EFFICACY OF AN ONLINE PEDAGOGY ON TVET PRACTICAL SKILLS TRAINING IN UGANDA

BY

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DECLARATION

Declaration by the Candidate

This thesis is my original work and has not been submitted for any academic award in any institution; and shall not be reproduced in part or full, or in any format without prior written permission from the author and/or the University of Eldoret.

Mutebi Ronald

SEDU/TED/P/001/19	**Date**

Declaration by the Supervisors

This thesis has been submitted with our approval as university supervisors.

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DEDICATION

This thesis is dedicated to my parents Mr and Mrs JK Mutebi. Although they never made it that far in school, they have, since my childhood, encouraged me to study up to the highest level possible. Every graduation day of my previous qualifications, they would take me aside, thank me for making them proud and then ask when I would complete the next level. Daddy and Mummy thank you for pushing me to the summit.

ABSTRACT

To commit to the 'everywhere' acquisition of practical skills (at and away from the training institution), there is need to for evidence that supports the idea of acquiring practical skills through an online pedagogy. As such, this quasi-experimental study compared and analysed the outcomes of TVET practical skills training in the face-to-face and online pedagogies in order to determine the efficacy of an online pedagogy on TVET practical skills training. Specifically, the study determined the efficacy of an online pedagogy on training delivery, acquisition, assessment, and performance of TVET practical skills. The study also assessed trainee's, instructors and assessor's perception towards an online pedagogy as a method for TVET Practical skills training as well as the related challenges. The postpositivsm philosophy served as the study's compass and the quasi-experimental design enabled the researcher to identify a comparison group (face-to-face pedagogy) from which baseline data was captured and compared with outcomes of the treatment group (online pedagogy). The sample for this quasi-experimental study consisted of UBTEB Assessors (n = 8), Instructors (n = 20), and Trainees (n = 69). Observation checklists, questionnaires, practical test items and competency assessment tools were the instruments used for data collection of the study. Descriptive statistics were used to define and explain the characteristics of the data (mean, mode and frequency) whereas line and bar charts were the data analysis tools that were used to make sense of the collected data. Inferential statistics (Independent-Samples Mann-Whitney U Test, Independent-Samples T- Test and Paired Samples T Test) were then used to examine the significance of the identified difference(s) between the means. Qualitative analysis was used for the data from the open-ended posttest questionnaires to address the study research question. The central thesis of the study was that the processes of online practical skills training delivery, acquisition, assessment and performance of a practical skill were as effective as those in the face-to-face. The findings of the study also demonstrated that the perception of trainees, instructors and assessors about online training, acquisition, assessment and performance significantly changed after undergoing an online pedagogy. The results then showed that poor or no internet connectivity, electricity outages and the lack of ICT equipment ranked as the top challenges of online pedagogy that need to be addressed if practical skills are to be effectively delivered online. The study recommends development of an online training framework, investment in online pedagogy enablers, development of online practical skills content and integration of online training and assessment into the training routine.

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LIST OF ACRONYMS AND ABBREVIATIONS

CAI	Computer-Assisted Instruction
CAT	Competency Assessment Tool
CBT	Competency Based Training
CLT	Cognitive Load Theory
COVID 19	Corona Virus Disease of 2019
DEDICT	Demonstration, Explaining, Demonstration again, Imitation, Coaching, and Testing.
GOU	Government of Uganda
ICT	Information and Communications Technology
JICA	Japan International Cooperation Agency
NCBC	National Certificate in Building Construction
NCDC	National Curriculum Development Centre
NCWT	National Certificate in Woodwork Technology
NDP	National Development Plan
QE	Quasi-Experiment
RCT	Random Controlled Trials
TVET	Technical and Vocational Education and Training
UBTEB	Uganda Business and Technical Examinations Board
UNACOSTI	Uganda National Council for Science, Technology and Innovation
UNESCO	United Nations Educational Scientific and Cultural Organisation
UNEVOC	International Centre for Technical and Vocational Education and Training

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CHAPTER ONE

INTRODUCTION

1.1 Introduction

This chapter presents the background of the study, a statement of the problem, the purpose of the study, specific objectives of the study, study hypotheses and the study research question. The chapter also unfolds the justification of the study, significance of the study, scope of the study, assumptions of the study, limitations of the study, delimitations of the study, scope of the study and operational definition of terms used in the study.

1.2 Background of the study

Technologies and their accelerated advance in the 21st century have created both an opportunity and a dilemma for the 21st century trainer and the education system as a whole. The prospect of reorienting our perspective of teaching and learning processes towards an era of the *'active student'* that takes charge of their own learning, is such a wonderful opportunity. As part of the future evolution of technology into a world of calm and continuous experiencing of life, it's now plausible to predict that technology shall transition from its current state as a "tools we use to do something" to a more complex context in which "we extend our abilities" to earlier unimagined horizons. This seemingly prophetic notion has not only already come true, but it's a basis for predicting what will happen in the foreseable future. Technology is here to stay and will affect and influence every aspect of our lives in various ways. In education for instance, technology has the potential to supply the tools that are necessary for enhancing the process of teaching and

learning, as well as opening up new chances and pathways. In particular, it has the potential to improve the degree to which the educational process can be personalized and adapted to the specific requirements of the learner (OECD, 2010).

An online pedagogy depends on ICTs and as such the two terms (Online Pedagogy and ICTs) are married and in the context of education, are inseparable. For the technologies to be effective in the teaching and learning process, we need packages of the curriculum content designed in an interactive manner to be delivered to the students via the ICTs. The term '*pedagogy'* is defined by Tes (2018) as the strategy and execution of the instructional process. It considers pedagogical approaches, educational philosophy, as well as feedback and evaluation. When individuals discuss the pedagogy of teaching, they are talking to the manner in which educators present the subject matter covered in a curriculum to a group of students in a classroom setting. When preparing a lesson, a good teacher would think about a variety of approaches to presenting the material to their students. This selection will be made based on the individual's preferred method of instruction, their level of expertise, and the environment in which they instruct. (Tes, 2018). Pedagogy encompasses both theory and practice (conceptual understandings of what learning and knowledge are, as well as how humans learn, think, and interact) and who should teach, where, when, how, and what for. As discipline, pedagogy is continually developing new methods for teaching and supporting students as they expand their knowledge (Daniela, 2019).

The core tenet of Education 2030 is to expand upon fundamental education and launch a thorough reexamination of the educational industry in order to create a society that values lifelong learning. It emphasises the necessity for equal access to high quality and relevant

learning throughout one's life, wherever and whenever that learner chooses (UNESCO, 2017). The enormous potential of information and communication technologies (ICTs) in attaining lifelong learning for everyone is acknowledged in the Education 2030 Framework for Action, which describes how to put this international commitment into effect. It emphasises the need for ICT to "be utilised to boost education systems" and to help increase knowledge diffusion, broaden access to information, enhance learning quality and effectiveness, and provide more effective services (UNESCO, 2015).

An online pedagogy is one of the ways in which the issue of lifelong learning and access to TVET can be addressed. The technology of today has the ability not only to enlighten and entertain, but also to instruct. Learning can now no longer be confined in the brick walls of a classroom or workshop but take place everywhere and at any time. ICT is an effective tool for expanding access to high-quality, lifelong TVET and enabling the integration of the industry into learning. Under the fundamental premise that learning is primarily a social phenomenon, current technologies can accelerate the acquisition of practical skills even though hands-on practical training cannot be substituted by the technologies (UNESCO, 2017).

The results of a study by Haddad and Draxler (2002) done in the UK and Africa (Ghana, Rwanda, South Africa, Tanzania) showed that the efficiency of ICTs was increased when the pedagogy changed from a teacher-centered classroom environment to a more learner-centered environment. A UNESCO report titled "*Transforming TVET from idea to action*" further emphasised the need for learning and teaching strategies to change, moving away from rigid, theory-based frameworks and toward more generic, adaptable approaches that embrace the use of digital media: rather than learning how to use ICTs,

TVET students must use ICT to enhance learning (UNESCO, 2012). According to the paper, ICTs may be used to share knowledge and information, increase flexibility, and improve the quality of teaching and learning (UNESCO, 2012).

In the Uganda Vision 2040, the government of Uganda committed that "ICT shall be mainstreamed in education to benefit from ICT-enabled learning and to prepare future generations of ICT-savvy professionals, and to assure ICT effective usage" (National Planning Authority, 2013). As a result, government education agencies are now obligated with the task of realigning the teaching and learning processes at all levels of learning to this government commitment. However, the use of ICTs to reconstruct the teaching and learning practice in Education has not been discussed frequently by the academe in Uganda. The little work that has been done thus far has all been in the area of general education, leaving the TVET sub-sector solely reliant on the traditional pedagogies of the last decade to train the 21st century TVET trainee. Of course, what has worked well in the general Education sub-sector can always be 'copied and pasted' in the TVET sub-sector. Its indeed true that presently there are some TVET instructors delivering courses using some form of ICTs. However, the key question is whether practical skills can also be delivered, assessed and acquired via ICTs and if so, to what extent can this be possible?

Globally, practical skills are at the centre of all TVET systems and strategies. As hallmarks for TVET, practical skills and how they can be acquired effectively, are the two subjects that dominate most discussions on TVET today. Uganda's strategic plan titled "Skilling Uganda" denotes a paradigm shift for skills development in Uganda through the creation of employable skills and competencies relevant in the labour market instead of educational certificates (Uganda Ministry of Education and Sports, 2012).

Considering that practical skills have until now been predominantly acquired through face-to-face and hands-on experiences at the training institutional workshop or the workplace, the idea of teaching them remotely (such as online learning) poses numerous concerns. Most of these apprehensions arise from the lack of tangible evidence on how the separation in space and time affects the core facets of practical skills such as: competency in manipulation of equipment; effective selection and use of materials, adherence to health and safety practices; and time taken to perfect a particular skill.

You can “get the idea” of how to perform all sorts of complex action sequences known as skills by watching other people demonstrate them. Learning a skill depends mainly on imitation or on following instructions about what to do plus – as musicians and athletes know especially well - a lot of practice (Bernstain et al, 1991). The competence of a person in operating a tool or equipment is a typical example of a practical competence (Abrahams & Reiss, 2015). Okorie and Ezeji cited in (Udo, 2015) pointed out that a person's behaviour within a society or a nation's behaviour within a community of countries may be influenced by the skills and competencies that person or that nation possesses. Socially, having the most skills enables one to amuse, make others happy, show them love and affection, and bring enjoyment to the whole country. Any teaching and learning activity that at some point requires the students to observe or handle the things and materials they are studying is referred to as "practical work." This observation or object manipulation may take place in a laboratory or workshop at school, but it may also happen elsewhere, like the student's home or a field (Millar, 2004). If practical work can take place outside of school, then it means the student may at some point need to be

remotely (instructors and students separated in time and distance) taught or guided on some of the practical skills and processes.

1.3 Statement of the problem

When His Excellency the President of the Republic of Uganda closed institutions of learning on March 20, 2020, the Ministry of Education and Sports (MoES) created a preparedness and response plan to COVID-19 with an emphasis on continuity of learning among other things. Under the direction of the National Curriculum Development Centre (NCDC), the MoES collaborated with a group of various stakeholders to create standardized study lesson packages in the main disciplines for primary and secondary levels, which were then made available to all students. Additionally, model teachers were expected to create lessons that would be broadcast on radio and television stations nationwide as well as pre-recorded lessons that could be viewed online (Ministry of Education, 2020). Whereas a number of theory-based lessons were taught on radios, televisions, and websites; most of the practical subjects were not taught. Subjects such as Technical Drawing, Fine Art, and practical topics of science subjects such as Chemistry, Physics, and Biology, were not taught. The situation was even worse when it came to TVET institutions as a majority hardly managed to even engage their students during the period of COVID-19 lockdown. The country was again locked down in 2021 over the second wave of COVID-19 and in 2022, the Ebola outbreak caused partial lockdowns in the affected districts. These new realities, as amplified by these pandemics, have dictated that the acquisition of practical skills can no longer be confined to the institutions' workshops, laboratories and classrooms, but should be acquired everywhere (at the institution and home). However, to commit to such an endeavour, there is need to

generate evidence that supports the idea of acquiring practical skills through an online pedagogy. Considering that practical skills are at the centre of any effective TVET programme, the need for evidence showing the effectiveness of an online pedagogy in training, assessment, acquisition and performance of practical skills has now become imperative. This quasi-experimental study therefore determined; in an objective, quantifiable and measurable context; the efficacy of an online pedagogy on training, assessment, acquisition and performance of practical skills.

1.4 Purpose of the study

The purpose of the quasi-experimental study was to compare an online pedagogy to a face-to-face pedagogy so as to determine the effectiveness of an online pedagogy as a method for TVET practical skills training in Uganda.

1.5 Specific objectives

1. To determine the efficacy of an online pedagogy on delivery of TVET practical skills;
2. To determine the effectiveness of an online pedagogy on trainees' acquisition of TVET practical skills;
3. To determine the efficacy of an online pedagogy on assessment of TVET practical skills;
4. To determine the effectiveness of an online pedagogy on trainees' performance of TVET practical skills;
5. To assess perception towards an online pedagogy as a method for TVET Practical skills training delivery, acquisition, assessment and performance; and

6. To determine the challenges of an online pedagogy as a method for TVET practical skills training, acquisition, assessment and performance.

1.6 Study hypotheses

The null hypotheses for this quasi-experimental study are as follows:

1. **H_0:** There is no significant difference in the TVET practical skills training delivered face-to-face and that delivered online;
2. **H_0:** There is no significant difference in the TVET practical skills acquisition of trainees trained face-to-face and those trained online;
3. **H_0:** There is no significant difference in the TVET practical skills assessment conducted face-to-face and that conducted online;
4. **H_0:** There is no significant difference in the TVET practical skills performance of trainees trained face-to-face and those trained online; and
5. **H_0:** There is no significant difference in the study participants' perception of an online pedagogy before and after undergoing online practical skills training, acquisition and assessment.

1.7 Research questions

Considering that objective six (6) of this quasi-experimental study had no comparison component and as a result never had a hypothesis, the following research question was used instead.

RQ1: What are the challenges of online pedagogy in TVET practical skills training, assessment, acquisition and performance?

1.8 Justification of the study

According to UNESCO, as of April 14, 2020, almost 1.6 billion school children, which is 91.3% of all school students worldwide, had been affected by education system closures in 188 different countries. The COVID-19 pandemic and its resulting disruptions in the teaching and learning process has created a new normal in which educationists have to seriously consider a future where most teaching and learning may have to be done remotely. Despite the numerous challenges that have resulted from these closures, the opportunity of using digital tools to develop learning solutions that are more flexible has been presented. Comyn (2020) cautions that while online or remote learning in TVET and skills development during the pandemic can be and has been used to find short-term solutions, we must take this chance to have long-term beneficial impacts and increase resilience (Comyn, 2020).

This new reality calls for immediate attention towards refining and standardising those learning experiences where learners and their teachers are separated in time and space. This shall provide a paradigm shift from sitting in the lecture room to studying from anywhere at the learner's convenience and pace. By analysing and comparing data from practical skills training, assessment and acquisition of an online pedagogy (experimental group) to those of the face-to-face pedagogy (control group), this quasi-experimental study determined the extent to which an online pedagogy can produce the desired learning outcomes as regards to practical skills in TVET. In addition, this study has availed the data that is needed by educationists to plan, design, and make choices in the best training and assessment mechanisms for practical skills content.

1.9 Significance of the study

Data on the Efficacy of an online pedagogy on TVET practical skills training, acquisition, assessment, performance and perceptions, is of great significance in the teaching and learning process of TVET and general education sub-sectors. By providing valuable data concerning the effectiveness of training and assessment of practical skills online, the findings of this quasi-experimental study are of great importance to the: Uganda Ministry of Education departments and agencies; universities and colleges; TVET and other tertiary institutions; primary and secondary schools; and other private teaching and learning content developers. The results of this study will also form a basis upon which other scholars and academicians can further research into how effectively the online platform can be used to deliver and assess practical skills. Also, as the future is destined to bring an element of flexibility (such as distance education) in the learning process by the use of technologies, the data generated from this study shall inform decisions of institutions of higher learning (especially TVET institutions) on the feasibility and methodology of including practical modules in future online study packages.

1.10 Assumptions of the study

The study assumed that responses provided by trainees, instructors and assessors were honest, genuine and sincere. Thus, the researcher assumed that, contrary to guidance by McLeod (2018), the respondents neither lied out of social desirability nor projected a favourable picture of themselves, thus embellishing or distorting the reality in order to seem good.

1.11 Limitations of the study

The study had inherent limitations and other limitations that arose during the intervention. The limitations included those categorised under the study research design and sample selection and size. Whereas the quasi-experimental non-equivalent research design used for the study had its advantages, it limited the study because of its inherent threats to external and internal validity. The inherent threat to internal validity was selection bias. The researcher used the sample population groups of first year NCBC and NCWT trainees from St. Josephs Technical Institute, Kisubi and Nakawa Vocational Training College located in Kampala District to participate in the study. However, considering that the study had to fit within the routine day-to-day timetable of the institutions, and thus need to minimise disruptions of the teaching and learning process, the researcher alternately used an entire programme (A or B) as a group (control or experimental) in both institutions (X and Y). Therefore, within those groups, the researcher was unable to randomly assign students to the control and experimental groups and as a result, the study was limited by the selection bias. Also, in terms of external validity, the study design also presented a threat of stimulus characteristics and setting.

The need for trainees to work on practical tasks meant that the study had to take place in the workshops. This dictated that the sample population had to be numbers that could be accommodated comfortably in the respective workshops. The resulting small sample size and the fact that only two programmes were selected for the study, was a limitation to the study that may possibly make the results less generalisable to the larger national or regional population. Also, because of the limited number of female trainees in the TVET

programmes selected for the study, the study sample did not represent the gender population size.

Methodologically, whereas the quasi-experimental non-equivalent design used for the study enabled the researcher to ably determine with certainty that the differences in participants' perception between pre-test and posttest were due to participants exposure to online training and assessment as opposed to maturation, the research methods implemented were unable to guide the study in establishing trainees' cooperation and teamwork as they worked on the assigned tasks.

1.12 Delimitations of the study

To increase the generalization of the study findings to the extent that generalizations can be made in most social science research, the study conditions reflected: the real-life environment in which practical skills are delivered at training institutions (instructors presenting and demonstrating a skill to be performed by trainees), the realistic process through which assessors score practical skills during assessment; the natural demographic characteristics of the trainees, instructors and assessors; and a relatively homogeneous sample. Also, the study mitigated physical maturation of the subjects by having the study conducted within a period of one week and structured as site and location specific.

1.13 Scope of the study

The scope of the study included geographical, content and time scopes.

1.13.1 Geographical scope

This quasi-experimental study was conducted in two TVET institutions located in two districts in Uganda. The institutions were St. Josephs Technical Institute, Kisubi located in Wakiso District and Nakawa Vocational Training College located in Kampala District.

1.13.2 Content scope

The study analysed and compared TVET practical skills training, acquisition, assessment, performance and perception in the face-to-face and online pedagogies so as to determine the efficacy of an online pedagogy. The study as such analysed and compared TVET practical skills training delivered face-to-face with that delivered online; TVET practical skills acquisition of trainees trained face-to-face with those trained online; TVET practical skills assessment conducted face-to-face with that conducted online; TVET practical skills performance of trainees trained face-to-face with those trained online; TVET trainees' perception of online pedagogy before and after undergoing online practical skills training and assessment; and challenges of online pedagogy in TVET practical skills training, assessment, acquisition and performance.

1.13.3 Time scope

The study took 18 months. Proposal writing started in September 2021 and concluded with a defence in December 2021. The quasi-experiment and compiling of the report were undertaken throughout 2022.

1.14 Conceptual framework

The relationship between the various variables of this quasi-experimental study is shown in **Figure 1.1**. The independent variable for the study was online pedagogy and the

dependent variables were TVET practical skills training, acquisition, assessment, performance, perception and challenges. The study's conceptual framework was based on delivering selected practical training tasks via an online and face-to-face pedagogies so as to produce the intended results in terms of training, acquisition, assessment, performance, perception and challenges. As earlier observed by White and Sabarwal (2014), this quasi-experimental conceptual framework was preferred for the study because it is not possible to randomize individual TVET trainees to treatment and control groups. When it is logistically impossible or unethical to perform a randomised, controlled trial—the "gold standard" of causal research design—quasi-experimental studies, which cover a wide spectrum of non-randomised intervention studies, are widely utilized (Harris, et al., 2004).

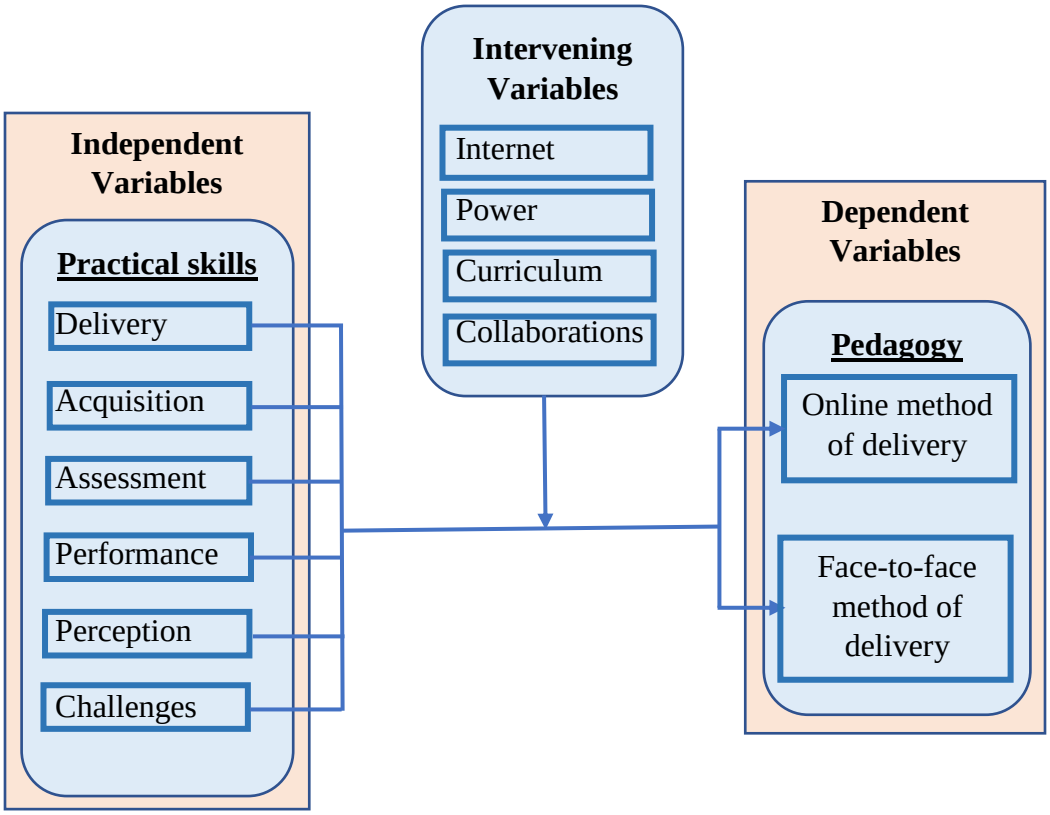

Figure 1.1: Conceptual framework for the efficacy of an online pedagogy on TVET practical skills training, acquisition, assessment, performance and perception.

As shown in the conceptual framework **(Figure 1.1**), this study involved an intervention in which a treatment - in this case an online pedagogy - was compared with the control - in this case face-to-face pedagogy- for the extent to which it enables TVET trainees to acquire and perform practical skills, enables assessment and performance of practical skills, establish participants perceptions of the pedagogy and challenges as measured by a pre-specified set of parameters. Equipment, tools, materials and content scope were all controlled for both the control group (face-to-face pedagogy) and the experiment group (Online pedagogy) in the study. This was in tandem with Thomas (2021) observation that

when using this type of design, researchers must try to account for any confounding variables by trying to control for them in their analysis or by selecting groups that are as similar as possible.

1.15 Theoretical underpinnings of the study

Effective and pedagogically relevant educational activities need the use of learning theories. Clarity, focus, and direction are provided by a learning theory during the instructional design process. Consequently, a successful instructional framework should consider the theoretical underpinnings of its design (McLeod, 2003). Two theories will help to shape, describe, explain, and/or predict phenomena of this study and the chosen treatments involved in the study. Romiszowski's Instructional Theory and the three instructional theories for online learning (connectivism, online collaborative learning and Community of Inquiry).

1.15.1 Instructional skills development theory

According to Romiszowski, as mentioned in Hajaraih et al. (2012), a skill is "the capacity to accomplish a certain sort of work or activity with a specific degree of effectiveness, efficiency, speed, or other measure of quantity or quality". He makes a distinction between mental skills (intellectual), bodily skills (motor, sensorimotor, or psychomotor), emotional skills (personal), and social skills (interpersonal) that involve interacting with others. This theory proposes that skills may be thought of as existing along a complex continuum, that ranges from productive to reproductive. Multiplying numbers and typing are examples of skills that fall under the category of reproductive skills. These skills are focused on the use of conventional methods or automated systems. To the contrary, productive skills entail applying the concepts for example playing chess or

creative writing. According to Romiszowski, assessing whether a skill is productive or reproductive has a considerably bigger impact on the design of an instructional method than determining whether the skill is motor, personal, intellectual or interpersonal (Hajaraih et al, 2012).

1.15.2 Learning theories for online Education

From major learning theories, others such as connectivism, online collaborative learning, and community of inquiry have developed expressly for the online world.

1.15.2.1 Connectivism

This theory contends that because of the extensive data communications networks, there are significant changes in the way knowledge and information travel, develop, and change (Picciano, 2017). The theory claims that learning has shifted from private, individualistic activities to group, communal, and even crowd activities as a result of the development of the Internet. The theory contents that, students need to know how to navigate and identify vast bodies of continually changing and expanding information. They also need to have experiences doing so. He, thus offered the following eight connectivism principles: 1) Diversity of viewpoints is the foundation for learning and knowledge; 2) Learning is the process of connecting specialised nodes or sources of information; 3) Learning could very well reside in non-human gadgets; 4) The capacity to know more is more important than what is currently known; 5) Connections must be nurtured and maintained to support ongoing learning; 6) The capacity to see connections between different concepts, fields, and ideas is a core skill; 7) Learning may reside in non-human appliances. All connectivist learning activities aim to produce

currency (true, current information), and 8) Decision-making is a learning activity in and of itself.

1.15.2.2 Online Collaborative Learning

This theory focuses on the capabilities of the Internet to offer learning settings that promote cooperation and knowledge creation. To redesign formal, non-formal, and informal education for the Knowledge Age, this theory of learning is centered on collaborative learning, knowledge development, and Internet use (Harasim, 2012). According to this theory, knowledge is created in a group through conversation in three phases, which include:

a) The phase of idea generation known as brainstorming, which involves the collection of a variety of different concepts;

b) The phase known as "idea structuring," in which ideas are contrasted, examined, and categorised via the use of argumentation and discussion; and

c) The phase of Intellectual convergence in which intellectual synthesis and consensus takes place, including the act of agreeing to disagree with one another. This often takes place through the completion of a task, essay, or other piece of cooperative effort.

1.15.2.3 Community of Inquiry

This theory focuses on the three separate "presences" of instruction, social interaction, and cognitive presence to form the foundation of the theory (Picciano, 2017). Their framework encourages the creation of online and hybrid learning environments that function as communities where teachers and learners interact and exchange knowledge.

With the advent of discussion boards, blogs, wikis, and video conferencing, the community of inquiry has emerged as one of the most well-liked instructional models for online and hybrid courses (Picciano, 2017).

1.16 Operational definition of terms

Efficacy: refers to the extent to which a particular pedagogy produces a satisfactory degree of the desired outcomes in terms of practical skills training, assessment and acquisition.

Pedagogy: refers to the training method (Face-to-face or Online) used to equip TVET trainees with practical skills.

Face-to-face pedagogy: refers to the training of TVET practical content by a trainer in person to a group of trainees. The TVET trainees and trainer are in in the same physical location at the same time.

Online pedagogy: refers to the training of TVET practical content that is intentionally designed and developed in advance, via online. The TVET trainees and trainer are separated in time and physical locations.

TVET: means a comprehensive term referring to those aspects of the educational process involving, in addition to general education, the study of technologies and related sciences, and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life.

Practical skills: refer to TVET trainee's observance, working and perfection of the use of a technology, tools or equipment; to manipulate objects, systems, drawings and materials; in an institution workshop or an out-of-school setting.

Training: refers to the action of teaching a practical skill to a trainee through demonstration.

Assessment: refers to the action of making a judgment about a trainee's performance of a practical task.

Acquisition: refers to the ability to learn, master and apply a practical skill in different situations.

1.17 Chapter summary

This chapter has established the background, context, and brief overview underlying the study and clearly stated the barriers posed by the current state of affairs. The chapter has then presented the specific objectives, hypotheses and research questions of the study. Finally, the chapter has described the justification of the study, contributions and benefits of the study, scope of the study and definition of terms used in the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides an overview of previous research on TVET practical skills training, acquisition and assessment mechanisms in face-to-face and online pedagogies. As a result of this, the major data collection requirements for this quasi-experimental study have been mapped out, and the emergent research design process has been built on this information (Dencombe, 1998). The methodology used is consistent with what is generally accepted in the field of grounded research. Before beginning their own studies, it is now considered acceptable for researchers to read over previously conducted studies to get a better understanding of the field (Easterby-Smith, Thorpe, & Lowe, 2002).

This understanding of earlier work on the important elements of the study has primarily served three goals in its application. First, it has reduced the potential for overload during the primary data collecting stages of the study by guiding the creation of the tools that were used for data gathering and so provided direction for their construction. Secondly, incorporating the findings of the quasi-experimental study into the existing body of literature has assisted in preserving a sense of the topic's perspective throughout the course of the study. Thirdly, during data analysis, the prospects for expressing a critical examination of the actual "meaning" of the data acquired was increased thanks to the impact of this activity.

The chapter begins by outlining the strategy that was used to search for the data and then sets the conceptual framework of TVET practical skills training, acquisition, assessment, performance and perception in face-to-face and online pedagogies. Literature on the

previous studies about the key parameters of the study is then discussed under the headings of TVET practical skills training, acquisition, assessment, performance and perception.

2.2 Literature search strategy

Through the use of search engines and library databases, relevant material concerning TVET practical skills training, acquisition, and evaluation mechanisms in face-to-face and online pedagogies was sourced. In particular, numerous databases were searched using PDF drive, Google, and Google Scholar in an effort to find the most recent research on these parameters. Different searches were undertaken starting with descriptors that appear only in the study title (online pedagogy, TVET practical skills, TVET skills training, TVET skills acquisition, TVET skills assessment and TVET performance), and later various keywords encountered during the literature search. During the search, it was discovered that whereas the topic of practical skills was predominantly discussed in the medical field, literature on the subject was scanty and this called for widening the search parameters to include all descriptors encountered during the search for literature.

The seminal studies threshold for this quasi-experimental study's literature review was fifteen (15) years. Studies older than the initial criterion, however, were occasionally helpful to the study since they supported grasp of the historical perspective and correlations that exist between the many study parameters.

2.3 Conceptual underpinnings of the study

This section reviews relevant literature to define and contextualise the various concepts of this quasi-experimental study and then with a visual representation, shows the relationship and organisation of the different variables to achieve the purpose of this

study. The key concepts for the study included Efficacy, Pedagogy, TVET and practical skills.

2.3.1 Efficacy

The terms safety and effective are used a lot in the medical world, especially in questions concerning drugs and/or procedures. Questions such as “how safe and effective are antidepressants in children and adolescents? Are commonly asked to determine and as such address the Risks (safety), and the Benefits (effectiveness) of a particular drug or procedure in question. The latter is what gives birth to the term efficacy and is the reason its commonly used in the medical field. The term "efficacy" was used to describe outcome measures in a clinical study on the "Efficacy and Safety of Antidepressants for Children and Adolescents" that demonstrated a statistically significant benefit for an antidepressant based on effectiveness judgments by doctors (Jureidini, et al., 2004).

In the field of Education, the use of the term *efficacy* can be traced back to Bandura’s 1977 and 1986 works on *self-efficacy* (learners) cited in Schunk (1995), and Cohen’s 1983 works on *teacher efficacy* cited in Ashton (1984). Self-efficacy was described by Bandura as "people's assessments of their capacities to plan and carry out the courses of action necessary to achieve specified types of performances." He proposed that students' own performances serve as trustworthy indicators of their level of self-efficacy. Failure may not have much of an impact once a strong feeling of self-efficacy has been created because successes increase self-efficacy while failures decrease it (Schunk, 1995). The foundation for explaining how the motivational concept of teacher efficacy can be used as the organising concept for a teacher education programme was laid by Cohen's 1983

construct of Teacher Efficacy as a powerful paradigm for Teacher Education. Cited in Ashton (1984), the construct proposed that motivation theory could provide a framework to guide and strengthen teacher education programs. The degree to which teachers feel they can influence student achievement was described as the teachers' feeling of effectiveness (Ashton, 1984).

From the above discussions on the term Efficacy, a number of phrases have stood out as a basis upon which the term can be contextualised for this particular study. Phrases such as: achieving a satisfactory or expected degree; effectiveness; outcome measures; significant advantage; attaining designated types of performances; and capacity to affect student performance, have stood out as key interpreters for the term efficacy. Therefore, the term efficacy in the context of this study means the extent to which an online pedagogy produces a satisfactory degree of the desired outcomes in terms of practical skills training, acquisition, assessment, performance and perception.

2.3.2 Pedagogy

Pedagogy refers to the philosophy and practice of teaching, including feedback and assessment, as well as teaching methods and styles (Tes Editorial, 2018). According to Cole (2019), pedagogy in education can take a low-tech or high-tech approach and can either be teacher- or learner-centered. High-tech and low-tech approaches, she continues, refer to how much technology a teacher utilizes to support subject instruction. According to McPheat's observation from 2021, the delivery of lessons and training should rely on the learner's preferred method of learning and the level of comprehension they currently possess. Therefore, effective teaching is about getting reactions that show understanding (McPheat, 2021).

Bates (2016) sees teaching as a continuum of three parts. At one extreme, there is face-to-face instruction without the use of technology, which is not online learning but rather "pure" face-to-face instruction. The use of technology as a classroom aid falls somewhere in the middle of the continuum. This component of the continuum, also known as blended learning, may involve the instructor using a projector and MS PowerPoint slides, or it may involve the teacher instructing students to use a device such as a laptop, tablet, or mobile phone to look at a website during a lesson in the classroom. On the other extreme, there is complete online learning, which is a type of distance education in which students do not come to the physical campus at all but instead study entirely online (Bates, 2016).

The four distinct categories to discuss the impact that technology has on education include: *Face-to-face instruction* in which students and instructors interact in person and in which class time is the only time when content and discussions can be accessed; *Technology-enhanced or web-facilitated face-to-face teaching and learning* which is when information and communication technology (ICT) is used within face-to-face classes or when the web might be used to post written information that is also provided in the face-to-face class; *Blended teaching*, which is when online and face-to-face instruction are combined to deliver a course considering that between 30 and 70 percent of the content is available online; and *Teaching online* which is when the majority of the course material and all of the class discussions can be accessed through the internet (Redmond, 2015). Traditional classrooms, also known as face-to-face instruction, are described by Perdue University as "that situation when the students and instructor of an educational institution are in a place devoted to instruction and the teaching and learning takes place at the same time" (Perdue University, 2021).

Since the printing of the first book a little over 500 years ago, the rapid development of technology over the past ten years has brought about the biggest change in education and learning (Duncan & Young, 2009). In addition to offering educational opportunities to those who could not or would not otherwise do so, online education has recently emerged as a preferred mode for many "traditional" students, who frequently combine traditional and online courses in their schedules (Stone & Perumean-Chaney, 2011). According to Duncan and Young (2009), this transformation places greater importance on pedagogy than just the delivery method. They continue by saying that the emphasis of online learning frequently is driven by technology potential rather than educational principles. The main problem of online education is to create a system that improves rather than hinders learning by utilising the many course resources (Duncan & Young, 2009).

Online courses, according to Allen and Seaman (2013), are those that deliver at least 80% of the course material online, while face-to-face courses only give 0% to 29% of the material online. They note that between 30 and 80 percent of the course content is supplied online in the remaining alternative, blended (also known as hybrid) education (Allen & Seaman, 2013). Then, according to Sentz (2020), online pedagogy is a collection of established techniques, approaches, and procedures for instructing students in academic topics in a virtual (or hybrid) setting while they are physically dispersed from the instructor and/or other students. Online teaching, he says, acknowledges the particular potential and constraints of the online environment, even while certain approaches and strategies may be similar to those employed in a face-to-face setting (Sentz, 2020).

Based on the aforementioned observations, in the context of this study, pedagogy refers to the training method (face-to-face or online) used to equip TVET trainees with practical skills; Face-to-face pedagogy will refer to the training of TVET practical content by a trainer in person to a group of trainees with the TVET trainees and trainer in the same physical location at the same time; and online pedagogy will refer to the training of TVET practical content that is intentionally designed and developed in advance, via online with the TVET trainees and trainer separated in time and physical location.

2.3.3 Technical Vocational Education and Training (TVET)

Technical Vocational Education and Training (TVET) is defined as a comprehensive term referring to those aspects of the educational process involving, in addition to general education, the study of technologies and related sciences, and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life (UNESCO, 2012). This definition, whereas comprehensive and all-inclusive, remains silent on the nature of future jobs which all signs show will be altered by technology. This is where the European Commission definition sheds light to the term. TVET is defined by the European Commission as learning pathways which aim to equip people with knowledge, know-how, skills and/or competences required in particular occupations or more broadly in the labour market' for the jobs of today and tomorrow (European Commission, 2014).

Availability, Accessibility and Acceptability to TVET have been some of the main challenges of the decade in most developing countries. Sambu and Simiyu (2013) opined that: first, it is important to ensure that everyone has access to high-quality education by removing all obstacles, whether they are financial, physical, institutional, or systemic;

second, it is equally important to ensure that everyone can benefit from that education by eradicating all forms of discrimination and by implementing flexible modes of instruction, especially for the most disadvantaged and marginalised students who might not otherwise be reached by conventional modes; and third, it is also important to emphasize that simply having access to education is not enough (Sambu & Simiyu, 2013).

2.3.4 Practical skills

Skills are an essential part of TVET and an indispensable aspect in the eventual employment of the resulting graduates. However, despite the terms numerous uses, available literature on the meaning of practical skills in TVET is scanty. The term "practical skills" is variously used in ordinary discourse in many Educational articles, journals and works on TVET training, however despite these numerous uses, its true meaning is not always defined. The meaning of the term in these various contexts is always implied and as such to establish the terms operational meaning as it relates to this study, available literature has been scanned for similar terms such as practical work, practical activity, soft skills, hard skills, technical skills, process skills, and competency; that in practice have regularly been used to refer to the term.

In many learning environments, the term "competency" has replaced the term "practical skill" which gives the impression that the two terms may be used interchangeably. But do the two terms mean the same thing? Whereas in general TVET practice, the demonstration of a practical skill can also be described as demonstrating competency, available literature seems to draw a distinction between the two terms. Skills are the specific learned abilities that are required to perform a given job well, such as welding or

writing tenders (McNeill, 2021), and they tell us "what." kinds of abilities a person needs to perform a specific activity or job (Beckett, 2018). On the other hand, competencies, are a person's behaviours and knowledge that lead them to be successful in a job. As such, competencies efficiently describe how an individual's behaviours bring about the intended results in their role or job (McNeill, 2021). Because skills don't tell us the "how" (of the individual's behavior in the working environment to obtain the intended outcome), skills are only one of the three components that make up a competency. The other two components are knowledge and abilities (Beckett, 2018). The implication is that, skills are a part of competencies, but competencies are never a part of skills.

Soft skills and hard skills are frequently mentioned terms in training and as such differentiating the two terms also expounds and deepens the understanding of skills. Soft skills are non-technical skills with less root in specific vocations (McNeill, 2021), and involving civil society awareness and digital presence in workplaces (One Education, 2021). Hard skills, on the other hand, cover technical skills for a particular job (One Education, 2021), and/or the precise abilities or knowledge required to accomplish a job, such as the proficiency with certain computer programs, platforms, or tools as well as the capacity to carry out specific tasks and familiarity with procedures (Borsellino, 2021). A hard skill is a technical and quantitative competence that a professional may demonstrate by their unique expertise and professional experiences (McNeill, 2021).

Closely related to the term practical skills in use and practice in TVET, are the terms technical skills and practical work. *Technical skills* are a subset of hard skills, which are the knowledge or abilities needed to perform specific tasks such as working with a piece of technology or equipment or to use a certain technique (Borsellino, 2021). They are the

individual’s affinity or ability to complete tasks related to a specific science or technology and as such they cover a broad array of subjects and areas such as Math, Engineering, Science or Computer-Technology. and as such, technically skilled individuals are often an essential part of the economy because they are responsible for the creation of innovation (My Accounting Course, 2021; Chen, 2021). On the other hand, Millar (2004) notes that practical work refers to any teaching and learning activity that, at some point throughout the activity, requires the students to either observe or manipulate the items and materials that they are studying. Because the setting does not play a significant role in defining the nature of the work being done, the term "practical work" is preferred to the more traditional "laboratory work." It is possible that the examination or manipulation of things may take place in a school laboratory (workshop), but it is also possible that it will take place in an environment other than a school setting, such as the student's home or out in the field (Millar, 2004).

The term *practical skills*, as pointed out earlier is not clearly defined in relation to TVET. Since the phrase is essential to a healthcare professional's duty, the medical area has produced the majority of the literature on its definition. The teaching of practical skills in medicine has historically, as the old adage in medical training goes, been founded on the principles of "see one, do one, teach one,". This is because, as Allery (2020) pointed out, a patient's good clinical result frequently rests on the competent execution of a technical process. Even in this field, however, there is no single term used to describe or provide a specific definition for basic practical skills in medical education literature; instead, a variety of terms (such as surgical skills, procedural skills, basic skills, physical examination skills, clinical technical skills, clinical skills, hands-on skills, technical

skills, and basic technical procedures) are often used inconsistently to describe the same or interrelated practical skills (Vogel & Harendza, 2016).

The Reverso Dictionary (2021) defines practical skills as the practical aspects of something involving real situations and events, rather than just ideas and theories and/or a session in which you make things or do experiments rather than simply writing answers to questions. However, these skills should not be confused with process skills. Abrahams and Reiss (2015) defined process skills as those that are "generalisable, transferable from one context to another, and readily applicable in any context". Practical skills are those that unmistakably reveal a person's competence in using a particular tool, machinery or equipment (Abrahams & Reiss, 2015).

From the above discussions of existing literature, the term *practical skills* shall be used in this study to refer to TVET trainee's observance, working and perfection of the use of a technology, tools or equipment; to manipulate objects, systems, drawings and materials; in an institution workshop or an out-of-school setting. The examples of practical skills referred to in this study shall include; woodwork technology and building construction.

2.4 A curriculum framework for TVET practical skills

To ably analyse the efficacy of a particular pedagogy (face-to-face or online) in TVET practical skills training, acquisition, assessment, performance and perception it's important to first standardise and sequence the practical content that is to be delivered to the trainees. This calls for a framework to analyse and describe the fundamentals of learning, and guide the packaging of practical training modules that can then be delivered either through face-to-face (control) pedagogy or through an online (experimental) pedagogy. The creation of engaging and inclusive learning environments, the integration

of assessment into learning, and the alignment of learning objectives with classroom activities are all made possible by teaching and learning frameworks, which are research-based models for course design. Frameworks may be simply blended and changed to act as conceptual maps for designing or changing any course, syllabus, or lesson (Yale Poorvu Center for Teaching and Learning, 2021). According to the United States of America (USA) National Research Council (2000), Students learn most effectively when: their pre-existing knowledge and "preconceptions" are acknowledged and engaged; they are given practice and time to construct "conceptual frameworks" on the basis of foundational knowledge through active, experiential, and contextually varied learning; and they are given practice and time to "take ownership of the learning" through metacognitive reflective thinking (National Research Council, 2000).

A curriculum framework is a document (or group of papers) that establishes educational standards and specifies the environment (available resources, instructors' skills, and system support) in which subject-matter experts create curricula (Stabback, 2007). Such a framework is most commonly developed at a national and sometimes at international level by a group of countries with similar goals and educational environments. At this level, according to Stabback (2007): Educational Policy Statements; Current Context; Statement of Broad Learning Objectives and Outcomes for each Level; Structure of Curriculum Content; Structure of the Education System; Learning Areas and Subjects, Teaching Methodology; Standards of Resources Required for Implementation; and Assessing Student Achievement are the common components of a Curriculum Framework.

Task analysis, according to Allery (2020), may help instructors choose precisely what to teach, determine the standard to which a skill should be taught, choose the teaching sequence, and foresee trainees' queries. She suggested four major phases for doing a task analysis, which are as follows: 1) Identify the general elements of the skill; 2) Break the elements down into procedural stages first, and then into sub-steps; 3) Expect challenges that a rookie learner may run across at any point in the procedure; 4).Take into account a range of distinct settings and how the skill could be performed differently in each of them (Allery, 2020).

2.5 Practical skills training

Benjamin Bloom's (1956) learning taxonomy concerned with intellectual skills development, offers a concise entry point towards effective delivery of training. The six key elements of Bloom's taxonomy as cited in Picciano (2017) include are*: Creating* -the process of planning, producing or arranging elements in order or into new patterns or structures that are cohesive or functional; *Evaluating* - making decisions based on standards and criteria by inspecting and criticizing; *Analysing* - the process of separating a piece of information into its component parts and figuring out how those parts connect to one another and to a larger structure or goal by distinguishing, organising, and assigning; *Applying* - performing or making use of a technique by carrying it out or putting it into practice; *Understanding* - making sense of oral, written, and visual communications by interpreting, exemplifying, categorising, sumarising, inferring, contrasting, and clarifying; and *Remembering* - the process of recalling, locating, identifying, and retrieving pertinent information from long-term memory.

Building on Bloom's works, educational psychologist Robert Gagne's taxonomy of events of instruction, became the basis for cognitivist instructional design (Harasim, 2012). The nine teaching experiences proposed by Gagne include: *Drawing attention* by using the appropriate medium; *Describing the aim* by providing specific objectives for the overall course objectives; *Stimulating past knowledge* by going through the information and ideas that were previously covered and make connections between them and the content that will be covered in the current module; *Presenting the subject matter* available for learning through readings, demonstrations, presentations, multimedia, images, audio files, animations, etc.; and *Giving guidance for learning* through dialogues that encourage students to actively reflect on new material in order to assess their topic knowledge and comprehension. Others include: *Encouraging performance-based learning* through assignments, discussions, and group research projects; *Giving feedback* to enable students receive rapid, detailed, and constructive comments; *Evaluating performance* using a test, research project, essay, or presentation as the evaluation tool; and *Supporting retention and transfer* through guided practice or projects that could connect learning towards other real-life scenarios.

When teaching learners, a new skill, either in person (face-to-face) or online, Cordiner (2017) notes that the DEDICT method is a great step–by–step principle to make your training engaging and impactful. She explains DEDICT to include: Demonstrating the task at normal speed (real time) to enable learners get a clear idea of what it is they are trying to achieve; Explaining what you did step-by-step by use of talking, animations, frozen images and diagrams; Demonstrating again, but this time slowly with less in–depth explanation than the previous step; Imitating the skill is key to learning a new skill

especially when the learner is encouraged to follow along, do an activity, and share their results; Coach the learner by giving feedback, further advice, scenarios where the skill would apply, or different scenarios where there may be an alternative way of executing the skill; and, Test the learners by giving them a practical challenge, quiz, assessment or activity (Cordiner, 2017).

Allery (2020) points out that skills learning can be seen as a hierarchical pyramid that starts with knowing at the base of the pyramid, then knowing how, showing how, and then doing at the apex of the pyramid. She suggests a four-step model in teaching practical skills that involves: 1) A realistic demonstration in which the trainer does the exercise normally while making no comments. This enables learners to see how a skill is being mastered; 2) Trainer speak through - the trainer goes over the steps again while explaining each one, responding to queries from the trainees, and making any necessary clarifications. 3) Learner talk through - the student guides the instructor, explaining each move and step while the instructor does the skill. 4) Learner does - the student does the skill under careful observation by the instructor, outlining each step as they go (Allery, 2020). Whereas this model was primarily related to the structured approach to acquiring medical skills, such as Advanced Trauma Life Support, it also provides a solid framework for the teaching of practical skills and, consequently, for the measuring of those abilities, in a variety of TVET sectors.

2.5.1 Online TVET practical skills training

Does online pedagogy mean taking a course taught face- to-face and simply putting that course online without making many adjustments? This phenomenon also known as curriculum conversion is disputed by Palloff and Pratt (2007) who claim that "when we

migrate to online learning, it is not the curriculum we are converting; rather, it is our teaching approach; as our pedagogy changes, so must the course". They continue, that developing an effective online course necessitates a paradigm change in terms of how the course materials are delivered (Palloff & Pratt, 2007). Students who learnt abdominal examination using an interactive software with a "drag version" fared less well than students who acquired the same material through a "click version" of the same programme, which was much easier to use (Vogel & Harendza, 2016). The difference may have resulted from cognitive overload caused by dragging objects on the screen as opposed to simplifying the job without decontextualising it to tailor the intrinsic load of learning the given skill to the developmental level of the learner (Vogel & Harendza, 2016).

Working from the multimedia principle that the combination of text and pictures leads to better learning outcomes than text alone, Ayres and Paas (2012) noted that the way in which text and pictures (or diagrams) are combined can have both positive and negative effects. However, they add, that positioning diagrams and written explanation text far apart might have detrimental consequences due to divided attention, but integrating diagrams with explanation text can have good benefits (Ayres & Paas, 2012).

For some time now, practical skills have been taught using multimedia especially in the field of medical training. The works of Kalet et al (2012), encourage the use of computer-assisted materials to teach skills such as the physical exam (in the medical area) and indicate that careful attention to the design of interactive elements has the potential to significantly improve educational efficacy. Vogel and Harendza (2016) suggest that study, either voluntarily or obligatorily, using multimedia applications such as video clips

of certain skills, in combination with a structured programme that includes the possibility for individual exercise with personal feedback from peers or teachers, seems to provide a good opportunity for learning fundamental practical skills.

2.5.2 The learning experience and process

It's imperative to consider the learning experience and environment when delivering practical skills training. Duncan and Young (2009) pointed to social, cognitive, and instructional presences as three interrelated dimensions that frame the educational experience. Social presence supports open communication and group cohesiveness by creating a supportive environment; cognitive presence is the cyclical process of inquiry that begins with questioning, which is followed by exchange of information, connection of ideas, new ways of seeing and knowing, and finally testing of these concepts in new situations; and teaching presence lays the groundwork for social and cognitive presences through curriculum, course design, direction, guidance, and facilitation (Duncan & Young, 2009).

The Glossary of Education Reform (2013) defines learning environments as various physical settings, social situations, and cultural contexts where students learn. The term is frequently used as a more accurate or preferred substitute for classroom, which has more restricted and traditional connotations—a room with rows of desks and a chalkboard, for example—because students can learn in a wide variety of settings, including outside-of-school locations and outdoor settings. The term also refers to how a teacher might set up a classroom to promote learning, such as by holding lessons in relevant natural ecosystems, arranging desks in particular groups, hanging educational materials on the walls, or using audio, visual, and digital technologies. It also includes the culture of a

school or class, which includes its prevailing ethos and characteristics, including how people interact with and treat one another (The Glossary of Education Reform, 2013).

According to Heick (2018), a highly successful learning environment has the following 10 qualities: 1) Good questions are asked by pupils; 2) Questions are preferred over responses; 3) Different sources provide different ideas; 4) Different learning models are employed; 5) Learning outside of the classroom "empties" into a linked community; 6) Learning is tailored based on a range of factors; 7) Assessment is constant, genuine, open, and never punishing; 8) Transparent and balanced success criteria; 9) Learning behaviors are continuously modeled, and 10) practice opportunities are available at all times (Heick, 2018). However, whereas technologies used to teach and the infrastructure that houses the teaching and learning facilities (classrooms, laboratories, and lecture rooms) have been the focal point of discussions on learning environments, The Glossary of Education Reform (2013) notes that the concept extends to: the student characteristics, the educational objectives, the learning-supporting activities, the assessment techniques that will best gauge and promote learning, and the culture that permeates the learning environment. They continue, that terms like "positive learning environment" or "negative learning environment" are frequently used to refer to a school's or class's social and emotional dynamics (The Glossary of Education Reform, 2013).

While choosing instructional strategies that are centred on skill development, it is crucial to equip students with the necessary fundamental information, such as concepts or procedures that are crucial for performance. Not every person will have the same previous knowledge, hence Hajaraih et al (2012) warn that repeating material that a learner already knows will reduce engagement, or a person's probability to absorb and

interact with the information. The amount of prior knowledge of the learners should be considered when determining if they are capable of doing the work and whether they have the procedural knowledge necessary to carry out the activity in order to sustain engagement (Hajaraih, et al. 2012). Various psychological researchers have pointed to: distributing practice session; part-task training; adaptive and guided training; immediate feedback; practicing well; and positive transfer of skills, as important pillars in training and practice that leads to the most rapid development of a variety of skills.

Distributing practice session over a long time, rather than massing them together, leads to more efficient learning during each session (Dempster, 1988). In his book entitled *the first twenty hours: How to learn anything fast*, Kaufman (2013) pointed out that skill acquisition requires practicing the skill in question. It requires significant periods of sustained, focused concentration. It requires creativity, flexibility, and the freedom to set your own standard of success.

Part-task training makes the learning of very complicated skills easier by practicing each component of the skill separately, then putting them all together (Mane, et al. 1989). However, when components of a complex skill are intimately coordinated, it may not be a good idea to practice them separately (Bernstain et al, 1991). In their findings of a meta-analyses study that investigated the effects of part-task training (PTT), on transfer of skills, Wickens et al (2013) noted that PTT generally produced negative transfer when the parts were performed concurrently in the whole transfer task but not when the parts were performed in sequence.

Adaptive and guided training are two closely related techniques that can aid skill development (Bernstain et al, 1991). In adaptive training the student begins with very

easy versions of the skill and then attempts gradually more difficult versions. Actually, skill acquisition has been characterised as the development of a hierarchy of habits (Johnson & Proctor, 2017). There has been consensus on the fact that for effective learning to take place, then the learning process has to be structured. Guided training provides supports – like "training wheels" – that prevent the learner from making disruptive or dangerous mistakes as skill develops. Both techniques have drawbacks. Adaptive training can teach low-level skills that must be unlearned once more advanced levels are reached, and guided training can make some students so dependent on the "training wheels" that they may fail to learn the skills needed to perform without them (Bernstain et al, 1991).

Immediate feedback about which responses are right and wrong, plus the opportunity to correct errors, is vital for efficient skill development (Glaser & Bassok, 1989). Feedback is information that helps the learner remain aware of success and identify sources of error and as such it should be given as soon as possible, but only when the student can give it full attention. Feedback in general and self-directed learning, such as planning one's own timetable, knowing which skill to practice, or taking part in explicitly stated voluntary activities, have been found to be beneficial for developing a variety of fundamental practical skills (Vogel & Harendza, 2016). For instance, in the clinical setting, feedback is encouraged to give students information about their performance for possible improvement and as direction for them to review their accomplishment of goals (Ramani & Leinster, 2007). Hajaraih et al. (2012) inform instructional designers that in order to tailor feedback on performance to enhance processes like perception and planning that occur in the learner's mind, they need to be aware of what approaches each learner prefers

or at the very least provide feedback that considers the various learning styles of each learner (Hajaraih, et al. 2012).

Practicing well beyond initial mastery is the surest way to maintain a skill. This practice is called overlearning, and it allows the skill to operate automatically. A skill that is practiced only until it is performed perfectly once will be easily forgotten, but a skill that is practiced time and again after perfection is reached is usually maintained, or at least easily recovered, for a life time (Bernstain et al., 1991). Johnson and Proctor (2017) observed that highly practiced skills are characteristically automatised as a consequence of extensive practice in contexts similar to those under which the skills will ultimately have to be performed.

Positive transfer occurs when a skill learned on one kind of task sometimes aids performance of a second, but only if the second task is procedurally similar to the first. This will only happen for as long as the tasks require similar responses (Bernstain et al, 1991). This makes transfer of learnt skills another sticking point. Johnson and Proctor (2017) add that the criterion for successful learning is not always performance on the task at hand. In many cases, the critical issue is whether practice of one task will lead to improved performance of another one (Johnson & Proctor, 2017).

2.5.3 The online training environment

Whether the course is taught online or in a more traditional face-to-face classroom environment, the focus of any pedagogical approach or technique should be on the student's learning. However, assessing student learning in online courses comes with some particular difficulties. Online pedagogy usually incorporates consultation and

collaboration with a variety of support people, in contrast to traditional classroom pedagogy, which derives from a "Lone Ranger" approach to course preparation. Collaborations include those between graphic designers, web programmers, instructional designers, e-producers, and librarians, many of whom help teachers with design and implementation or online students with subject-specific research (Stone & Perumean-Chaney, 2011).

Pelz (2004) put out three principles for successful online pedagogy, which are as follows: 1) Allow the students to do the work (student-led conversations, discovery and discussion of online resources, peer-to-peer learning, grading of personal homework projects, and case study analysis); 2) Effective asynchronous learning relies heavily on interaction (collaborative research papers, research proposals for team projects), and 3) it is also important to strive for presence (social presence, cognitive presence, and teaching presence) (Pelz, 2004). The setting in which learning and practice take place should be the same as the environment in which the skill will be used, since this will enhance the transferability of what is learnt. To encourage training transfer in the skills cycle model, it is essential to replicate the necessary components needed for decision-making. Additionally, simulating various environments helps improve the transfer of skills learnt to new contexts (Hajaraih, et al. 2012).

Whereas the rapidly changing learning environment, requires TVET trainers to respond with an expanded toolset especially in the delivery of practical skills, a number of challenges and bottlenecks still affect online learning as an alternative for practical skills training. According to Hoftijzer et al (2020), obstacles to providing TVET skills online include a lack of access to internet connectivity, electricity, equipment or media, learning

platforms, and poor teacher and student preparation for remote learning (Hoftijzer et al., 2020). Harasim et al, cited in Palloff and Pratt (2007), have written about the drawbacks of online learning and how students react to it. Students express worries about health problems associated to computer use, information overload, communication anxiety due to the delayed replies in an asynchronous setting, more work and responsibility, difficulties navigating online and following discussion threads, and lack of visual clues. They go on to add that the usual student response to overload is to withdraw or drop out of an online course (Palloff & Pratt, 2007). Another challenge is the requirement for tools or supplies not often found within the home to which Hoftijzer et al. (2020) suggest can be overcome through simulated training, virtual or augmented reality experiences, and work-based learning such as virtual internships or apprenticeships (Hoftijzer et al., 2020).

2.6 Practical skills acquisition

To determine the efficacy of a particular pedagogy in delivering practical skills to TVET trainees, the indicators that will identify what has to take place need to first be determined. A search for existing literature on the different skills domains, the different types of skills, and then the pillars that support an effective skills training and practice brings to light the common grounds in any form of effective skills acquisition that can be summarised into the required indicators. Establishing effective and reliable means for measuring trainees' learning and acquisition of Practical Skills is key in determining the efficacy of a particular pedagogy. Kettunen (2013) noted that two interrelated, but fundamentally diverse processes make up learning. Learning might come about as a consequence of the learner's interactions with his or her social, cultural, or physical

surroundings, or it can come about as a result of an internal psychological acquisition process and elaboration in which fresh impulses are linked to the outcomes of previous learning (Kettunen, 2013). Frymier and Houser (1999) based on the idea that students engage in particular behaviours or activities when they are immersed in learning, to select nine student actions as learning indicators for a measure to solve the issue. Their findings showed that empowerment, motivation, emotional learning, and relevance were all positively correlated with students' performance on learning markers (Frymier & Houser, 1999).

The following seven behaviours were emphasised by Lee, Song, and Hong (2019) in their research on the "factors and Indicators for Measuring Students' Sustainable Engagement in e-Learning" as indicators of student engagement in face-to-face learning environments: 1) Making an effort to learn - this includes habits that students pick up on their own, such as finishing their homework, getting ready for class, and studying after school; 2) involvement in class activities, which includes showing up, presenting, asking questions, and expressing oneself; 3) Interaction - the exchange of information regarding the learning materials between the instructor and the student, which might include queries or requests for learning assistance; 4) Cognitive task solving, or the internal cognitive processes of a learner, such as information acquisition, comprehension, application, and memory; 5) Learning satisfaction, a psychological condition that involves learning interest, learning expectations, and learning enjoyment; 6) The feeling of being a part of the learning community, which is the degree of ties to friends and classmates; and 7) Learning enthusiasm, which is having an active mentality during learning and may show

itself as mental energy and a readiness to take on difficulties, is having a passion for learning (Lee, Song, & Hong, 2019).

Johnson and Proctor (2017) noted that "skills may have large perceptual (e.g., reading a medical image), cognitive (e.g., reading or remembering large amounts of information), or motor (e.g., typing or skiing) components". This observation opens up a whole new dimension in the quest to understand and thus be able to determine the effectiveness of any pedagogy (face-to-face or online) on practical skills acquisition. Two questions arise here: 1) what is common about skills in the perceptual, cognitive, and motor domains? and 2) Is it possible to use such a commonality to demonstrate an objective, measurable and quantifiable efficacy of a pedagogy on the acquisition of practical skills? The answers to these two questions would offer a solid foundation for designing a calibrated benchmark of indicators upon which to measure the extent of practical skills being acquired by the trainees. Whereas some researchers emphasise commonalities across the different domains, and others point to differences such as Johnson (2013), almost all skills, however, require coordinated processes of perception, cognition, and action. In acquiring a skill, we learn to select relevant information and link it to actions in a smooth, integrated fashion (Johnson & Proctor, 2017). Practical work involves four skills that are closely related and these include; procedural skills (ability to do something e.g. cut a timber joint), conceptual skills (to understand complex scenarios and develop creative solutions), process skills (to manage and modify actions e.g. selecting the right tools), and practical skills (competence in operating a certain piece of machinery or equipment). Abrahams and Reiss (2015) used the following example of a teacher teaching an

electricity lesson to illustrate how these abilities connect in the setting of scientific practical practice.

> *The instructor of an electrical class wants to utilize a hands-on activity to illustrate how current remains constant inside a parallel circuit. In this case, procedural comprehension would require knowing how, in theory, to construct a workable parallel circuit and how to use and interpret an ammeter with reasonable accuracy in order to obtain the necessary readings as required by the instructor. Knowing that the data obtained from the ammeter readings can be understood in terms of the scientific principle that the flow of electric charge is preserved in a parallel circuit would be the conceptual understanding. The process skills comprise adhering to the instructor's instructions and understanding the fundamental issues that arise with things like fair tests and measurement inaccuracies. Lastly, the practical skills would refer to the student's capability to use the components and tools that are at their disposal in this example to set up a functioning electrical circuit.* (Abrahams & Reiss, 2015).

Lamprianou and Athanasou (2009) proposed three phases (not necessarily distinct but overlap in a continuous fashion) for the learning of a complex skill: 1) an early cognitive phase – where initial performance depends more on mental factors including the ability to understand the task instructions, to concentrate one's attention on the task and to perceive important task details; 2) a practice fixation stage – where correct behaviour patterns are practiced until the chance of making incorrect responses is reduced to zero; and 3) an

autonomous stage – where performance is usually locked in as a response pattern and as such characterised by increasing speed of performance in which errors are unlikely to occur (Lamprianou & Athanasou , 2009).

2.7 Practical skills assessment

Lamprianou and Athanasou (2009) opined that practical assessments are important where education or training involves performance because some abilities require mastery, for example, conducting a chemical analysis, creating a sculpture, completing a woodwork project, giving a hypodermic injection, operating a forklift or piloting a plane. They add that in such cases, where people must reach a given level of performance, it is imperative that it is evaluated by practical tasks (Lamprianou & Athanasou , 2009). Hodson (1992) argued that educational assessment should be a component of learning rather than something apart from it and thus should serve at least four purposes. First, a summative purpose: at the conclusion of the course, they should describe a student's levels of achievement in all course-related areas. Second, they should have a formative purpose, allowing teachers to analyse students' strengths and weaknesses, learning progress, and misconceptions in order to better prepare for each student's future learning. Third, in order to help instructors with decision-making and planning for the curriculum, educative assessment should also perform an evaluative purpose. Fourth, they should serve an educational purpose by giving students intriguing, difficult, and important experiences that will help them gain new perspectives and knowledge (Hodson, 1992).

The widely held perception that practical performance of a task is directly related to the knowledge about the task has frequently led to assessment of practical skills being unreliable. Wilson et al. cited in Harden and Cairncross (1980) showed that the scores

assigned to identical practical examination by fourteen examiners varied by as much as 25%. Even the same examiners were inconsistent since their marks varied from the initial mark by as much as 15% when they marked a video recording of the exam three months later. Another issue with assessing practical skills is that the method used is usually time-consuming. As a result, practical examinations are typically created with practicability in mind rather than with the proper skills being tested in mind (Harden & Cairncross, 1980).

Competency checklists and practical assignments which are the two tools used by the City and Guilds to evaluate and record practical skills in International Vocational Qualifications, both permit observation of performance - meaning that assessment occurs while the activity is being carried out. In cases where observation of performance is not used, assessment of products (such as objects produced, a plan, a design, a report, or an item of processed information) as a means of evaluating practical skills is used instead. City and Guilds mandates that the training facility use the competence checklist to plan a series of activities during this performance observation and product evaluation that will allow the candidate to demonstrate competence in the necessary practical skills, which frequently involve using equipment in a workshop (City and Guilds, 2013). DAPS (Direct Assessment of Practical Skills) and IAPS (Indirect Assessment of Practical Skills) are two terms established by Abrahams and Reiss (2015) in their investigation on how practical skills that are part of school science can be assessed. They defined the first (referred to as DAPS) as any assessment method that asks students to physically manipulate real objects in order to demonstrate a specific or generic skill in a way that can be used to assess their level of competency in that skill; and the second (referred to as IAPS) as any assessment method that determines a student's level of competency in a

specific or generic skill by inferring it from the data they provide, such as practical work reports. They suggest that IAPS is typically more appropriate if the goal is to assess students' understanding of a skill or process, whereas DAPS is generally more appropriate if the goal is to assess students' competency in terms of real practical skills (Abrahams & Reiss, 2015).

A study conducted on the "experience" of air traffic controllers in order to address the issue of assessing students' operational skills when training in dynamic and highly risky domains, such as air traffic control and nuclear plant operations, among others. The results revealed that experienced air traffic controllers developed a "prudence" or "systematic uncertainty" that was absent from the behavior of novices. In order to be ready for unforeseen eventualities, this group adds a safety "buffer" to their procedural and declarative knowledge. The findings also demonstrated that the training of operators is not limited to the acquisition of information such as facts, guidelines, etc.; rather, it must also focus on the cultivation of a cautious instinct and the intelligent application of knowledge, which is referred to as operational skill (Yacef & Alem, 1997). According to the results of Zatta et al (2019), who conducted an inquiry into the process by which operational competencies are formed, information, knowledge, and learning are major constructs that have a substantial effect on the growth of operational skills. The capacity to employ declarative and procedural information in a timely and correct manner, as well as the ability to cope with dynamic problem-solving scenarios that entail many tasks and goals, are both examples of operational skills (Yacef & Alem, 1997).

2.8 Practical skills performance

Lamprianou and Athanasou (2009) noted that practical tests can be undertaken while one is teaching through observation of selected aspects of students' behaviours and performances. This may be used to describe a students' progress at a particular time in a learning activity, however in order to make the judgment, a teacher would have to use learning outcomes or competency criteria. They add that, when these observations are recorded on a checklist or rated in some way, they become more formal assessments (Lamprianou & Athanasou , 2009). Students' own performances serve as trustworthy indicators of their level of self-efficacy (Schunk, 1995).

A number of studies have been conducted to examine different factors influencing the academic performance of students in a tertiary institution. In one study, Communication, learning facilities and proper guidance have been shown to have a positive impact whereas family stress has been shown to have a negative impact on the students' academic performance (Mushtaq & Khan, 2012). In another study by Jayanthi et al (2014) that used students' cumulative Grade Point Average (CGPA) as a measure of academic performance, the results showed that factors such as gender, nationality of student, co-curricular activities and an interest in pursuing higher degrees affected students' academic scores; and the use of past year examination papers as a learning method improved students' academic scores compared to other methods (Jayanthi, et al. 2014).

The role of teaching methods or pedagogy and gender in performance of practical skills is an area of concern. In a study to investigate the differential effectiveness of teaching methods on students' academic performance, the mean scores results demonstrated that

teacher-student interactive method was the most effective teaching method, followed by student-centered method while the teacher-centered approach was the least effective teaching method (Ganyaupfu, 2013). Teachers' instructional practices and interpersonal relationships with students have been highlighted as potentially powerful factors influencing student motivation and performance; whereas students' competence-related beliefs, control beliefs, achievement values, achievement goal orientations, and social and academic goals have been highlighted as the important psychological processes that mediate students' persistence, choice, and classroom behaviour (Wentzel & Wigfield, 1998). Despite past studies having identified gender differences in performance on science tasks, a study by Lock (1992) found little evidence to support these findings. Few significant differences in performance were found. No gender differences were detected in observation, reporting, or planning skills, and there was no differential performance on the use of scientific language (Lock, 1992). Then, a study to evaluate the laboratory skills performance of undergraduate biology students in Ethiopian universities based on skill performance rubric, recommended that in biology laboratory, performance-based assessment needs to be undertaken in placement to written exam and instructors need much more assistance and professional development of biology laboratory performance skills as well as pedagogies of how to assess the laboratory performance skills of their students (Gobaw & Atagana , 2016).

The analytical results of a study by Rahman et al (2021) that explored how practical skills are influential in improving students' academic performance, showed that better practical (e.g., programming) skills have a positive effect on academic performance. The findings showed that if a student of an ICT or engineering discipline performs well in practical

assignments (e.g., programming, logical implementation, PL/SQL, etc.), then they are likely to perform well in other academic activities (Rahman, Watanobe, Kiran, Thang, & Paik, 2021). Lamprianou and Athanasou (2009) note that skilled performance used in tasks such as machine operation, use of equipment or repairs; involves the ability to perform a task to some standard and results from prolonged training or experience. They however caution that, because a one-off adequate performance may not be sufficient for inference of competent or expert performance and that it would be unlikely that mastery of complex skills will be achieved in less than 5,000 hours; then instructors may benefit from repeated assessment that produces a learning curve for the individual (Lamprianou & Athanasou , 2009). On the other hand, a trainee may have difficulty learning a particular skill because of having an inaccurate perception of their own performance, and may not be able to identify how or why the skill was performed incorrectly (Allery, 2020).

2.9 Perception of online pedagogy

In line with Walker and Avant (2005) recommendation of using dictionaries, thesauruses, available literature, and other sources to identify uses of a concept, the term perception is referred to as a belief or opinion, often held by many people and based on how things seem (Cambridge Dictionary, 2023); awareness of the elements of environment through physical sensation or physical sensation interpreted in the light of experience (Merriam-Webster Dictionary, 2023); the way that one thinks about something or the impression one has of something, and/or the recognition of things using ones senses,

especially the sense of sight (Collins Dictionary, 2023); and an idea, a belief or an image you have as a result of how you see or understand something (Oxford Learner's Dictionary, 2023).

Philosophically, the concept of perceptual relativity was examined by Forrester (2017) by looking at sense perception in other animals, and at neurology and cognitive psychology, and at various examples of perceptual relativity in science. He established that the universe is observer dependent and that there is no reality independent of the observer, which is knowable to the observer and thus concluded that recognition of an observer dependent world would lead to a much more open minded and tolerant world (Forrester, 2017). Hoffman et al (2015) opined that perception was a product of evolution and our perceptual systems, like our limbs and livers, have been shaped by natural selection. To this end, when they defined and classified perceptual strategies and allowed them to compete in evolutionary games in a variety of worlds with a variety of fitness functions, they found that veridical perception—strategies tuned to the true structure of the world—were routinely dominated by nonveridical strategies tuned to fitness. They observed that, a perceptual strategy favoured by selection is best thought of not as a window on truth but as akin to a windows interface of a PC that serves to guide useful actions, not to resemble truth hidden behind the interface. Just as the colour and shape of an icon for a text file do not entail that the text file itself has a colour or shape, so also our perception of space-time and objects do not entail (by the Invention of Space-Time Theorem) that objective reality has the structure of space-time and objects. They conclude, that because our perception of space-time and objects have been shaped by natural selection to hide the

truth and guide adaptive behaviors, then perception is an adaptive interface (Hoffman, Singh, & Prakas, 2015).

In psychology, most theories of perception in one way or another have their roots in the Gestalt Theory. There is always a similarity of structure between the phenomena as seen (what has been called the 'phenomenal' or 'behavioural environment') and the corresponding cortical processes (Hamlyn, 2017). This refusal to distinguish between sensation and perception is evidence of how Gestaltists assimilate the latter to the former (Hamlyn, 2017). However, psychologists Bernstein et al (1991) used the example of a cat lying on the sofa to distinguish between '*sensation'* – the initial message from the senses - and '*perception*' - which is an interpreted message from the senses and thus been given meaning in terms of previous experiences. They noted that, one sees shapes and colours – which is the visual sensations, and because of one's knowledge of the world, they then interpret, or perceive, these sensations as a cat (Bernstain, Roy, Srull, & Wickens, 1991). The Muller-Lyer illusion cited in Hamlyn (2017) used an illustration of lines to demonstrate that the ways in which individuals may perceive something can be divided into two classes—the right ways and the wrong ways. To say that two lines of equal length look of different length (or, in other words, we see them as of different length), or that two lines of equal length look of equal length; requires to first state what precise factors may make them look different from, or same as, their normal or correct length. This helps to explain why the answer to the question is either 'Under normal conditions' or 'Under any conditions except those which tend to make them look different' (Hamlyn, 2017).

Among the numerous fields where the concept of perception is key, is that of health. The Health Belief Model for example, which is a renown conceptual structure for understanding the drivers of individual health decisions, proposes that, an individual's perception of susceptibility, benefits, severity and barriers as regards to their health are the key elements upon which that individual takes health actions (Daddario, 2007). In the nursing profession, McDonald (2011) notes that, the only perception nurses are privy to are their own. This often comes to light as nurses encounter ethnically diverse clientele in their everyday practice. She adds that, conflict between nurse and client perception can lead to miscommunication and suboptimal outcomes and thus understanding self and client perception are important for nurses to effectively meet clients' unique needs in the global health arena (McDonald, 2011). Also, a study on the effectiveness of placebo analgesia on relieving pain, Roche (2007) found that the neural pathway was affected by both the mind and the body and thus Patients' beliefs, attitudes, and expectations shaped their perception of pain before and after using placebo analgesia. The study concluded that the effectiveness of placebo analgesia may be dependent on brain components involving affective and emotional processes based on evidence showing that suggestion/expectation cognitively triggered powerful neurohumeral mechanisms in patients' brains, bodies, and behaviors that will either relieve or exacerbate pain (Roche, 2007).

Perception also plays a key role in the education and learning process. While exploring the transfer of a scientific principle (competitive specialisation) across superficially dissimilar pedagogical simulations in science, Goldstone et al (2009) found that, people learn to attend mathematical operations in the order in which they should be executed,

and the extent to which students employ their perceptual attention in this manner is positively correlated with their mathematical experience. They, thus concluded that for both science and mathematics, relatively sophisticated performance is achieved not by ignoring perceptual features in favour of deep conceptual features, but rather by adapting perceptual processing so as to conform with and support formally sanctioned responses (Goldstone, Landy, & Son, 2009). To confirm that ensemble percepts can be extracted holistically, Han et al (2021) asked observers to report the average emotional valence of Mooney face (two-tone, shadow-defined images that cannot be recognised in a part-based manner) crowds. The study was structured in such a way that to recognize features in a Mooney face, one had to first recognise the image as a face by processing it holistically, and across experiments, the study findings demonstrated that observers successfully extracted the average emotional valence from crowds that were spatially distributed or viewed in a rapid temporal sequence even when Mooney faces that were difficult to recognise when inverted were included. The experiments provide evidence that ensemble perception can operate selectively on holistic representations of human faces, even when feature-based information is not readily available (Han et al. 2021).

Bernstein et al (1991) summarised the six characteristics of perception as 1) perception is generally knowledge based – you must know how snakes look like if your to avoid snakes in the woods; 2) perception is often inferential – people do not always have sensory information at hand but their perceptual systems make perceptual hypotheses about what they can't see, hear or smell; 3) perception is categorical – it places sensations into categories based on common features; 4) perception is relational – you perceive a stimulus pattern because its features are related to one another in a coherent and

consistent way; 5) perception is adaptive – allows you to focus on the most important information needed to handle a particular situation; and 6) perceptual processes operate automatically – you do not have to stop and consciously ask yourself about it.

The results of a study by Smart and Cappel (2006) that examined students' perception of integrating online components in two undergraduate business courses, indicated that participants in an elective course rated the online modules significantly better than those in a required course. The outcomes suggested that instructors should be selective in the way they integrate online units into traditional, classroom-delivered courses and the integration should be carefully planned based on learner characteristics, course content, and the learning context. They add that the largest dissatisfaction factor reported among the participants was the time required to complete the online modules (Smart & Cappel , 2006). Syauqi et al (2020) study aimed at providing an overview of students' perception of Mechanical Engineering Education on online learning as a result of the impact of the COVID-19 pandemic, revealed that students felt that online learning had not provided better experience and productivity in mastering competencies, but provided ease of access to resources, motivation and ease in their learning (Syauqi, Munadi, & Triyon, 2020). Thongsri et al (2019) found that performance expectancy, effort expectancy, social influence, information quality and system quality were all important factors for learner's intention and acceptance of the novel online learning method. whereas previous research appeared to confirm that service quality was an important element in the success of information systems, the study findings showed that service quality had little or no influence on the intention acceptance of the novel online learning method (Thongsri, Shen, & Bao, 2019).

2.10 Chapter summary

This chapter has reviewed existing literature to define the key concepts of the study (TVET, Efficacy, Pedagogy, and Practical Skills); and then reviewed previous works on TVET practical skills training, acquisition, assessment, performance and perception. However, the researcher did not find any research on the efficacy of online pedagogy on TVET practical skills training, assessment, acquisition and performance. Therefore, this study generated vital data and knowledge for TVET providers, trainers, assessors, and policy makers, on the effectiveness of online practical skills training. The study will also provide recommendations from the analysed data, that will inform future developments of TVET practical skills training frameworks, content delivery and assessment.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter details what was done in the quasi-experimental study and how it was done. To achieve this rational and methodological detail, the chapter begins with the research philosophy in which the study is anchored, and the research design. The chapter then details the area where the study was conducted, the population that was targeted and sampled by the study, the technique that was used to sample the population for the study, study variables, methods and the instruments that were used for data collection. The chapter concludes with a description of the study validity and reliability, procedures, ethical considerations, and data analysis.

3.2 Research philosophy

A research philosophy is a set of beliefs about how information on a topic should be gathered, processed, and applied because it focuses on the origins, nature, and growth of knowledge (Business Research Methodology, 2021). The philosophy facilitates interpretation and meaningfulness of reseach results from different frameworks (Rehman & Alharthi, 2016). Thus, the decision of what data to gather, how to gather and analysis the information, the meanings to be made with the information, and the degree of generalisability of research findings are all influenced by their research philosophies (IPL, 2021).

3.2.1 Positivism and postpositivsm

The positivist school of thought served as the study's compass. Positivism holds that reality exists apart from people, unmediated by our perception and subject to unchangeable rules. Therefore, as reality is context-free, researchers from various eras and locations always come to the same conclusions regarding a certain phenomenon (Rehman & Alharthi, 2016). In its essence, notes Business Research Methodology (2021), positivism is based on the idea that science is the only way to learn about the truth which truth or factual knowledge can only be trusted if it is gained through observation (the senses), including measurement. As a result, there are no accommodations for human interests in positivist investigations, and the researcher is thus autonomous from the study, which limits the researcher's function to just gathering and objective evaluation of data (Business Research Methodology, 2021).

According to Creswell (2014), postpositivsm is the school of thought that sprang from positivism. It challenges the concept of ultimate truth in knowledge and acknowledges that it is impossible to be certain of our knowledge claims while researching human behaviour and action. He points out that the issues explored by postpositivists are a reflection of the necessity to recognise and evaluate the factors that affect results, such as those discovered in experiments. A postpositivist's understanding is built upon meticulous observation and measurement of the objective reality that exists "out there" in the world. Therefore, for a postpositivist, creating numerical measurements of observations and researching human behaviour become crucial (Creswell, 2014).

In line with the postpositivist approach, data that is quantifiable and empirically observable through the researchers' senses was collected; and interaction with the study

participants was maintained to the minimal so as to ensure the study's independence and objectivity. Inductive reasoning was used to develop hypotheses that were tested during this quasi-experimental study to determine whether there is enough statistical evidence in support of the parameters; and consistency or inconsistency between the observed data and the proposed hypotheses. Also, the study questionnaires comprised mainly close ended questions whose responses were converted using the Likert scale into small, discrete sets of data that were then tested. The philosophy guided: the selection of best methods that were used to collect data for the study (observation, survey and test methods); the data sources for the study that included trainees, instructors and UBTEB assessors; the decisions on the type of data that was collected and used to test the study hypotheses and respond to the research question; and also, the type of data analysis that was used when interpreting the findings.

3.3 Research design

A quasi-experimental (QE) design, according to Siedlecki (2020), should be considered when the purpose of a study is to demonstrate a relationship between cause and effect, but it is either impractical or unethical to perform a randomised controlled trial (RCT). This is because, despite the fact that the evidence in this sort of design is less than in RCTs, there are multiple strategies to control for or decrease hazards by anticipating and planning for them beforehand (Siedlecki, 2020). As a result, a quasi-experimental non-equivalent design was used to conduct this comparative research investigation. This experimental design's primary goal was to compare outcomes (training, acquisition, assessment, performance and perception of practical skills) of the experimental group (which is online pedagogy) with the control group (which was face-to-face pedagogy), to

determine the efficacy of the online pedagogy, while controlling for any other factors that could affect that result (Creswell, 2014). The comparison group (face-to-face pedagogy) captured the baseline data upon which a comparison for differences in outcomes with the experiment (online pedagogy) group was made (White & Sabarwal, 2014). Given that it is simply impossible to control and manipulate the requirements of a true experiment in educational research, the researcher will use a design that is somewhat akin to a true experiment in which they have control over "the who and to whom of measurement" but lack control over "the when and to whom of exposure," or the randomisation of exposures—essential for a true experiment.

Siedlecki (2020) explored the benefits and pitfalls of quasi-experimental (QE) research (2020). Quasi-experimental studies can determine the efficacy of an intervention and may be more generalisable than experimental studies such as randomised controlled trials (RCTs) since they are done in real-world settings with fewer controls and are often less expensive and use fewer resources. Therefore, they are more practical than experimental designs. In addition, they let the researcher to view data both prospectively and retrospectively. However, Siedlecki (2020) notes, QE designs tend to overstate effect magnitude, and because subjects are not randomly assigned to groups, causality should be interpreted with caution; and, in general, the challenges to the internal validity of QE designs are larger than those of experimental designs (Siedlecki, 2020).

3.4 Study area

This quasi-experimental study was conducted in the districts of Wakiso and Kampala located in the Republic of Uganda in East Africa. The selection of these districts was dependent on the balance between the need for stable internet connection to facilitate

online pedagogy; available resources to conduct the study; and the need for a sizable representation thus generalisability of the results of the study. Despite the several Technical institutes in Wakiso and Kampala, St Joseph's Technical Institute - Kisubi and Nakawa Vocational Training College (NVTC) were selected for the study from Wakiso and Kampala respectively. The justification for selecting the two institutions for the study was that despite the two being located within an area with good internet connectivity (Wakiso and Kampala District), having well-furnished workshops, ICTs and a teaching staff that is well versed with the use of ICTs in the teaching and learning process; there was no online training of practical skills during the two COVID-19 lockdowns. This is what motivated the researcher to select the two institutions from the two districts to conduct the quasi-experiment.

St Joseph's Technical Institute, Kisubi is located on Coordinates 0°7'25"N 32°32'19"E on the Kampala-Entebbe Road about 15 miles (21 km) from Kampala. This Catholic-founded technical institute, is the oldest technical institute in Uganda, established in 1911 by the White Missionary Fathers to train young men from primary schools in basic crafts. The TVET courses offered at the institute include Automotive Mechanics, Building Construction, Electrical Services, Fashion and Garment Design, Leather Tanning and Production, Plumbing, and Woodwork Technology.

Nakawa Vocational Training College (NVTC), is a public vocational training institution under the Ministry of Education and Sports (MoES). The institute is located in the Nakawa Division of Kampala on the Kampala-Jinja Road, approximately 5.5 kilometres, east of the central business district of the city at geographical coordinates 0°19'56.0"N, 32°37'04.0"E. This TVET institution was established in 1971 as a

vocational centre through a bilateral cooperation between the Government of Uganda (GOU) and that of Japan with Japan International Cooperation Agency (JICA) as the executing organ of the Government of Japan. The primary objective of the establishment was to provide vocational training to workers in industries to upgrade their skills so as to enable them address the job challenges arising from the changing technology in enterprises.

3.5 Target population

Identification and naming of the population, commonly referred to as the "unit of analysis," is the first stage in comprehending and portraying a population (O'Leary, 2004). Thus, the target population for this quasi-experimental study included: first year trainees and instructors of St. Josephs Technical Institute, Kisubi located in Wakiso District and Nakawa Vocational Training College located in Kampala District; and assessors from the Uganda Business and Technical Examinations Board (UBTEB). **Table 3.1** shows the target population and their respective purpose in the study.

Table 3.1: Target population and their respective purpose in the study

	Target Population	Population Institution	Purpose in the study
1	Assessors	Uganda Business and Technical Examinations Board (UBTEB)	To develop practical test items; To assess and score trainees practical work; and Provide own perception of online pedagogy.
2	Instructors	St. Josephs Technical Institute, Kisubi and Nakawa Vocational Training College.	To conduct practical training sessions in the face-to-face pedagogy; To participate in development of digital content for the online pedagogy; To observe and score the face-to-face and online study sessions; To observe and score the training, practice and assessment processes; and Provide own perception of online pedagogy.
3	Trainees	St. Josephs Technical Institute, Kisubi and Nakawa Vocational Training College.	To undertake practical training sessions in the respective pedagogy; To undertake practical assessment sessions; and Provide own perception of online pedagogy.

3.6 Study sample

This quasi-experiment was conducted on two programmes offered by each of the selected institutions. These programmes were: The National Certificate in Building Construction (NCBC) and the National Certificate in Woodwork Technology (NCWT). These two programmes were selected for the study because they are offered in all the two selected institutions (St. Josephs Technical Institute, Kisubi and Nakawa Vocational Training College) and have practical modules. Although some difference existed between the programs in regards to how they are timetabled at the institutions and training approaches, the programmes had practical modules that are mandatory for all trainees offering the programme. Within the two programmes, a total of four practical tasks offered in the first year were selected for the study and these are: *steel bending* and *broken bond* for the NCBC programme; and *beam formwork* and *equilateral arch centre* for the NCWT programme. The decision to use only trainees enrolled in the first year of study was twofold: first to promote homogeneity between groups, and second, that first year students are still at the takeoff stage of their skills development and as such more open minded and positive towards new ideas.

Expense, time, and accessibility are factors that sometimes restrict researchers from gathering information from the complete population, and thus data is obtained from representative groups of the population to ensure that the knowledge collected is typical of the total population (Cohen, Manion, & Morrison, 2000). However, Siedlecki (2020) explains that when samples are small, researchers may commit a type II error, which means they will detect no differences despite the fact that there are differences. On the other hand, when samples are too large, researchers risk making a type I error which

means the will detect a difference despite the fact that there are no differences. Thus, the population sample for this quasi-experimental study (N = 97) consisted of UBTEB Assessors (n = 8), Instructors (n = 20), and Trainees (n = 69). St. Josephs Technical Institute, Kisubi had a total of 45 participants that included 35 trainees and 10 instructors whereas Nakawa Vocational Training College had a total of 44 participants that included 34 trainees and 10 instructors. The study sample population also had a total of 8 assessors (from Uganda Business and Technical Examinations Board – UBTEB) that included 4 assessors of the NCBC programme and 4 assessors of the NCWT programme. **Table 3.2 s**hows the study sample and **Table 3.3** shows the sample size.

Table 3.2: Study sample

Programme	**Participant Category**	**St. Josephs Technical Institute, Kisubi (n)**	**Nakawa Vocational Training College (n)**	**UBTEB (n)**	**TOTAL (N)**
NCBC Programme	Trainees	20	19		39
	Instructors	05	05		10
	Assessors			04	04
NCWT Programme	Trainees	15	15		30
	Instructors	05	05		10
	Assessors			04	04
TOTAL (N)		**45**	**44**	**08**	**97**

Table 3.3: Sample size of the study

	Participant category	Number of participants (Sample)	Target Population (Size)	Percentage (%)
1	UBTEB Assessors	08	401	02
2	Instructors	20	32	63
3	Trainees	69	189	37
	Total	**97**	**622**	**16**

3.7 Sampling technique

Most of the time, notes Bluman (2014), if a sample's subjects are appropriately chosen, they should share or be comparable to those of the population's subjects (Bluman, 2014); and, Cohen et al (2000) adds that the appropriate sample size is dependent on the purpose and characteristics of the population being studied, therefore there is no simple answer to the question of how large the sample size should be. They note that, prior to the actual research project, the decision on sample size must be informed by the different variables that the study is set to control in the analysis and the type of statistical test to be used on the data. According to Blaikie (2003), the general rule for samples is that the larger they are, the better. However, he continues by saying that expanding the size of the sample is subject to the "rule" of diminishing returns. This is due to the fact that although significant benefits are obtained initially, those gains become smaller as the sample size expands. There comes a point where the expense of future increases surpasses the gain in accuracy that can be achieved when estimating the population's parameters or patterns (Blaikie, 2003). According to Siedlecki (2020), a group sample size of 199 for

minor impact size and 34 for a medium or large impact size for the nonequivalent pretest-posttest design.

The entire population of first year NCBC programme and NCWT programme trainees from the two institutions were eligible to participate in the study (N = 189). To promote homogeneity between groups, and ensure equipment and tools are enough for trainees to work on the practical tasks, only trainees that would be comfortably accommodated in the respective institution workshop were selected to participate in the study. Therefore, whereas for the NCWT programme the workshops were enough for the trainees in each institution (St. Josephs Technical Institute, Kisubi =15 and Nakawa Vocational Training College = 15), for the NCBC programme, the number of trainees in each institution was much bigger than what the workshops could accommodate comfortably (St. Josephs Technical Institute, Kisubi = 104 and Nakawa Vocational Training College = 85). Thus, following administration of the pre-test questionnaire, stratified sampling was used to select the NCBC programme trainees who participated in the study. The population of the NCBC programme in each of the institutions was first divided into gender strata or subgroups (males and females) and then trainees were randomly selected from each gender group to ensure representation of each subgroup in the sample. The selected trainees included; St. Josephs Technical Institute, Kisubi (n = 20) and Nakawa Vocational Training College (n = 19). This made the total number of trainees in the study (N = 69).

The entire population of UBTEB assessors for the NCBC programme (n = 120) and NCWT programme (n = 281) were eligible to participate in the study (N = 401). However, for both the control and experiment groups to be assessed effectively in both programmes of both institutions, a total of 4 assessors per programme were optimum.

Thus, basing on the list of assessors for both programmes provided by UBTEB **(Appendix IX),** cluster sampling was used to select the assessors who participated in the study. Cluster sampling was preferred for this category because the population was large and involved subjects residing in a large (countrywide) geographic area. The population was divided into clusters of institutions where the assessors work and thus originate (based on Reg. Number of Institution where Assessor works), and then the assessors (n = 4 for the NCBC programme and n = 4 for the NCWT programme) for the study were randomly selected from the clusters that were geographically in close proximity to the institutions where the study was conducted. This made the total number of assessors in the study to be eight (N = 8).

Purposive sampling was used to select only instructors from the two selected institutions on the basis of their typicality and specific purpose in the study. This technique was chosen so as to focus on a specific group for this category, fully aware that this group does not accurately reflect the entire population but rather only itself. Whilst this non-probability sampling technique satisfied the needs of the study, the technique did not pretend to represent the wider population because it was deliberately and unashamedly selective and biased (Cohen, Manion, & Morrison, 2000). However, the choice for the technique for this particular category was based on its specific and specialised need, proximity to the study, functions in the study (training and observation of practical skills processes) and a small population to draw from.

3.8 Study variables

According to Creswell (2014), a variable is a characteristic or attribute of a person or an organisation that can be measured or seen and that differs among the individuals or

organisation under study. The concept of a variable is predicated on the premise that it is capable of taking on a variety of values and that the qualities of things, happenings, and individuals may be quantified along some continuum that corresponds to a standard numerical scale (Blaikie, 2003). In regards to variables of a study that are not directly measurable, Cohen et al (2000) observed that such variables should be operationally defined to let something else (proxy) that is measurable stand for them. They add that, when this occurs, the substituted variable (proxy) should as much as possible be an effective or valid indicator of the variable that is the main focus of the study. Independent variables are those that (presumably) cause, influence, or affect outcomes and/or what may be having an effect on the items the researcher is attempting to understand (Creswell, 2014). They are also known as treatment, manipulated, antecedent, or predictor factors. On the flip side, dependent variables are the results or outcomes of the independent variables influence and/or the things that the researcher is trying to study or measure. They are also known as the response, outcome, effect and criterion variables (Cohen, Manion, & Morrison, 2000).

The main variables for this study were the practical skills training, assessment, acquisition and performance which are the dependent variables of the study, and the online pedagogy which was the independent variable of the study. To enable measurability of practical skills training, assessment, acquisition and performance (the variables that the study is attempting to analyse and measure to determine the efficacy of an online pedagogy), the variables were clearly defined (in Chapter 2) to bring out a number of measurable proxies that will become valid indicators of the variables. The variables that could potentially impact on the extent of TVET practical skills training,

assessment, acquisition and performance (the dependent variable) but whose effects are not of interest to this study, included: Trainees health, trainees' access to equipment, scope of content to be covered for a particular skill, and degree of complexity of a particular skill. Also, for the actual influence of the independent variable on the dependent variable to be established, demographic or personal variables such as age or gender of participants, were among the other variables controlled. To successfully test the efficacy of the online pedagogy on TVET practical skills training, assessment, acquisition and performance, these variables, also known as controlled variables, were held constant for both control (face-to-face Pedagogy) and experimental (online pedagogy) groups so that they don't interfere with the results of the study.

3.9 Methods of data collection

The methods of data collection for this study were observation, survey, and test methods.

3.9.1 Observation method

Observation, according to O'Leary (2004), is a systematic approach of data gathering that depends on a researcher's capacity to receive information through his or her senses. In its philosophical definition, observation refers to the use of human senses to create 'evidence' about the 'empirical' world; in its social research sense, observation refers to methods of data gathering that involve the sense of vision (Blaikie, 2003). A structured observation method based on a predetermined criterion focused on relevant concepts and data points of the study, was used to collect both qualitative and quantitative data. The researcher, research assistants and instructors were physically present during the observations, but an attempt was made by the team to be unobtrusive by sitting in the corner of the workshop

(taking on a non-participant role) so as to document the actual behaviour and interactions of the trainees as they went about their practical tasks.

The method was used to capture observational data on the training process, trainees' work processes and the assessment process in both the face-to-face and online pedagogies. The observations were made and scored by the instructors (n = 20). Each observation process commenced with forethought planning for all study issues and contingencies, then the monitoring of the environment, noting and scoring of observations, assessing the procedure, making any adjustments to the observation process, and then analyzing the data that has been gathered (O'Leary, 2004) were undertaken. During the planning phase, the researcher first sought acceptance and approval from the relevant agencies to observe the trainees (**Appendix VI**), laid out a plan for ensuring credibility of data collected, considered all the alternatives and expectations, developed an observation checklist, and finally sought ethics approval. Observations were captured as they occurred in a timely manner, recorded in data sheets in a systematic mode and repeated until a saturation point (when new information is no longer yielded from the observations) at the end of each process being observed. The researcher then reviewed the process to address any accruing difficulties and made modifications to the data collection process.

3.9.2 Survey method

A survey is a research technique used to gather information from a predetermined sample of respondents in order to learn more and acquire insights into a range of interesting topics (Questionpro, 2021). When data is collected using the survey approach, a variety of people are questioned using the same questions about their traits, lifestyles, attitudes,

and other traits (O'Leary, 2004). The researcher used standardized closed-ended and open-ended questionnaires administered to each of the participants at the pretest and posttest stages of the study by the research assistants to collect generalisable data from assessors, instructors and trainees. This method was one of the ways through which entry and exit behaviors and characteristics of all the participants were captured. This data collection method ensured that each research participant answered the questions without bias that could influence the results of the study.

3.9.3 Assessment method

One of the formidable tools at the disposal of researchers for data collection, is tests because they impressively gather numerical rather than verbal data (Cohen, Manion, & Morrison, 2000). The study used non-parametric criterion-referenced practical tests in the post-test phase of the study to collect data on trainee's performance in practical tasks in relation to a predefined criterion of the UBTEB competency assessment grading system. This method was used for the posttest phases of the trainee's category and it was the same for the control and experimental groups of a given practical task, and same level of difficulty for the tasks in both programmes (A and B). Trainees were assigned practical tasks at the end of each training sessions. As the trainees worked on the tasks, the entire process was continuously assessed and scored by UBTEB assessors at each stage of the process. The assessment of trainee's work processes focused mainly on the actual performance process of the practical task and final result as the primary source of evidence and data.

The appeal of non-parametric tests, according to Cohen et al (2000), stems from their applicability for small samples. The fact that these tests do not make any assumptions on

the distribution of scores in regards to how regular, normal and even they are, makes them more appealing, even though these tests are less effective than parametric tests that are derived from standardised scores. Additionally, non-parametric test statistics computation is simpler than parametric test computation. Their main advantage is that they are adapted to specific institutional, departmental, and individual conditions. They present teachers with a priceless chance to receive prompt, pertinent, and concentrated feedback on students' performance (Cohen, Manion, & Morrison, 2000).

3.10 Data collection instruments

In the course of this quasi-experimental study, measures were observed and obtained using a number of instruments at the pretest, experiment and posttest stages of the study. The purpose of this data collection was to gather high-quality data for analysis, and creation of persuasive and believable responses to the issue the study was attempting to investigate (Formplus, 2021). Instruments were designed to collect data relevant to the concepts (Blaikie, 2003), and as such, this section discusses the instruments—their development, items, and scales.

3.10.1 Observation checklists

Observation checklists for the study were developed for the study and were used for observations of the training process, trainee’s practical work processes and the assessment process during the face-to-face and online pedagogies so as to extend the researchers senses and increase their precision. Due to the structured nature of the observation method to be used for this study, the observation checklists were developed well in advance ensuring that they are objective, neutral, and aimed at minimising

interaction of observers (instructors) and trainees. Three checklists were used in the study (**Appendix III**) for observation of the training, acquisition and assessment process.

3.10.2 Questionnaires

A questionnaire is a research tool made up of a list of questions used to elicit responses from participants (McLeod, 2018). The questionnaire is a popular and effective tool for gathering survey data because it offers organised and frequently numerical data, can be delivered without the researcher present, and is frequently very simple to interpret (Cohen et al. 2000). O'Leary (2004) draws attention to the considerable thinking and effort that goes into the creation (question writing, layout, and design) of a tool capable of producing reliable data. The identical topic or subject may be posed in roughly 762 distinct ways, and each one has the potential to provide completely different results (O'Leary, 2004). However, whereas this tool made it possible to get data fairly rapidly because there was no need for the researcher to be present when the questionnaires are filled out, McLeod (2018) points out that the drawback of questionnaires is that respondents may lie out of social desirability. He adds that, most individuals like to project a favorable picture of themselves, thus they may embellish or distort the reality in order to seem good (McLeod, 2018).

This tool was used to collect standardized, quantifiable, empirical data through close-ended questions. Two survey instruments were construct and administered to collect credible and generalizable data from the assessors, instructors and trainees while keeping their details confidential and anonymous. The instruments included one close-ended pre-test and posttest questionnaire and one open-ended posttest questionnaire (**Appendix II**). The use of the Likert scale in the pre-test and posttest questionnaire enabled respondents

to choose from a range of predetermined responses that ranged from ‘strongly disagree’ to ‘strongly agree’ that were generally easy to code and statistically analyse. The close-ended structure also ensured that only responses that fall into predetermined categories of ordinal data that can be graded using a continuous scale to determine the quality of the generated data, were elicited. The questions were structured in a form that enables the collection of data and figures that are measurable and expressed in numerical form. Background information on the purpose of the study, assurance on anonymity and confidentiality of the information provided by the participants, as well as clear instructions to introduce each section of the instrument were included in the instrument and consent form. Initially, two differently organised versions of both instruments were developed and piloted so as to zero on the final logical order that covers all the key data points without being overly lengthy.

These two tools were in paper and pen format and was self-completed by the assessors, instructors and trainees whose particulars were coded to keep their actual identity unanimous. The close-ended pre-test and posttest tool was administered to all trainees at the start of the study (pretest) and again administered at the end of the study (posttest) during mandatory practical sessions to enable the attendance of all participants of this category. The open-ended posttest questionnaire was administered at the end of the study to the assessors, instructors and trainees within the planned timelines.

3.10.3 Practical assessment items

Summative test items focused on practical competences were developed by UBTEB assessors and used in testing trainee’s competency acquisition of practical skills. These test items were administered to the trainees by the instructors at the end of each practical

skills training session and the scope of each item was confined to measuring achievement, outcomes, or 'mastery of the practical task learned. The same test item was administered to the control and experimental groups of a particular practical task to enable comparison of performance of the two pedagogies. Each test item had clear instructions to guide and explain to the trainees, what is expected of them, and each test item was worked on by the trainee's individually. Whereas Science and Technology Learning Lab (2021) proposed the use of practical assessment as continuous assessment or portfolio assessment as a solution, the challenge of limited time in relation to creating a meaningful practical skills test, practical tests for a particular group were conducted on the same day to ensure a leveled platform for all trainees and as such credibility of data generated. Each of the four practical tasks delivered during the study, had one practical task item developed and administered during the study (**Appendix IV**).

3.10.4 Assessment Guide

The collection of standardised data on trainee's practical skills performance for the two pedagogies was guided by the UBTEB assessment guide that was scored and well-documented by the UBTEB assessors as trainees worked on the assigned tasks. The tool was developed based on a standard template provided by UBTEB, that is also used for national competency assessment of technical examinations. The tool was formally obtained in advance by the researcher from UBTEB and copies given to all the assessors to guide them in development of the study assessment tools (**Appendix V**). The tool captured and scored the trainees work processes on the assigned task (process-P), the final product of the task (Result – R) and the final resulting grade as per UBTEB's grading system.

3.11 Validity and reliability of the study instruments

For, research to be seen as credible in terms of its power to elicit belief, it should have the potential to provide new information, and in the realm of research, this is shown by indicators like reliability and validity (O'Leary, 2004). While previous validation interpretations solely focused on evidence that and instrument actually measured what it claimed to measure, today the term has since taken on a variety of forms. Validity in quantitative data is now reliant on thoughtful sampling, suitable instrumentation, and suitable statistical data processing (Cohen, Manion, & Morrison, 2000). Validity is associated with the truth value by considering whether the methods, approaches, and techniques used actually relate to what is being explored, whereas reliability is associated with internal consistency by considering whether the data or results collected, measured, or produced are the same under repeated tests (O'Leary, 2004).

To ensure internal validity of the data collected by the instruments, efforts were made to ensure that the instruments focus on collecting data that accurately address the objectives of the study. This was achieved through: ensuring that in the design phase of the instruments, the objectives of the study were fairly addressed with an appropriate degree of precision to determine the real, observable behaviour that constituted achievement; consulting with supervisors in the development of the instruments; piloting the instruments to ensure all gaps are identified and bridged; enlisting instructors (with training and assessment experience) to administer, observe and record data on or from the participants; and recording, storing, and retrieving the data gathered through mechanical means. In regards to the transferability and comparability (external validity) of the study data to the wider population, cases or situations; the researcher ensured that sufficiently

accurate and rich data is availed to the users of findings to determine whether generalisability is possible.

To ensure reliability of observations made and recorded, the number of observations made were increased and the observations were made by Instructors who are well versed with the practical tasks being performed. The instructors were urged and encouraged to rigorously pay attention to what they see and hear; the ability to record only what is pertinent to the performance of the study and ignoring trivia. To eliminate unnatural behaviour of the trainees due to the presence and as such them being observed by the instructors, the trainees were allowed considerable time to work on different tasks in the presence of the instructors until such a time when they felt comfortable to be natural in the presence of the observing instructors. The reliability of the data collected in the post-test practical tasks were addressed through maintaining the same number of test items for each group and ensuring that levels of test item discriminability and difficulty are similar across the groups. The trainees in the control and experimental groups got two very identical practical test items at the same time and for every task, each trainee was scored by two assessors whose scores were then averaged and recorded.

Harlen, cited in Cohen et al (2000), contends that in order to address reliability, moderation procedures are required to iron out discrepancies between test markers. The moderation procedures include: inspection of samples; post hoc adjustment of marks; defining marking criteria; verifier visitations; and group moderation meetings. To ensure fairness and reliability of the posttest assessment processes, each group of four assessors (for a particular programme) met before and after every task assessment to: discuss and agree on the marking criteria for the practical tests; moderate trainee's scores and grades

in the practical tasks; and agree on adjustment (upwards or downwards) of marks awarded where necessary.

3.11.1 Piloting questionnaires

To increase the reliability, validity and practicability of the questionnaire (Cohen, Manion, & Morrison, 2000), a pilot study to test the reliability and validity of the Likert scale questionnaires was conducted at Kyambogo University. The Likert scale questionnaires that were piloted included (**Appendix II**) the: pretest and posttest questionnaire; training session observation checklist; trainees practical work session observation checklist; and practical skills assessment observation checklist. The pilot included a total of 15 students drawn from the Bachelor of Vocational Studies and Diploma in Education with technological studies, and trainees from programmes that were not taking part in the study. The Cronbach alpha test (SPSS) was used to check the internal consistency (reliability) of the four questionnaires. After making some adjustments and deleting some items in the questionnaire items as guided by the different total item statistics, the final Cronbach alpha test results as summarised in **Tables 3.4, 3.5, 3.6** and **3.7**; found the four questionnaires to be reliable (Cronbach's alpha: 0.726, 0.726, 0.806 and 0.701 respectively).

Table 3.4 Reliability statistics for the pre-test and post-test questionnaire

Cronbach's Alpha	N of Items
.726	24

Table 3.5 Reliability statistics for training Session observation checklist

Cronbach's Alpha	N of Items

.726	10

Table 3.6 Reliability statistics for trainees' practical work session observation checklist

Cronbach's Alpha	N of Items
.806	8

Table 3.7 Reliability statistics for practical skills assessment observation checklist

Cronbach's Alpha	N of Items
.701	9

3.12 Study procedures

It is incredibly difficult (and perhaps unwise) to establish precise guidelines that experimental research should abide by because it rarely occurs in a methodical manner and as such it is advisable to just suggest an ideal path to be pursued (Cohen, Manion, & Morrison, 2000). The route for this study started with approval of the study proposal by the School of Education and research clearance from the various institutions concerned with research in the country. A visit to the study institutions was made so as to familiarise with the environment, available facilities, equipment (Workshop and ICT) and available technical staff (Workshop and ICT technicians) that eventually offered technical support to the study. The selection and meetings of the instructors and UBTEB assessors was then conducted at the study institutions alongside their acclimatisation with the study trainees, during which time, the researcher introduced the study participants to the purpose and objectives of the study, their respective roles in the study, the procedures and processes involved in the study and the ethical considerations of the study.

Once the instructors and UBTEB assessors were acclimatise with the quasi-experimental study, the researcher convened and coordinated the meeting(s) of the instructors of both programmes, and of UBTEB assessors to develop: practical training tasks for the face-to-face and online pedagogies in the selected programmes; test items and the respective marking criteria for the study practical tests. To ensure uniformity of extent and difficulty of content, the practical tasks taught in the face-to-face (control) group were the ones recorded, filmed, digitally enhanced, and livestreamed with the use of ICTs, to the online pedagogy (experimental) group. To avoid the control and experimental group from mixing and as such contaminating each other and the study, the two groups for the same programme were in separate institutions so that the experimental group has no other training on the task at hand other than online training. The same procedure was repeated for the second programme but this time with the two groups switching sides. To ensure reliability of the data collected, the control and experimental group of the first task switched to the experimental and control groups of the second task respectively.

With all the participants well versed with the expected study procedures and processes, the researcher then simulated the quasi-experimental study so as to determine possible hiccups in any facet of the experiment by pilot testing all the procedures. The tested and agreed-on processes and procedures in the pilot phase were then adhered to throughout the experimental study. The timing and sequencing of training sessions, the timing and sequencing of the posttest practical tasks, the observations and recording procedures, scoring and moderation procedures were all meticulously followed throughout the experimental study. As soon as the research assistants had finalised the administering of questionnaires to all participants so as to gather pretest data, the training sessions

commenced for both programmes in the two institutions and were conducted during the scheduled timetable so as to minimise interference with normal class routine. As the sessions proceeded, the instructors used the observation checklist to capture various observed data in all the groups. The control group of each task was trained in the traditional format of face-to-face with the instructors and trainees in the same place and time as trainees were guided through the tasks whereas the experimental group was trained via video live stream. The recorded, filmed and digitally enhanced video that was transmitted online was the only source of training for the experimental group to guide them in performing the task at hand. For the second task, the experimental group of the previous task became the control group that is taught face-to-face and the control group of the previous task became the experimental group whose only training and guidance to perform the task was online. This procedure was repeated for the second programme.

First, the pretest results were analysed to determine study entry demographic data that can directly identify the participants, as well as initial (onset) perception towards online pedagogy; and then after the study, the posttest results were analysed to determine if the onset trainees' attitudes had significantly changed after undergoing online training and assessment. Then to ascertain the effectiveness of the online pedagogy in TVET practical skills training, assessment, acquisition and performance, the dependent variables for the two groups were measured, compared and analysed.

3.13 Data analysis

Descriptive statistics were used to assist define and explain the characteristics of the data set by providing brief summaries (mean, mode and frequency) of the data obtained from the Likert scales. Then inferential statistics were used to examine the significance of the

identified difference(s) between the means. The Nonparametric Test, the Independent-Samples Mann-Whitney U Test, was used to test the means for: the first hypothesis of the study "*There is no significant difference in TVET practical skills training conducted through face-to-face and that conducted online;* the second hypothesis of the study "*There is no significant difference in TVET practical skills acquisition of trainees trained face-to-face and those trained online";* and the third hypothesis for the study "*There is no significant difference in TVET practical skills assessment conducted through face-to-face and that conducted online".* Then the Independent-Samples T- Test was used to test the fourth hypothesis for the study "*There is no significant difference in TVET practical skills performance of trainees trained face-to-face and those trained online".* And the within subjects' statistical test (Paired Samples T - Test) was used to test the fifth hypothesis for the study "*There is no significant difference in TVET trainees' perception of online pedagogy before and after undergoing online practical skills training, acquisition and assessment".*

Qualitative analysis was used for the data from the open-ended posttest questionnaires to address the study research question and as a result establish the challenges as per objective 6 of the study. The qualitative data was organised and transcripts printed out to enable the researcher to read it several times over and, in the process, make sense of what it contained. Key words and phrases with in the data were then highlighted and grouped into themes that the researcher then described in a systematic manner to best respond to the research question of the study.

3.14 Ethical considerations

Upon receipt of the introductory letter from the School of Education University of Eldoret, the research proposal was submitted to the Research Ethical Committee of Mbarara University of Science and Technology where approval of the: study research protocol; and the informed consent documents that were used to get consent from be the respondents before collection of the data was secured. The committee was preferred due to its excellent efficiency and effectiveness track record. Then, a research permit from Uganda National Council for Science and Technology (UNCST), the body responsible for research in the country was secured to allow the researcher conduct the study in the country. Also, permission was secured from: the Ministry of Education and Sports to conduct the study in the selected institutions; UBTEB to allow selected assessors to participate in the study; and the administration and management of the selected institutions to allow their instructors, trainee's, and facilities to be involved or be part of the study. All the above approvals are appended to this thesis.

Informed consent was then obtained from each participant of the study after ensuring that they had a thorough understanding of the study's aim, procedures, hazards, and requirements. The study ensured that no participant was exposed to any danger of stress, humiliation, or loss of self-esteem. In addition to ensuring participants' anonymity, the study protected the confidentiality of the information collected as provided for in the cover letter. Respondents were provided with a summary of the preliminary findings. Also, participants were encouraged by assurances of confidentiality, anonymity, and non-traceability in the research, as well as by disclosure of their rights to discontinue

participation at any time or to opt out of completing certain questionnaire items (Cohen, Manion, & Morrison, 2000).

3.15 Chapter summary

This chapter has described the postpositivsm research philosophy in which this study is anchored, and the quasi-experimental (pretest, posttest) design of the study. The chapter has also detailed the area where the study is to be conducted, the population that shall be targeted and sampled by the study, the technique that shall be used to sample the population for the study, study variables, methods and the instruments to be used for data collection. The chapter has concluded with a description of the study validity and reliability, procedures, ethical considerations, and data analysis.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, INTERPRETATION AND DISCUSSION

4.1 Introduction

This chapter is divided into three sections. The first presents an overview of the study design and data analysis is presented. The second, section then presents a demographic profile of the sample population of trainees, instructors, and assessors. Third, the study findings are presented under the respective objective, interpreted using descriptive and inferential statistics and then discussed in relation to the previous literature to make logical inferences and draw out their implication to the theoretical fundamentals of future training, acquisition, assessment, performance and perception of TVET practical skills.

4.2 Overview of study design and data analysis

The study was conducted at St. Josephs Technical Institute, Kisubi and Nakawa Vocational Training College. A total number of sixty-nine (69) trainees, twenty (20) instructors and eight (8) assessors participated in the study. The trainees were first years' offering the National Certificate in Building Construction - NCBC and the National Certificate in Woodwork Technology – NCWT. For each programme, two practical tasks were delivered, worked on by trainees and assessed through both face-to-face and online. To avoid the control and experimental group from mixing and as such contaminating each other and the study, the two groups were in separate institutions for the same practical task and to ensure reliability of the data collected, the control and experimental group of the first task switched to the experimental and control groups of the second task respectively (**Table 4.1**). For uniformity of extent and difficulty of content, the practical task taught in the face-to-face (control) group was the one recorded and digitally

enhanced with the use of ICTs, for training the online (experimental) group. To ensure that the experimental group has no other training on the task at hand other than online training, both sessions (Face-to-face and online) of the same practical task, took place simultaneously as shown by the training schedule in **Appendix VII d**. The study analysed and compared TVET practical skills training, assessment, acquisition, and performance in face-to-face and online pedagogies in order to determine the efficacy of online pedagogy on TVET practical skills training, assessment, acquisition, and performance.

Table 4.1: Schedule for face-to-face and online training of practical tasks

	NCBC programme		**NCWT programme**	
	Steel Bending	Broken Bond	Beam Framework	Equilateral Arch
St. Josephs Technical Institute, Kisubi	Face-to-face	Online	Online	Face-to-face
Nakawa Vocational Training College	Online	Face-to-face	Face-to-face	Online

Three categories of instruments were used to collect data for the study and they included observation instruments, Assessment tools and survey questionnaires. The instruments were used to capture trainees' (N=69) performance and perception, instructors (N=20) observations of training and assessment, and assessors (N=8) scores of trainees' performance. The data collected was analysed using the statistical package for social sciences (SPSS) to test the following hypotheses for the study:

1. H_0: There is no significant difference in TVET practical skills training conducted through face-to-face and that done online;

2. H0: There is no significant difference in TVET practical skills assessment conducted through face-to-face and that done online;
3. H0: There is no significant difference in TVET practical skills acquisition of trainees trained face-to-face and those trained online; and
4. H0: There is no significant difference in TVET practical skills performance of trainees trained face-to-face and those trained online.
5. H0**:** There is no significant difference in TVET trainees', instructors' and assessors' perception of online pedagogy before and after undergoing online practical skills training, acquisition, assessment and performance.

The study alpha (significance level) of 0.05 was established for each of the statistical tests that was done to analyse and test the five hypotheses. Descriptive statistics were generated for each data set to summarise the collected data/responses from the instruments and then a normality test (Shapiro-Wilk test of Normality) was conducted to determine if the amalgamated data of each set was normally distributed. For the data that was not normally distributed, the nonparametric test, the independent-Samples Mann-Whitney U Test, was used to test the means whereas for the data that was normally distributed, a parametric Test, the independent-samples T- Test, was used to test the means.

4.3 Demographic profile of the sample population

The source for the onset demographic profile of the sample population was Section 1 (Demographic and Background Information) of the trainees/instructors/assessor's pretest

Questionnaire shown in **Appendix II** (**a**). The results of the demographic profile are presented according to category of participants (trainees, instructors and assessors).

4.3.1 Demographic profile of the trainee's population

Demographically, the sample population of trainees (n = 69) varied in institution of study,

programme of study, gender, academic background, competency in use of ICT and experience in online learning (

Table 4.2 up to **Table 4.6**). For both institutions, the NCBC programme, male trainees, trainees with an academic background of Uganda Certificate of Education - UCE (S4), trainees competent in use of ICT, trainees with no experience on online learning, and trainees having previous experience/training in practical skills represented the majority of the population sample.

Table 4.2, shows the case summary of trainee participants per programme of study**.** The programme of study profile was NCBC programme 56.5% trainees and NCWT programme 43.5% trainees and 50.7% trainees from St. Josephs Technical Institute, Kisubi and 49.3% trainees from Nakawa Vocational Training College.

Table 4.2: Case summary of trainee participants per programme of study

Name of Institution	Programme of Study	N	% of Total N
St. Josephs Technical Institute, Kisubi	NCBC programme	20	29.0
	NCWT programme	15	21.7
		35	**50.7**
Nakawa Vocational Training College	NCBC programme	19	27.5
	NCWT programme	15	21.7
		34	**49.3**
Total	NCBC programme (Total)	39	56.5
	NCWT programme (Total)	30	43.5
		69	**100**

Table 4.3 shows the case summary of trainee's gender. The NCBC programme trainees' profile was females 23.2% and males 33.3% whereas the NCWT programme profile was females 2.9% and males 40.6%. The NCBC programme had the highest percentage of female trainees (23.2%) as compared to male trainees (33.3%) in the study. However, despite the fact that all year one trainees in the NCWT programme from both institutions were selected for the study, the percentage of female trainees (2.9%) was so small compare to male trainees (40.6%). This gender demographic profile of the sample population is indicative and in tandem with the national profile of fewer females in TVET programs that society still 'regards' as not suitable for females. Thus, this gender demographic profile of the study reflected the real-life trainees gender environment in technical TVET programmes across the country.

Table 4.3: Case summary of trainee participants' gender

Programme of Study	Gender	N	% of Total N
NCBC programme	Female	16	23.2
	Male	23	33.3
		39	**56.5**
NCWT programme	Female	2	2.9
	Male	28	40.6
		30	**43.5**
Total	Female (Total)	18	26.1
	Male (Total)	51	73.9
		69	**100**

Table 4.4: Shows the case summary of trainee's academic background. The NCBC programme trainees' profile was education background of UACE (S6) 17.4%, UCE (S4) 37.7% and Community Polytechnic/Technical School 1.4% whereas the NCWT programme profile was education background of UACE (S6) 7.2%, UCE (S4) 33.3% and Community Polytechnic/Technical School 2.9%. At a total percentage of UACE 24.6%, UCE 71.0% and Community Polytechnic/Technical School 4.3%; all trainee background categories were fairly represented in the study.

Table 4.4: Case summary of trainees' academic background

Programme	Academic Background	N	% of Total
NCBC programme	Uganda Advanced Certificate of Education	12	17.4
	Uganda Certificate of Education	26	37.7
	Community Polytechnic/Technical School	1	1.4
		39	**56.5**
NCWT programme	Uganda Advanced Certificate of Education	5	7.2
	Uganda Certificate of Education	23	33.3
	Community Polytechnic/Technical School	2	2.9
		30	**43.5**
Total	Uganda Advanced Certificate of Education	17	24.6
	Uganda Certificate of Education	49	71
	Community Polytechnic/Technical School	3	4.3
		69	**100**

Table 4.5, shows the case summary of trainee's competency in use of ICT. The NCBC programme trainees' profile was, trainees competent in ICT 49.3% and trainees not competent in ICT 7.2%, whereas the NCWT programme profile was trainees competent in ICT 30.4% and not competent 13.0%. Thus, 79.7% of the total number of trainees in the study were competent in the use of ICTs, whereas 20.3% were competent in the use of ICT. The presence of both categories in the study was a fair representation considering that whereas ICTs are part of the school's curriculum and as such many primary and secondary schools, especially in the urban centres are teaching them, in the rural countryside they still lack ICTs and thus have little exposure to them.

Table 4.5: Case summary of trainees' competency in use of ICT

Programme	Competency in use of ICT	N	% of Total
NCBC programme	Competent	34	49.3
	Not Competent	5	7.2
		39	**56.5**
NCWT programme	Competent	21	30.4
	Not Competent	9	13.0
		30	**43.5**
Total	Competent	55	79.7
	Not Competent	14	20.3
		69	**100**

Table 4.6, shows the case summary of trainee's experience in online learning. The NCBC programme profile was, trainees having experience in online learning 17.4% and no experience 39.1%, whereas the NCWT programme profile was trainees having experience in online learning 8.7% and no experience 34.8%. Thus, 73.9% of the total number of trainees in the study had no prior experience in online learning, whereas 26.1% had previous experience of online learning. Considering that online learning is not yet fully embraced as an alternative for learning at all levels of education and training in the country, the presence of both categories in the study was a fair representation that contributed to the truth value of the findings.

Table 4.6: Case summary of trainees' experience in online learning

Programme of Study	Experience in online learning	N	% of Total N
NCBC programme	Have Experience	12	17.4
	No Experience	27	39.1
		39	**56.5**
NCWT programme	Have Experience	6	8.7
	No Experience	24	34.8
		30	**43.5**
Total	Have Experience	18	26.1
	No Experience	51	73.9
		69	**100**

4.3.2 Demographic profile of the instructors' and assessors' population

Demographically, the sample population of instructors (n = 20) and that of assessors (n = 8) varied in programme taught or assessed, gender**,** academic background, competency in use of ICT and experience in online learning (**Table 4.7 up to Table 4.11**). For the instructors, the majority were male (70%), diploma holders (50%), competent in use of ICT (100%) and with no experience in online learning (90%); whereas for the assessors, the majority were male (87.5%), diploma holders (62.5%) and were competent in use of ICT (100%) and had no experience in online learning (100%).

Table 4.7: Case summary of instructors and assessors per programme taught/ assessed

Category	Programme instructed/Assessed	N	% of Total
Instructors	NCBC programme	10	50
	NCWT programme	10	50
		20	**100**
Assessors	NCBC programme	4	50
	NCWT programme	4	50
		8	**100**

Table 4.8 shows the case summary of instructor's and assessors' gender. The instructors' profile was females 30% and males 70% whereas the assessors' profile was females 12.5% and males 87.5%. This gender demographic profile of the sample population of instructors and assessors' is indicative and in tandem with the national profile of fewer females in TVET programs that society still 'regards' as not suitable for females. Thus, this gender demographic profile of the study reflected the real-life instructors and assessors gender environment in technical TVET programmes across the country.

Table 4.8: Case summary of instructor's and assessors' gender

Category	Gender	N	% of Total
Instructors	Female	6	30
	Male	14	70
		20	**100**
Assessors	Female	1	12.5
	Male	7	87.5
		8	**100**

Table 4.9 shows the case summary of instructor's and assessors' academic background. The instructors' profile was education background of post graduate 10%, degree holders' 40% and diploma holders' 50%; whereas the assessors' profile was education background of post graduate 12.5%, degree holders' 25% and diploma holders' 62.5%. This demographic profile meant that instructors and assessors with different academic background were represented in the study.

Table 4.9: Case summary of instructor's and assessors' academic background

Category	Academic Background	N	% of Total N
Instructors	Post Graduate	2	10
	Degree Holder	8	40
	Diploma Holder	10	50
		20	**100**
Assessors	Post Graduate	1	12.5
	Degree Holder	2	25
	Diploma Holder	5	62.5
		8	**100**

Table 4.10, shows the case summary of instructor's and assessors' competency in use of ICT. All the twenty (20) instructors and eight (8) assessors were competent in the use of ICTs. This profile was indicative of the national characteristics considering that ICTs are part of the training process of all instructors (including those instructors that eventually become assessors) in the country.

Table 4.10: Case summary of instructor's and assessors' competency in use of ICT

Category	Competency in use of ICT	N	% of Total N
Instructors	Competent	20	100
	Not Competent	0	0
		20	**100**
Assessors	Competent	8	100
	Not Competent	0	0
		8	**100**

Table 4.11 shows the case summary of instructor's and assessors' experience in online learning. The instructor's profile was, 10% having experience in online learning and 90% having no experience in online learning, whereas all 8 assessors in the study had no experience in online learning and assessment. The complete lack of an assessor with experience in online learning and assessment was due to the fact that all forms of assessment in the country have been done face to face. Considering that online learning and assessment is not yet fully embraced as an alternative at all levels of education and training in the country, the presence of both categories of trainers in the study was a fair representation that contributed to the truth value of the study findings. Also, the assessors lack of previous exposure to online assessment meant that they were to experience it for the first time during the study and as such have no preconceptions and pre-existing bias towards the process.

Table 4.11: Case summary of instructor's and assessors' experience in online learning

Category	**Experience in online learning**	**N**	**% of Total N**
Instructors	Have Experience	2	10
	No Experience	18	90
		20	**100**
Assessors	Have Experience	0	0
	No Experience	8	100
		8	**100**

4.4 Effectiveness of an online pedagogy on training of TVET practical skills

The first objective of the study was to determine the effectiveness of an online pedagogy on training of TVET practical skills. To achieve this, a group of twenty (20) instructors observed both the face-to-face and online training of two practical tasks in the NCBC programme (Steel Bending and Broken Bond), and another two practical tasks in the NCWT programme (Beam Formwork and Equilateral arch center). Since each practical session that was delivered face-to-face was also being live streamed for the online group to train simultaneously, the instructors were split into two groups of ten (10) each to observe and score both pedagogies (Face-to-face and Online). Each observer scored their respective training session (face-to-face or online) using the training session observation checklist shown in **Appendix III (a)**. The observations of each practical task training were based on ten (10) parameters as summarised in **Table 4.12** below.

Table 4.12 Parameters observed during training sessions of each practical task

	Observed Parameter
Parameter 1	Training session is clearly presenting the material to be learned
Parameter 2	The training is adaptive to enable trainees to begin with very easy versions of the practical task and then move gradually to more difficult versions of the task.
Parameter 3	The training elicits performance
Parameter 4	The training provides immediate feedback
Parameter 5	The training enhances retention and transfer by providing opportunities for additional guided practice or projects that might relate learning to other real-life activities.
Parameter 6	The training delivery is a collaborative process including more than one trainer, technician, ICT staff, librarians, etc.
Parameter 7	The training session is not affected by service(s) interruption (by lack of access to electricity, internet connectivity, devices or media, learning platforms).
Parameter 8	Trainees are properly following the training content and material being presented during the training session.
Parameter 9	Trainees are participating in the training session activities (such as full attendance, asking questions, and free expression to the instructor).
Parameter 10	Trainees have the option of playing back the training session over and over again to reinforce their learning as they practice.

The scoring of each observed parameter was made along a ranked Likert scale (**Table 4.13**) that ranked from Strongly Disagree, Disagree, Neutral, Agree and Strongly Agree. To simplify the presentation of the findings, the rankings were condensed to just three

points that included Disagree (merging strongly disagree and disagree), Agree (merging strongly agree and agree) and Neutral.

Table 4.13 Ranking of the Likert scale

Response	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Rank	1	2	3	4	5

4.4.1 Presentation of descriptive statistics

A total of eighty (80) observations of the training process were made for both programmes [10 observations per practical task session x 2 tasks per programme x 2 pedagogies (face-to-face and online) x 2 programmes (A and B)]. The results of the observations made for each practical session are summarized in frequency of observed scores (**Table 4.14**) of the online and face-to-face training sessions across the nine observed parameters. The results show a high frequency of observed scores of "Agree" in parameters 1, 2, 3, 8 and 9 across both pedagogies for all the practical tasks. However, the frequency of observed scores tend to differ significantly for parameters 4, 6 and 10 across both pedagogies.

To have a better and clear understanding of the results, the means were computed and are presented in **Table 4.15**. The results in the table show that the mean score of parameters 1, 2, 3, 5, 8 and 9 are consistently bordering around or over 4.0 (a rank for 'agree' on the Likert scale) for both face-to-face and online data. On the other hand, Parameter 4, 6, 7 and 10 showed a disparity between the face-to-face and online means. Parameter 6, 7 and

10 had the lowest mean scores for the face-to-face data set, whereas parameter 4 and 7 had the lowest mean scores for the online data set.

Table 4.14: Frequency of observed scores of the online and face-to-face training sessions across the ten observed parameters

Practical task being observed	Pedagogy being observed		Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5	Parameter 6	Parameter 7	Parameter 8	Parameter 9	Parameter 10
1. Steel Bending	Face-to-face	Disagree						3	3			5
		Neutral				3	1	5	4			4
		Agree	10	10	10	7	9	2	3	10	10	1
	Online	Disagree				6	1		5			
		Neutral		1		4	2		5		1	
		Agree	10	9	10		7	10		10	9	10
2. Broken Bond	Face-to-face	Disagree						3	2			6
		Neutral				4	1	6	3			3
		Agree	10	10	10	6	9	1	5	10	10	1
	Online	Disagree				4	1		4		1	
		Neutral		1		5	1	2	4			2
		Agree	10	9	10	1	8	8	2	10	9	8
3. Beam Form work	Face-to-face	Disagree						4	3			5
		Neutral				3		4	2			5
		Agree	10	10	10	7	10	2	5	10	10	
	Online	Disagree				5			4			
		Neutral		1		5	2		5		1	1
		Agree	10	9	10		8	10	1	10	9	9
4. Equilateral Arch Center	Face-to-face	Disagree						4	1			6
		Neutral				3		6	3			4
		Agree	10	10	10	7	10		6	10	10	
	Online	Disagree				5			3			
		Neutral				5	2	2	5		1	1
		Agree	10	10	10		8	8	2	10	9	9

Conversely, parameters 1, 2, 3, 5, 8 and 9 showed the highest mean scores (4.58, 4.43, 4.38, 4.28, 4.40 and 4.40 respectively) for the face-to-face data, whereas parameter 1, 2, 3, 5, 6, 8, 9 and 10 had the highest mean scores (4.38, 4.20, 4.28, 3.98, 4.47, 4.45, 4.22 and 4.40 respectively) for the online data set. The means of the observed data set for the face-to-face training process are in the agreement range for parameters 1, 2, 3, 4, 5, 7, 8 and 9 whereas for parameters 6 and 10 the data set is in the disagreement range. The means of the online assessment process show parameters 1, 2, 3, 5, 6, 8, 9 and 10 in the agreement range; whereas parameters 4 and 7 are in the disagreement range.

Table 4.15: Observed scores of the online and face-to-face training sessions

Observed Parameter	Number of Observations	Face-to-face Mean	Online Mean
Parameter 1	80	4.58	4.38
Parameter 2	80	4.43	4.20
Parameter 3	80	4.38	4.28
Parameter 4	80	3.75	2.53
Parameter 5	80	4.28	3.98
Parameter 6	80	2.78	4.47
Parameter 7	80	3.25	2.73
Parameter 8	80	4.40	4.45
Parameter 9	80	4.40	4.22
Parameter 10	80	2.40	4.40

To graphically present the difference in mean scores of the parameters, the mean scores of observed responses for the online and face-to-face training sessions across the ten

observed parameters were plotted in a line chart. The biggest gaps between the line chart plots (**Figure 4.1**) of the face-to-face and online mean scores can be seen to occur at parameter 4, 6 and 10.

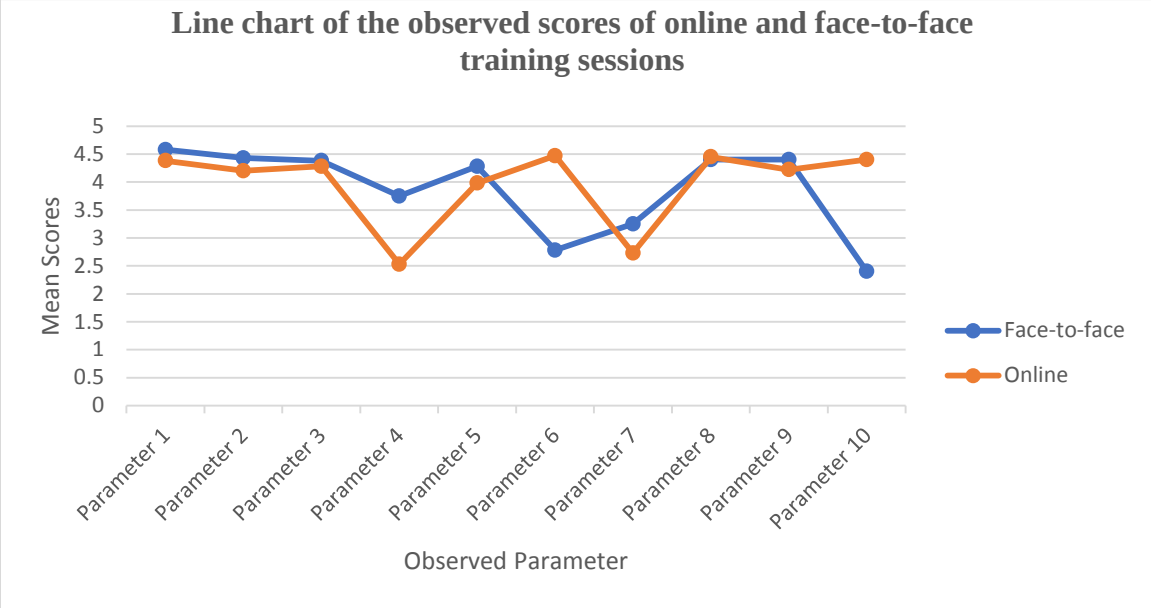

Figure 4.1: Line chart of the observed scores of online and face-to-face training sessions

4.4.2 Presentation of inferential statistics

The first hypothesis for the study stated that "*There is no significant difference in TVET practical skills training conducted through face-to-face and that conducted online"*. To test the hypothesis, the normality of the scores was first determined before deciding on which inferential statistical test to run on the data set. The normality of the mean scores was run in SPSS and due to the number of samples in the study, the Shapiro-Wilk test of Normality was used to test the normality of the mean scores of the practical skills training process as shown by the results in **Table 4.16**.

Table 4.16: Normality test for the amalgamated means of all the tasks combined

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Mean	.152	80	.000	.963	80	.020

Table 4.16 shows that the significant value 0.020 of the amalgamated means is less than 0.05 which indicates that the means are not normally distributed. This is confirmed by the Detrended Normal Q-Q Plot of the amalgamated means (**Figure 4.2**) in which a sizable number of means are far above and below the horizontal line which represents how much higher and lower they are respectively, than what would be expected if the data were normally distributed.

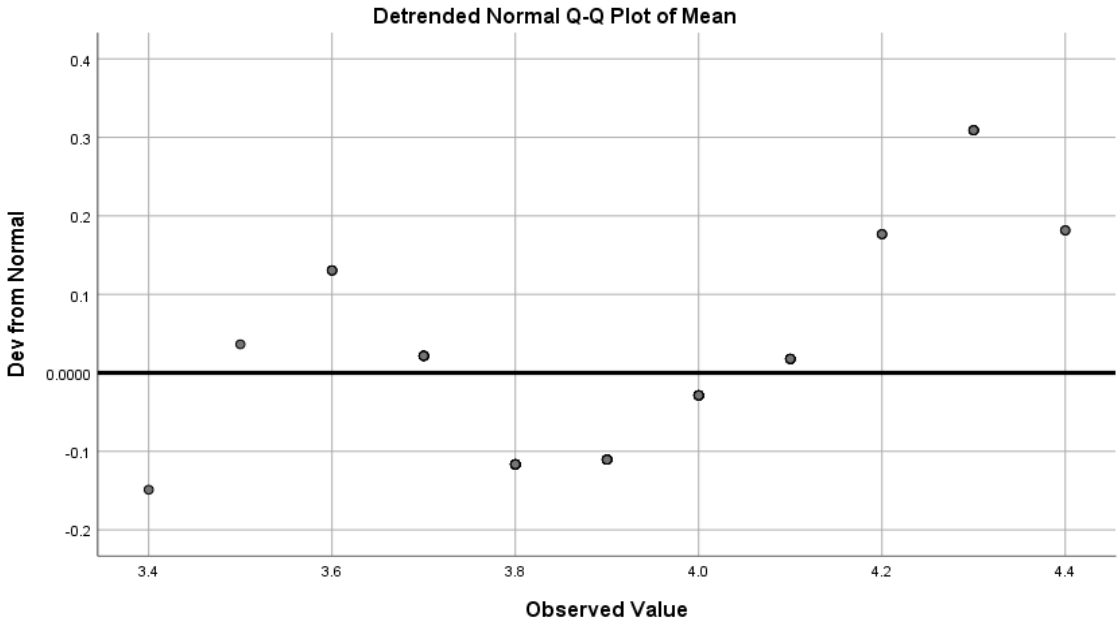

Figure 4.2: Detrended Normal Q-Q Plot for the amalgamated means of all the tasks combined

Considering that the amalgamated means of all the tasks that were to be used in the analysis are not normally distributed as shown above, then a Nonparametric Test, the Independent-Samples Mann-Whitney U Test, was used to test the means. The results of the test are summarised in **Table 4.17** and **Figure 4.3**.

Table 4.17: The Independent-Samples Mann-Whitney U Test Summary for the observed scores of online and face-to-face training sessions

Total N	80
Mann-Whitney U	997.000
Wilcoxon W	1817.000
Test Statistic	997.000
Standard Error	102.692
Standardised Test Statistic	1.918
Asymptotic Sig. (2-sided test)	.055

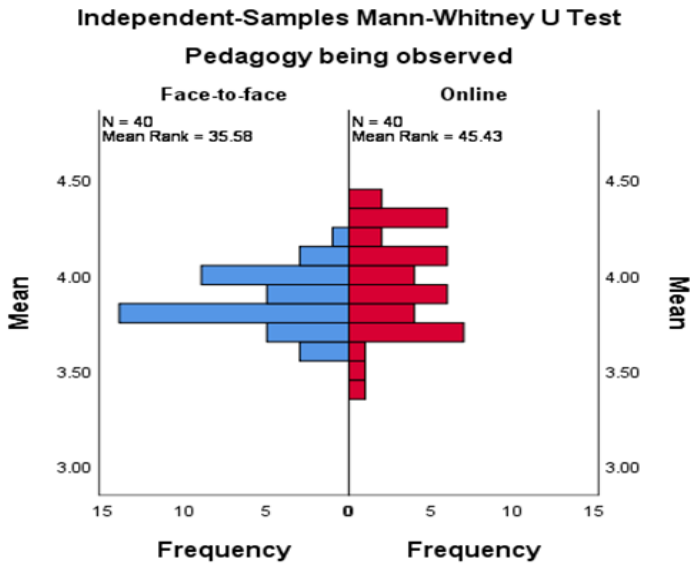

Figure 4.3: The Independent-Samples Mann-Whitney U Test Comparison of means of online and face-to-face training sessions

As summarised in the hypothesis test summary in **Table 4.18**, Since the significant value p = 0.055 is greater than the study significance level α = 0.05, then the study fails to reject the null hypothesis. This means that the distribution of trainees' average performances is the same across the face-to-face and online categories of pedagogy being observed in the study. Based on the results, there was no statistically significant difference in the TVET practical skills training delivered face-to-face and that delivered online.

Table 4.18: Hypothesis Test Summary

Null Hypothesis	Test	Sig.	Decision
The distribution of mean is the same across categories of Pedagogy being observed.	Independent-Samples Mann-Whitney U Test	.055	Fail to reject the null hypothesis.

4.5 Effectiveness of an online pedagogy on TVET practical skills acquisition

The second objective of the study was to determine the effectiveness of an online pedagogy on trainees' acquisition of TVET practical skills. To achieve this, a group of twenty (20) instructors observed trainees as they worked on the assigned practical tasks after undergoing training. The observations of each trainee working on the assigned tasks were made for the group that had trained for the practical task face-to-face and the group that had trained for the task online. The observations were made for the work sessions of the two practical tasks in the NCBC programme (Steel Bending and Broken Bond), and another two practical tasks in NCWT programme (Beam Formwork and Equilateral arch centre). Since the work sessions for the group that had trained face-to-face and that of the

group that had trained online took place simultaneously, then the instructors were split into two groups of ten (10) each to observe and score both groups (face-to-face trained group and online trained group). Thus, with the number of instructors (10) per session being smaller than the trainees being watched (15, 19 or 20 per group for each work session), some instructors followed and thus scored two trainees during a single work session. Each observer (instructor) scored their respective trainee (s) for a particular work session (face-to-face trained group or online trained group) using the trainees' work session observation checklist shown in **Appendix III (b)**. For each practical task being worked on, the instructors scored trainees along eight parameters as shown in

Table 4.19.

Table 4.19: Parameters observed during work sessions of each practical task

	Observed Parameter
Parameter 1	Trainee demonstrates ability to read and interpret working drawings.
Parameter 2	Trainee consistently demonstrates procedural skills (ability to do something e.g. cut a steel bar).
Parameter 3	Trainee demonstrates competence in handling of tools and equipment.
Parameter 4	Trainee demonstrates conceptual skills (understands complex scenarios and develop creative solutions).
Parameter 5	Trainee observes and focuses on the skill being taught.
Parameter 6	Trainee shows interest and is motivated as he/she works on the practical task.
Parameter 7	Trainee demonstrates process skills (to manage and modify actions e.g. selecting the right tools).
Parameter 8	Trainee demonstrates a sense of belonging and connection with colleagues in the learning community.

The scoring of each observed parameter was made along a five-point ranked Likert Scale (**Table 4.20**) that ranked from Strongly Disagree, Disagree, Neutral, Agree and Strongly Agree. To simplify the presentation of the findings, the rankings were condensed to just three points that included Disagree (merging strongly disagree and disagree), Agree (merging strongly agree and agree) and Neutral.

Table 4.20: Ranking of the Likert scale

Response	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Rank	1	2	3	4	5

4.5.1 Presentation of descriptive statistics

A total of one hundred thirty eight (138) observations of trainees' work sessions were made and they included: seventy (70) observations made at St. Josephs Technical Institute, Kisubi –NCBC programme [20 trainees observed per session x 2 work sessions (one face-to-face trained and one online trained)] and NCWT programme [15 trainees observed per session x 2 work sessions (one face-to-face trained and one online trained)]; sixty eight (68) observations made at Nakawa Vocational Training College – NCBC programme [19 trainees observed per session x 2 work sessions (one face-to-face trained and one online trained)]; and NCWT programme [15 trainees observed per session x 2 work sessions (one face-to-face trained and one online trained)]. The frequency of the observations made are summarized in **Table 4.21**. From the results, it's evident that the majority of the observations lay in the 'agree' score for both the face-to-face trained and the online trained groups.

Table 4.21: Frequency of trainees work session scores across the eight observed parameters for the face-to-face trained and online trained groups

Practical task being observed	Pedagogy being observed		Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5	Parameter 6	Parameter 7	Parameter 8
1. Steel Bending	Face-to-face	Disagree								1
		Neutral			1	3				5
		Agree	20	20	19	17	20	20	20	14
	Online	Disagree								1
		Neutral			1	4	1		1	5
		Agree	19	19	18	15	18	19	18	13
2. Broken Bond	Face-to-face	Disagree								
		Neutral					1		3	3
		Agree	19	19	19	19	18	19	16	16
	Online	Disagree			2					2
		Neutral			2	4		3	3	5
		Agree	20	20	16	16	20	17	17	13
3. Beam Form work	Face-to-face	Disagree								
		Neutral				2		2		
		Agree	15	15	15	13	15	13	15	15
	Online	Disagree								
		Neutral	1	1		1	2	1		2
		Agree	14	14	15	14	13	14	15	14
4. Equilateral Arch Center	Face-to-face	Disagree						1		
		Neutral					2	1	1	2
		Agree	15	15	15	15	13	13	14	13
	Online	Disagree			1			1		
		Neutral				3		2	2	
		Agree	15	15	14	12	15	12	13	15

To have a better and clear understanding of the results, the means were computed and are presented in **Table 4.22**. The results in the table show that the mean scores of all parameters are above the 4.0 rank (Agree) across both pedagogies (Online and face-to-face).

Table 4.22: Observed scores of the trainees' practical work session

Observed Parameter	Number of Observations	Face-to-face Mean	Online Mean
Parameter 1	138	4.77	4.70
Parameter 2	138	4.39	4.51
Parameter 3	138	4.52	4.30
Parameter 4	138	4.39	4.19
Parameter 5	138	4.43	4.48
Parameter 6	138	4.39	4.42
Parameter 7	138	4.35	4.38
Parameter 8	138	4.14	4.12

To graphically present the difference in mean scores of the parameters, the mean scores of observed responses for the online and Face-to-face training sessions across the eight observed parameters were plotted in a line chart. Slightly smaller differences between the line chart plots of the face-to-face and online mean scores exist at parameters 2, 3 and 4 as shown in **Figure 4.4** below.

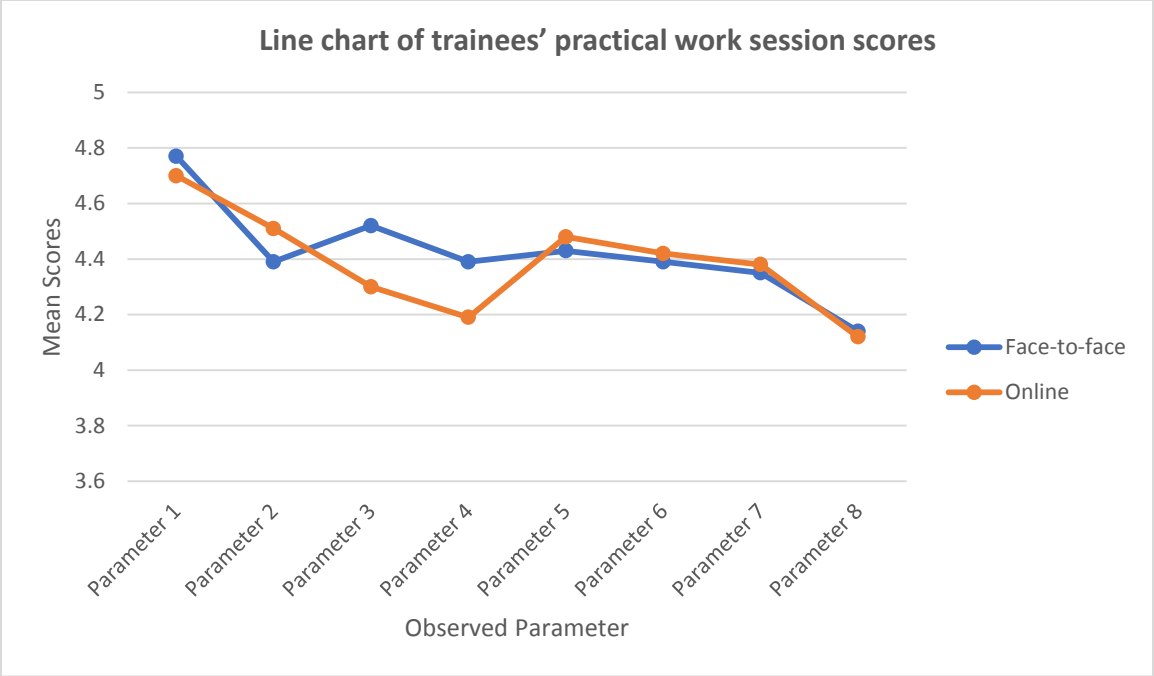

Figure 4.4: Line chart of trainees' practical work session scores

4.5.2 Presentation of inferential statistics

The second hypothesis for the study stated that "*There is no significant difference in the TVET practical skills acquisition of trainees trained face-to-face and those trained online.*" To test the hypothesis, the normality of the scores was first determined before deciding on which inferential statistical test to run on the data set. The Normality of the mean scores was run in SPSS and due to the number of samples in the study, the Shapiro-Wilk test of Normality was used to test the normality of the mean scores of trainee's practical skills acquisition as shown by the results in **Table 4.23**.

Table 4.23: Normality test for the amalgamated observation means of all the work sessions

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Mean	.126	138	.000	.971	138	.005

Table 4.23 shows a significant value 0.005 for the amalgamated means. The value was less than the study alpha (significance level) of 0.05 which indicated that the amalgamated means were not normally distributed. This is confirmed by the Detrended Normal Q-Q Plot of the amalgamated means (**Figure 4.5**) in which a sizable number of means are far below the horizontal line which represents how much lower they are, than what would be expected if the data were normally distributed.

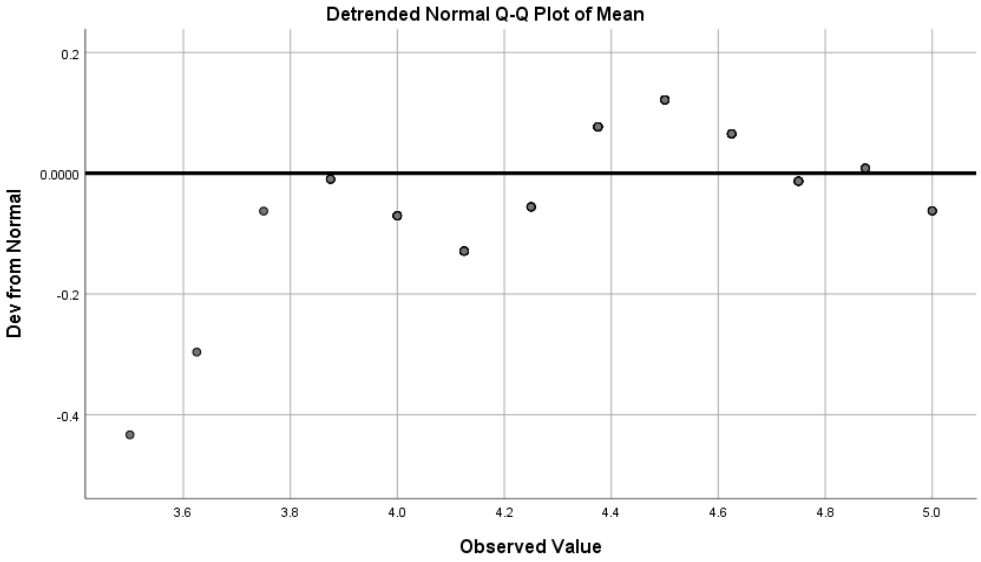

Figure 4.5: Detrended Normal Q-Q Plot for the amalgamated observation means of all the work sessions

Considering that the amalgamated observation means of all the work sessions that were to be used in the analysis are not normally distributed as shown above, then a Nonparametric Test, the Independent-Samples Mann-Whitney U Test, was used to test the means. The results of the test are summarized in **Table 4.24** and **Figure 4.6**.

Table 4.24: The Independent-Samples Mann-Whitney U Test Summary for the observed scores of the trainees' practical work session

Total N	138
Mann-Whitney U	2208.500
Wilcoxon W	4623.500
Test Statistic	2208.500
Standard Error	232.973
Standardized Test Statistic	-.738
Asymptotic Sig. (2-sided test)	.460

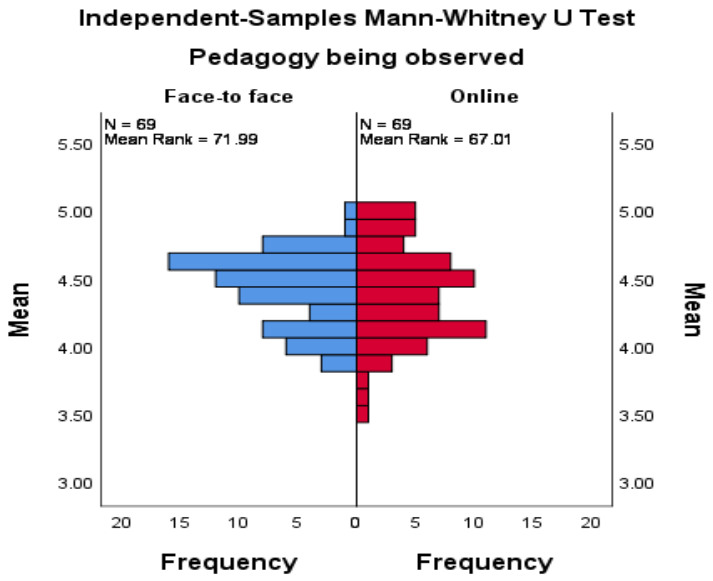

Figure 4.6: The Independent-Samples Mann-Whitney U Test Comparison of means of the trainees' practical work session

As summarized in the hypothesis test summary in **Table 4.25**, Since the significant value p = 0.460 is greater than the study significance level α = 0.05, then the study fails to reject the null hypothesis. This means that the distribution of trainees' average performances is the same across the face-to-face and online categories of Pedagogy being observed in the study. Based on the results, there was no statistically significant difference in the acquisition of practical skills by trainees who trained for the skills face-to-face and those that were trained online.

Table 4.25: Hypothesis Test Summary

Null Hypothesis	Test	Sig.	Decision
The distribution of Mean is the same across categories of Pedagogy being observed.	Independent-Samples Mann-Whitney U Test	.460	Fail to reject the null hypothesis.

4.6 Effectiveness of an online pedagogy on assessment of TVET practical skills

The third objective of the study was to determine the effectiveness of an online pedagogy on assessment of TVET practical skills. To achieve this, a group of Twenty (20) instructors observed assessors scoring (assessing) trainees as they worked (and completed) the assigned practical tasks after undergoing training. The observations of the assessment process were made for the assessment that was conducted face-to-face (in same physical location with the trainees) and that which was done online (assessor and trainee in separate locations). A total of eight assessors (4 for each programme) assessed trainees practical work sessions and for each practical work session, the four (4) programme assessors were based at the institution that was training online (via live

stream). During the practical work session, the assessors were split into groups of two (2) with one group assessing the group that had learnt the skill online (this was face-to-face assessment because the assessors were in the same physical location with the trainees), and the other group assessing the group that had learnt the skill face-to-face (this was online assessment because the assessors were assessing the group online since they were in separate locations).

The observations of the assessment process were made for the work sessions of the two practical tasks in the NCBC programme (Steel Bending and Broken Bond), and another two practical tasks in NCWT programme (Beam Formwork and Equilateral arch center). Since the work sessions for the group that had trained face-to-face and that of the group that had trained online took place simultaneously, then the instructors were split into two groups of ten (10) each to observe and score the assessment process of both groups (face-to-face trained group and online trained group). Each observer scored the assessment process of a particular work session (face-to-face trained group or online trained group) using the Practical skills Assessment observation checklist shown in **Appendix III (c)**. For each assessment session, the instructors scored the process along nine parameters (**Table 4.26***).*

Table 4.26: Parameters observed during assessment sessions of each practical task

	Observed Parameter
Parameter 1	Practical skills are effectively being assessed
Parameter 2	Assessment of practical skills is not affected by electricity and internet connectivity.
Parameter 3	Assessment is a collaborative process (Includes Assessors, Instructors, Technicians, ICT, etc.)
Parameter 4	Assessment of practical skills is giving feedback to trainees about their work.
Parameter 5	Assessors navigating around content to be assessed is a challenge.
Parameter 6	Trainees strengths and weaknesses, learning gains and misconceptions are being diagnosed effectively by assessors.
Parameter 7	The procedure of assessing practical skills is time-consuming.
Parameter 8	Assessment by observation of performance of practical skills is being done.
Parameter 9	Trainees work products are being appraised as a means of assessing practical skills.

The scoring of each observed parameter was made along a five-point ranked Likert Scale (**Table 4.27**) that ranked from Strongly Disagree, Disagree, Neutral, Agree and Strongly Agree. To simplify the presentation of the findings, the rankings were condensed to just three points that included Disagree (merging strongly disagree and disagree), Agree (merging strongly agree and agree) and Neutral.

Table 4.27 Ranking of the Likert scale

Response	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Rank	1	2	3	4	5

4.6.1 Presentation of descriptive statistics

A total of eighty (80) observations of the assessment process were made for both programmes [10 observations per practical task session x 2 tasks per programme x 2 pedagogies (face-to-face and online) x 2 programmes (A and B)]. The results of the observations are summarized and presented in the form of (**Table 4.28**) frequency of the assessment process scores across the nine observed parameters for the face-to-face trained and online trained groups. The frequency table shows that a majority of the scores were in the "Agree" rank across all the nine parameters for all the four practical tasks that were observed and scored.

Table 4.28: Frequency of the assessment process scores across the nine observed parameters for the face-to-face and online assessment processes

Practical task being observed	Pedagogy being observed		Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5	Parameter 6	Parameter 7	Parameter 8	Parameter 9
1. Steel Bending	Face-to-face	Disagree		1	1	8	2		1		
		Neutral	2		4		4			1	1
		Agree	8	9	5	2	4	10	9	9	9
	Online	Disagree		2	1	6	2	1			
		Neutral	1	3	1	4	6	1	3		4
		Agree	9	5	8		2	8	7	10	6
2. Broken Bond	Face-to-face	Disagree			3	5	2				
		Neutral	4	1	4	3	2			3	2
		Agree	6	9	3	2	6	10	10	7	8
	Online	Disagree		2		6	2				
		Neutral	1	4	2	4	6		3	1	3
		Agree	9	4	8		2	10	7	9	7
3. Beam Form work	Face-to-face	Disagree	1		1	4	5				
		Neutral		2	2	3	1	3	2		1
		Agree	9	8	7	3	4	9	8	10	9
	Online	Disagree		2		5	3				
		Neutral		7	1	5	5		1		2
		Agree	10	1	9		2	10	9	10	8
4. Equilateral Arch Center	Face-to-face	Disagree	1		1	6	7				
		Neutral		1	1	3	2	1	4		4
		Agree	9	9	8	1	1	9	6	10	6
	Online	Disagree		1	1	8	3				
		Neutral		2	1	2	4		2	2	1
		Agree	10	7	8		3	10	8	8	9

Parameter 3, 4 and 5 had the lowest mean scores (3.48, 2.35 and 3.18 respectively) for the face-to-face data set, whereas parameter 2, 4 and 5 had the lowest mean scores (3.33, 2.33 and 2.98 respectively) for the online data set. Conversely, parameters 6 and 7 showed the highest mean scores (4.20 and 4.28 respectively) for the face-to-face data, whereas parameter 1 and 6 had the highest mean scores (4.38 and 4.38 respectively) for the online data set. The means of the observed data set for the face-to-face assessment process are in the agreement range for parameters 1, 2, 3, 6, 7, 8 and 9 whereas for parameters 4 and 5 the data set is in the disagreement range. The means of the online assessment process show parameter 2 and 5 in the neutral range; parameters 1, 3, 6, 7, 8 and 9 in the agreement range; whereas parameter 4 is in the disagreement range.

Table 4.29: Observed scores of the assessment process

Observed Parameter	Number of Observations	Face-to-face Mean	Online Mean
Parameter 1	80	4.05	4.38
Parameter 2	80	4.10	3.33
Parameter 3	80	3.48	4.20
Parameter 4	80	2.35	2.33
Parameter 5	80	3.18	2.98
Parameter 6	80	4.20	4.38
Parameter 7	80	4.03	4.10
Parameter 8	80	4.28	4.22
Parameter 9	80	4.13	4.10

To graphically present the difference in mean scores of the parameters, the mean scores of observed responses for the online and Face-to-face training sessions across the nine observed parameters were plotted in a line chart. The biggest gaps between the line chart plots of the face-to-face and online mean scores can be seen to occur at parameter 2 and 3 as shown in **Figure 4.7**.

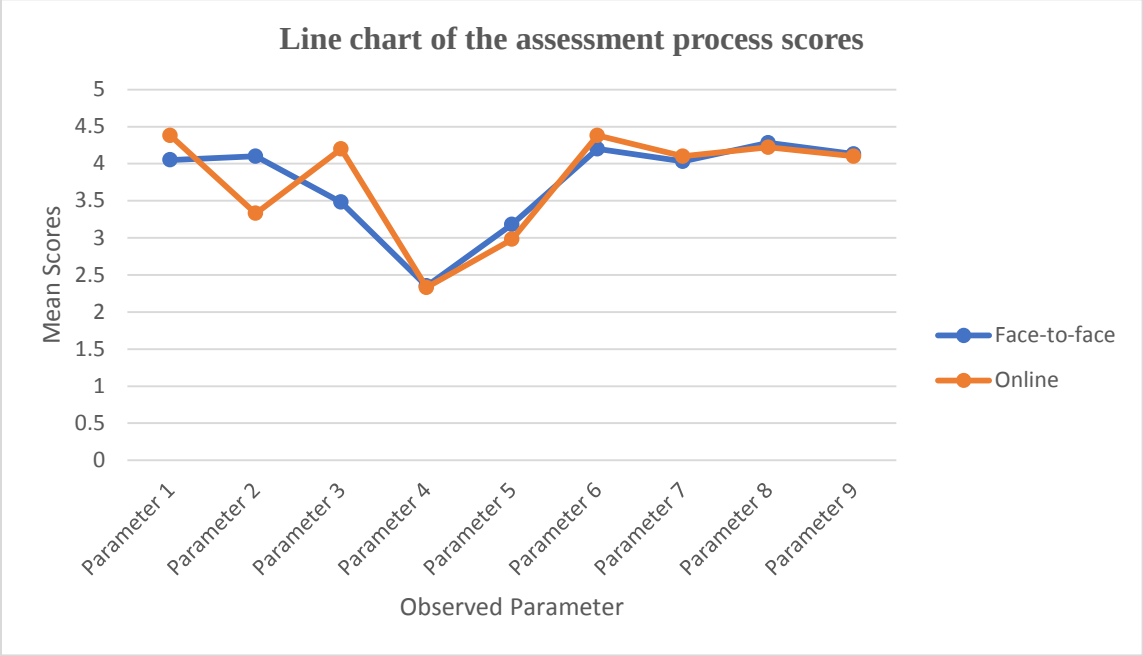

Figure 4.7: Line chart of the assessment process scores

4.6.2 Presentation of inferential statistics

The third hypothesis for the study stated that "*There is no significant difference in the TVET practical skills acquisition of trainees trained face-to-face and those trained online.*" To test the hypothesis, the normality of the scores was first determined before deciding on which inferential statistical test to run on the data set. The Normality of the mean scores was run in SPSS and due to the number of samples in the study, the Shapiro-

Wilk test of Normality was used to test the normality of the mean scores of the assessment process as shown by the results in **Table 4.30**.

Table 4.30: Normality test for the amalgamated observation means of all the assessment sessions

	Kolmogorov-Smirnov			Shapiro-Wilk		
`	Statistic	df	Sig.	Statistic	df	Sig.
Mean	.132	80	.002	.966	80	.031

As shown in **Table 4.30** the significant value 0.031 of the amalgamated means was less than the study alpha (significance level) of 0.05 which indicates that the means are not normally distributed. This is confirmed by the Detrended Normal Q-Q Plot of the amalgamated means (**Figure 4.8**) in which some means are far below and above the horizontal line which represents how much higher or lower they are, than what would be expected if the data were normally distributed.

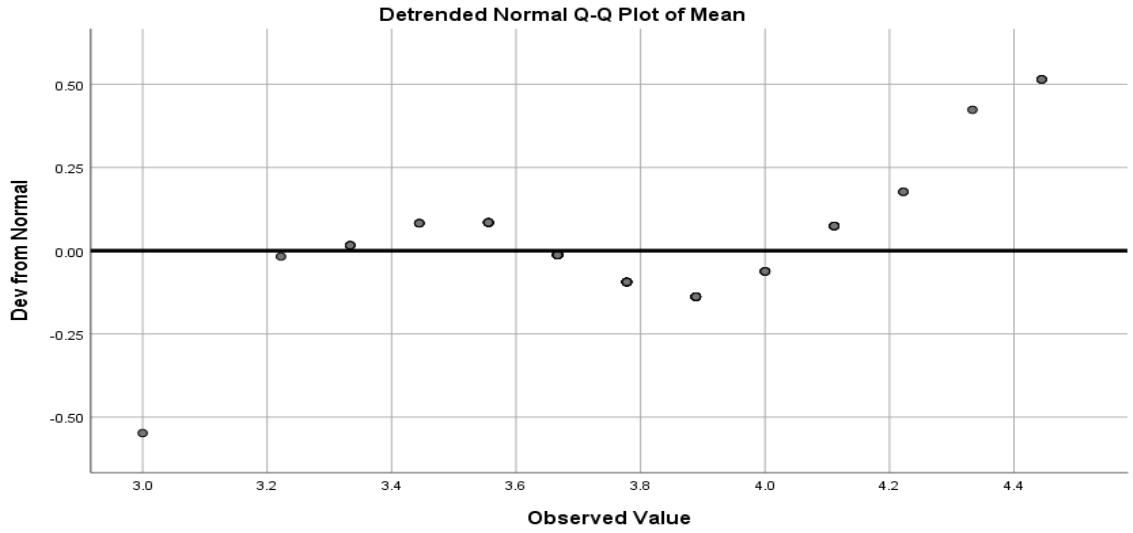

Figure 4.8: Detrended Normal Q-Q Plot for the amalgamated observation means

Considering that the amalgamated observation means of all the assessment processes that were to be used in the analysis are not normally distributed as shown above, then a Nonparametric Test, the Independent-Samples Mann-Whitney U Test, was used to test the means. The results of the test are summarized in **Table 4.31** and **Figure 4.9**.

Table 4.31: The Independent-Samples Mann-Whitney U Test Summary for the observed scores of the assessment process

Total N	80
Mann-Whitney U	862.000
Wilcoxon W	1682.000
Test Statistic	862.000
Standard Error	102.811
Standardized Test Statistic	.603
Asymptotic Sig. (2-sided test)	.546

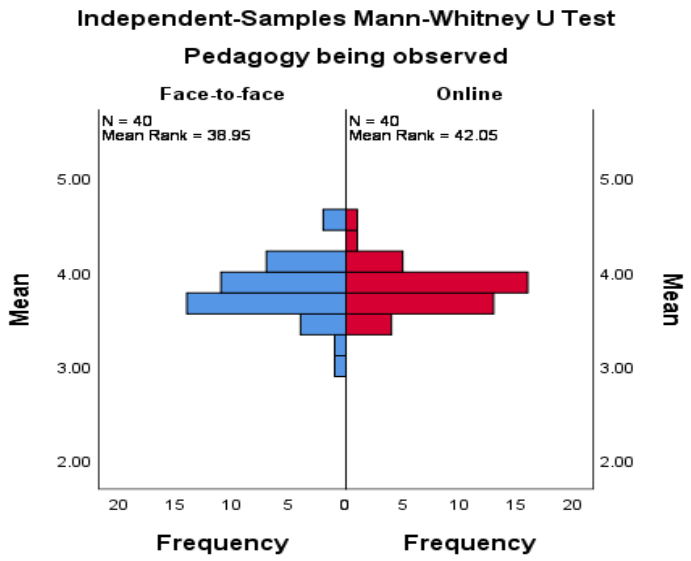

Figure 4.9: The Independent-Samples Mann-Whitney U Test Comparison of means of the assessment process

As summarized in the hypothesis test summary in **Table 4.32**, Since the significant value p = 0.546 is greater than the study significance level α = 0.05, then the study fails to reject the null hypothesis. This means that the distribution of trainees' average performances is the same across the face-to-face and online categories of Pedagogy being observed in the study. Based on the results, there was no statistically significant difference in the assessment of practical skills conducted face-to-face and that conducted online.

Table 4.32: Hypothesis Test Summary

Null Hypothesis	Test	Sig.	Decision
The distribution of Mean is the same across categories of Pedagogy being observed.	Independent-Samples Mann-Whitney U Test	.546	Fail to reject the null hypothesis.

4.7 Effectiveness of an online pedagogy on trainees' performance of TVET practical skills

The fourth objective of the study was to determine the effectiveness of an online pedagogy on trainees' performance of TVET practical skills. To achieve this, trainees work process and results for the assigned tasks were assessed and scored by assessors. Four (4) assessors for the NCBC programme and four (4) for the NCWT programme assessed and scored trainees work processes and results. The assessment was conducted for the groups that were trained face-to-face and those which were trained online. During each practical work session, the four (4) assessors were based at the institution that was training online (via live stream). The assessors were split into groups of two (2) with one

group assessing the group that had learnt the skill online, and the other group assessing the those that had learnt the skill face-to-face.

During the assessment, each assessor scored the work process and end result (final product) of the trainee using the respective assessment tool for the practical task being assessed (**Appendix V**). To ensure that the assessors get to identify the trainee they are scoring, all trainees wore unique identifying numbers at their back all through the work processes. During the filming for the online assessment, the trainees identifying number was always captured first by the camera crew every time their work process and result was being filmed. The camera crew made several rounds of filming of every trainee work process to enable the assessors following the live stream to get enough evidence to base on when assessing and scoring the trainees online. Considering that the live streamed video was available even after the end of each session, the online assessors were able to replay any part of the work session to enable them catch up with any part of a trainees work process or result that they may have missed.

4.7.1 Presentation of descriptive statistics

A total of sixty-nine (69) scores were recorded by the assessors for both programmes [35 for St. Josephs Technical Institute, Kisubi (20 NCBC programme and 15 NCWT programme), and 34 for Nakawa Vocational Training College (19 for NCBC programme and 15 NCWT programme)]. For each practical work session (both face-to-face and online), the trainees work process and end product (result) were assessed and scored by two (2) assessors and the average of their scores in each of the practical tasks was computed and recorded as shown in **Table 4.33**. From the table, the results show that the

means scored across all tasks was above 70% for both the online and face-to-face pedagogies.

Table 4.33: Trainees average performance in each of the four practical tasks

	Steel Bending		**Broken Bond**		**Beam Formwork**		**Equilateral Arch Center**	
S/N	Face-to face	Online	Face-to face	Online	Face-to face	Online	Face-to face	Online
1	80.5	74	71.5	82.5	75.5	80	78	84.5
2	74.5	77.5	74.5	71.5	73.5	81.5	77	81.5
3	81	89	76	67.5	84	84.5	83	75
4	71.5	67.5	90.5	68.5	77	74	77.5	79.5
5	77	78.5	82.5	66.5	78	85.5	81.5	78
6	69	89	74	63	73	79	77.5	81
7	76.5	70.5	64	72	71	73.5	79.5	80.5
8	68.5	68	86.5	64.5	84	71.5	76.5	76.5
9	68	65.5	64	66	86.5	70	70	79.5
10	83.5	73.5	66.5	87	73	76	77.5	78.5
11	67.5	69	65	63.5	79.5	75	79.5	82
12	80.5	76.5	86.5	73	84.5	76.5	74.5	78.5
13	75.5	80.5	76	59	85.5	88	84	71
14	79.5	67.5	60.5	74.5	82	74.5	80	78
15	79	74.5	71.5	75.5	84.5	77.5	78	79.5
16	70.5	77.5	69.5	61				
17	72	78.5	71	69.5				
18	92	76	65	88				
19	71	77.5	70	68				
20	72.5			73.5				
Mean	**75.5**	**75.3**	**72.9**	**70.7**	**79.4**	**77.8**	**78.9**	**78.9**

The bar chat in **Figure 4.10** gives a clear graphic representation of the scores that can be used to compare both pedagogies (online and face-to-face) across all the four practical tasks. The results of trainees mean scores in each practical task performance show an average similarity in the mean scores for the face-to-face and online groups of each practical task. the bar chat also shows that the broken bond task posted the lowest mean scores for both pedagogies, whereas the beam formwork and equilateral arch tasks had the highest mean scores.

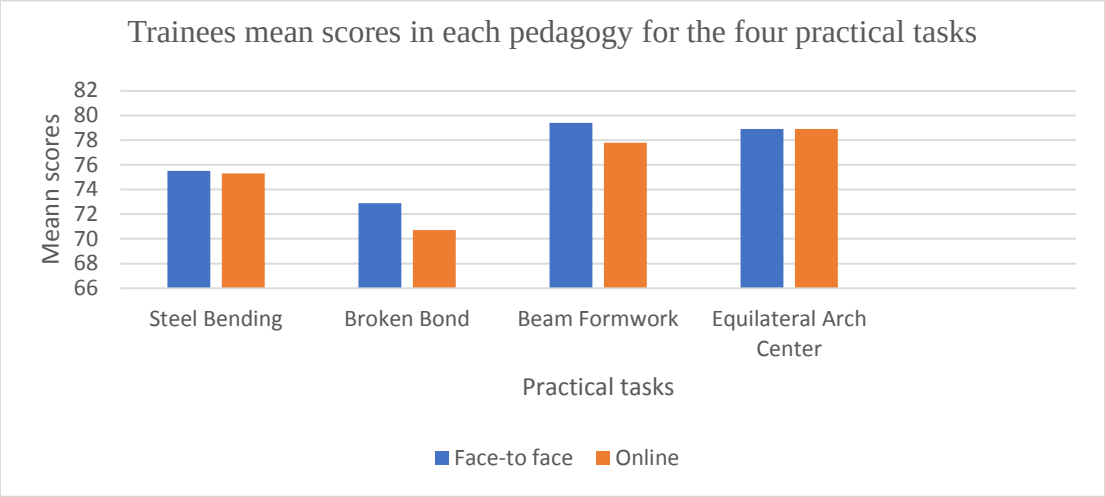

Figure 4.10: Trainees mean scores in each pedagogy for the four practical tasks

To closely analyse the differences in performances recorded for the two groups, **Table 4.34** presents a combined trainees performance range frequency for each pedagogy. The table shows that whereas both the face-to-face and online trained groups had eight (8) scores above 85% each, only the face -to-face group had scores above 90% (2 scores). Also, the lowest score for the face-to-face trained group was in the range of 60-64 and that for the online trained group was in the range of 55-59.

Table 4.344: Combined trainees performance range frequency for each pedagogy

Range	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94
Face-to face		3	7	16	19	16	6	2
Online	1	3	11	13	22	11	8	

Whereas a couple of differences existed between the scores recorded for both the online and face-to-face pedagogies, the scores followed a relatively similar trajectory when plotted on a line graph as shown in **Figure 4.11**. Besides following a similar path, the frequency of the performance range for both pedagogies also peaks at a range of 75-79% which means that for both pedagogies, a majority of the scores are around this range.

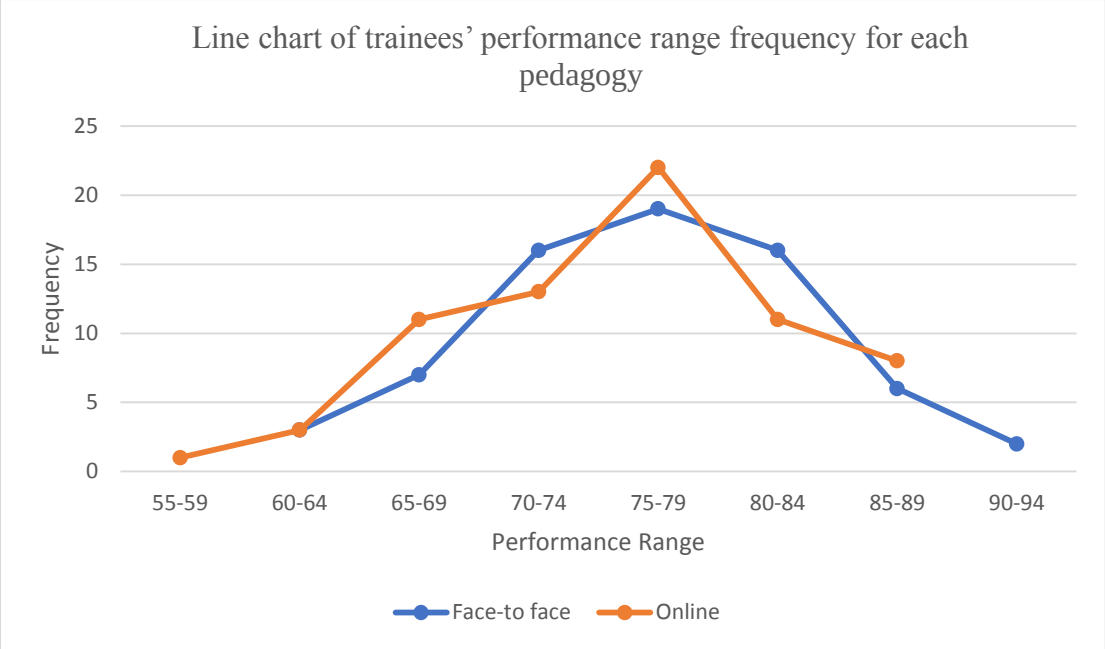

Figure 4.11: Line chart of trainees' performance range frequency for each pedagogy

4.7.2 Presentation of inferential statistics

The fourth hypothesis for the study stated that "*There is no significant difference in the TVET practical skills performance of trainees trained face-to-face and those trained online.*" To test the hypothesis, the normality of the scores was first determined before deciding on which inferential statistical test to run on the data set. The Normality of the mean scores was run in SPSS and due to the number of samples in the study, the Shapiro-Wilk test of Normality was used to test the normality of the mean scores of trainee's performances of the practical tasks as shown by the results in **Table 4.35**.

Table 4.355: Tests of Normality for the average score of trainees' performances

	Kolmogorov-Smirnov			**Shapiro-Wilk**		
	Statistic	df	Sig.	Statistic	df	Sig.
Average	.043	138	.200	.995	138	.905

The significant value 0.905 of the average scores (**Table 4.35**) is greater than the study alpha (significance level) of 0.05 which indicates that the means are normally distributed. This is also confirmed by the Detrended Normal Q-Q Plot of the average scores (**Figure 4.12**) which shows that the average scores are approximately equally distributed below and above the horizontal line (laying between -0.10 and +0.10) which represents how close they are to what is expected if the data is normally distributed.

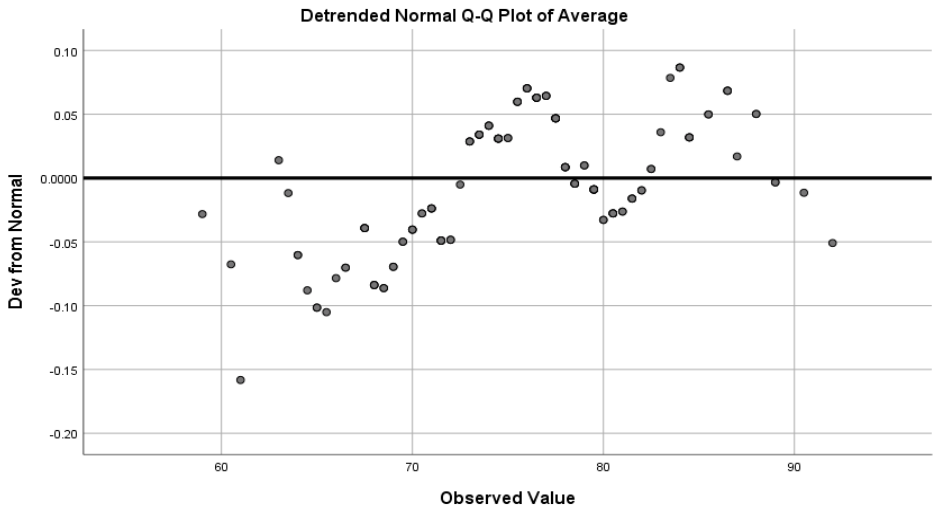

Figure 4.12: Detrended Normal Q-Q Plot of the mean scores of trainees' performances

The normal distribution of the means is also confirmed by the histogram of the average score of trainees' performances (**Figure 4.13**) which shows that the scores are symmetrically distributed in a bell-shaped symmetry with no skew. Also, most scores are clustered around a central region, with values tapering off as they go further away from the center which is evidence of the scores being normally distributed.

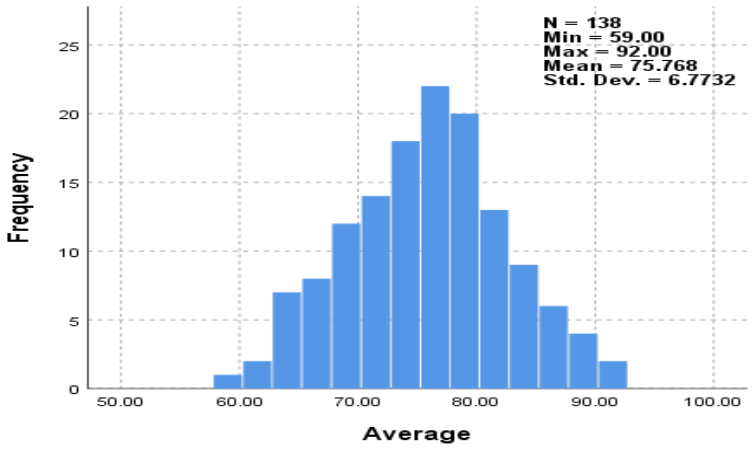

Figure 4.13: Histogram of the mean scores of trainees' performances

Since the average scores of trainees' performances to be used in the analysis were found to be normally distributed as evidenced above, and that the face-to-face and online groups were different for a given practical test, then a parametric (for normally distributed data), between subject's statistical test, the Independent-Samples T- Test, was used to test the means. The results of the test run in SPSS are summarized in **Table 4.36** and **Table 4.37**.

Table 4.366: Group Statistics for the mean scores of trainees' performances

	Pedagogy being observed	N	Mean	Std. Deviation	Std. Error Mean
Average	Face-to face	69	76.2391	6.68768	.80510
	Online	69	75.2971	6.87403	.82754

Table 4.37: Independent Samples Test for the mean scores of trainees' performances

			Average	
			Equal variances assumed	Equal variances not assumed
Levene's Test for Equality of Variances	F		.015	
	Sig.		.902	
t-test for Equality of Means	t		.816	.816
	df		136	135.897
	Sig. (2-tailed)		.416	.416
	Mean Difference		.94203	.94203
	Std. Error Difference		1.15456	1.15456
	95% Confidence Interval of the Difference	Lower	-1.34118	-1.34120
		Upper	3.22524	3.22525

Considering that the Significant value (*p*-Value) of Levene's Test for Equality of Variances (0.902) is greater than the study significance value of 0.05 (*p>0.05,* i.e. *p* very large) as shown in **Table 4.37**, then equal variances were assumed in interpreting the independent samples T test results. Then, since $p = 0.416$ is greater than the study significance level $\alpha = 0.05$, the study fails to reject the null hypothesis. This means the distribution of trainees' average performances is the same across the face-to-face and online categories of Pedagogy being observed in the study. Based on the results, the following is stated:

i. There was no statistically significant difference in the average performances of trainees that learnt practical tasks in the face-to-face and those that did so in the online pedagogy; and

ii. The average performance difference of 0.94203 percent between trainees that learnt practical tasks in the face-to-face and those that did so in the online pedagogy, is statistically insignificant.

4.8 Perception towards an online pedagogy

The fifth objective of the study was to assess perception towards an online pedagogy as a method for TVET Practical skills training, acquisition, assessment and performance. To achieve this, sections 2, 3 and 4 of the pre-test and posttest survey questionnaires (**Appendix II**) were used to collect standardized, quantifiable, empirical data through close-ended questions using the Likert scales. The questionnaires were administered and self-completed by all trainees, instructors and assessors at the start of the study (pretest) and again at the end of the study (posttest). To ensure that only responses that fall into

predetermined categories of ordinal data that are measurable, expressed in numerical form, and can be graded using a continuous scale, are elicited, the questionnaires had a closed question structure. This enabled trainees, instructors and assessors to choose from a range of predetermined responses generally ranging from 'strongly disagree' to 'strongly agree' that were easy to code and statistically analyze. To address some of the drawbacks of the questionnaire method such as lying out of social desirability, projection of a favorable picture of oneself, or embellishing or distorting the reality in order to seem good; key themes of concern to the study were posed in more than two (2) distinct ways, with each one having the potential to provide a different result.

4.8.1 Presentation of descriptive statistics

A total of sixty-nine (69) trainees', twenty (20) instructors and eight (8) assessors' perception were collected across twenty-four (24) parameters that were structured into three (3) parts (sections 2, 3 and 4 of **Appendix II a**). The three sections were structured to elicit trainees', instructors and assessors' perception on online training, acquisition and assessment of practical skills. Trainees, instructors and assessor's perception before exposure to online training and assessment (pre-test) and perception after undergoing online training and assessment were both captured under the three sections of the questionnaire. The mean score of all the trainees' (n=69), Instructors' (n = 20) and assessors' (n = 8) pre-test and posttest responses across each parameter and the difference between posttest and pre-test means (Posttest Mean – Pre-test Mean) were computed, tabulated and graphically illustrated in the respective sections that follow below.

4.8.1.1 Perception on online practical skills training

The training section of the questionnaires (section 2 of **Appendix II a**) captured trainees' instructors' and assessors' perception across eight (8) parameters that are shown in **Table 4.38** below**.**

Table 4.38: Mean scores of trainees, instructors and assessors' pre-test and posttest perception of online practical skills training

	Perception on Training	Pre-test Mean score	Posttest Mean score	Difference
Parameter 1	I believe that practical skills can only be delivered by a trainer in person to a group of trainees with the TVET trainees and trainer in the same physical location at the same time.	4.04	2.29	-1.75
Parameter 2	I believe that practical skills can effectively be delivered online with the trainees and the trainer separated in time and physical location.	2.46	4.03	1.57
Parameter 3	I believe that for practical skills to be effectively delivered online, there is need for high-tech and advanced technology to first be in place.	3.41	3.38	-0.03
Parameter 4	Online training of practical skills can enable a trainee have communication with the instructor if they have a challenge and need clarification.	2.33	2.26	-0.07
Parameter 5	I believe that online training of practical skills has the same potential to enhance educational effectiveness as face to face training.	2.49	4.22	1.72
Parameter 6	I believe that in online training of practical skills, it's possible to get feedback from peers and instructors about one's work.	2.48	2.80	0.32
Parameter 7	I believe that electricity outages can only affect online training but does not affect face to face training of practical skills.	4.04	2.80	-1.25

Parameter 8	I believe that inadequate preparation of instructors and trainees for practical skills training is a challenge for only online training and not face to face training.	2.97	2.90	-0.07

The results show that whereas parameters 1, 2, 5 and 7 recorded a relatively big difference between the pre-test and posttest mean scores, parameters 3, 4, 6 and 7 mean scores showed a very small difference between the posttest and pre-test values. In the pre-test mean scores, Parameter 1 and 7 recorded the highest mean score (4.04) while parameter 4 recorded the lowest mean score (2.33). In the posttest mean scores, Parameter 5 recorded the highest mean score (4.22) while parameter 4 recorded the lowest mean score (2.26). It was also evident from the results that parameter 4 and 6 had the lowest mean scores across both the pre-test and posttest data (2.33, 2.26 and 2.48, 2.80 respectively). Parameters 3, 4, and 8 recorded the least difference (-0.03, -0.07 and -0.07 respectively), while parameters 1, 2 and 5 recorded the highest difference (-1.75, 1.57 and 1.72). Whereas the difference in mean scores is either positive or negative, there was considerable variation in the magnitude of the differences (**Figure 4.14**). Parameters 1,2,5 and 7 had values that are greater than positive one or less than negative one (>1 or < -1), whereas parameters 3, 4, 6 and 8 had values that are less than positive one or greater than negative one (<1 or > -1).

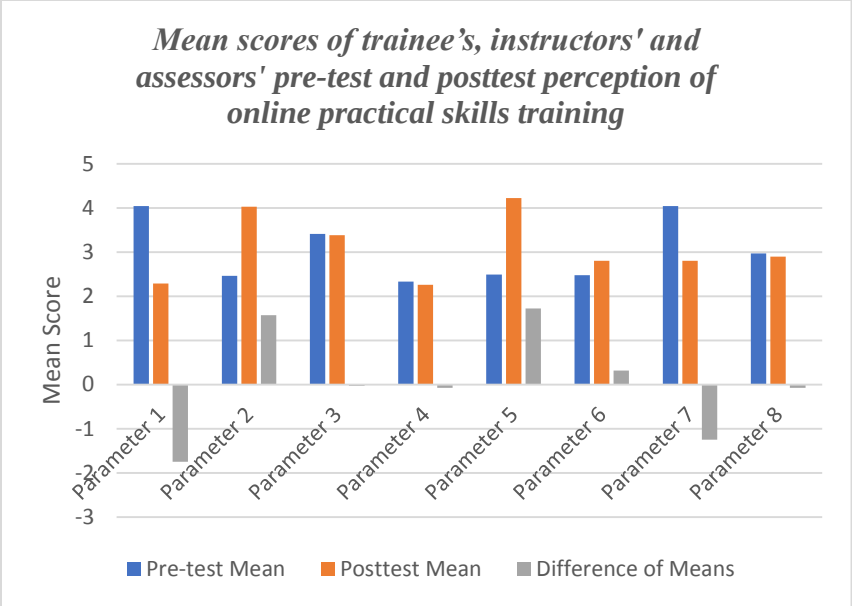

Figure 4.14: Mean scores of trainee's, instructors' and assessors' pre-test and posttest perception of online practical skills training.

4.8.1.2 Perception on online practical skills assessment

The assessment section of the questionnaires (section 3 of **Appendix II a**) captured trainees', instructors' and assessors' perception across ten (10) parameters (**Table 4.39**). The results show that whereas parameters 1, 2, 3, 4, 7, 9 and 10 recorded a relatively big difference between the pre-test and posttest mean scores, parameters 5, 6 and 8 mean scores showed a very small difference between the posttest and pre-test values.

Table 4.39: Mean scores of trainees, instructors and assessors' pre-test and posttest perception of online practical skills assessment

	Perception on assessment	Pre-test Mean	Posttest mean	Difference of means
Parameter 1	I believe that trainee's practical work can effectively be assessed online.	2.36	4.46	2.10
Parameter 2	I believe that for practical work to be effectively assessed online, there is need for high-tech and advanced technology to first be in place.	4.13	2.54	-1.59
Parameter 3	I believe that online assessment of practical work has the same potential to enhance educational effectiveness as the traditional face to face assessment.	2.57	4.07	1.51
Parameter 4	I believe that in online assessment of practical work, it's possible to get feedback from the assessor	3.35	2.26	-1.09
Parameter 5	I believe that navigating around content to be assessed on ICT screen(s) is one of the major challenges facing online assessment.	3.32	3.17	-0.14
Parameter 6	I believe that levels of attainment in all aspects of the course can be done online.	3.03	3.14	0.12
Parameter 7	A trainee's strengths and weaknesses, can be diagnosed by assessors online.	2.48	4.10	1.62
Parameter 8	I believe that the procedure of assessing practical skills online is time-consuming.	3.54	3.39	-0.14
Parameter 9	I believe that assessment by observation of performance of practical skills can be done online.	2.71	4.30	1.59
Parameter 10	I believe that it's not possible to appraise products as a means of assessing practical skills online.	4.10	2.46	-1.64

In the pre-test mean scores, parameter 2 and 10 recorded the highest mean scores (4.13 and 4.10 respectively) while parameter 1 recorded the lowest mean score (2.36). In the posttest mean scores, parameter 1 and 9 recorded the highest mean scores (4.46 and 4.30 respectively) while parameter 4 recorded the lowest mean score (2.26). The results of the difference in means show two key highlights. First is the positive difference in means that implies a higher posttest mean score compared to the pre-test mean score for the respective parameters. Second, is a negative difference that implies a higher pre-test mean score compared to the posttest mean score for the respective parameters.

Whereas the difference in mean scores as shown In **Table 4.39** is either positive or negative, there is considerable variation in the magnitude of the differences as shown in **Figure 4.15**. Parameters 1,2,3, 4, 7, 9 and 10 have values that are greater than positive one or less than negative one (>1 or < -1), whereas parameters 5, 6, and 8 have values that are less than positive one or greater than negative one (<1 or > -1). Parameters 5, 6, and 8 recorded the least difference (-0.14, 0.12 and -0.14 respectively), while parameter 1 recorded the highest difference (2.10).

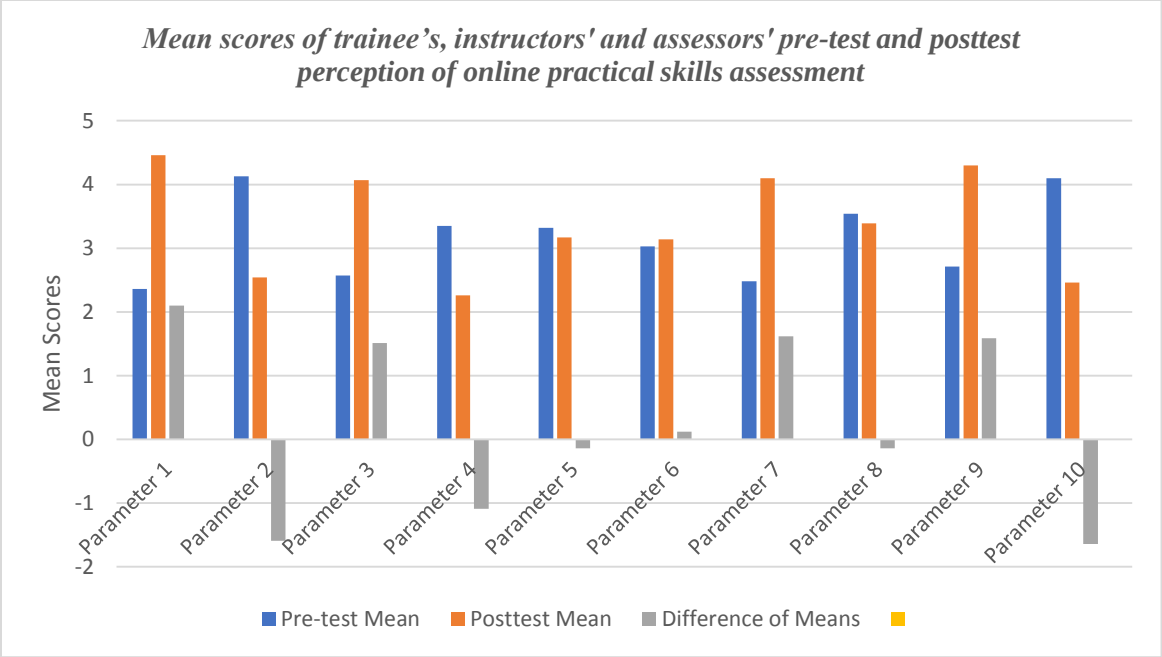

Figure 4.15: Mean scores of trainee's, instructors' and assessors' pre-test and posttest perception of online practical skills assessment

4.8.1.3 Perception on acquisition of practical skills delivered online

The acquisition section of the questionnaires (section 4 of **Appendix II a**) captured trainees', instructors' and assessors' perception across six (6) parameters as shown in **Table 4.40**. The results show that whereas parameters 1, 2, 3 and 5 recorded a relatively big difference between the pre-test and posttest mean scores, parameters 4 and 6 mean scores showed a very small difference between the posttest and pre-test values. In the pre-test mean scores, parameter 4 recorded the highest mean scores (3.33) while parameter 1 recorded the lowest mean score (2.12). In the posttest mean scores, parameter 3 recorded the highest mean scores (4.17) while parameter 6 recorded the lowest mean score (2.26).

Table 4.40: Mean scores of trainee's, instructors' and assessors' pre-test and posttest perception of acquisition of practical skills delivered online

	Perception on acquisition	Pre-test Mean	Posttest mean	Difference of means
Parameter 1	A trainee can learn a practical skill entirely online without coming to the institution.	2.12	4.04	1.93
Parameter 2	I believe online learning can produce a satisfactory degree of desired outcomes in terms of practical skills acquisition.	2.55	4.01	1.46
Parameter 3	I believe a trainee can learn a practical skill online and then be able to perform it to a satisfactory or expected degree.	2.23	4.17	1.94
Parameter 4	I believe that online learning of practical skills can make one feel involved with the activity or task being demonstrated.	3.33	3.59	0.26
Parameter 5	I believe that learning practical skills online can create the same active engagement and ability to understand and interact with concepts, techniques and practical tasks as face to face learning.	2.48	4.13	1.65
Parameter 6	Online training of practical skills can provide constructive feedback to trainees for the opportunity to correct errors.	2.49	2.26	-0.23

The results of the difference in means (**Table 4.40**), show two key highlights. First is the positive difference in means that implies a higher posttest mean score compared to the pre-test mean score for the respective parameters. Second, is a negative difference that

implies a higher pre-test mean score compared to the posttest mean score for the respective parameters.

Whereas the difference in mean scores is either positive or negative, there is considerable variation in the magnitude of the differences (**Figure 4.16**). Parameters 1,2,3, and 5 have values that are greater than positive one (>1), whereas there was no parameter with a value that is less than negative one (> -1). Parameters 4 and 6 recorded the least difference (0.26 and -0.23 respectively), while parameters 1 and 3 recorded the highest difference (1.93 and 1.94 respectively).

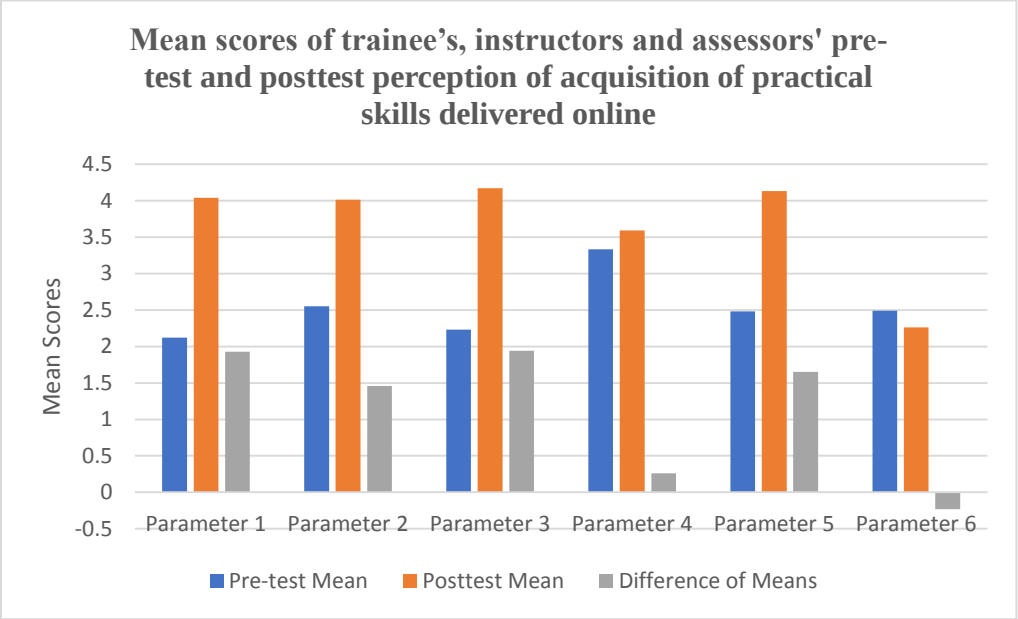

Figure 4.16: Mean scores of trainee's, instructors' and assessors' pre-test and posttest perception of acquisition of practical skills delivered online

4.8.2 Presentation of inferential statistics

The fifth hypothesis for the study stated that "*There is no significant difference in the study participants' perception of an online pedagogy before and after undergoing online*

practical skills training, acquisition and assessment". Thus, the question to be answered by the statistical test was; "what are the chances that the differences observed between the posttest and pre-test data occurred due to random error alone?". Considering that the same trainees', instructors and assessors' perception were captured at the onset of the study (pre-test) and after the online experience (posttest), then a within subjects' statistical test (Paired Samples t-test) was used to test whether there was significant difference between the mean scores of the pre-test and posttest data across all the sixty-nine (97) records. The test results show (**Table 4.41**) that the analysis was done for all 97 records of the posttest and pre-test trainees', instructors' and assessors' perception, and the mean of the posttest scores (3.3665) is slightly higher than that of the pre-test mean (2.9589) by 0.40761.

Table 4.41: Paired Samples Statistics of trainee's, instructors' and assessors' pre-test and posttest perception of online training, assessment and acquisition of practical skills

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Posttest Mean	3.3665	97	.23846	.02871
	Pre-test Mean	2.9589	97	.30084	.03622

The positive correlation value of 0.242 as shown in **Table 4.42** means that in general large values of the first variable (posttest) were often observed with large values of the second variable (pre-test). The p-value 0.045 (**Table 4.42**) is less than the study

significance level $\alpha = 0.05$ which means the null hypothesis that the correlation is zero, is rejected.

Table 4.42: Paired Samples Correlations of trainee's, instructors' and assessors' pre-test and posttest perception of online training, assessment and acquisition of practical skills

		N	Correlation	Sig.
Pair 1	Posttest Mean and Pre-test Mean	97	.242	.045

Since $p < 0.001$ is less than the study significance level $\alpha = 0.05$ (**Table 4.43**), then the null hypothesis is rejected. This means that the observed difference of 0.40761 between the posttest and pre-test mean scores of trainees', instructors' and assessors' perception, is statistically significant because there was a less than 5% chance that the differences that were observed occurred due to random error alone. Thus, based on the results, there was statistically significant difference in trainee's, instructors' and assessors' perception of online training, acquisition and assessment at the start of the study (pre-test) and their perception after undergoing online training, acquisition and assessment ($t_{97} = 10.089$, $p > .005$).

Table 4.43: Paired Samples Test of trainee's, instructors' and assessors' pre-test and posttest perception of online training, assessment and acquisition of practical skills

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Posttest & Pre-test Mean	.40761	.33561	.0400	.32699	.48823	10.089	96	.000

4.9 Challenges of an online pedagogy

The sixth objective of the study was to determine the challenges of an online pedagogy as a method for TVET practical skills training, acquisition, assessment and performance. To achieve this a posttest questionnaire on challenges was administered to trainees, instructors and assessors after undergoing and experiencing the online pedagogy. The open-ended questionnaire (**Appendix II b**), required respondents to write down their own views and opinions on what they felt were the main challenges of online training delivery, acquisition, assessment and performance of practical skills delivered online. Participants responses were then categorized and grouped into twelve (12) themes as shown in **Table 4.44**.

The collected data was first processed into operational data that was then clustered into closely related meanings. The clustered data was then statistically illustrated so as to use its features to make associations, connections and inferences. The findings of the frequency and percentage of participants (trainees, instructors, and assessors) responses

on challenges with online delivery and assessment of TVET practical skills are tabulated in **Table 4.44**.

Table 4.44: Participants' frequency and percentage of responses on challenges with online delivery and assessment of TVET practical skills

Category of challenge	Participant category	Number of participants	Frequency Mentioning challenge	Percentage Mentioning challenge
1. Inadequate preparation of trainers & assessors	Trainees	69	11	16
	Instructors	20	14	70
	Assessors	8	6	75
2. Lack of feedback and Realtime interaction	Trainees	69	43	62
	Instructors	20	12	60
	Assessors	8	7	88
3. Lack of ICT Equipment	Trainees	69	56	81
	Instructors	20	14	70
	Assessors	8	8	100
4. Electricity outages	Trainees	69	60	87
	Instructors	20	10	50
	Assessors	8	5	63
5. Lack of adequate knowledge in ICT	Trainees	69	8	12
	Instructors	20	12	60
	Assessors	8	6	75
6. Poor or no Internet connectivity	Trainees	69	67	97
	Instructors	20	10	50
	Assessors	8	6	75
7. Lack of Classroom Management	Trainees	69	9	13
	Instructors	20	6	30
	Assessors	8	3	38
8. Low Concentration and focus	Trainees	69	21	30
	Instructors	20	6	30
	Assessors	8	3	38
9. Lack of inclusiveness to learning abilities	Trainees	69	7	10
	Instructors	20	4	20
	Assessors	8	1	13
10. Poor Course/Training design	Trainees	69	44	64
	Instructors	20	16	80
	Assessors	8	5	63

11. Tedious/Time consuming pedagogy	Trainees	69	10	14
	Instructors	20	2	10
	Assessors	8	1	13
12. It is an expensive option	Trainees	69	12	17
	Instructors	20	2	10
	Assessors	8	2	25

The percentages of each category of participants' responses on the challenges of online delivery and assessment of TVET practical skills are then graphically represented in a bar chart shown in **Figure 4.17.**

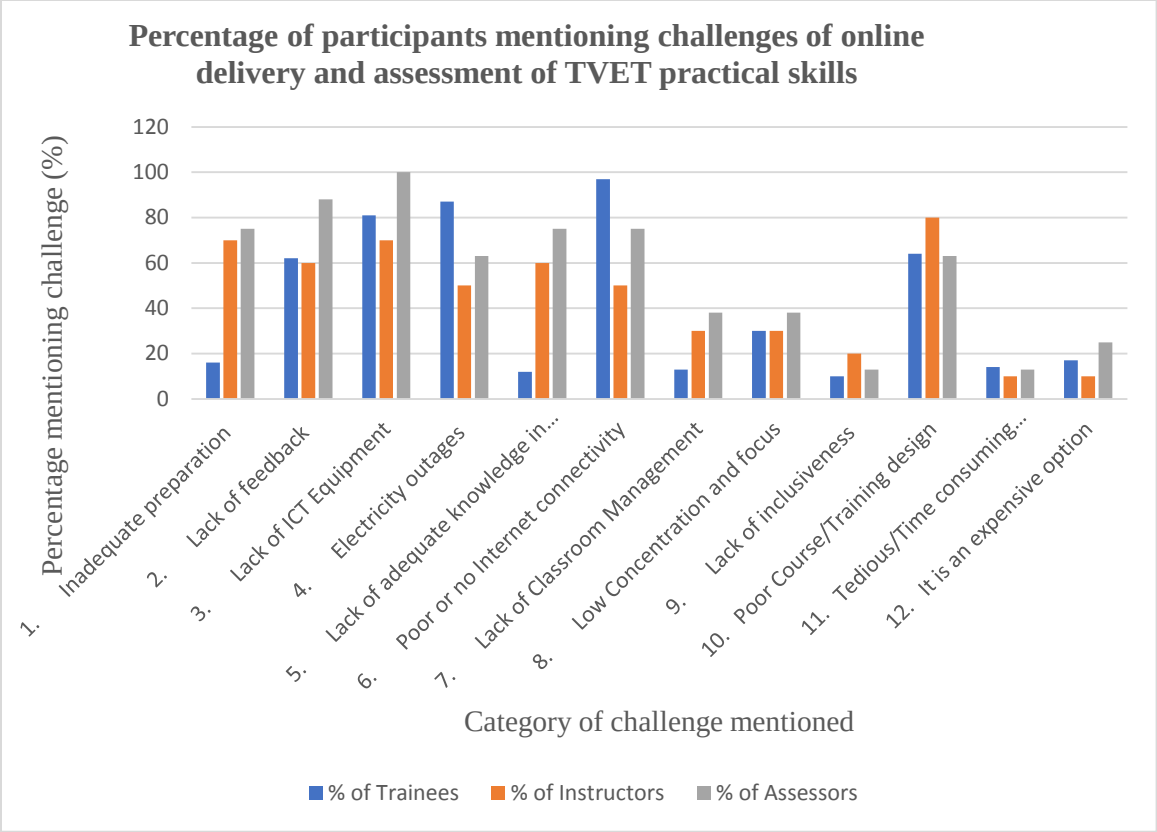

Figure 4.17: Percentage of participants mentioning challenges of online delivery and assessment of TVET practical skills

The average percentage of participants mentioning a particular category of challenge with online delivery and assessment of TVET practical skills was computed and used to determine the overall ranking of mentioned category of challenges. The results are tabulated in **Table 4.45**.

Table 4.45: Participants' average percentage mention of challenge and overall ranking of challenges with online delivery and assessment of TVET practical skills

Category of Challenge	% of trainees mentioning the challenge	% of instructors mentioning the challenge	% of assessors mentioning the challenge	Average % mention of challenge	Overall ranking of the challenge
1. Inadequate preparation of trainers and assessors	16	70	75	54	6
2. Lack of feedback and Realtime interaction	62	60	88	70	3
3. Lack of ICT Equipment	81	70	100	84	1
4. Electricity outages	87	50	63	67	5
5. Lack of adequate knowledge in ICT	12	60	75	49	7
6. Poor or no Internet connectivity	97	50	75	74	2
7. Lack of Classroom Management	13	30	38	27	9
8. Low Concentration and focus	30	30	38	33	8
9. Lack of inclusiveness to learning abilities	10	20	13	14	11
10. Poor Course/Training design	64	80	63	69	4
11. Tedious/Time consuming pedagogy	14	10	13	12	12
12. It is an expensive option	17	10	25	17	10

The overall ranking of the participants' average mention of the challenges (category) of online delivery and assessment of TVET practical skills is graphically represented in the bar chart shown in **Figure 4.18** in order of prevalence.

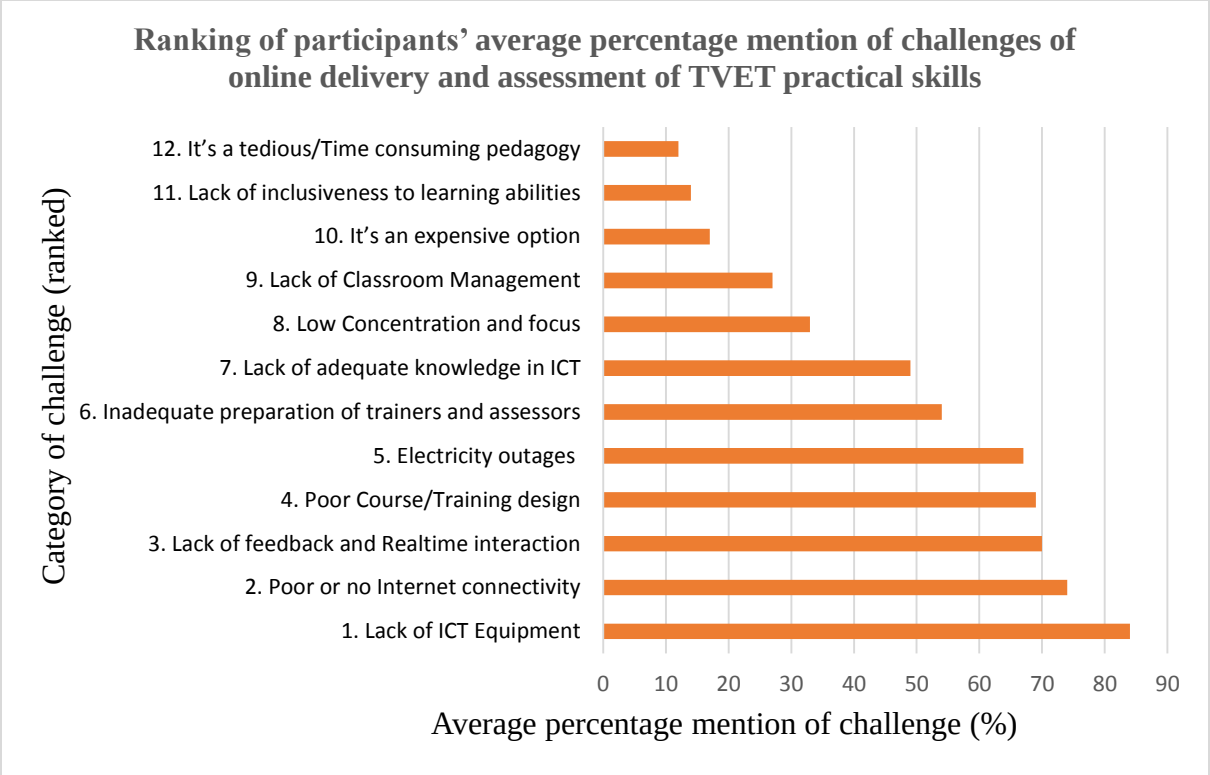

Figure 4.18: Ranking of participants' average percentage mention of challenges of online delivery and assessment of TVET practical skills

4.10 Discussion of findings

4.10.1 Training of practical skills

The results of the study showed that the distribution of the mean scores was the same across both training categories (face-to-face and online pedagogies) being observed. The findings of the study demonstrated that the process of training a practical skill online (experimental group) was as effective as the process of training the same practical skill face-to-face (control group).

The findings agree with the foundations of the community of Inquiry theory that is formed on three separate "presences" of instruction, social interaction, and cognitive presence and Picciano (2017) observations that with the advent of discussion boards,

blogs, wikis, and video conferencing, this theory (community of Inquiry) has emerged as one of the most well-liked instructional models for online and hybrid courses. Keeping in league with the theory's central focus of creating online and hybrid learning environments that function as communities where teachers and learners interact and exchange knowledge, the study content about the practical tasks was presented by instructors at the start of each training session to the group training face-to-face and it was recorded on video and livestreamed to the group that was being trained on the task online. This online engagement of the mind that incorporated original video and audio content of the instructor teaching, enabled the trainees that were training online to follow the content being presented that they later used when working on the assigned tasks. The lack of significant difference in TVET practical skills training conducted through face-to-face and that conducted online was also evidence enough of existence of instruction and cognitive presence for the online group during the study.

The study results showed that both pedagogies (face-to-face and online) clearly presented the material to be learned in an adaptive way that enabled trainees to begin with very easy versions of the practical task and then moved gradually to more difficult versions of the task; elicited performance and enhanced retention and transfer by providing opportunities for projects that might relate what was learnt to other real-life activities; and enabled trainees to participate and properly follow the training content and material being presented during the training session. These findings of the study are well aligned with the findings of other studies, which claim that: adaptive and guided training are two closely related techniques that can aid skill development by enabling a student to begin with very easy versions of the skill and then gradually move to more difficult versions

(Bernstain et al, 1991); and Johnson and Proctor (2017) characterization of skill acquisition as the development of a hierarchy of habits. The results are also in agreement with one of the nine teaching experiences proposed by Robert Gagne's taxonomy of events of instruction (cited in Harasim, 2012) that emphasized supporting retention and transfer through guided practice or projects that could connect learning towards other real-life scenarios.

With findings showing that trainees effectively trained for the respective practical tasks online, thanks to the livestreaming of the training via the ICTs, the study results are in tow with the connectivism theory which contends that because of the extensive data communications networks, there are significant changes in the way knowledge and information travel, develop, and change (Picciano, 2017). As held by the theory, the study findings supported the claims that learning has shifted from private, individualistic activities to group, communal, and even crowd activities as a result of the development of the Internet. conversely, it's also important to note, that whereas online training was able to be made available to groups further away from the physical location where the training was taking place thanks to the internet, the results of the study showed that the online training session and assessment process were affected by service(s) interruption (by lack of access to electricity, internet connectivity, devices or media, learning platforms).

Although there was no significant statistical difference in TVET practical skills training conducted through face-to-face and that conducted online, a few means of the two pedagogies (face-to-face and online) differed in some of the parameters which signified the respective strength and weakness of each pedagogy. The results showed that training of a practical skills online had two major strengths when compared to the face-to-face

pedagogy, and these were its ability to foster and integrate collaboration and access within the training process. In terms of collaboration, the results showed that online training of practical skills was a collaborative process that included a trainer (s), technician (s), ICT staff among others during its delivery. Whereas this finding means added overall costs of training, it is also congruent with previous literature that points to online pedagogy usually incorporating consultation and collaboration with a variety of support people to help teachers with design and implementation as opposed to the "Lone Ranger" approach of the face-to-face pedagogy (Stone & Perumean-Chaney, 2011). The results also corroborated Sambu and Simiyu (2013) findings on the importance of ensuring that everyone has access to high-quality education by removing all obstacles, whether they are financial, physical, institutional, or systemic. To this extent, it was evidenced from the results that online training enabled trainees' flexible access to the training since they had the option of playing back the training session over and over again to reinforce their learning as they performed the task at hand.

On the other hand, the results showed that training of practical skills online had three major drawbacks. The first was its inability to provide immediate feedback to the trainees since they were separated in time and space with the instructor. This finding contrasted with various literature that emphasized the significance of feedback in training. The finding contradicts with one of the nine teaching experiences proposed by Robert Gagne's taxonomy of events of instruction (cited in Harasim, 2012) that emphasized giving of feedback to enable students receive rapid, detailed, and constructive comments; Cordiner (2017) observations on coaching the learner by giving feedback, further advice and scenarios where the skill would apply; Glaser and Bassok (1989) insistence on

Immediate feedback about which responses are right and wrong so as to give the trainee an opportunity to correct errors; and Ramani and Leinster (2007) and Hajaraih et al. (2012) who advised instructional designers to provide for feedback that takes into account the various learning styles of each learner.

The second drawback of training practical skills online was the finding that it was greatly affected by service(s) interruption that included electricity outages, internet connectivity and slow download speeds. This result was consistent with the findings of Hoftijzer et al. (2020), who summarized the obstacles to providing TVET skills online as lack of access to internet connectivity, electricity and equipment or media. As such, considering that teaching only takes place online when the majority of the course material and all of the class discussions can be accessed through the internet (Redmond, 2015), then this finding points to a serious drawback to online pedagogy for practical skills training.

The third drawback was that the results cannot be used to support or negate Harasim's (2012) views of knowledge being created in a group through conversation in three phases, which include: 1- idea generation known as brainstorming, that involves the collection of a variety of different concepts; 2- "idea structuring," in which ideas are contrasted, examined, and categorized via the use of argumentation and discussion; and 3- Intellectual convergence in which intellectual synthesis and consensus takes place, including the act of agreeing to disagree with one another. This is because whereas the data showed cooperation in the training processes (instructors, assessors, technicians, camera crew, and ICT staff working together); the fact that trainees were confined and thus accessed online training in one location, meant that it was not possible to definitively establish existence and thus extent of trainees' cooperation in idea generation or

brainstorming and idea structuring. In the same vein, considering that the study was not designed to have a group task for the trainee's cooperative effort to be established, the results of the study cannot support Harasim (2012) views on intellectual convergence.

4.10.2 Acquisition of practical skills

The results of the study showed that the distribution of the mean scores was the same across both categories (face-to-face and online pedagogies) being observed. The findings of the study demonstrated that training of a practical skill online (experimental group) was as effective in eliciting desired outcomes in regards to trainees' practical skills acquisition as the process of training of the same practical skills face-to-face (control group).

The results of the study by the United States of America (USA) National Research Council (2000) confirmed that students learn most effectively when among other aspects, they are given practice and time to "take ownership of the learning" through metacognitive reflective thinking. The study findings showed that both trainees trained face-to-face (control group) and those trained online (experimental group) in the respective practical tasks, clearly demonstrated ability to read and interpret working drawings; observe and focus on the skill being taught; showed interest and were motivated as they worked on the practical task; process skills (managed and modified actions such as selecting the right tools); and a sense of belonging and connection with colleagues in the learning community. These findings are consistent with conclusions of various literature that was reviewed for the study. The results are in tandem with the fifth element of Bloom's taxonomy in which he concluded that for understanding to deemed to have happened, the trainee should be able to make sense of oral, written, and visual

communications by interpreting, exemplifying, categorizing, summarizing, inferring, contrasting, and clarifying what has been learnt or delivered (Picciano, 2017).

There is consistency between the findings of the study and Abrahams and Reiss (2015) categorization of process skills as comprising adherence to the instructor's instructions and understanding the fundamental issues that arise with things like fair tests and measurement inaccuracies; and Kaufman (2013) writings on skill acquisition as requiring significant periods of sustained, focused concentration; as well as creativity, flexibility, and the freedom to set one's own standard of success, captured in his book entitled "The first twenty hours: How to learn anything fast". The results were in conformity with three of the seven behaviors emphasized by Lee et al. (2019) as indicators of student engagement in a learning environment. The study results of trainees trained face-to-face (control group) and those trained online (experimental group) both showed strong outcomes on learning satisfaction, as a psychological condition that involves learning interest, learning expectations, and learning enjoyment; a feeling of being a part of the learning community, which is the degree of ties to friends and classmates; and learning enthusiasm, as trainees in both pedagogies exhibited an active mentality during the work sessions and may showed positive mental energy, a readiness to take on difficulties, and a passion for learning (Lee et al, 2019).

Although there was no significant statistical difference in TVET practical skills acquisition of trainees trained face-to-face and those trained online, a few means of the two pedagogies (face-to-face and online) slightly differed in some of the parameters. The results showed that the mean score of trainees that had trained in a practical skill online was slightly higher for demonstrated procedural skills (ability to do something such as

cut a steel bar) which was consistent with Abrahams and Reiss (2015) works on procedural skills; whereas the mean score for those who had trained in a practical skill face-to-face demonstrated was higher for competence in handling of tools and equipment. These findings were concurrent with City and Guilds requirement that the demonstration of competence in the necessary practical skills should frequently involve using equipment in a workshop (City and Guilds, 2013); and the description of practical skills as those that unmistakably reveal a person's competence in using a particular tool, machinery or equipment (Abrahams & Reiss, 2015). However, as noted earlier, the observed differences were so small and thus did not in any way signify a strength or weakness of the respective pedagogy.

The findings collaborated Kettunen (2013) view of two interrelated but fundamentally diverse processes that make up learning, and Johnson and Proctor (2017) observations that, all skills, require coordinated processes of perception, cognition, and action. The mean scores showed that trainees that had trained for the task in both pedagogies demonstrated a sense of belonging and connection with colleagues in the learning community; and at the same time consistently exhibited good procedural, conceptual and process skills. Also, in agreement with the findings of Frymier and Houser (1999), that that empowerment, motivation, emotional learning, and relevance were all positively correlated with students' performance on learning markers; the findings showed that trainees of both pedagogies showed interest and were motivated as they worked on the practical tasks. However, whereas the findings were in tandem with two of Lamprianou and Athanasou (2009) three phases for the learning of a complex skill (early cognitive phase and the practice fixation stage), the limited duration of the experiment meant that

the results were not conclusive on the third phase (autonomous stage – where performance is usually locked in as a response pattern and as such characterised by increasing speed of performance in which errors are unlikely to occur).

There were mixed and inconclusive evidence relating to Lee et al. (2019) emphasis on the feeling of being a part of the learning community requiring trainees to exhibit a degree of ties to friends and classmates. Whereas the results suggested that during the work sessions, trainees that had trained for a practical task online, consistently demonstrated a sense of belonging and connection with colleagues in the learning community, this result may only have been possible because they accessed the online training from the same location during the study. As such this result cannot be generalized and this calls for more investigations to establish with certainty whether online training of practical skills can elicit trainees' sense of belonging with colleagues in the learning community.

4.10.3 Assessment of practical skills

The results of the study showed that the distribution of the mean scores was the same across both assessment processes (face-to-face and online) being observed. The findings of the study demonstrated that the process of assessing a practical skill online (experimental group) was as effective as the process of assessing the same practical skill face-to-face (control group).

The study results showed that in both the assessment process done face-to-face (control group) and the assessment done online (experimental group) in the respective practical assessment sessions, practical skills were effectively assessed. Also, clearly shown by the findings, was that for both face-to-face and online assessment sessions, trainees' strengths and weaknesses, learning gains and misconceptions were diagnosed effectively

by assessors through assessment by observation of performance of practical skills and trainees work products being appraised as a means of assessment. A high mean score was also evident for both face-to-face and online assessment data for the procedure of assessing practical skills being a time-consuming exercise. These findings were consistent with the works of Hodson (1992) who argued that educational assessment should be a component of learning rather than something apart from it and thus should serve, among other four purposes, a formative purpose, allowing teachers to analyze students' strengths and weaknesses, learning progress, and misconceptions in order to better prepare for each student's future learning. Whereas the results also confirmed that assessing practical skills online still remains a time-consuming exercise as earlier reported by Harden and Cairncross (1980), evidence from the study showing that the process was more collaborative (including assessors, instructors, technicians, ICT staff, etc.) than that of the face-to-face process, was a key mitigating factor. The later finding is compatible with the conclusions of Gobaw and Atagana (2016) that for performance-based training and assessment to be effective, then instructors need much more assistance and professional development of performance skills as well as pedagogies of how to assess the performance skills of their students (Gobaw & Atagana, 2016).

The study results showed that in both the assessment process done face-to-face (control group) and the assessment done online (experimental group) in the respective practical assessment sessions, assessment of practical skills was not giving feedback to trainees about their work, assessors had challenges navigating around content to be assessed, and the online assessment process was affected by electricity and internet connectivity. The results agree with the drawbacks of online learning such as communication anxiety due to

the delayed replies in an asynchronous setting, difficulties navigating online and following discussion threads, and lack of visual clues (Palloff & Pratt, 2007). The inability of online assessment to provide feedback to trainees as shown by the results, contradicts with Ramani and Leinster (2007) insistence on feedback as a means of giving students information about their performance for possible improvement and as direction for them to review their accomplishment of goals.

The findings of the study also had a mixed fit with Abrahams and Reiss (2015) DAPS (Direct Assessment of Practical Skills) and IAPS (Indirect Assessment of Practical Skills) which are two terms they established in their investigation on how practical skills can be assessed. The study results fit well and thus were consistent with DAPS because they showed that the assessment process effectively assessed trainees' level of competency as they (trainees) physically manipulated real objects in order to demonstrate competence in the respective practical tasks. However, on the other hand, because trainees were not required to, and thus never submitted a practical work report as part of the study, the results of study were unable to support the second term (IAPS). Thus, the results of the study support the assessment of trainee's competency in terms of real practical skills, but, however, they cannot be used to support the assessment of trainees 'understanding' of a skill or process (Abrahams & Reiss, 2015).

The findings are consistent with the Glossary of Education Reform (2013) that points to assessment techniques that will best gauge and promote learning, and the culture that permeates the learning environment. The results suggest that trainees' strengths and weaknesses, learning gains and misconceptions can be effectively diagnosed by assessors through online observation of trainees' performance of practical skills and appraisal of

their final product. This study gives trainees, parents and employers the option and thus confidence that practical skills acquired online can elicit relatively the same performance outcomes for those who have trained for them online and those who have done so face-to-face.

However, the results can neither be used to support Rahman et al (2021) analytical study which showed that better practical (e.g., programming) skills have a positive effect on academic performance, nor be used to support, imply or make inference of mastery or expert performance of skills which as observed by Lamprianou and Athanasou (2009) which would be unlikely to be achieved in less than 5,000 hours. This was because the central focus of the study was never about comparing practical skills and academic performance as noted by Rahman et al (2021), or about mastery or expert competencies as observed by Lamprianou and Athanasou (2009), but solely on the effectiveness of online pedagogy in training, acquisition, assessment, performance and perception of practical skills.

4.10.4 Performance of practical skills

The results of the study showed that the distribution of trainees' average performances was the same across both categories (face-to-face and online) being assessed in the study. The findings of the study demonstrated that the performance of trainees trained in a practical skill online (experimental group) was not significantly different from that of trainees trained in the same practical skill face-to-face (control group).

The trend of trainees' average performance in all the four tasks followed a similar trajectory for both the trainees that had trained for the particular task face-to-face (control

group) and those that had trained online, with the majority of the scores for both groups in the range of 75%-79%. Considering that the assessment process was conducted as part of the overall practice and work process of trainees as they worked on the assigned tasks, the results are concurrent with works of Hodson (1992) who argued that educational assessment should be a component of learning rather than something apart from it and thus should serve, among other purposes, a summative purpose in which, at the conclusion of the course, the assessemnt should describe a student's levels of achievement in all course-related areas. The findings are also cosistent with the observations of Lamprianou and Athanasou (2009) in which they noted that practical tests can be undertaken while one is teaching through observation of selected aspects of students' behaviors and performances that are recorded on a checklist or rated in some way, as a means to describe a students' progress at a particular time in a learning activity; and also, as noted in Schunk (1995), these students' own performances served as trustworthy indicators of their level of self-efficacy in the practical tasks. The findings are also in line with educational psychologist Robert Gagne's teaching experiences proposals that included, among others, encouraging performance-based learning through assignments, discussions, and group research projects; and evaluating performance using a test, research project, essay, or presentation as the evaluation tool (cited in Harasim, 2012).

Although the study results showed no statistically significant difference between the performance of trainees who had trained a practical skill online (experimental group) and those that had trained in the same practical skill face-to-face (control group), the mean score of the face-to-face group was slightly higher than that of the online group. Also, the

findings showed that the two highest scores were recorded in the face-to-face group (90%-94%) whereas the lowest score was recorded in the online group (55%-59%). Whereas the observed small differences in performance between the face-to-face and online groups do not affect the overall interpretation of the results, they may be explained by Frymier and Houser (1999) ideas that students engage in particular behaviors or activities when they are immersed in learning, and thus their empowerment, motivation, emotional learning, and relevance may all have positively correlated with their performance in the tasks (Frymier & Houser, 1999).

The slightly better performance of the group trained face-to-face compared to that trained online can also be anchored in the findings of Mushtaq and Khan (2012) which found that communication, learning facilities and proper guidance have a positive impact on academic performance; findings of Ganyaupfu (2013) which demonstrated that teacher-student interactive method was the most effective teaching method; the works of Wentzel and Wigfield (1998) which highlighted that teachers' interpersonal relationships with students are potentially powerful factors that influence student motivation and performance; and the works of Allery (2020) who noted that a trainee may not be able to identify how or why the skill was performed incorrectly because of having an inaccurate perception of their own performance.

The results also showed an average variation between scores of the two assessors that scored trainees' performance in a particular task to range between 0% to 5% across both pedagogies. These results, to some extent, dispute earlier findings in Harden and Cairncross (1980) which had showed that the scores assigned to identical practical examination by fourteen examiners varied by as much as 25% and that even the same

examiners were inconsistent since their marks varied from the initial mark by as much as 15% when they marked a video recording of the exam three months later. Having followed City and Guilds guidance to training facilities that required the use of detailed competence checklists during observations of performance and product evaluation (City and Guilds, 2013), the study assessment tool acquired from UBTEB, enabled assessors scores to be consistent and kept the average variations of scores to the minimum. The very small variation in scores of two separate assessors scoring the same trainee on the same task was also evidence enough of trainees' performances in the tasks serving as trustworthy indicators of their level of self-efficacy (Schunk,1995).

4.10.5 Perceptions towards online pedagogy

The results of the study showed that the recorded difference between the posttest and pre-test mean scores of trainees', instructors' and assessors' perception, was statistically significant. The findings of the study thus demonstrated that the perception of trainees, instructors and assessors about online training, acquisition, assessment and performance significantly changed after undergoing an online pedagogy.

The results of the study showed that after experiencing online training and assessment, participants believes and perception towards the effectiveness of online training and assessment of practical skills positively changed. The change in participants' perception occurred mainly in the potential and effectiveness of online practical skills training and assessment to enhance educational and training effectiveness the same way as face to face training; assess and diagnose a trainee's strengths and weaknesses, learning gains and misconceptions through observation of performance of a practical task; and creating

the same active engagement and ability to understand and interact with concepts, techniques and practical tasks as face to face learning. Also, the results showed that previously held misconceptions and information vacuums about online pedagogy in terms of its ability to effectively be used for training and assessment of practical skills were rectified after participants undergoing and experiencing online training and assessment. The study findings showed that among the rectified perception were the beliefs that electricity outages can only affect online training but does not affect face to face training of practical skills; that for practical work to be effectively assessed online, there is need for high-tech and advanced technology to first be in place; and that it's not possible to appraise products (such as objects produced, a plan, a design, a report or an item of processed information) as a means of assessing practical skills online.

Considering that the majority of participants in the study had never experienced online training and assessment, as depicted by their study entry data, the findings of the study are consistent with McDonald (2011) conclusions, because the participants only perception of online training and assessment were those acquired during the study. Without previous experiences of online training and assessment to base their interpretation of their senses of the pedagogy, as noted by Bernstain et al (1991), and perceptual processing that would conform with and support formally sanctioned responses, as noted by Goldstone et al (2009), then participants pre-test perception may have been what Bernstain et al (1991) referred to as visual sensations – shapes and colors, and as pointed out by Roche (2007), they may have been affected and shaped merely by participants beliefs, attitudes, and expectations.

Experiencing online training enabled the participants to get “knowledge of the world” upon which to base to interpret, or perceive, these sensations of online pedagogy (Bernstain, Roy, Srull, & Wickens, 1991). This experience and subsequent change of participants perception towards online training and assessment is evidence enough to support Forrester (2017) view of the universe as observer dependent and there being no reality independent of the observer, which is knowable to the observer and thus conclusion that recognition of an observer dependent world would lead to a much more open minded and tolerant world (Forrester, 2017). As such, the findings of the study were consistent with one of Bernstein et al (1991) characteristics of perception considering that after participants had gone through the online training and assessment experience and thus acquired knowledge that can anchor their sensations, their perception of the pedagogy changed.

These findings are consistent with earlier findings of Syauqi et al (2020) in which students revealed that online learning provided them with ease of access to resources, motivation and ease in their learning; and with the findings of Smart and Cappel (2006) who noted that the largest dissatisfaction factor reported among the participants was the time required to complete the online modules (Smart & Cappel , 2006). On the other hand, the findings of the study also dispute the other findings of Syauqi et al (2020) which had revealed that students felt that online learning had not provided better experience and productivity in mastering competencies; and the findings of Thongsri et al (2019) which showed that service quality had little or no influence on the intention acceptance of the novel online learning method. This contradiction in terms of experience and productivity in mastering competencies, may have its roots in the nature, context,

focus and structure of the two studies. Whereas this study sought to compare perception before and after experiencing online training and assessment, the study by Syauqi et al (2020) only sought to provide an overview of students' perception of Mechanical Engineering Education on online learning as a result of the impact of the COVID-19 pandemic.

However, the results also showed that some of the participants perception never changed even after undergoing and experiencing online training and assessment. The findings of the study showed that participants perception that never changed included the ability of online pedagogy to enable a trainee have communication with the instructor if they have a challenge and need clarification; the possibility of getting feedback from peers, instructors, and assessors about one's work for the opportunity to correct errors; the believe that the procedure of assessing practical skills online is frequently time-consuming; and whether inadequate preparation of instructors and trainees for practical skills training is a challenge for only online training and not face to face training. These findings agree with Smart and Cappel (2006) who observed that the largest dissatisfaction factor reported among the participants of online learning was the time required to complete the online modules.

4.10.6 Challenges of online pedagogy

The results of the study showed that the challenges facing online training, assessment, acquisition and performance of practical skills can be categorized under: 1- inadequate preparation of trainers and trainees; 2- lack of feedback and real-time interaction; 3- lack of ICT equipment; 4- electricity outages; 5- lack of adequate knowledge in ICT; 6- poor or no internet connectivity; 7- lack of classroom management; 8- low concentration and

focus; 9- lack of inclusiveness to learning abilities; 10- poor course/training design; 11- it's a tedious/time consuming pedagogy; and 12- it's an expensive option.

The results showed that trainees ranked poor or no internet connectivity, electricity outages and the lack of ICT Equipment as the top challenges of online pedagogy, whereas lack of classroom management, lack of adequate knowledge in ICT and lack of inclusiveness to learning abilities, were ranked as the least of the challenges to online pedagogy. Instructors ranked poor course/training design, lack of ICT equipment and inadequate preparation of trainers and assessors as the top challenges of online pedagogy, whereas lack of inclusiveness to learning abilities, it being a tedious/time consuming pedagogy, and being an expensive option, were ranked as the least of the challenges to online pedagogy. Then the assessors ranked lack of ICT equipment, lack of feedback and real-time interaction, inadequate preparation of trainers and assessors, lack of adequate knowledge in ICT, and poor or no Internet connectivity as the top challenges of online pedagogy whereas it being an expensive option, lack of inclusiveness to learning abilities, and it being a tedious/time consuming pedagogy were ranked as the least of the challenges to online pedagogy.

The results are consistent with the findings of Hoftijzer, et al. (2020) that concluded that obstacles to providing TVET skills online include a lack of access to internet connectivity, electricity, equipment or media, learning platforms, and poor teacher and student preparation for remote learning. The findings of Palloff and Pratt (2007) are also supported by the results. They wrote about the drawbacks of online learning and how students react to it. Students express worries about health problems associated to computer use, information overload, communication anxiety due to the delayed replies in

an asynchronous setting, more work and responsibility, difficulties navigating online and following discussion threads, and lack of visual clues. (Palloff & Pratt, 2007).

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

In this chapter, three areas are presented. First, the main research findings of the study are summarized and presented under the respective hypotheses of the study. Second, the chapter then presents concluding insights into the core outcomes of the study and their impact on TVET practice and theory. Third, in the order and priority for implementation, the recommendations that accrue from the study findings are then presented.

5.2 Summary of findings

The primary research purpose of this quasi-experimental study, was to analyse and compare TVET practical skills training, acquisition, assessment, performance and perception in the face-to-face and online pedagogies in order to determine the efficacy of an online pedagogy on TVET practical skills training, assessment, acquisition, and performance. To achieve this purpose, five hypotheses served as a guide to this this quasi-experimental study and thus now shall serve as the framework for summarizing the study findings in this section.

The first hypothesis for the study stated that:

> ***H0:*** *There is no significant difference in the TVET practical skills training delivered face-to-face and that delivered online.*

The results of testing this hypothesis showed that the distribution of the mean scores was the same across both training categories (face-to-face and online pedagogies) being observed. The study results showed that both pedagogies (face-to-face and online) clearly

presented the material to be learned in an adaptive way that enabled trainees to begin with very easy versions of the practical task and then moved gradually to more difficult versions of the task; elicited performance and enhanced retention and transfer by providing opportunities for projects that might relate what was learnt to other real-life activities; and enabled trainees to participate and properly follow the training content and material being presented during the training session. Thus, the findings of the study demonstrated that the process of training a practical skill online was as effective as the process of training the same practical skill face-to-face.

The second hypothesis of the study stated that:

> ***H0:*** *There is no significant difference in the TVET practical skills acquisition of trainees trained face-to-face and those trained online.*

The results of testing this hypothesis showed that the distribution of the mean scores was the same across the face-to-face and online pedagogies. The study findings showed that both trainees trained face-to-face and those trained online in the respective practical tasks, clearly demonstrated ability to read and interpret working drawings; observe and focus on the skill being taught; showed interest and were motivated as they worked on the practical task; process skills (managed and modified actions such as selecting the right tools); and a sense of belonging and connection with colleagues in the learning community. This finding demonstrated that training of a practical skill online was as effective in eliciting desired outcomes in regards to trainees' practical skills acquisition as the process of training of the same practical skills face-to-face.

The third hypothesis stated that:

> ***H0:*** *There is no significant difference in the TVET practical skills assessment conducted face-to-face and that conducted online.*

The results of testing this hypothesis showed that the distribution of the mean scores was the same across both assessment processes (face-to-face and online) being observed. The findings showed clearly that for both face-to-face and online assessment sessions, trainees' strengths and weaknesses, learning gains and misconceptions were diagnosed effectively by assessors through assessment by observation of performance of practical skills and trainees work products being appraised as a means of assessment. Thus, the findings demonstrated that the process of assessing a practical skill online was as effective as the process of assessing the same practical skill face-to-face.

The fourth hypothesis stated that:

> ***H0:*** *There is no significant difference in the TVET practical skills performance of trainees trained face-to-face and those trained online; and*

The results of testing this hypothesis showed that the distribution of trainees' average performances was the same across both categories (face-to-face and online) that were assessed and scored in the study. The trend of trainees' average performance in all the four tasks followed a similar trajectory for both the trainees that had trained for the particular task face-to-face (control group) and those that had trained online, with the majority of the scores for both groups in the range of 75%-79%. The findings of the study demonstrated that the performance of trainees trained in a practical skill online was not significantly different from that of trainees trained in the same practical skill face-to-face.

The fifth hypothesis stated that:

H0: *There is no significant difference in the study participants' perception of an online pedagogy before and after undergoing online practical skills training, acquisition and assessment.*

The results of testing this hypothesis showed that the recorded difference between the posttest and pre-test mean scores of trainees', instructors' and assessors' perception on an online pedagogy, was statistically significant. The results of the study showed that after experiencing online training and assessment, participants believes and perception towards the effectiveness of online training and assessment of practical skills positively changed. Previously held misconceptions and information vacuums about online pedagogy in terms of its ability to effectively be used for training and assessment of practical skills were rectified after participants undergoing and experiencing online training and assessment. The findings of the study thus demonstrated that the perception of trainees, instructors and assessors about online training, acquisition, assessment and performance significantly changed after undergoing an online pedagogy.

Considering that objective six (6) of this quasi-experimental study had no comparison component and as a result never had a hypothesis, the following research question was used instead.

RQ1: *What are the challenges of online pedagogy in TVET practical skills training, assessment, acquisition and performance?*

To answer this question, the collected data was first processed into operational data that was then clustered into closely related meanings. The clustered data was then statistically illustrated so as to use its features to make associations, connections and inferences. The

results showed that trainees ranked poor or no internet connectivity, electricity outages and the lack of ICT Equipment as the top challenges of online pedagogy, whereas lack of classroom management, lack of adequate knowledge in ICT and lack of inclusiveness to learning abilities, were ranked as the least of the challenges to online pedagogy. Instructors ranked poor course/training design, lack of ICT equipment and inadequate preparation of trainers and assessors as the top challenges of online pedagogy, whereas lack of inclusiveness to learning abilities, it being a tedious/time consuming pedagogy, and being an expensive option, were ranked as the least of the challenges to online pedagogy. Then the assessors ranked lack of ICT equipment, lack of feedback and real-time interaction, inadequate preparation of trainers and assessors, lack of adequate knowledge in ICT, and poor or no Internet connectivity as the top challenges of online pedagogy whereas it being an expensive option, lack of inclusiveness to learning abilities, and it being a tedious/time consuming pedagogy were ranked as the least of the challenges to online pedagogy.

5.3 Conclusion

This quasi-experimental study has offered insights into the efficacy of an online pedagogy on TVET practical skills training by comparing, analyzing and drawing conclusions on both face-to-face and online pedagogies. The results of this study have provided statistical support and thus demonstrated that the processes of training delivery, acquisition, assessment and performance of a practical skill online were as effective as those done in the face-to-face. The results have also demonstrated that the perception of trainees, instructors and assessors about online training, acquisition, assessment and performance significantly change after them undergoing an online pedagogy.

The data generated in this study forms a foundation that supports trainers, training delivery institutions and training/learning content developers to deliver and assess practical skills online for the formal, non-formal and informal training purposes. The data also gives confidence to parents, trainees and employers that practical skills acquired online are as effective as those acquired in the face-to-face pedagogy. This will greatly ease access to skills as those who may have difficulty or challenges to get skilled at the training institutions shall still be able to access the same practical skills at home, or at the workplace via the online pedagogy in the same way the theoretical content has been accessed to date. The evidence supporting the process of assessing practical skills online, gives assessment bodies, training providers and employers the option and thus confidence that practical skills can be effectively assessed online with the trainee and assessor separated in time and space. The implication is that, the assessment process of practical skills, can now be made more flexible since those who may have difficulty or challenges to get assessed face-to-face shall still be able to be assessed online.

Considering that that perception towards online practical skills training and assessment is greatly dependent on stakeholders' experiences or lack of it, as evidenced by the study, training providers, content developers and education planners now have a heads up on what to expect from their respective stakeholders at the onset of a migration to online delivery of practical skills. The implication is that they need to appreciate that the often-negative perception towards online pedagogy, is often based on stakeholder's lack of prior experience of the same and thus lack of a basis upon which interpretation of new happenings can be based. With this realization, its now agreeable that practical skills training and assessment can no longer be confined to formal training, in workshops and

laboratories, but can now be accessed everywhere including to trainees in the nonformal and informal training setup. Practical skills can now be for everyone everywhere through the internet.

5.4 Recommendations

1. TVET providers and institutions should be equipped with enablers of online training and assessment that may include internet connectivity with good speeds; stable electricity source that also has a backup system in case of an outage; and ICT equipment (Digital video cameras, video editing equipment, sound equipment, projectors, computers and Wi-Fi routers among others).
2. Education quality assurance agencies, planners and managers, should develop a detailed framework for online training and assessment of practical skills that shall harmonize and be the guiding benchmark upon which all practical skills content developers, providers, assessors and recipients (trainees) shall be measured for quality and standards.
3. Assessment bodies should summarize assessment tools to only focus on the key aspects that can optimally provide evidence of a trainee's competence in the practical task at hand.
4. TVET providers and assessment bodies should recruit and train the right personnel (ICT technicians, video technicians and scriptwriters) to design and operationalise online delivery and assessment of practical skills.
5. TVET providers should develop and accumulate practical skills training content that is to be used in the online pedagogy starting with recording their face-to-face training sessions that may be then edited and enhanced for online delivery later.

6. Considering that no one is certain of ‘if’ and ‘when’ the next pandemic or natural disaster may disrupt the teaching and learning process, then Education overseers, planners and managers need to Integrate online training and assessment of practical skills into the training and assessment routine.
7. Conduct further studies on delivery and assessment of practical skills online that should address some of the limitations of this study and have participants from more than just two training institutions.

5.5 Suggestions for further research

This study has compared the face-to-face and online pedagogies to: first determine the efficacy of an online pedagogy on training delivery, acquisition, assessment, and performance of TVET practical skills; and secondly assess trainee’s, instructors and assessor’s perception towards an online pedagogy as a method for TVET Practical skills training as well as the related challenges. However, for these findings to be conclusive and generalisable, there is still need for:

A replication of this study to be done with an expanded scope of study to include several other formal and non-formal TVET institutions (both public and private) across the country to see if there are any changes in the results of this study;

Studies to investigate and establish with certainty whether online training of practical skills can elicit trainees’ sense of belonging with colleagues in the learning community; and

Research to explore the potential and limitations of existing and future technological alternatives to enable feedback and real-time interactions in online training delivery and assessment of TVET practical skills.

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APPENDICES

Appendix I: Consent Forms

Appendix I (a): Trainees Informed Consent Form

MBARARA UNIVERSITY OF SCIENCE AND TECHNOLOGY

RESEARCH ETHICS COMMITTEE

P.O. Box 1410 Mbarara, Tel: +256-48-543-3795, Fax: +256-48-542-0782

E-mail : irc@must.ac.ug, mustirb@gmail.com

TRAINEES INFORMED CONSENT FORM

Study title

The Efficacy of Online Pedagogy on TVET Practical Skills Training, Acquisition and Assessment: A Quasi-Experimental Study Conducted in Uganda.

Principal Investigator(s)

Ronald Mutebi - Technology Department, University of Eldoret, Kenya

Introduction

What you should know about this study:

1. You are being asked to join a research study.
2. This consent form explains the research study and your part in the study.
3. Please read it carefully and take as much time as you need.
4. You are a volunteer. You can choose not to take part and if you join, you may quit at any time. There will be no penalty if you decide to quit the study.

Brief background to the study

The new realities of the Covid 19 pandemic have dictated that the acquisition of practical skills can no longer be confined to the institutions' laboratories and classrooms, but

should be acquired everywhere (at the institution and home). However, to commit to such an endeavor, there is need to generate evidence that supports the idea of acquiring practical skills through an online pedagogy. As such, this study seeks to analyse and compare TVET practical skills training, assessment and acquisition in the face-to-face and online pedagogies, so as to determine the efficacy of online pedagogy.

Purpose of the research project

This study shall have 149 participants consisting of 8 UBTEB Assessors 8 Instructors, and 133 Trainees. The purpose of this quasi-experimental study will be to analyse and compare TVET practical skills training, assessment and acquisition in the face-to-face and online pedagogies, so as to determine the efficacy of online pedagogy on TVET practical skills training, assessment and acquisition. Your participation shall only last for the duration of data collection and that is expected to last not more than 3 weeks.

Why you are being asked to participate?

Your being asked to participate in the study so as:

1. To undertake practical training sessions in the respective pedagogy;
2. To undertake practical assessment sessions; and
3. To provide feedback on own experiences during the study

Procedures

To ensure uniformity of extent and difficulty of content, the modules taught in the face-to-face (control) group shall be the ones recorded, filmed and digitally enhanced with the use of ICTs, for use to the online pedagogy (experimental) group.

To avoid the control and experimental group from mixing and as such contaminating each other and the study, the two groups for the same programme shall be in separate institutions so that the experimental group has no other training on the task at hand other than online training. the same procedure shall be repeated for the second programme but this time with the two groups switching sides.

The research assistants will administer questionnaires to all participants so as to gather pretest data. The training sessions will then commence for both programmes in the two institutions with the research assistants using the observation checklist to capture various observed data in all the groups. The control group will be trained in the traditional format of face-to-face with the instructors in the same place and time with them as they are guided through the tasks whereas the experimental group will be trained via augmented reality. The recorded, filmed and digitally enhanced video that is transmitted online shall be the only source of training for the experimental group to guide them in performing the task at hand. For the second task, the experimental group of the previous task shall become the control group that is taught face-to-face and the control group of the previous task shall become the experimental group whose only training and guidance to perform the task is online. This procedure shall be repeated for the second programme.

Risks or discomforts

No reasonably foreseeable hazards, risks or discomforts-physical, psychological, social and legal are anticipated from your participation in this study.

Benefits

The findings of the study will be of great significance in the teaching and learning process of both TVET and General education sub-sectors by providing valuable data concerning the effectiveness of teaching and learning of practical skills online to inform decisions of institutions of higher learning (especially TVET institutions) on the feasibility and methodology of including practical modules in future online study packages. Thus, the benefit to you shall be your contribution to the body of knowledge in this regard.

Incentives or rewards for participating

There shall be no cost to you for taking part in this study. The study shall be conducted during the routine timetabled lectures and practical sessions of your institution and as such shall be part of your scheduled training activities.

Protecting data confidentiality

The study data shall be collected on questionnaires, observation checklists, test items and assessment tool, shall not bear any identifying details such your name and as such cannot be traced back to you after the study.

Protecting subject privacy during data collection

Once you consent to participating in the study, you shall be assigned a unique identification number that shall be used instead of your name or initials on the questionnaires and test items. This shall be intended to ensure that your replies are kept confidential at all times during and after the process of data collection.

Right to refuse or withdraw

Participation in this study is voluntary and as such you may decline to respond to any or all questions/tasks, and you may end your participation at any moment if you so choose.

What happens if you leave the study?

There shall be no penalty or loss of benefits whatsoever should you freely opt to discontinue participation in this study at any time.

Who do I ask/call if I have questions or a problem?

1. Ronald Mutebi
   Principle Researcher,
   University of Eldoret
   P.O. Box 1125-30100 Eldoret, Kenya
   Tel: +256772373643
2. Dr. Francis Bajunirwe
   Chairman, MUST-REC
   P.O. Box 1410 Mbarara
   Tel: 0485433795/0772 576 396

What does your signature or thumbprint on this consent form mean?

Your signature on this form means

1. You have been informed about this study's purpose, procedures, possible benefits and risks
2. You have been given the chance to ask questions before you sign
3. You have voluntarily agreed to be in this study

_ _ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _ _
Name of adult participant	Signature/Thumbprint of participant/ Parent/Guardian/Next of Kin	Date

_ _ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _
Name of person obtaining consent	Signature	Date

_ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _
Print Name of witness	Signature or thumbprint or mark	Date

Appendix I (b): Instructors Informed Consent Form

MBARARA UNIVERSITY OF SCIENCE AND TECHNOLOGY

RESEARCH ETHICS COMMITTEE

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E-mail: irc@must.ac.ug, mustirb@gmail.com

INSTRUCTORS INFORMED CONSENT FORM

Study title

The Efficacy of Online Pedagogy on TVET Practical Skills Training, Acquisition and Assessment: A Quasi-Experimental Study Conducted in Uganda.

Principal Investigator(s)

Ronald Mutebi - Technology Department, University of Eldoret, Kenya

Introduction

What you should know about this study:

1. You are being asked to join a research study.
2. This consent form explains the research study and your part in the study.
3. Please read it carefully and take as much time as you need.
4. You are a volunteer. You can choose not to take part and if you join, you may quit at any time. There will be no penalty if you decide to quit the study.

Brief background to the study

The new realities of the Covid 19 pandemic have dictated that the acquisition of practical skills can no longer be confined to the institutions' laboratories and classrooms, but should be acquired everywhere (at the institution and home). However, to commit to such an endeavor, there is need to generate evidence that supports the idea of acquiring

practical skills through an online pedagogy. As such, this study seeks to analyse and compare TVET practical skills training, assessment and acquisition in the face-to-face and online pedagogies, so as to determine the efficacy of online pedagogy.

Purpose of the research project

This study shall have 149 participants consisting of 8 UBTEB Assessors 8 Instructors, and 133 Trainees. The purpose of this quasi-experimental study will be to analyse and compare TVET practical skills training, assessment and acquisition in the face-to-face and online pedagogies, so as to determine the efficacy of online pedagogy on TVET practical skills training, assessment and acquisition. Your participation shall only last for the duration of data collection and that is expected to last not more than 3 weeks.

Why you are being asked to participate?

Your being asked to participate in the study so as:

1. To conduct practical training sessions in the face-to-face pedagogy;
2. To participate in development of digital content for the online pedagogy;
3. To supervise the face-to-face and online study sessions; and
4. To provide feedback on own experiences and observations during the study.

Procedures

To ensure uniformity of extent and difficulty of content, the modules taught in the face-to-face (control) group shall be the ones recorded, filmed and digitally enhanced with the use of ICTs, for use to the online pedagogy (experimental) group.

To avoid the control and experimental group from mixing and as such contaminating each other and the study, the two groups for the same programme shall be in separate institutions so that the experimental group has no other training on the task at hand other than online training. the same procedure shall be repeated for the second programme but this time with the two groups switching sides.

The research assistants will administer questionnaires to all participants so as to gather pretest data. The training sessions will then commence for both programmes in the two institutions with the research assistants using the observation checklist to capture various observed data in all the groups. The control group will be trained in the traditional format of face-to-face with the instructors in the same place and time with them as they are guided through the tasks whereas the experimental group will be trained via augmented reality. The recorded, filmed and digitally enhanced video that is transmitted online shall be the only source of training for the experimental group to guide them in performing the task at hand. For the second task, the experimental group of the previous task shall become the control group that is taught face-to-face and the control group of the previous task shall become the experimental group whose only training and guidance to perform the task is online. This procedure shall be repeated for the second programme.

Risks or discomforts

No reasonably foreseeable hazards, risks or discomforts-physical, psychological, social and legal are anticipated from your participation in this study.

Benefits

The findings of the study will be of great significance in the teaching and learning process of both TVET and General education sub-sectors by providing valuable data concerning the effectiveness of teaching and learning of practical skills online to inform decisions of institutions of higher learning (especially TVET institutions) on the feasibility and methodology of including practical modules in future online study packages. Thus, the benefit to you shall be your contribution to the body of knowledge in this regard.

Incentives or rewards for participating

There shall be no cost to you for taking part in this study if and when the study is conducted during the routine timetabled lectures and practical sessions of your institution and as such being part of your scheduled teaching activities. However, in the event of

some study activities being conducted outside your scheduled timetable, a facilitation fee of Twenty thousand (20,000) shillings per session shall be paid at the end of each session.

Protecting data confidentiality

The study data shall be collected on questionnaires, observation checklists, test items and assessment tool, shall not bear any identifying details such your name and as such cannot be traced back to you after the study.

Protecting subject privacy during data collection

Once you consent to participating in the study, you shall be assigned a unique identification number that shall be used instead of your name or initials on the questionnaires and test items. This shall be intended to ensure that your replies are kept confidential at all times during and after the process of data collection.

Right to refuse or withdraw

Participation in this study is voluntary and as such you may decline to respond to any or all questions/tasks, and you may end your participation at any moment if you so choose.

What happens if you leave the study?

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   P.O. Box 1125-10100 Eldoret, Kenya
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Your signature on this form means

1. You have been informed about this study's purpose, procedures, possible benefits and risks
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_ _ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _ _
Name of adult participant	Signature/Thumbprint of participant/ Parent/Guardian/Next of Kin	Date

_ _ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _
Name of person obtaining consent	Signature	Date

_ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _
Print Name of witness	Signature or thumbprint or mark	Date

Appendix I (c): UBTEB Assessor Informed Consent Form

MBARARA UNIVERSITY OF SCIENCE AND TECHNOLOGY

RESEARCH ETHICS COMMITTEE

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E-mail : irc@must.ac.ug, mustirb@gmail.com

UBTEB ASSESORS INFORMED CONSENT FORM

Study title

The Efficacy of Online Pedagogy on TVET Practical Skills Training, Acquisition and Assessment: A Quasi-Experimental Study Conducted in Uganda.

Principal Investigator(s)

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Brief background to the study

The new realities of the Covid 19 pandemic have dictated that the acquisition of practical skills can no longer be confined to the institutions' laboratories and classrooms, but should be acquired everywhere (at the institution and home). However, to commit to such

an endeavor, there is need to generate evidence that supports the idea of acquiring practical skills through an online pedagogy. As such, this study seeks to analyse and compare TVET practical skills training, assessment and acquisition in the face-to-face and online pedagogies, so as to determine the efficacy of online pedagogy.

Purpose of the research project

This study shall have 149 participants consisting of 8 UBTEB Assessors 8 Instructors, and 133 Trainees. The purpose of this quasi-experimental study will be to analyse and compare TVET practical skills training, assessment and acquisition in the face-to-face and online pedagogies, so as to determine the efficacy of online pedagogy on TVET practical skills training, assessment and acquisition. Your participation shall only last for the duration of data collection and that is expected to last not more than 3 weeks.

Why you are being asked to participate?

Your being asked to participate in the study so as:

1. To develop practical test items;
2. To assess and score trainees practical work; and
3. To provide feedback on trainee's performance of the practical work.

Procedures

To ensure uniformity of extent and difficulty of content, the modules taught in the face-to-face (control) group shall be the ones recorded, filmed and digitally enhanced with the use of ICTs, for use to the online pedagogy (experimental) group.

To avoid the control and experimental group from mixing and as such contaminating each other and the study, the two groups for the same programme shall be in separate institutions so that the experimental group has no other training on the task at hand other than online training. the same procedure shall be repeated for the second programme but this time with the two groups switching sides.

The research assistants will administer questionnaires to all participants so as to gather pretest data. The training sessions will then commence for both programmes in the two institutions with the research assistants using the observation checklist to capture various observed data in all the groups. The control group will be trained in the traditional format of face-to-face with the instructors in the same place and time with them as they are guided through the tasks whereas the experimental group will be trained via augmented reality. The recorded, filmed and digitally enhanced video that is transmitted online shall be the only source of training for the experimental group to guide them in performing the task at hand. For the second task, the experimental group of the previous task shall become the control group that is taught face-to-face and the control group of the previous task shall become the experimental group whose only training and guidance to perform the task is online. This procedure shall be repeated for the second programme.

Risks or discomforts

No reasonably foreseeable hazards, risks or discomforts-physical, psychological, social and legal are anticipated from your participation in this study.

Benefits

The findings of the study will be of great significance in the teaching and learning process of both TVET and General education sub-sectors by providing valuable data concerning the effectiveness of teaching and learning of practical skills online to inform decisions of institutions of higher learning (especially TVET institutions) on the feasibility and methodology of including practical modules in future online study packages. Thus, the benefit to you shall be your contribution to the body of knowledge in this regard.

Incentives or rewards for participating

You shall be paid per candidate's task assessed (at UBTEB current rates) and all your transport costs (Public transport) to the assessment center (Training institution) shall be reimbursed at the end of each assessment activity.

Protecting data confidentiality

The study data shall be collected on questionnaires, observation checklists, test items and assessment tool, shall not bear any identifying details such your name and as such cannot be traced back to you after the study.

Protecting subject privacy during data collection

Once you consent to participating in the study, you shall be assigned a unique identification number that shall be used instead of your name or initials on the questionnaires and test items. This shall be intended to ensure that your replies are kept confidential at all times during and after the process of data collection.

Right to refuse or withdraw

Participation in this study is voluntary and as such you may decline to respond to any or all questions/tasks, and you may end your participation at any moment if you so choose.

What happens if you leave the study?

There shall be no penalty or loss of benefits whatsoever should you freely opt to discontinue participation in this study at any time.

Who do I ask/call if I have questions or a problem?

1. Ronald Mutebi
   Principle Researcher,
   Eldoret University
   P.O. Box 1125-10100 Eldoret, Kenya
   Tel: +256772373643

2. Dr. Francis Bajunirwe
   Chairman, MUST-REC
   P.O. Box 1410 Mbarara
   Tel: 0485433795/0772 576 396

What does your signature or thumbprint on this consent form mean?

Your signature on this form means

1. You have been informed about this study's purpose, procedures, possible benefits and risks
2. You have been given the chance to ask questions before you sign
3. You have voluntarily agreed to be in this study

_ _ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _ _ _
Name of adult participant	Signature/Thumbprint of participant/ Parent/Guardian/Next of Kin	Date

_ _ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _
Name of person obtaining consent	Signature	Date

_ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _
Print Name of witness	Signature or thumbprint or mark	Date

Appendix II: Questionnaires

Appendix II (a): Pretest and Posttest Questionnaire

Participant Identification code …….

Section 1: Demographic and Background Information

Please tick in the box of the most appropriate option

1. Category of participant

    A. Trainee ☐

    B. Instructor ☐

    C. Assessor ☐

2. Name of Institution

    A. St Joseph's Technical Institute, Kisubi ☐

    B. Nakawa Vocational Training College ☐

3. Programme of study/Teaching/Assessing

    A. National Certificate in Building Construction ☐

    B. National Certificate in Woodwork Technology ☐

4. Gender

    A. Female ☐

    B. Male ☐

5. Academic Background

   A. Uganda Advanced Certificate of Education – UACE (S6) ☐

   B. Uganda Certificate of Education – UCE (S4) ☐

   C. Community Polytechnic/ Technical School ☐

   D. Diploma holder ☐

   E. Degree holder ☐

   F. Post Graduate ☐

6. Competency in use of ICTs

   A. Competent ☐

   B. Not Competent ☐

7. Experience in online learning

   A. Have Experience ☐

   B. No Experience ☐

Section 2: Practical Skills Training

How do you rate your agreement on each of the following in training and acquisition of practical skills online? (*Please tick in the box of the most appropriate option*)

8. I believe that practical skills can only be delivered by a trainer in person to a group of trainees with the TVET trainees and trainer in the same physical location at the same time.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

9. I believe that practical skills can effectively be delivered online with the trainees and the trainer separated in time and physical location.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

10. I believe that for practical skills to be effectively delivered online, there is need for high-tech and advanced technology to first be in place.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

11. Online training of practical skills can enable a trainee have communication with the instructor if they have a challenge and need clarification.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

12. I believe that online training of practical skills has the same potential to enhance educational effectiveness as face to face training.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

13. I believe that in online training of practical skills, it's possible to get feedback from peers and instructors about one's work.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

14. I believe that electricity outages can only affect online training but does not affect face to face training of practical skills.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

15. I believe that inadequate preparation of instructors and trainees for practical skills training is a challenge for only online training and not face to face training.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

Section 3: Practical skills assessment mechanisms

16. I believe that practical work can effectively be assessed online.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

17. I believe that for practical work to be effectively assessed online, there is need for high-tech and advanced technology to first be in place.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

18. I believe that online assessment of practical work has the same potential to enhance educational effectiveness as the traditional face to face assessment.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

19. I believe that in online assessment of practical work, it's possible to get feedback from the assessor about one's work.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

20. I believe that navigating around content to be assessed on ICT screen(s) is one of the major challenges facing online assessment of practical skills.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

21. I believe that levels of attainment in all aspects of the course can be done online.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

22. I believe that my strengths and weaknesses, learning gains and misconceptions can be diagnosed by assessors online.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

23. I believe that the procedure of assessing practical skills online is frequently time-consuming.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

24. I believe that assessment by observation of performance of practical skills can be done online.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

25. I believe that it's not possible to appraise products (such as objects produced, a plan, a design, a report or an item of processed information) as a means of assessing practical skills online.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

Section 4: Practical Skills Acquisition

26. One can learn a practical skill entirely online without coming to the institution.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

27. I believe online learning can produce a satisfactory degree of desired outcomes in terms of practical skills acquisition.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

28. I believe that one can learn a practical skill online and then be able to perform it to a satisfactory or expected degree.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

29. I believe that online learning of practical skills can make one feel involved with the activity or task being demonstrated.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

30. I believe that learning practical skills online can create the same active engagement and ability to understand and interact with concepts, techniques and practical tasks as face to face learning.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

31. I believe that online training of practical skills can provide constructive and specific feedback to trainees for the opportunity to correct errors.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

Dear trainee/Instructor/Assessor: Thank you for sparing time to help with this study.

Appendix II (b): Post-test open-ended Questionnaire on challenges of online pedagogy

Participant Identification code …….

1. Category of participant

   A. Trainee ☐

   B. Observer ☐

   C. Assessor ☐

2. Write down your own views and opinions on what you feel are the main challenges of online training, assessment and acquisition of practical skills online.

   ……

   ……

   ……

   ……

   ……

   ……

   ……

   ……

   ……

   ……

   ……

   ……

   ……

Dear trainee: Thank you for sparing time to help with this study.

Appendix III: Observation Checklists

Appendix III (a): Training Session observation checklist

(To be filled by instructors during the course of the training session)

1. Practical task being observed ……

2. Pedagogy being observed (online/Face-to-face) ……

Section 1: Background Information

Please tick in the box of the most appropriate option

3. Institution being observed
    A. St Joseph's Technical Institute, Kisubi ☐
    B. Nakawa Vocational Training College ☐

4. Programme being observed
    A. National Certificate in Building Construction ☐
    B. National Certificate in Woodwork Technology ☐

Section 2: Practical skills Training observation

Please tick in the box of the most appropriate option.

	Parameter being observed	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1	Training session is clearly presenting the material to be learned (to include graphics, presentations by instructors, practical demonstrations, etc.					
2	The training is adaptive to enable trainees to begin with very easy versions of the					

	practical task and then move gradually to more difficult versions of the task.					
3	The training elicits performance (training is activity-based learning such as group work, discussions, practice tasks, etc.).					
4	The training provides immediate feedback (immediate, specific, and constructive feedback is provided to trainees for the opportunity to correct errors as they train on the task).					
5	The training enhances retention and transfer by providing opportunities for additional guided practice or projects that might relate learning to other real-life activities.					
6	The training delivery is a collaborative process including more than one trainer, Technician, ICT staff, librarians, etc.					
7	The training session is not					

	affected by service(s) interruption (by lack of access to electricity, internet connectivity, devices or media, learning platforms).					
8	Trainees are properly following the training content and material being presented during the training session.					
9	Trainees are participating in the training session activities (such as full attendance, asking questions, and free expression to the instructor).					

Appendix III (b): Trainees practical work session observation checklist

(To be filled by instructors during the course of the practice session)

1. Participant Identification code of trainee being observed ……
2. Practical task being observed ……
3. Pedagogy being observed (online/Face-to-face) ……

Section 1: Background Information

Please tick in the box of the most appropriate option

4. Institution being observed
   A. St Joseph's Technical Institute, Kisubi ☐
   B. Nakawa Vocational Training College ☐
5. Programme being observed
   A. National Certificate in Building Construction ☐
   B. National Certificate in Woodwork Technology ☐

Section 2: Trainees Practical skills Acquisition observation

	Parameter being observed	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1	Trainee demonstrates ability to read and interpret working drawings.					
2	Trainee consistently demonstrates procedural skills (ability to do something e.g. cut a timber joint).					
3	Trainee demonstrates competence in handling of					

	tools and equipment					
4	Trainee demonstrates conceptual skills (understands complex scenarios and develop creative solutions).					
5	Trainee observes and focuses on the skill being taught.					
6	Trainee shows interest and is motivated as he/she works on the practical task.					
7	Trainee demonstrates process skills (to manage and modify actions e.g. selecting the right tools).					
8	Trainee demonstrates a sense of belonging (Which is the degree of connection with friends and colleagues in the learning community, classroom or workshop).					

Appendix III (c): Practical skills Assessment observation checklist

(To be filled by instructors during the course of the practice session)

1. Practical task assessment being observed ……
2. Pedagogy being observed (online/Face-to-face) ……

Section 1: Background Information

Please tick in the box of the most appropriate option

3. Institution being observed
    A. St Joseph's Technical Institute, Kisubi ☐
    B. Nakawa Vocational Training College ☐

4. Programme being observed
    A. National Certificate in Building Construction ☐
    B. National Certificate in Woodwork Technology ☐

Section 2: Practical skills Assessment observation

Please tick in the box of the most appropriate option.

	Parameter being observed	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1	Practical skills are effectively being assessed					
2	Assessment of practical skills is not affected by electricity and internet connectivity.					
3	Assessment of practical skills is not affected by ICTs (computers, projectors, speakers)					
4	Assessment of practical skills is giving feedback to trainees about their work.					

5	Assessors navigating around content to be assessed is a challenge.					
6	Trainees strengths and weaknesses, learning gains and misconceptions are being diagnosed effectively by assessors.					
7	The procedure of assessing practical skills is time-consuming and tiresome.					
8	Assessment by observation of performance of practical skills is being done.					
9	Trainees work products are being appraised as a means of assessing practical skills.					

Appendix IV: Practical tasks

Appendix IV (a): Practical task 1 (Steel Bending) Worksheet

Training: Basic Training	Code: NCBC 122
Course: NCBC - National Certificate in Building Construction	
Module: Concrete Theory	Instructor: …….
Sub-Module: Steel Bending	Date:……..

1. Task

Study the working drawing provided and set out, construct the chain link post cage of 3 bars.

2. Materials

1. Bars
2. Rings
3. Binding wire

3. Tools and equipment required

1. Measuring Tape
2. Hawk saw
3. Piece of pipe half inch
4. Hammer
5. Bench

4. Work Procedure

a) Making a template

i. Cutting 150mm of Y10 steel bar. (4 pieces) or nails 6 inch.

ii. Fix two pieces in line on the bench.

iii. From the two pieces fixed measure 75mm, fix other two of 15mm of Y10 in line.

b) Forging (Stirrup)

i. Measure 390mm and cut 16 pieces of stirrups of Y6 steel bar (ring)

ii. Mark the ends with 50mm from each end.

iii. From 50mm mark 75mm three times.

iv. Using the template on a work bench, start curving following the dimensions given to obtain a triangular shape of a ring.

c) Cranking steel bars

i. Cut steel bars of Y10 measuring 2650mm each, measure from one end of each 250and mark.

ii. Cut one steel bar of Y10 measuring 2610mm, measure 210mm and mark from one end.

iii. Curve at an angle of 45 degrees using a template or a steel bender

d) Assembling

i. Arrange two steel bars of Y10 measured 2650mm each and another steel bar of Y10 measuring 2610mm on the stand

ii. Fit 16 triangular stirrups into the three arranged steel bars.

iii. Cut 350mm pieces of binding wire 48 in number for one unit.

iv. Pick one by one and start tying the stirrups onto the bars as guided by the drawing.

v. Continue trying placing the stirrup 200mm per interval center to Centre until you finish.

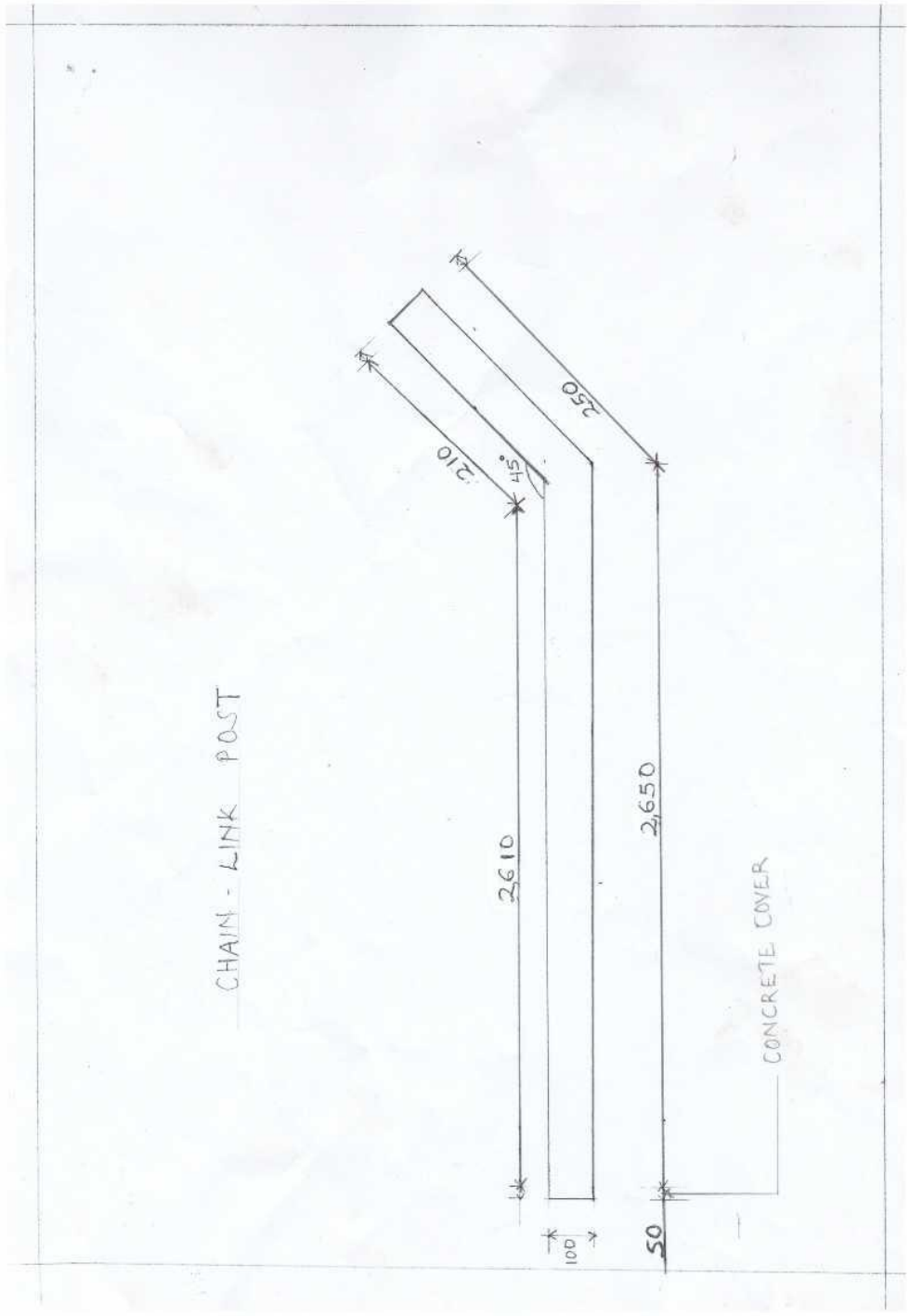
vi. Stack the cages under a shade and on a raised platform.

e) Cleaning tools and working area

i. Greasing / oiling metallic tools and store them.

ii. Clean the working area.

5. Drawing



Appendix IV (b): Practical task 2 (Broken Bond) Worksheet

Training: Basic Training	Code: NCBC 122
Course: NCBC - National Certificate in Building Construction	
Module: Brickwork	Instructor: ……
Sub-Module: Broken Bond with Bricks on Edge, Toothing and a Racking Back	Date:……..

1. Task

Follow the procedures below carefully and perform the task given

2. Tools and equipment required

- Trowel, Level, Builder's Square, Builder's string, Plumb bob

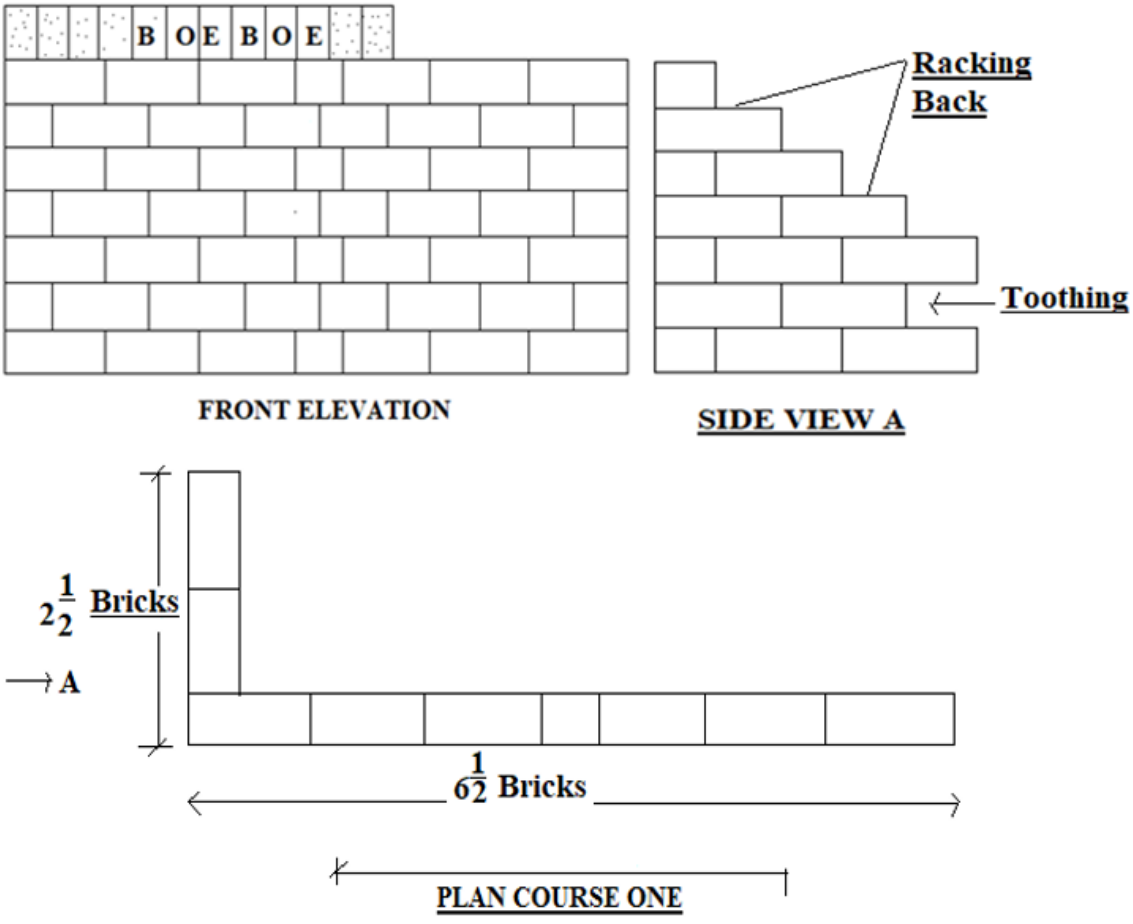
3. Work procedures

- Observe safety precautions during all stages of operations;
- Obtained the base line and demarcated dimensions of the model on the ground;
- Lay, level and plumb the courses;
- Gauge mortar joints 10 +-5 mm;
- Built model with toothing, racking back and contrasting bricks design;
- Plumb, level and aligned B.O.E;
- Finish brick work joints, collect broken bricks mortar and sweep working area;
- Collect all the tools, clean the working area; and
- Hand over the project.

4. The Materials list

No.	Description	Quantity
1	Bricks	50
2	Moartar	$2m^3$

5. Drawing



Appendix IV (c): Practical task 3 (Beam Formwork) Worksheet

Training: Basic Training	Code: NCTW121
Course: NCTW - National Certificate in Woodwork Technology	
Module: Temporary structures	Instructor: Olwa Tom
Sub-Module: Formwork	Date:……..
Sub-Module Detail: Beam Formwork	

1. Task

Follow the procedures below carefully and perform the task given

2. Tools and equipment required

Hand saw, spore shave, try square, Tape measure, smoothing plane

Bow saw/ coping saw, claw hammer

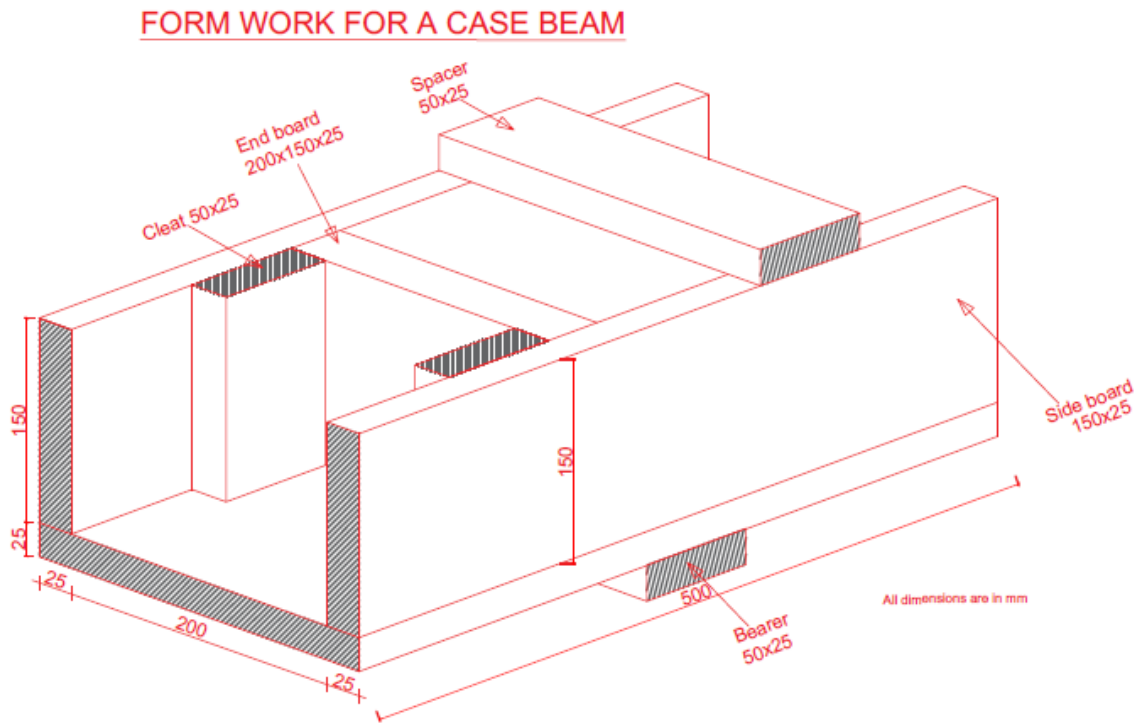
3. Work procedures

- Observe safety precautions during all stages of operations;
- Prepare the materials given (cut and plane to sizes as in the cutting list);
- Set out the formwork members according to the drawing;
- Cut the side boards, soffit, cleats, end board, spacer, and bearer to the given dimensions in the cutting list;
- Fix and assemble the members together as per the drawing provided;
- Collect all the tools, clean the working area; and
- Hand over the project.

4. The cutting list

No.	Description	Quantity	Finished size L W TH
1	Side Board	2	500 x 150 x 25
2	End Board	1	200 x 150 x 25
3	Cleats	2	150 x 50 x 25
4	Spacer	1	250 x 50 x 25
5	Bearer	1	250 x 50 x 25
6	Soffit	1	500 x 250 x 25
7	Nails 1.5"	50	

5. Drawing



Appendix IV (d): Practical task 4 (Equilateral Arch Center) Worksheet

Training: Basic Training	Code: NCTW121
Course: NCTW - National Certificate in Woodwork Technology	
Module: Temporary structures	Instructor: Aloro Francis
Sub-Module: Centering	Date:……..
Sub-Module Detail: Equilateral wooden arch center	

1. Task

Follow the procedures below carefully and perform the task given

2. Tools and equipment required

Hand saw, spore shave, try square, Tape measure, smoothing plane

Bow saw/ coping saw, claw hammer

3. Work procedures

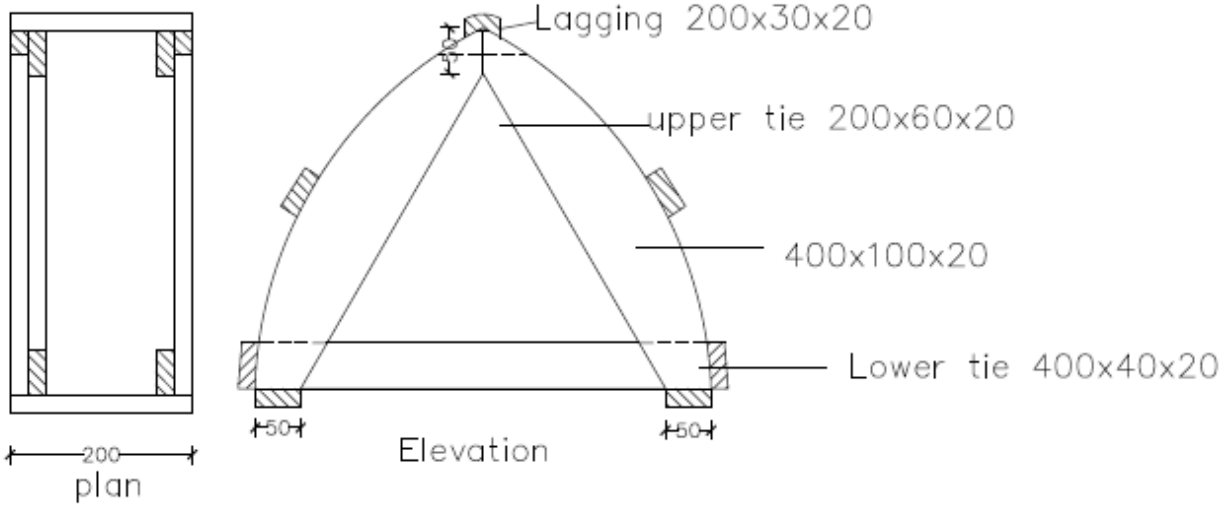
- Observe safety precautions during all stages of operations
- Prepare the materials given (cut and plane to sizes as in the cutting list)
- Set out the center according to the drawing
- Use template provided to mark the ribs
- Cut and shape the ribs
- Fix and assemble the ribs together
- Fix the bearers to strengthen the centers
- Fix the laggings and finish the centers
- Collect all the tools, clean the working area.

4. The cutting list

No.	Description	Quantity	Finished size L W TH
1	Lower tie	2	420x40x20
2	Upper tie	2	200x70x20
3	Ribs	4	420x100x20
4	laggings	6	210x40x20
5	Bearer	2	210x40x2
6	Nails 1.5[ll]	50	

5. Drawing

plan and the elevation through an equilateral arch center



Appendix V: Assessment tools

Appendix V (a): Assessment tool for practical Task 1 (Bending Steel)

Name of Assessor…….. Institution……. Center No:……

Test Item: Bending Steel Time: 1 Hour

S/N	ASSESSMENT CRITERIA	SCORING GUIDE	MAX SCORE		`CANDIDATES REGISTRATION NUMBERS																					
			PROCESS (P)	PRODUCT (R)	P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R
1	Observed health and safety.	Clothed in overall		1																						
		Put on helmet		1																						
		Used gloves during the performance of the task		1																						
		Put on strong shoes /gum boots.		1																						
2	Prepared materials	Steel bars.		2																						
		Tools put in		1																						

		one place																								
		Prepared equipment and environment		2																						
3	Making of template	Marked work bench.	3	4																						
		Fixed pieces of steel and their measurements.	4	4																						
		Use of template	4	3																						
4	Forging (stirrups)	Marking and measuring	3	4																						
		Curving	5	4																						
5	Cranking steel bars	Marking	2	3																						
		Measuring	4	4																						
		Cutting	2	2																						
		Curved angle 45 degrees	4	4																						
		Arrangement of bars	2	4																						
6	Assembling	Marking of steel bars at	2	3																						

		interval																								
		Fitting stirrups	1	1																						
		Tying stirrups	2	2																						
7	Completed unit	Assembled and completed unit		6.5																						
		Accuracy		4																						
		Cleaned working area		2																						
		Cleaned tools		1																						
		Placed tools in one place		0.5																						
SUB TOTAL			**36**	**64**																						
GRAND TOTAL = PROCESS + PRODUCT			**100**																							

Appendix V (b): Assessment tool for practical Task 2 (Broken Bond)

Assessor……. Institution……Center No……

Test Item: Broken Bond **Time:** 2Hrs

No.	Assessment Criteria	Scoring Guide	Max. Score																							
			P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R
1	Observed Safety	Gumboots		1																						
		Head Helmet		1																						
		Overall		1																						
2	Organizing working platform.	Required tools and materials available		1																						
		Arranged in convenient positions		1																						
3	Set out the model	Obtained the base line.	2	2																						
		Demarcated dimensions of the model on the ground	1	1																						
		Dry bonded first and second courses	2	2																						
	model	Laid course one and levelled.	2	2																						

		Plumbed the first course	1	2																						
		Gauged mortar joints 10 +-5 mm		2																						
		Laid course four	2	2																						
		Levelled and plumbed course four.	1	1																						
5	**Toothing and Racking back**	Built model with toothing	2	2																						
		Built model with racking back	2	2																						
6	**Bricks on Edge**	Contrasting bricks design was observed.		2																						
		B.O.E was on plumb, level and aligned.	1	3																						
		B.O.E cleanliness was observed		3																						
7	**Finished wall construction**	Finished brick work joints weather struck	1	2																						
		Good Completed block work.		2																						
		Good Completed brickwork.		2																						
		Maintained good quality of brickwork.		2																						

8	**Cleaned working area**	Collected broken bricks mortar and swept working area,		2																									
		Collected and cleaned tools.		2																									
		Sub Score	**17**	**43**																									
		TOTAL SCORE (Process +Result)	**60**																										
		Percentage score (Process +Result)/60 * 100%																											

P=Process, R =Result

Appendix V (c): Assessment tool for practical Task 3 (Beam Formwork)

Name of Assessor ……..……Institution ……Centre No……

Test Item: Beam Formwork Time: 2 hours CANDIDATES REG. No's (in Order of Registration)

#	Assessment criteria	Scoring guide	Max. Score																					
			P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R
1	Observe safety and health in the workshop	Put on protective shoes		2																				
		Put on an overall		2																				
		Put on helmet		2																				
2	Prepared materials	Mark two side board to length 500mm and depth 150mm	2	2																				
		Mark soffit to length 500mm and width 250mm	2	2																				
		Mark two cleat to length of 150mm and width of 50mm	2	2																				

#	Assessment criteria	Scoring guide	Max. Score																					
		Mark the end board of width 200mm and depth 150mm	2	2																				
		Mark the spacer of length 250mm and width 50mm	2	2																				
		Mark the bearer of length 250mm and width 52mm	2	2																				
		cut two side board to length 500mm and depth 150mm	2	2																				
		Cut soffit to length 500mm and width 250mm	3	2																				
		Cut two cleats to length of 150mm and width 50mm	2	2																				
		Cut the End board of width 200mm and depth 150mm	3	2																				

#	Assessment criteria	Scoring guide	Max. Score																					
		Cut the spacer of length 250mm and width 50mm	2	2																				
		Cut the bearer of length 250mm and width 50mm	2	2																				
3	Assembled and finished	Measure and place the soffit and fix the two boards on both sides	2	2																				
		Measure length 150mm and width 50mm and nail the cleats on both sides.	2	2																				
		Measure length 200mm and width 150mm and nail the end board to the cleats	2	2																				
		Measure length 250mm and width 50mm and nail the spacer to the side ends	2	2																				

#	Assessment criteria	Scoring guide	Max. Score																					
		Measure length 250mm and width 50mm and nail the bearer to the soffit	2	2																				
		Plan unwanted projections	2	2																				
		Collect all tools		2																				
		Clean workshop		2																				
		Hand over the project		4																				
		SUBTOTAL	**20**	**50**																				
		TOTAL /70	**70**																					
		Total Percentage/100	**100%**																					

P – Process, R- Result

Appendix V (d): Assessment tool for practical Task 4 (Equilateral Center Arch)

Name of Assessor ……..……Institution ……Centre No……

Test Item: Centered Arch Time: 2 hours CANDIDATES REG. No's (in Order of Registration)

#	Assessment criteria	Scoring guide	Max. Score																					
			P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R	P	R
1	Observe safety and health in the workshop	Put on an overall		2																				
		Put on strong shoes		2																				
		Put on helmet		2																				
2	Prepared materials	Mark two sides to length 300mm ± 1mm	2	2																				
		Mark two sides to length 300mm ± 1mm	2	2																				
		Mark soffit to length 300mm ± 1mm	2	2																				
		Mark end piece to length 200mm and wide of 150± 1mm	2	2																				

#	Assessment criteria	Scoring guide	Max. Score																					
		Mark two cleat to length of 200mm and wide of 150mm ±1mm	2	2																				
		cut two sides to length 300mm ± 1mm	2	2																				
		cut two sides to length 300mm ± 1mm	2	2																				
		cut soffit to length 300mm ± 1mm	2	2																				
		cut end piece to length 200mm and wide of 150± 1mm	2	2																				
		cut two cleats to length of 200mm and wide of 150mm ±1mm	2	2																				
		Marked tenons on eight rails (@½ mark)	2	2																				
		Marked one top	2	2																				
3	Assembled and finished	Measure 70mm and fixed the cleats on both sides	2	2																				

#	Assessment criteria	Scoring guide	Max. Score																					
		Measure 40mm and nail the bearers to the soffit on both ends.	2	2																				
		Fixed the soffit to the sides	1	2																				
		Secured top	2	2																				
		Place in the end piece in its position	2	2																				
		Nail spacer 200mm from one end	2	2																				
		Trim the projections		2																				
		Plan unwanted projections		2																				
		Collect all tools		2																				
		Cleaned workshop		3																				
		Hand over the project		4																				
		SUBTOTAL	**35**	**55**																				
		TOTAL /90	**90%**																					
		Total Percentage/100	**100%**																					

P – Process, R- Result

Appendix VI: Research Proposal Approvals

Appendix VI (a): UNCST Research Proposal Approval

Uganda National Council for Science and Technology

(Established by Act of Parliament of the Republic of Uganda)

Our Ref: SIR181ES **3 January 2023**

Ronald Mutebi
TVET Policy Implementation Secretariat - Ministry of
Education and Sports
Kampala

Re: Research Approval: **THE EFFICACY OF ONLINE PEDAGOGY ON TVET PRACTICAL SKILLS TRAINING, ASSESSMENT AND ACQUISITION IN UGANDA**

I am pleased to inform you that on 03/01/2023, the Uganda National Council for Science and Technology (UNCST) approved the above referenced research project. The Approval of the research project is for the period of 03/01/2023 to 03/01/2024.

Your research registration number with the UNCST is SIR181ES. Please, cite this number in all your future correspondences with UNCST in respect of the above research project. As the Principal Investigator of the research project, you are responsible for fulfilling the following requirements of approval:

1. Keeping all co-investigators informed of the status of the research.
2. Submitting all changes, amendments, and addenda to the research protocol or the consent form (where applicable) to the designated Research Ethics Committee (REC) or Lead Agency for re-review and approval prior to the activation of the changes. UNCST must be notified of the approved changes within five working days.
3. For clinical trials, all serious adverse events must be reported promptly to the designated local REC for review with copies to the National Drug Authority and a notification to the UNCST.
4. Unanticipated problems involving risks to research participants or other must be reported promptly to the UNCST. New information that becomes available which could change the risk/benefit ratio must be submitted promptly for UNCST notification after review by the REC.
5. Only approved study procedures are to be implemented. The UNCST may conduct impromptu audits of all study records.
6. An annual progress report and approval letter of continuation from the REC must be submitted electronically to UNCST. Failure to do so may result in termination of the research project.

Please note that this approval includes all study related tools submitted as part of the application as shown below:

No.	Document Title	Language	Version Number	Version Date
1	Informed Consent forms	English	1	09 August 2022
2	Data collection tools	English	1	09 August 2022
3	Project Proposal	English	CLEAN COPY	
4	Approval Letter	English		
5	Administrative Clearance	English		

Yours sincerely,

Hellen Opolot
For: Executive Secretary
UGANDA NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

LOCATION/CORRESPONDENCE

Plot 6 Kimera Road, Ntinda
P.O. Box 6884
KAMPALA, UGANDA

COMMUNICATION

TEL: (256) 414 705500
FAX: (256) 414-234579
EMAIL: info@uncst.go.ug
WEBSITE: http://www.uncst.go.ug

Appendix VI (b): Research Ethics Committee (REC) Approval

MBARARA UNIVERSITY OF SCIENCE AND TECHNOLOGY
P.O. Box 1410, Mbarara Uganda. Tel: +256 485433795; Fax: +256 4854 20782
RESEARCH ETHICS COMMITTEE
E-mail: sec.rec@must.ac.ug

10/11/2022

To: Ronald Mutebi

+256772373643

Type: Initial Review

Re: MUST-2022-570: THE EFFICACY OF ONLINE PEDAGOGY ON TVET PRACTICAL SKILLS TRAINING, ASSESSMENT AND ACQUISITION IN UGANDA, Clean Copy, 2022-10-10

I am pleased to inform you that at the 147th convened meeting on 01/09/2022, the MUST Research Ethics Committee, committee meeting, etc voted to approve the above referenced application.
Approval of the research is for the period of 10/11/2022 to 10/11/2023.

As Principal Investigator of the research, you are responsible for fulfilling the following requirements of approval:

1. All co-investigators must be kept informed of the status of the research.
2. Changes, amendments, and addenda to the protocol or the consent form must be submitted to the REC for re-review and approval prior to the activation of the changes.
3. Reports of unanticipated problems involving risks to participants or any new information which could change the risk benefit ratio must be submitted to the REC.
4. Only approved consent forms are to be used in the enrollment of participants. All consent forms signed by participants and/or witnesses should be retained on file. The REC may conduct audits of all study records, and consent documentation may be part of such audits.
5. Continuing review application must be submitted to the REC eight weeks prior to the expiration date of 10/11/2023 in order to continue the study beyond the approved period. Failure to submit a continuing review application in a timely fashion may result in suspension or termination of the study.
6. The REC application number assigned to the research should be cited in any correspondence with the REC of record.
7. You are required to register the research protocol with the Uganda National Council for Science and Technology (UNCST) for final clearance to undertake the study in Uganda.

The following is the list of all documents approved in this application by MUST Research Ethics Committee:

No.	Document Title	Language	Version Number	Version Date
1	Protocol	English	Clean Copy	2022-10-10
2	Informed Consent forms	English	1	2022-08-09
3	Data collection tools	English	1	2022-08-09

Yours Sincerely

Assoc. Prof. Paul Alele
For: MUST Research Ethics Committee

Appendix VI (c): Ministry of Education and Sports Research Proposal clearance

Telegram: "EDUCATION"
Telephone: 256-41-234451/8
Fax: 256-41-234920
Email: permasec@education.go.ug
Website: www.education.go.ug

THE REPUBLIC OF UGANDA

Ministry of Education and Sports
Embassy House
P.O. Box 7063
KAMPALA-UGANDA

In any correspondence on
this subject please quote: **ADM/48/85157/01**

5th October 2022

Mr. Mutebi Ronald
PhD Student, Principal Researcher
+256772373643
KAMPALA

PERMISSION TO CONDUCT RESEARCH AT NAKAWA VOCATIONAL COLLEGE AND KISUBI TECHNICAL INSTITUTE

Reference is made to your request dated 14th September 2022 on the above captioned subject.

I note that you are investigating a study titled; "The Efficacy of online pedagogy on TVET practical skills training, assessment and acquisition in Uganda" whose purpose is to analyze and compare TVET practical skills training, assessment, and acquisition in face-to-face and online pedagogies in order to determine the efficacy of online pedagogy on TVET practical skills training, assessment, and acquisition.

This is a good case of study and we hope the results will be of great significance in the teaching and learning process of both TVET and General education sub-sectors by providing both pathways with valuable data concerning the effectiveness of teaching and learning of practical skills online.

Permission is hereby granted for you to undertake the study at Nakawa Vocational College and Kisubi Technical Institute located in Kampala and Wakiso respectively.

You are requested to share your findings with the Ministry of Education and Sports when you finalize your research.

Ismael Mulindwa
For: PERMANENT SECRETARY

Copy: Director, H/TVET
Executive Director, National Council for Science & Technology
Commissioner, TVET Operations & Management

Appendix VI (d): Permission to conduct Research at Kisubi Technical Institute

ST. JOSEPH'S TECHNICAL INSTITUTE KISUBI

P. O. Box 20, Kisubi, Entebbe.
Mobile: 0772489558
Website: www.stjoseph-kisubi.com
katongoleJ@yahoo.com

*Your Ref:*_____

Our Ref: KTI /ADM/21/22

Date: 18th October, 2022.

Mr. Mutebi Ronald
PhD Student, Principal Researcher
+256772373643

Re: PERMISSION TO CONDUCT RESEARCH AT KISUBI TECHNICAL INSTITUTE

Reference is made to your request dated **12th October, 2022** on the above captioned subject.

I note that you are investigating a study titled; "The Efficacy of online pedagogy on TVET practical skills training, assessment and acquisition In Uganda" whose purpose is to analyze and compare TVET practical skills training, assessment, and acquisition in face-to-face and online pedagogies in order to determine the efficacy of online pedagogy on TVET practical skills training, assessment, and acquisition.

This is a good case of study and we hope the results will be of great significance in the teaching and learning process of both TVET and General education sub-sectors by providing both pathways with valuable data concerning the effectiveness of teaching and learning of practical skills online.

Permission is hereby granted for you to undertake the study at Kisubi Technical Institute and the contacts of the instructors and technicians for National Certificate in Building Construction (NCBC) and National Certificate in Woodwork Technology (NCWT) that will work with you on the study are:

1. **Mr. Kalema Charles (NCBC)** **Phone No.0782605318/ 0704750017**
2. **Mr. Aloro Francis (NCWT)** **Phone No. 0782054273**

Please share your findings with the Institution when you finalize your research.

Yours faithfully,

ST. JOSEPH'S TECHNICAL INSTITUTE - KISUBI
18 OCT 2022
Sign.....
PRINCIPAL

Joseph Katongole
PRINCIPAL

Appendix VI (e): Permission to conduct Research at Nakawa Vocational Training College

Telephone: 0414220935/668999

NAKAWA VOCATIONAL TRAINING COLLEGE
MINISTRY OF EDUCATION AND SPORTS
P.O. Box 20121 Nakawa, Kampala
Plot M 96 Mukabya Road
Home Page: www.nakawavtc.ac.ug
E-mail:nakawavtc@yahoo.com
Info@nakawavtc.ac.ug

NVTC/ADMN/EC/19

18th October 2022

The Mr. Mutebi Ronald,
TVET Specialist - TVET Secretariat,
Ministry of Education and Sports,
P.O. Box 7063,
Kampala.

Dear Sir,

RE: REQUEST TO CONDUCT RESEARCH AT NAKAWA VOCATIONAL TRAINING COLLEGE.

Reference is made to your letter dated 12TH October 2022 on the above subject.

I wish to acknowledge receipt of your letter and to thank you for choosing Nakawa VTC as a centre for collecting data for your thesis. I wish to inform you that as a TVET institution we embrace all activities intended to contribute to the development of TVET in this country.

This letter therefore serves to inform you that your request has been granted and feel free to engage the following members of staff to help you accomplish your study;

1. Mr. Obbo Alfred
   Head of Department Building Construction
   Mob. 0705395497
2. Mr. Olwa Tom
   Head of Department Woodworking
   Mob. 0750510365

I wish you the best of luck in your research.

Muwanga Godfrey Fred

PRINCIPAL

C.C: D/Principal

" Head of department BCP

" Head of department Woodworking

Appendix VII: Research Budget

S/N	Item	Category	Number	Days	Unit Cost	Total Cost
1	Stationary	all	Assorted	all	800,000	800,000
2	Refreshments	Assessors	8	4	5,000	160,000
		Instructors	8	4	5,000	160,000
		Assistants	10	8	5,000	400,000
		Technicians	2	8	5,000	80,000
3	Transport	Researcher	1	10	20,000	200,000
		Research Assistants	10	10	10,000	1,000,000
		Assessors	8	4	20,000	640,000
		Instructors	8	4	20,000	640,000
		Technicians	2	8	20,000	320,000
4	Facilitation	Assessors	8	4	50,000	1,600,000
		Instructors	8	4	20,000	640,000
		Technicians	2	8	20,000	320,000
5	ICTs	Video Cameras	4	8	100,000	3,200,000
		Streaming equipment	4	8	130,000	4,160,000
		Internet Data	Assorted	all	200,000	200,000
		Airtime	Assorted	all	100,000	100,000
	Total					**14,640,000**

Appendix VIII: Similarity Report

DrillBit

The Report is Generated by DrillBit Plagiarism Detection Software

Submission Information

Author Name	Mutebi Ronald SEDU/TED/P/001/19
Title	EFFICACY OF AN ONLINE PEDAGOGY ON TVET PRACTICA..
Paper/Submission ID	968125
Submission Date	2023-09-13 12:32:30
Total Pages	299
Document type	Dissertation

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