online Skill Levels***

Internet Skill	Very Skilful		Skilful		Less(Semi) Skilful		Unskilful	
	N	%	N	%	N	%	N	%
Using internet to research	23	55	17	41	2	4	0	0
Using email for communication	23	55	15	36	4	9	0	0
Using search engine	20	48	15	36	4	10	3	7
Using World Wide Web	21	50	13	31	3	7	5	12

Table 4.10 presents results in ICT knowledge and skills required to access and use the internet. Across all the skill areas over 80% of the respondents were either very skilful or skilful. A total of 96% (55% very skilful and 41% skilful) and 91% (55% very skilful and 36% skilful) of the respondents reported that they were skilful using internet to search and open emails for communication respectively. It could be observed that 48% and another 36% of the respondents were very skilful and skilful respectively in using the search engine. These results gave a clear indication that a majority of the trainers in the engineering areas in technical National polytechnics had well developed skills in using and accessing internet resources. This implies that a majority of the trainers were able to effectively use ICT online tools to disseminate and access information.

Table 4:11: ***Trainers Multimedia Skill Level***

	Very Skilful		Skilful		Less(Semi) Skilful		Unskilful	
	N	%	N	%	N	%	N	%
Using Digital Video and Animation	9	21	14	33	11	26	8	19
Using Computer Simulations	4	10	13	31	16	38	9	21
Using Computer Aided Design and Drafting	6	14	14	33	18	43	4	10
Using of digital images	3	7	20	47	15	35	4	10

Multimedia skills represent the abilities necessary for generating and editing audio-visual objects which include videos and images using computer. The results in Table 4.11 show that a total of 54% (21% very skilful and 33% skilful) of the respondents reported to be skilled in the use of digital video and animation. 41% (10% very and 31% skilful) of the respondents reported that they were skilled in using computer simulations while 47% (14% very skilful and 33% skilful) of the respondents reported to be skilled in using Computer Aided design and Drafting software. The study also revealed that 54% (7% and 47% skilful) of the respondents stated that they were skilled in using the digital images. On average, the results indicated that half the number respondents were skilled in using multimedia. This implied that more than half of the national polytechnic engineering trainers were able to use digital images and video in the classroom. The researcher therefore, summarised that slightly less than half of the trainers had an adequate level of skill in multimedia applications

Table 4.12 hereunder shows three skill areas which can be considered technical in nature because advanced skills are required to manipulate through the computer applications.

Table 4:12: ***Trainers Advance ICT Skill Level***

	Very Skilful		Skilful		Less(Semi) Skilful		Unskilful	
	N	%	N	%	N	%	N	%
Using statistical measurement	6	14	11	26	22	53	3	7
Using database	4	10	14	33	18	43	6	14
Using programming language	3	7	11	26	15	36	13	31

The results indicate that 40% (14% very skilful and 26% skilful) of the respondents had a high level of skill in the use of statistical measurements, 43% (10 % very skilful and 33% skilful) in database and 33% (7% very skilful and 26 % skilful) in programming language.

The results led the researcher to deduce that other than basic ICT and Online skills, all other ICT skill areas that are Multimedia in nature are considered highly technical by the trainers as less than 50% of the respondents reported to be skilled. In a study conducted by Mwangi (2013) in a tertiary institution found out that trainers lacked adequate knowledge and skills in both content and pedagogy. Trainers' inadequacy in knowledge and skills also limited the potential to use the technology for teaching and

learning opined Nurse and Gaible, (2002). According to Sage and Roses' (1985) chart on selection of the most convenient technology, the performance to be carried out would only be factored in the planning when the facilitator was competent and ready to perform the demonstration for purposes of transferring knowledge or skills.

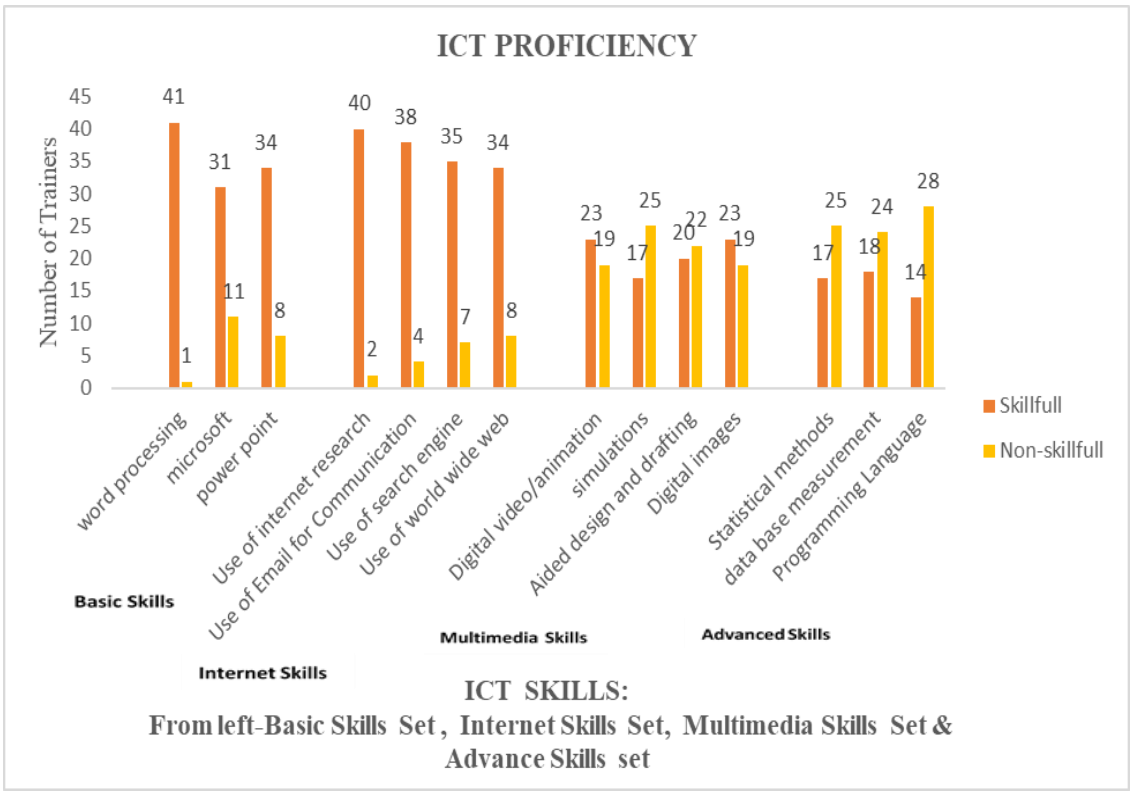

Figure 4.1 ICT Proficiency

Figure 4.1 shows a bar chart that summarises the various ICT skills under study as discussed in the earlier sections. The bar chart depicts that more than 76% of the trainers' are skilful in basic and internet skills; however, the numbers drops to about

66% in multimedia and advance skills. The literature review views this phenomenon of a limitation for the trainers to engage technology in transfer and imparting of skills to the learners. Conversely the trainers have satisfactory skills to use ICT for personal endeavours'. The trainers were non-skilful in multimedia and advance skills.

4.3.4.2 Findings from Interview Schedule

The interview investigated the level of ICT knowledge and skills of the trainers to use the technology to deliver the course content. The responses indicated that the trainers had the capacity to use basic skills they had learnt, however they had reservations in using more specialized soft-wares such as programming, simulations and drawing and design. The responses were expressed as follows:

> *The application of ICT as a tool for giving instruction and expounding on concept using specialized software such as simulations were rather complex which called for deeper understanding of ICT infrastructure contrary the original training of learning to operate a system and using it to search for information.*

This statement from a manager of one institution who portrayed that the trainers did not have 'the practical know-how to use ICT for teaching' and 'lacked ICT instructional skills for content delivery', though they 'use ICT for personal works. The manager noted that the trainers may require specialized focused courses for skill instruction. The information implied that the trainers had no preparation or training on the use of ICT for teaching and learning but for individualized work. The results from this study thus concurred with the findings of Hashim (2007) who argued that 'ICT integration in

teaching and learning was a complex process that required strategic planning by policy and decision makers. This school of thought was affirmed by Kitschner and Davis (2003) who stated that trainers in ICT utilization instruction required competence to use ICT in personal instruction, competence to understand a range of educational teaching model that make use of ICT in instruction, adequate aptitude to utilize ICTs as intelligence tools, competence to employ ICT in instruction as a tool for teaching.

The interview with the managers further investigated the attitude of trainers towards integration of ICT in teaching and learning and it revealed that the trainers were positively receptive as reflected by the statement from one of the managers:

> *I have noted that a reasonable number of trainers owned laptops and also demanded a high capacity internet connectivity; however, the recorded numbers using ICT for teaching and learning was considerably small.*

The explanation provided for this significant positive attitude towards integration of ICT was "predominantly influenced by the ever increasing popularity of mobile phones; a colossal source of social, economic and political information". The tendency for trainers to have personal laptops for personal works was motivated by the fact that ICT was taught as a discrete component by specialized ICT based teachers while engineering trainers' had basic knowledge and skills sufficient for personal development, remarked a manager of one of the polytechnics. There was limited literature on technology leadership capabilities in institutions of higher learning; however, Afshari et al (2008) observed that leadership significantly influenced the integration of ICT in TL. The studies conducted on the capacity of institutions to integrate ICT in TL found out that

few managers had developed plans for ICT integration in TL - at best expressed views and ideas of ICT supervisors. On the same subject of institutions leadership, Flanagan (2003) observed that principals, who were not prepared for technology leadership, struggled to develop the resources required for ICT integration.

4.3.4.3. Triangulation of Data Analysis on Trainers' ICT competency

On triangulation of the data analysis the findings revealed that the trainers were knowledgeable and skilful in basic ICT and were capable of browsing and sharing information through internet connectivity. The trainers had the capacity to use online tools and computer as the availability of mobile has motivated to use of ICT for personal advantage. The trainers were not skilful in advance ICT application such as programming or simulations. This deficiency was associated with the nature of the initial training they were exposed to as it was intended to provide basic knowledge and skills to connect and operate computers to the level of word processing and spreadsheet. The findings revealed that the trainers had discrete knowledge and skills on basics computer literacy. The trainers had limited knowledge on ICT instructional skills for content delivery. The trainers had reservation on the application of specialized soft wares for teaching and learning. The trainers had minimum ICT skills and knowledge for personal use.

4.3.5. Objective 4: To determine the trainers' utilization of ICT knowledge, skill and infrastructure in teaching and learning of engineering in National Polytechnics.

The study sought to find the application of trainers' ICT competencies and the available infrastructure for teaching and learning engineering courses.

4.3.5.1 Findings from Questionnaire

Figure 4.2 Teaching and Learning Activities

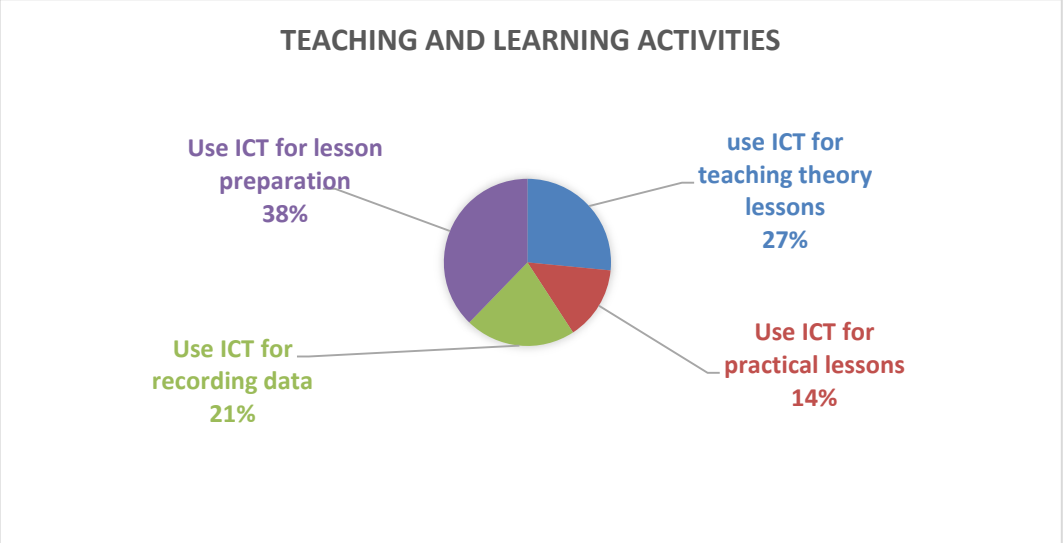

Figure 4.2 shows results obtained of various ways trainers utilize ICT in teaching and learning activities. The results showed that across all the teaching and learning activities, use of ICT tools was significantly low with 26% of the respondents using ICT in theory lessons, 14% in practical lessons, 21% for recordkeeping and 38% for lesson

preparation. This was an indicator of low utilization of ICT in teaching and learning in the National Polytechnic. Tasir et al (2012) observed that some level of ICT competency and confidence encouraged and motivated trainers to apply the knowledge and skills in lesson preparations, slides preparation and searching the internet; these observations were shared by Zafarullah and Pertti (2017). These two researchers further stated that adoption of ICT was only achievable with sound understanding of principles and ideas therein. The outcome of this study depicted the general impact of ICT integration on its application towards the implementation of TVET curriculum. Trainers' were understood to be agents of educational change through integration of ICT skills and knowledge as globally the adaptation to technology tackled the challenges of globalization and the knowledge base economy in the world as affirmed by Abuhmaid (2011). The use of ICT improved quality in teaching and learning in tertiary institutions according to Galbreath (2000). In view of this the trainers need to be confident with the use of ICT in class; this calls for deeper understanding of the root cause hindering the low uptake of ICT usage in NPs. According to Tasir et al (2012), equipping teachers with sufficient ICT skills and knowledge would remove any apprehension or nervousness and build their confidence to integrate ICT in the teaching and learning process and thereby make them more effective.

4.3.5.2. Findings from Interview Schedule

The interview of the leadership of the department and the institutions in regards to ICT integration complimented the data collected through the questionnaires. During the interviews of managers/heads of the department it was observed in a broad spectrum

that the computers in the laboratories were only used to teach the course content related to computer operations and the main topics being word processing and excel techniques with graphic designs as an added area. Generally, the managers interpreted the thoughts and the general approach to ICT integration was summarised by the statement: -

> The provision of computer laboratories is for purposes of training on the basic computer applications; to carry out simple operations such as word processing techniques and simple elements of excel techniques.....the use of computers for content delivery in skill subject areas was neither part of the schedule in the institution nor the department; there wasn't any emphasises laid on that.

No serious focus had been laid on the application of the technology to support trainee centred learning. The methodologies listed in the teaching plan were focused only on the common set of learning standards. The technology which could play the role of connecting the learning concepts to real life situations was generally left at the peripheral of teaching and learning. This agreed with the findings of Moeller and Reitze (2007) that the trainers used technology to present information and not to provide hands-on teaching and learning.

The trainers were asked about some of the ICT equipment the institutions had acquired for purposes of enhancing teaching and training. Generally, the response was that every institution had received smart boards. The numbers were limited as each institution had at least two instruction rooms with the equipment and the facilities were being shared by the departments.

On the efficient and effective use of the installed equipment one manager observed that:

> The Smart boards were special equipment for demonstration on the capacity of technology and reserved for use by those who were conversant with the technology; the most valued, knowledgeable and skilful in ICT. The cost of losing and the fact that it was a donation made us (Institution leadership) nervous about allowing every trainer to access the equipment for teaching and learning----------the uninterrupted influence was as limited as the infrastructure and the enabling environment would not permit

In order to effectively integrate ICT in instruction rooms the trainers must be knowledgeable and skilful in the technology. Cavas et al (2009) noted that there was a close connection between the trainers' ICT skills and the frequency in the use of technology in the instruction rooms. Agyei and Voogt (2011) confirmed that ICT skills were the strongest forward planner for ICT integration in instruction rooms. There was therefore need to equip the institutions to enable the agents to be conversant with the application of ICT technology in order to carry out practical activities in virtual laboratories or workshops. The provision of smart board was expected to create the enabling environment for the learners and the trainees to interact through the technology, as they managed the learning process thereby got along with the adoption of ICT; a progression in line with the theoretical framework. However, the arrangement and the procedure adopted in the utilization of smart board classrooms limits the interaction of the learners, trainers and the technology working negatively to the ideals of constructivists' theory that knowledge is constructed through interaction of all learning aspects.

4.3.5.3 Findings from Observation Schedule

The teaching processes were observed in a total of 24 sessions; eight from each of the three Polytechnics distributed equally in the sections of electrical, mechanical, automotive and building. The researcher spent at least three days in every institution making observations in classes on teaching and learning session. The general institutional timetable guided on the groups, the levels and the nature of classes on the basis of practice or in theory sessions.

The programmes which were being offered in the various departments in the selected National Polytechnics were in two levels certificate and diploma courses. In every selected engineering department two classes were randomly selected, one from the practical and theoretical sessions; one from certificate and the other from diploma classes. The departmental timetables were strictly followed as classes were not disrupted in any way; as also guided by the master timetable. The selection a criterion was applied to the entire institution's engineering department.

The trainers were not notified of the visit in advance. They were simply told, on the day of the visit, they would be visited in class while teaching was in progress. They were not informed on what was being observed, however they were requested to go on about their normal classroom activities. These procedures were followed with the objective of making observation in a typical class set up; teaching progressing on in a naturalistic setting. The observations were recorded to be used in the analysis phase to support the data collected using the questionnaires. These data were used to confirm the drifting

from the traditional practices to technological processes. The critical observation recorded were the organization of the classrooms the specific technology or infrastructure actually used for teaching.

Summary of the activities observed in class Activity

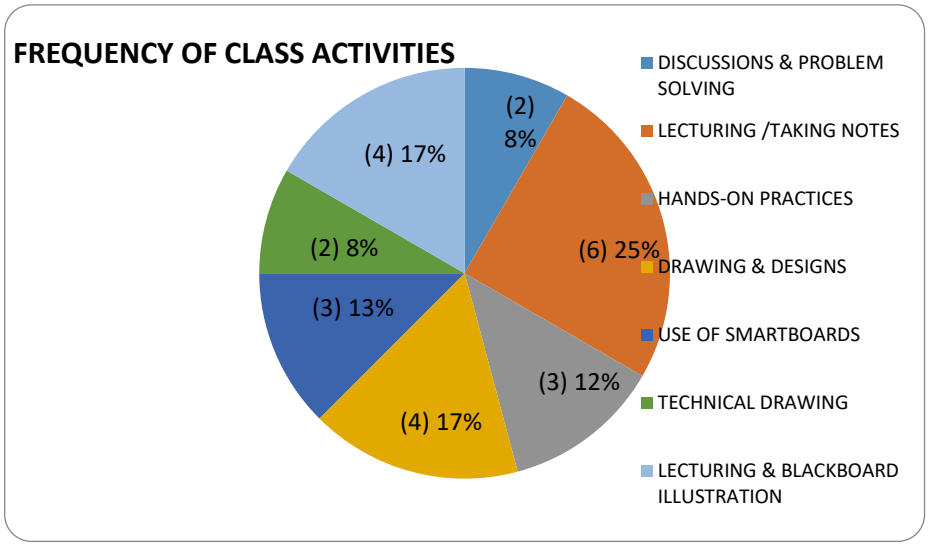

Figure 4:3 Proportions of teaching activities

The pie chart indicates the frequency of class activities observed in a total of 24 classes and workshops visited in the three polytechnics. There were seven common teaching activities observed either in classrooms, workshops, laboratories or drawing rooms, five of which falls under the traditional practices of teaching and learning, which translates 70% non- ICT activities while 30% ICT integrated. It was observed that ICT Integrated teaching and learning activities was low in National polytechnics. The observation made in classroom was not in line with the views of Majumbar (2007) that ICT can be used in

supporting traditional methods of teaching especially large groups. In one case a trainer was observed dictating notes from a laptop. The trainer was already agreeing and applying the idea of Gary (2002) who noted that having easy to get softcopy of lesson notes enables the trainers to update and analyze the course content which are readily available to the learners. According to Yilmaz (2015) the provision of lecture notes or videos to students who are fast learners creates an opportunity for them to study ahead. The organization of the instruction rooms was without any specialized infrastructure to signify arrangement for computers use. The smart classrooms were equipped with the white boards and a desktop. The laboratories for Drawing and Design were well furnished with computer desks, desk top computers installed with AutoCAD software. The laboratories were equipped to accommodate 20 trainees; however, the trainers who revealed to be competent in the use of drawing software were 47% (Table 4.11). As a summary of the observed activities in instruction rooms its coming out that the trainers in engineering have not fully embrace the philosophy of Engida (2011) that ICT-enhanced teacher; uses technology in the sense that it provides a visual representation of the concepts/knowledge from the understanding that teaching is broader and teaching activities can be applied to fit specific subject such as lesson planning, illustrations, simulations or classroom instruction and evaluation. The theory provided clear guidelines on the characteristics required; the technology, the organization culture and the environment, however but at minimum. In terms of knowledge construction presumed to be created through interaction; the observation witnessed minimum levels

of interaction between the learner and the trainer, worsened by failure of ICT integrations in TL.

According to Mirzajani, Mahmud, Ayub, & Luan (2015), trainers are incapable to utilize ICT in classroom owing to deficient in training, knowledge, skills, facilities, time and the values attached to the use of ICT. The trainers were of the opinion that ICT knowledge and skills were meant for individual learning progress, derived the fact that their exposure to the technology was for the understanding that the ICT knowledge was just to gain some status. This finding is supported by Hadriana (2017) who revealed that many factors may influence the trainers' use of ICT such as limited skills and limited knowledge of ICT, the availability of ICT equipment in schools, and teaching overloads. In terms of time preparation, the trainers were of the opinion that using ICT to prepare was time consuming in that one must prepare the teaching notes and thereafter converts into digital content; steps which could be combined if one was versatile in computer typesetting. Research scholars Kuskaya & Yasemin (2013) defined the critical steps in effective integration of ICT in teaching and learning as identification of activities to use develop trainees' ICT basic skills, preparation of digital content and identification of media applications needed to develop high thinking skills to provide solutions for real life problems. According to Muslem et al. (2108) reluctance to Integrate ICT in TL on the basis of time and overloads was associated to deficiency of methodological skills or supporting facilities. However, according to Mahdum, Hadriana, & Safriyanti (2019) though the trainers had a good level of

perception and motivation the failure to integrate ICT in TL were confronted with numerous concerns interrelated to provisions and practical proficiency.

A study conducted by Tezci (2009) and later confirmed by Mwila (2018) demonstrated that a positive correlation exists between the frequency of ICT use and trainers' attitude concerning ICT integration TL. literature review revealed that trainers' who; being classroom facilitators of ICT application in the classroom were influenced by conditions of related to the characteristics of the trainers' asserts Badia, Meneses & Sigalés (2013). The study went further to identify the key characteristics as the attitude and perception of usefulness of ICT, the belief and ability to innovate the utilization of ICT for teaching and learning. According to Ayub et al. (2012) trainers' attitudes were influenced by the perception of the efficacy of ICT and the instructional characteristics.

4.3.5.4. Triangulation of Data Analysis on Application of ICT

Through triangulation of data analysis, the finding of the study was that the conventional teaching methodology was quite dominant except in situations where the trainers used laptops to dictate notes. It was observed that in instruction rooms where ICT infrastructure was available they were used for limited application, for instance in smart classroom it was a reserve of the 'computer experts' and for Auto cad training otherwise the rooms were used as ordinary four wall classrooms. The engineering core subject were not scheduled in any of the computer equipped classrooms an indication that the organization, though has provided limited ICT infrastructure has not embraced its application in teaching and learning. The positive perception of trainers and ICT

competencies and the availability of basic ICT infrastructure was noted not to permits the integration of ICT in teaching and learning without the organization efforts to embrace the technology as an instructional tool which should be factored in planning and scheduling of the programs. The application of ICT for teaching and learning has not been embraced by the trainers, the traditional methodology was still significant as there was no noticeable evidence that the institutions have recognised the effectiveness of technology in teaching and learning. The success of integration of ICT in teaching and learning is dependence on all the constructs resource availability, ICT competencies and the perception of the trainers on the usefulness of the technology. The low utilization of ICT in the classrooms is influenced by the confidence and the ability of trainers to innovatively use ICT basic knowledge and skills to put into the infrastructure available to promote teaching and learning.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter details the study findings and their corresponding conclusions. The findings are discussed on the basis of the objectives of this study which focused on the evaluation of the availability of ICT infrastructure, perception of trainers towards ICT, ICT skills capacity among trainers and the use of ICT for teaching and learning engineering courses in relation to ICT integration in National Polytechnics. The chapter also outlines the various evidence based recommendations made by this study on the requirements for integration of ICT in National Polytechnics.

5.2 SUMMARY OF THE FINDINGS

Objective 1: Findings on the objective to establish the availability of ICT infrastructure for teaching and learning of engineering courses in National Polytechnics

The results collected from the trainers revealed that there was limited access of internet within the institutions since more than half of the trainer accessed internet using their mobile phones. The results also showed that the national polytechnics lack adequate computers that trainers could use for teaching and learning since over three quarters of the trainers used their own personal computers. It was also observed that instructional rooms lacked the required equipment such as the projectors, power sockets and Wi-Fi

hotspots to facilitate ICT use during the training sessions. These results agreed with UNESCO (2003) findings that the barriers that significantly hampered the integration of ICTs into teaching and learning in TVET included infrastructure, availability of suitable materials, job threat, appropriateness of the methods, and credibility of curriculum content. The study by Smith and Higgins (2006) qualified that the preparation of digital notes for classroom use was difficult, time consuming coupled with the challenges of limited skills. The availability of desktop computers as indicated by the numbers provided enormous opportunities for trainers- to utilize the technology to comprehend engineering principles. The key factor in the proper use of ICT was in empowering the upcoming skilled manpower to be acquainted with the varied technologies for use to tackle global problems. This was as reported by UNESCO (2010), that engineering was of great importance in addressing human societal needs which included solving global issues such as eradication of poverty and provision of clean energy and water.

Objective 2: Findings on the objective to describe the perception of trainers on ICT integration in teaching and learning of engineering courses in National Polytechnics

The results indicated that the trainers had positive perception on the influence of ICT use in teaching and learning of engineering courses in national polytechnics. An approximately three quarters of the trainers strongly agreed that ICT provided greater positive influence to learning. The trainers generally were of the opinion that using ICT enhanced content delivery and understanding in engineering courses and it paved way for research among the users.

The trainers were enthusiastic to learn new ICT related skills and the technology motivated trainees. The engineering trainers were of the view that combining technology and traditional methods of teaching yielded better results in trainees' performance. However, trainers perceived that the teaching role was under threat and the technology would reduce them to mere digital content developers, as teacher centered learning transformed to trainee centered learning. Findings from this study indicated that the engineering trainers in the national polytechnic had a positive opinion on their capacity to utilize ICT in the teaching and learning.

Objective 3: Findings on the objective to assess the level of ICT knowledge and skills of trainers with respect to teaching and learning of engineering courses in National Polytechnics

The results revealed that a high percentage of the trainers possessed basic ICT skills; Word processor, Spreadsheets and PowerPoint development skills. Trainers' skills in the use of internet was also above average since more three quarters of the trainers reported that they were skilful in using internet to search and disseminate information.

On the other hand, a majority of the trainers lacked skill in the use of multimedia software; Programming and AutoCAD and computer Simulations software as well as advanced skills in ICT. The trainers were knowledgeable and skilful in basic ICT skills and had the capacity to use online tools and were motivated to use ICT for their personal advantage. The trainers had limited knowledge and skills on how to use ICT

creatively for content delivery; pedagogical skills were unfamiliar. The trainers had reservation on the application of dedicated multi-media soft wares for teaching and learning engineering programs in National polytechnics.

Objective 4: Findings on the objective to determine the level of trainers' utilization of ICT knowledge, skill and infrastructure in teaching and learning of engineering in National Polytechnics

The result of the study revealed that there were a low percentage of trainers using ICT during teaching and learning; both for theory and practical lessons and also lesson preparation as well as record keeping. These low percentages of ICT use in teaching could be attributed to the limited skills and the inadequate equipment. The trainers were yet to seek alternative means other than the traditional methods of teaching. These revealed that the trainers preferred to use ICT for personal undertakings, a phenomenon reflecting the limited ICT instructional skills which also illustrated the nature of the primary training. The basic ICT knowledge, skills, the available infrastructure and the positive perception of trainers on the importance of ICT was yet to influence the application of ICT in classroom. The trainers were nonetheless nervous of the technology use in classroom. The provision of ICT infrastructure was for other benefits and not teaching and learning as the study had presumed. The smart classrooms were reserved for use by a few trainers who were believed to be more knowledgeable and skilful in ICT was an indication that integration of ICT in teaching and learning was not

significant. The study revealed that there was low ICT utilization in teaching and learning of engineering courses among trainers in National Polytechnics.

5.3 CONCLUSIONS

The data from various sources individually provided data analysis which were triangulated under each objective and conclusions were drawn. This section provides the conclusions of the study.

Conclusion of Objective 1: The establishment of the availability of ICT infrastructure for teaching and learning of engineering courses in National polytechnics

Inadequate infrastructure in National Polytechnics could be attributed to low utilization of ICT in teaching and learning by trainers. This inadequacy also limited access to computer laboratories and internet facilities by trainers. It could thus be deduced that lack of adequate ICT infrastructures had a negative effect on ICT integration in National Polytechnics.

Conclusion of Objective 2: The description of the perception of trainers on ICT integration in teaching and learning of engineering courses in National Polytechnics

The positive perception among trainers in National Polytechnics revealed that trainers would be willing to participate actively in integrating ICT in teaching and learning. This was evidenced by the high number of trainers already using ICT in the classroom.

From the findings gathered it was deduced that given better facilitation, trainers could be relied upon to greatly enhance integration of ICT in National Polytechnics.

Conclusion of Objective 3: The Assessment of the level of ICT knowledge and skills of trainers with respect to teaching and learning of engineering courses in National Polytechnics

The trainers were equipped with fundamental ICT knowledge and skills which were useful for personal works such as Internet search and dissemination of information, but was never used for teaching and learning. The study concludes that the trainers had the requisite knowledge and skills necessary for successful integration of ICT, but there was no provision for in the teaching schedule and designs to teach engineering courses in ICT equipped instruction rooms. The study deduced that the trainers had no challenges while using ICT for research, teaching and learning, and in the lesson preparation process, however the skills were not utilized for the transfer of knowledge. This therefore meant that the human resource was an asset that remained untapped, if motivated and guided then they would as well be more than willing because of the positive perception on the use of ICT, and this could largely contribute to the success of ICT integration in these institutions. The evidence that the trainers were using ICT for personal works confirms that ICT skills were a necessity rather than a luxury; a demonstration of a technology-rich institutions.

Conclusion of Objective 4: The determination of the trainers' utilization of ICT knowledge, skill and infrastructure in teaching and learning of engineering in National Polytechnics

The minimal utilization of ICT among the trainers in learning and teaching in national polytechnics was deduced to have been contributed by the limited ICT resources, inadequate skills among some trainers despite the positive perception on integration of ICT in the classroom. The study revealed that there were other extraneous factors such as trainers' confidence on the use of technology, methodological skills and policy guidelines on institutional position on the use of ICT in class; facts which may require further analysis of the situations.

The study revealed that integration of ICT was influenced by many factors some of which were incorporated in the theory which guided this research, and others were highlighted in the literature review. However, the literature review revealed that for effective integration of ICT in TL, the process would be gradual because the agents of teaching and learning; the trainers had limitations in terms of ICT knowledge and skills but their proficiency can only be achieved through constant use of the technology in order to acquire the needed experience. The study revealed that integration of ICT in TL was a change that could not be achieved instantaneously but required a continuous process of implementation and modification. Therefore, the agents of change; the trainers would need continuous methodological skill development in order to be responsive and adaptable to the ever growing technology.

5.4 KNOWLEDGE CONTRIBUTION

The review of literature on ICT integration in TL brought out an evident gap in engineering skill development that ICT integration had the capacity to bridge. The study provided a deeper understanding of ICT integration in teaching and learning and added to the limited number of studies carried out in Kenya and the wider world on integration of ICT in TL of engineering programmes.

The study exposed the benefits of ICT integration in TL of engineering courses to involve trainee interaction with industrial equipment through simulations thus reducing the cost that would otherwise be needed to purchase this essential equipment and at the same time bridge the gap between industrial set up and the training workshops. Integration of ICT in TL would address emerging skill mismatch reported by the industry and the shortfalls experienced by those entering the world of work as caused by the inadequate skills of trainees to cope up with the ever changing technology. The integration of technology in teaching and learning is expected to enhance knowledge and skills acquisition and nurture continuous learning skills; leading to e-learning.

The TOE theory provided a suitable outline which guided this study; however, the study exposed the need to consider a fourth element which could influence ICT adoption and integrating it in TL; the essential factor that presumes that the user's ability to adapt to emerging technologies is crucial. The study thus recommended further research to verify its impact for possible incorporation as a crucial characteristic to the theory. The

study deduced this recommendation on the fact that technology is dynamic and those who interact with it must be capable to of matching the emerging changes.

The ICT National policy of 2009 was developed with the main goal of guiding the introduction of ICT for education and training. The study uncover that the knowledge and skills possessed by the agents of change; trainers, were not being used for teaching and learning. This draw back on the importance capacity of ICT integration in TL was concluded that the trainers lacked the skills to use ICT as a tool for teaching. The study deduced that the skill of using ICT as a tool was ignored or assumed at the time of training, that it was easily attainable on exposure to ICT infrastructure. The study inferred that the methodology of using ICT as a tool is crucial in incorporating it at the time of developing the trainers

5.5 RECOMMENDATIONS

The study recommended the following that are significant in improving ICT integration in National Polytechnics in Kenya.

1. Investment in ICT Infrastructure

The study recommended that there is need for national polytechnics to include ICT infrastructure expansion as key items in their strategic plans to boost the use of technology in TL and this could be done through the development of comprehensive procurement procedures and enhanced budgetary allocations. This expansion should focus on ensuring that there is adequate and up to date hardware and software that

corresponds to the trainer trainee ratio, engineering specific technology, number of the users, and provides for reliable internet facilities. These interventions will see the enhancement of access to both trainers and trainees hence increase the rate of ICT integration in teaching and learning in National Polytechnics.

2. Trainers' Perception on ICT Integration in Teaching and Learning

National Polytechnics should take advantage of the positive perception held by trainers and formulate an all-inclusive ICT integration policy which should be aligned with existing Government policies in order to enhance harmony with the national goals and objectives of technical education. The policy will serve to guide trainers and trainees and should provide for the use and sharing of ICT resources, diversification of learning activities and monitoring the use of ICT resources in teaching and learning.

3. Trainers' ICT Competency

i) There is also need for National Polytechnic's management in partnership with the Ministry of Education to carry out an ICT needs assessment to guide ICT capacity building among staff. This will help to identify skills gaps among trainers and subsequently inform decision making and budgetary allocations.

ii) The study considered the knowledge deduced from the literature and the outcome of this study and made recommendation that further research be carried out with a view to integrating Adaptability of the agents of change in the theory in order to accommodate the following facts, key among them is

the perpetual evolution of the technology, the weaknesses of the initial training of trainers' and the need for progressive digital literacy.

4. Utilization of ICT Infrastructure and Trainers competencies ICT for Teaching and Learning Engineering.

The study concluded that the available ICT infrastructure, the positive perception and trainers' ICT competencies were not mutually used for teaching and learning engineering courses. These factors, despite the inadequacies required a railing guidelines at the policy and at the implementation provisions in planning and scheduling of the processes.

The trainers were deficient on how ICT knowledge and skills can be linked with infrastructure for effective and efficient teaching and learning engineering courses. The provision of adequate variety of ICT infrastructure gives the trainers the opportunity to practice the skills and have a wider range of computer accessories to choose from, for preparation of media integrated lessons and teaching as oppose to the situation where the tools to choose from was limited. If ICT equipment was readily available and trainers were proficient in technology, then opportunities to select the most convenient ICT tools for practice and improvement of the skills would be achievable. The study concludes that integration of ICT in teaching and learning engineering was at the level of experimental as it was featuring as an alternative training methodology. The institutions; the national polytechnics have not factored the application of ICT as a

significant methodology with aptitude to enhance the development of knowledge and offers great prospects to synchronize with the fast evolving technology.

5.5.1 Recommendation deduced from the study

The study recommended that the teaching staff be provided with staff computer centre, well furnished with all diverse media technologies. The study recommended that the trainers as well as trainees should be provided with sufficient equipment for preparation and facilitation of knowledge construction on equal measure as teaching and learning processes is in inseparable.

The Policy Makers to consider:

a). Mainstreaming the application of ICT in the engineering training as a training tool as opposed to teaching it as an independent unit as is the case in the current Kenya institute of curriculum development (KICD) training program

b). Incorporating development of digital content into teaching methods as a standalone unit covering areas which include animations, illustrations and simulations. This is because development of digital content is a specialised skill which trainers in engineering should be conversant with.

5.5.2. Further Research

The study recommended further research in the following areas:

The researcher recommended that by fusing the knowledge figured out from the literature review and the outcome of this study recommends further research with a view to integrating Adaptability of the ‘Agents’ of change in the theory to accommodate the perpetual evolution of the technology and the need for progressive digital literacy.

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APPENDICES

Appendix A: Trainers' Questionnaire

The survey focuses on the status of integration of Information Communication Technology teaching and learning engineering courses.

The questionnaire is directed to trainers' in engineering programs to seek their views on the integration of ICT in teaching and learning in classrooms.

All responses will be treated in the strictest confidence, no individual or institution will be identifiable in the published reports.

You are hereby humbly requested to answer the questionnaires by ticking on the boxes provided or filling in the spaces provided for you

SECTION A: BIO- DATA INFORMATION

1. What is your gender? [ ] Male, [ ] Female
2. Age bracket (in years)
   - [ ] Less than 20,
   - [ ] 21-30,
   - [ ] 31-40,
   - [ ] 41- 50,
   - [ ] 51 and above
3. What is your educational level?
   - [ ] Diploma
   - [ ] Higher Diploma
   - [ ] First Degree

[ ] Masters and above

[ ] Other (specify)……

4. How long have you been in the teaching service? (In years)

[ ] 0-5

[ ] 6-10

[ ] 11-15

[ ] 16- 20

[ ] over 20

5. What are your teaching course subjects?

[ ] Mechanical Engineering

[ ] Electrical Engineering

[ ] Automotive Engineering

[ ] Building/civil Engineering

6. Please state your teaching subjects.

Major(s)……

Minor(s)……

Others……

SECTION B: To determine the availability of ICT Infrastructure for ICT integration in teaching and learning of engineering courses in National polytechnics

7. Where do you access Internet from?

[ ] Computer laboratory

[ ] Staff rooms password

[ ] Personal mobile phone

[ ] Wi-fi Hot spot

8. Where do you normally access computer(s)?

[ ] Computer laboratory

[ ] Heads of department office

[ ] Staff preparation room

[ ] Library

[ ] Own a personal one

SECTION C: To establish the perception of trainers on ICT integration in teaching and learning of engineering courses in National polytechnics

Please read through and Tick [√] where in your opinion you agree or disagree with the statement describing the importance of ICT in teaching and learning engineering.

S/ o	**Influence of ICT in Teaching & learning process**	**Strongly Agree (1)**	**Agree (2)**	**Disagree (3)**	**Strongly disagree (4)**
1.	Enhance content delivery and understanding				
2.	Paves a way for educational research				
3.	Enhance Innovative and integrated activities				
4.	Promotes pedagogical and				

	organizational innovation				
5.	Provide new and diverse learning and teaching experiences				
6.	It minimizes the supremacy of trainers' in class				
7.	It makes trainers inferior to trainees				
8.	It makes teaching complex unnecessarily				
9.	ICT use enhances traditional teaching methods				
10	Integrating ICT is non consequential in teaching				
11	Effective use of ICT in teaching requires trainer's competencies				
12	ICT provides greater positive influence to Learning				
13	Use of ICT enhances trainees critical thinking skills				
14	Use of ICT in teaching and learning stimulates individual and group lifelong learning				

Please read and rate your considered opinion by ticking (√) the statement which describe precisely your personal proficiency use of Information Communication Technology.

Description of respondents opinion on his/her capacity to use of ICT	**Strongly agree**	**Agree**	**Disagree**	**Strongly Disagree**
I feel I am able to motivate students to use ICT in learning Engineering				
I am willing to learn new ICT related stuff				
I feel traditional method is more effective than technology integrated method				
I feel technology related teaching is more effective than the traditional method				
I feel combining technology and traditional is more effective				

SECTION D: To establish the level of ICT knowledge and skills of trainers with respect to teaching and learning of engineering courses in National Polytechnics

Please indicate your level of proficiency in the use of the following computer applications by putting a Tick (√) in the appropriate box.

APPLICATIONS OF ICT KNOWLEDGE AND SKILLS	**Very Skilful (1)**	**Skilful (2)**	**Less(semi) skilful (3)**	**Unskilful (4)**
Using word processing				
Using Micro-Soft Excel				
Using presentation tools e.g. PowerPoint				
Using internet to research				
Using email for communication				
Using statistical measurements; charts				
Using databases				
Using programming				
Using of digital images				
Using Search engines-google/yahoo				
Using World wide web				
Using Digital video and animation				
Using computer Simulations				
Using Computer Aided Design and drafting				

How often do you use ICT tools in the instruction rooms (Classroom/Laboratory/workshop)?

[ ] Not at all

[ ] In every theory lesson

[ ] In every practical lesson

[ ] Only for lesson preparation.

[ ] Only for record keeping

SECTION E: To establish trainers' utilization of ICT knowledge, skill and Infrastructure in teaching and learning of engineering in National Polytechnics

1. How often do you have a chance to use a computer?

   [ ] never

   [ ] very rare,

   [ ] a few times a week,

   [ ] almost every day

2. When you get a chance to use computer, what software programs do you mainly use?

   [ ] Word processor-Microsoft word

   [ ] Spread sheet MS excel

   [ ] Presentation- power point

   [ ] Micro-soft Drawing & paint

   [ ] Simulation software

   [ ] Auto CAD (solid works)

   [ ] Microsoft Internet Explorer

3. How often do you use internet in the college?

   [ ] Never

   [ ] Occasionally

   [ ] Almost everyday

4. How often do you use your email?

[ ] Never

[ ] Occasionally

[ ] Almost everyday

5. How often do you use computer for teaching and learning in a week?

[ ] 1-2 hours

[ ] 2-4 hours

[ ] 4-6 hours

[ ] 6-8 hours

6. What is your overall computer proficiency?

[ ] Good

[ ] Moderate

[ ] low

[ ] Very poor

7. Please indicate by ticking in the box provided whether you agree or disagree with the statement which describes the extent of integrating ICT in the different application portions you have so far achieved in your teaching and learning.

Description of the phase so far have achieved in ICT integration in teaching and learning.	Strongly Agree	Disagree	Agree	Strongly Disagree
I use Internet to search for teaching and learning materials				
I develop teaching and learning materials; e-copy inclusive of drawings				
I use ICT to Prepare and present learning content to the class				
I have embrace interactive white board for teaching and learning				
I develop Virtual Learning Environment/ video conferencing				
I can confidently simulate or Animate processes				
I can confidently develop multimedia presentations (video, audio or YouTube)				
I can confidently use ICT to present information to class on power point				
I continuously use ICT to teach Engineering				
I can use ICT effectively to teach Engineering, however demotivated by the trainees				
I have the readiness to use ICT in teaching Engineering lesson.				
I have the skills to teach engineering using ICT, however lack time to prepare				

In your own words describe what other factors influence the Integration of ICT in teaching and learning engineering courses.

……

……

THE END

Thank you for sparing your time to respond to the questionnaire

Appendix B: Managers' Interview Schedule

INTERVIEWS GUIDING QUESTIONS

The study being carried out is to evaluate whether Integration of ICT in our technical training is a reality and to what extent if it is so. The interview is to solicit your opinion on the same. This information will not be disclosed to anyone else and your name will not appear anywhere as well. Any information you will provide will be treated in confidence.

1. How many engineering departments/sections do you have? …….....

2. How many computer laboratories do you have? …….....
   - ✓ What variety of ICT Equipment is in the laboratory? .....
   - ✓ What other ICT equipment have you provided to your individual staff to assist in :- (i) E- content Preparation (i) classroom content delivery? .....
3. What ICT soft-wares have you provided for teaching? Please name them.....
   - ✓ What are some of the computer based teaching activities trainers' carry out to enhance teaching and learning? .....
4. Rating on the use and investment in the ICT labs, would you rate the investment to:-

(i)Improve student learning in all engineering subjects? ..... (Justify)

(ii) Assist trainers deliver course content? ..... (Justify)

- ✓ What are the major limitations of your teachers using ICT for teaching learning? .....

  (Justify) …….....

5. Describe the perception status of trainers on the use of ICT tools in teaching and learning?

   ……

   - ✓ What is the level of ICT integration in your department (s)?
   - ✓ What influences the attitude of trainers towards the ICT integration in teaching?

6. What is your assessment of integration of ICT in teaching and learning in your trade area?

   ……

   (Justify your response) …….....

7. What are some of the recommendations on utilization of ICT tools to improve teaching and learning engineering course?

   …….....

8. In your considered opinion what is the future of ICT in teaching and learning engineering?

   .....

THE END

Thank you for sparing your time to attend to respond to the interview

Appendix C: Observation Schedule

LESSON OBSERVATION SCHEDULE

OBSERVATIONS

Observation focused areas

1). Classroom and Instruction rooms set up

2). Observation of actual classroom teaching in various departments

3). Visits to the workshops and laboratories.

OBSERVATION GUIDE

(a) Integration of ICT in teaching and learning Engineering.

The table provided will be used to capture the equipment and learning activities together with the groups participating in the teaching and learning in various meeting points for learning purposes. The research will visit all the rooms being utilised under different names or labels.

Department…….Class session……..…..……Course Title……..

ACTIVITY OBSERVED	Learning activity	Learning resources available for the trainer	Learning resources available for the trainee	Other resources available in the learning room	Trainers role or Activity	Trainees role or activity	Teaching approach	Software in use or available
Lecture halls								
Staff rooms								
Laboratory work								
Workshop Demonstration								
General classroom Discussion								
Practical preparation rooms								
Library								

Appendix D: ICT Infrastructure Observation Checklist

ICT INFRASTRUCTURE OBSERVATION CHECK LIST

Department…….Section…Course Subject…….

(b) Please put a tick **(**√**)** against the instruction room where observation is being conducted

1. [ ] Laboratory
2. [ ] workshop demonstration room
3. [ ] workshop practice room
4. [ ] lecture room
5. [ ] Library
6. [ ] computer laboratory
7. [ ] Electronics laboratory
8. [ ] material science laboratory
9. [ ] Drawing room

Equipment type	**Available**	**Not Available**
Desktop Computers		
Laptops		
LCD Projectors		
Handheld Device e.g. mobile phones		
Optical disks- CD/DVD		
Ordinary Printers		
3D printers		

Interactive white boards		
Touch screen interactive		
Application Computer Software; e.g. Arc CAD,		
Digital cameras		
Recording Hardware-e.g microphone		
Internet connectivity		
Memory devices, Externals		
Functional Wall Socket		

Appendix E: Introductory Letter

JUNE, 2, 2019.
Daniel C. Mutai,
P. O.Box 13974-20100'Nakuru-Kenya.
danmutai74@yahoo.com.
Dear Sir/ Madam,

RE: INTRODUCTION TO COLLECT RESEARCH DATA

I'm writing to introduce myself and the research study for an award of doctor of philosophy in communication technology education; Moi University.

The title of the research is "**Integration of Information Communication Technology in teaching and learning of engineering courses in Kenya: a case of National Polytechnics"**

The study has been approved by the research board of examiners of Moi University and authorised by the National Commission for Science, Technology and Innovation.
The information gathered during this study will remain confidential, only the researcher will access to the data and information. There will not be any identifying of names on the survey and interview transcripts. Your names and any other identifying details will never be revealed in any publication of the results of this study. The knowledge obtained from this study will be of great value in guiding professional in effectively integrating ICT in teaching and learning.
You are welcome to ask researcher any question during the survey or interview.

You are highly appreciated for accepting to participate in the research; your responses will be kept anonymous.

Daniel Cheruiyot Mutai.
Cell phone: 0722258280
Email Address: danmutai74@yahoo.com

Appendix F: Informed Consent Form

RESEARCH TOPIC:

INTEGRATION OF INFORMATION COMMUNICATION TECHNOLOGY IN TEACHING AND LEARNING OF TECHNICAL COURSES IN KENYA: A CASE OF NATIONAL POLYTECHNICS

PURPOSE:

The purpose of this research study was to investigate the status of ICT integration in teaching and learning of engineering courses in National polytechnics in Kenya. The study is expected to establish factors that influence integration of ICT Integration in teaching and learning technical courses in National Polytechnics. There will be no noticeable risks to respondents associated with the study.

Consent to take part in the research

Please tick the box appropriately if in agreement

1. I the undersigned voluntarily agree to participate in this research study [ ]

2. I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences of any kind [ ]

3. I understand that I can withdraw permission to use data from my interview within two weeks' after the interview, in which case the material will be deleted [ ]

4. I have had the purpose and nature of the study explained to me in writing and I have had the opportunity to ask questions about the study. [ ]

6. I understand that I will not benefit directly from participating in this research. [ ]

7. I agree to my interview being audio-recorded. [ ]

8. I understand that all information I provide for this study will be treated confidentially. [ ]

9. I understand that in any report on the results of this research my identity will remain anonymous. [ ]

10. I understand that disguised extracts from my interview may be quoted in without my identity [ ]

11. I understand that if I inform the researcher that myself or someone else is at risk of harm they may have to report this to the relevant authorities - they will discuss this with me first but may be required to report with or without my permission. [ ]

12. I understand that signed consent forms and original audio recordings will be retained until the exam board confirms the results of their dissertation. [ ]

14. I understand that under freedom of information legalization I am entitled to access the information I have provided at any time while it is in storage as specified above. [ ]

15. I understand that I am free to contact any of the people involved in the research to seek further clarification and information. [ ]

16. I understand that other researchers will have access to this data only if they agree to preserve the confidentiality of the data and if they agree to the terms I have specified in this form [ ]

17. I, along with the researcher, agree to sign and date this informed consent form [ ]

Participant's informed consent

Signature of research participant	Name of Participant	Date
---	--- ---	---
Signature of researcher	Name of Researcher	Date
---	--- ---	---

I believe the participant is giving informed consent to participate in this study

--- ---

Signature of researcher Date

Appendix G: Research Authorization

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471,
2241349,3310571,2219420
Fax:+254-20-318245,318249
Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/19/69412/30626** Date: **24th June, 2019.**

Daniel Cheruiyot Mutai
Moi University
P.O Box 3900-30100
ELDORET.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Integration of Information Communication Technology in teaching and learning of engineering courses in Kenya: A case of National Polytechnics."*** I am pleased to inform you that you have been authorized to undertake research in **Kisumu, Nairobi and Uasin Gishu Counties** for the period ending **24th June, 2020.**

You are advised to report to **the County Commissioners, and the County Directors of Education, Kisumu, Nairobi and Uasin Gishu Counties** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Kisumu County.

The County Director of Education
Kisumu County.

Appendix H: Research Permit

THIS IS TO CERTIFY THAT:
MR. DANIEL CHERUIYOT MUTAI
of MOI UNIVERSITY, 0-20100
NAKURU,has been permitted to conduct
research in *Kisumu , Nairobi,*
Uasin-Gishu Counties

on the topic: *INTEGRATION OF INFORMATION COMMUNICATION TECHNOLOGY IN TEACHING AND LEARNING OF ENGINEERING COURSES IN KENYA: A CASE OF NATIONAL POLYTECHNICS.*

for the period ending:
24th June,2020

.....
Applicant's
Signature

Permit No : NACOSTI/P/19/69412/30626
Date Of Issue : 24th June,2019
Fee Recieved :Ksh 2000

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

Appendix J: Research Licence

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013

The Grant of Research Licenses is guided by the Science, Technology and Innovation (Research Licensing) Regulations, 2014.

CONDITIONS

1. The License is valid for the proposed research, location and specified period.
2. The License and any rights thereunder are non-transferable.
3. The Licensee shall inform the County Governor before commencement of the research.
4. Excavation, filming and collection of specimens are subject to further necessary clearance from relevant Government Agencies.
5. The License does not give authority to transfer research materials.
6. NACOSTI may monitor and evaluate the licensed research project.
7. The Licensee shall submit one hard copy and upload a soft copy of their final report within one year of completion of the research.
8. NACOSTI reserves the right to modify the conditions of the License including cancellation without prior notice.

National Commission for Science, Technology and innovation
P.O. Box 30623 - 00100, Nairobi, Kenya
TEL: 020 400 7000, 0713 788787, 0735 404245
Email: dg@nacosti.go.ke, registry@nacosti.go.ke
Website: www.nacosti.go.ke

REPUBLIC OF KENYA

NACOSTI

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RESEARCH LICENSE

Serial No.A 25425

CONDITIONS: see back page