



Exploring the Didactics of Learning in Technology-Rich Environments for Teacher Educators amidst Covid-19 Pandemic in Uganda

¹Wycliff Edwin Tusiime & ²Moses Wambi

¹Kyambogo University, Uganda

²National Teachers' College, Uganda

Email: wycliffdux@gmail.com; moswambi@yahoo.com

Abstract: *This study was conducted on Teacher Educators in National Teachers' Colleges found in the Northern (West-Nile) and South-Eastern Uganda. It focused on didactical questions to help teacher educators explore what it is that creates technology-rich environments to trainees. It was also anchored on a wide range of literature review. It adopted a phenomenological design with a qualitative approach of using interviews and Focus Group Discussions. Three specific objectives were used, namely to: (i). Assess how teacher educators implement technology-enhanced learning (ii). Establish the availability of Technology-enhanced learning tools used (iii). Identify challenges of Technology-enhanced learning in NTCs in Uganda. Participants were Sixty-four (64) in the study. Data was collected and analysed qualitatively using verbatim statements backed with direct quotations of participants. The findings of the study revealed that majority were short of ICT skills to conduct online teaching. The commonest tools were mobile phones because majority could access them as compared to Desktop and Laptop computers. In addition, blending of content and pedagogy was highly challenging, there was inadequate prior knowledge and skills in using ICT applications, coupled with network and unreliable power supply. Institution-based training through CPDs and peer mentorship are recommended in addition to the paradigm shift from teacher-centredness to learner-centredness.*

Keywords: *Didactics, Technology-rich environments, Teacher educators, Covid-19 Pandemic, Lockdown*

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1. Introduction

Recently, in Uganda like any other country, COVID-19 pandemic has accelerated a widespread demand and instructions on use of digital technologies in the education sector and many institutions around the world are getting equipped with the necessary technological facilities and devices. It is argued that activities of learning, as they have been practiced within the traditional schooling cultures, are starting to experience intensive pressure for rapid development of digital technologies amidst the

Covid-19 pandemic lockdown. Hence, educators need to understand the didactics of learning for them to exploit the considerable potential of digital technologies in education. Oftentimes, educators make assumptions about what is important for students to learn, about who can learn well and why, and about effective strategies for enhancing their students' learning. Such assumptions we make instead compromise the effective transfer of knowledge and skills.

Lately, education systems worldwide have been under increasing pressure to integrate digital technologies in guiding students to continue with online learning activities due to the Covid-19 pandemic lockdown. Consequently, this has seen a widespread use of digital technologies in the education sector, and more institutions around the world have been equipped with technological facilities or managed to implement some blended or online learning programs (Demuyakor, 2021; Li & Lalani, 2020). Consequently, there is need to adopt innovative instructional approaches in teaching, learning and work processes (Obi, 2016; Lund A. , Furbug, Bakken, & Engelién, 2014). Educational institutions and teachers, therefore, ought to address changing expectations associated with the learning experience and the wave of digital technologies and innovations in order to achieve high levels of learning (OECD, 2016). On that note, therefore, teachers across the globe and Uganda in particular, need to equip themselves with the didactics of learning in order to exploit the considerable potential of digital technologies in mitigating the effects of Covid-19 and promote hybrid learning strategies in the education system. In the context of this paper, digital technology refers to digital devices and applications that educators use to access and produce knowledge, create content, disseminate and share e-learning content during the teaching-learning processes.

The term didactics on the other hand, refers to the study of relationship which exists among learners, teachers and various branches of knowledge grouped into educational subjects (Mjelde, 2006). As applied to teacher education, didactics address; who, what, when, where, which, how and the why of the teaching/learning processes (Ligozat & Almqvist, 2018; Arnold, 2012). Therefore, it is imperative to note that answers to these didactical questions change over time due to dynamic learning environments, including technological advancements like use of digital technologies in education. In Uganda for instance, like most developing countries where technology is in its earlier integration phase into education, it is necessary for educators to recognize and address the new changes in education that digital technologies bring about when they plan the learning activities. Oftentimes, educators make assumptions about what is important for students to learn, about who can learn well and why, and about effective strategies for enhancing their students' learning (Bransford, Derry, Berliner, & Hammerness, 2005). Such assumptions we make instead compromise the effective transfer of knowledge and learning. In this paper, therefore, we present a debate, based on available literature and primary sources of data to report on the experience of teacher educators and offer opinions to didactical questions that could help educators understand what it is that creates good learning situations for students and how progress can occur in technology-rich learning

environments. In the context of this paper, the phrase 'technology-rich environments' is used to mean any learning environment in which digital technology has or is at its earlier stages of being integrated into the education systems of countries to enhance the teaching-learning activities. Focusing on Uganda, where the use of technology in teacher education is at its earlier stages of integration, we partly built the debate in this paper drawing on experiences from Uganda's education system comparing it with other countries.

The discussion in this paper is organized following the *How People Learn (HPL) framework* used by Bransford et al (2005). The HPL framework provides a conceptual map of components influencing learning (Gentry, 2015). The components are addressed in the present paper through the following questions / themes:

- ① *What should be taught, why and how this knowledge should be organized (knowledge-centeredness)?*
- ② *Who learns, how and why (learner-centeredness)?*
- ③ *What kind of classroom, school, community environments enhance learning (community-centeredness)?*
- ④ *What kind of evidence for learning is there to see if learning is occurring (assessment-centeredness)?*

The HPL framework provides a basis for discussion in this paper because of its outstanding focus on the learner in all components influencing learning that teachers need to get equipped with in preparation for teaching-learning processes. Though this to a certain degree might contradict to the current status of Uganda's education system, where for years the focus has been put more on what is to be taught (the subject), the HPL framework may be a model for Uganda in the on-going process of orienting its education system towards a more learner-centered approach amidst technological advancements. With the recent integration of ICT in Uganda's education system (UCC, 2014; Muweesi, et al., 2021; Madinah, 2020; Ouma, 2021), Uganda is in dire need of an education system that is oriented towards learner-centered approaches to teaching as greatly advanced by the HPL framework.

2. Literature Review

The literature review search was approached through systematic data-gathering strategies (Gough, Thomas, & Oliver, 2012). A search for relevant articles was conducted via databases; Google Scholar, Academic Search Premier, Academic Search Ultimate, ERIC and Education source with some additional hand-searched articles. These databases provided access to scholarly publications and other pertinent sources of information. A search strategy was devised, including a list of keywords,

to facilitate an efficient search of the databases. Boolean search operators such as "AND," "OR," "NOT," and "SAME" were employed to manage the search strategy, particularly during later stages to refine the search and narrow down the results. The searches aimed mainly at capturing published empirically based research articles addressing the variables in English language and in peer-reviewed journals. The key searches for the relevant literature were confined to the periods 2012–2022.

The search terms employed were "didactics," "learning," "technology-rich environments," "teacher educators," "Covid-19," and "pandemic." A combination of both general and specific search engines was employed to ensure a comprehensive search. To access relevant information sources, reputable tools, platforms, and databases focusing on teaching and learning were selected.

Out of the identified articles, a total of 42 were included in the study after excluding those that did not adequately address the research objective. The inclusion criteria ensured that the selected articles provided valuable insights in addressing didactical questions that could help educators understand what it is that creates good learning situations in technology-rich learning environments during the Covid-19 pandemic in Uganda.

Literature was reviewed following the specific objectives as indicated in the subsequent paragraphs:

2.1 Implementation of Technology-based learning

What should be taught, why and how this knowledge should be organized?

Jimoyiannis (2010) observes that authentic learning in the 21st century requires learners being able to use digital technologies, not only for enhancing the memorization of facts, but also for problem-solving in real-world settings. Likewise, it implies that teachers require vast knowledge and skills in the use of digital tools and how such knowledge can equally be transmitted to the understanding of the learner. This adds a new dimension to teaching effectiveness by enabling teachers to do things that might not be possible within the traditional classroom. This is because technology is changing the way subjects can be taught and learned in the 21st century (Dias & Angelin, 2017). Therefore, the need to develop subject-specific ICT training curricula by the teachers for technology-rich environments is intensified by the fact that technology is redefining subjects itself – in terms of their themes, tools and vocabulary. Teachers and/or curriculum experts should ensure that such curricula are

organized to enable learners acquire knowledge and skills relevant for today's dynamic world of work characterized by high-tech usage even in developing countries like Uganda.

Closely related, research in the learning sciences has explored the nature of the skills and knowledge that underlies expert performance and this research also provides important information on how knowledge should be organized. Bernstein (1972) suggests that "educational knowledge" should be organized / structured (selected, classified, transmitted and evaluated) to make meaning to the consumers or target audience. This, Bernstein posits, can be realized through message systems that include: curriculum (valid knowledge), pedagogy (valid transmission of knowledge) and evaluation (valid realization of knowledge taught). However, expert knowledge is much more than a list of disconnected facts about their disciplines in teacher education (Bransford, et al, 2005). Because of such disconnectedness, Lund et al (2014) continue to observe that teacher education doesn't sufficiently prepare its consumers (student teachers) for dynamic learning environments, and the opportunities and pitfalls that follow due to the changes technology has brought in the way subjects are taught and learned in the 21st Century.

In countries like Uganda where the use of technology is in its earlier/mild stages of integration in teaching-learning processes, learners still find challenges to synchronize the knowledge with the practice. The way knowledge is organized by expert teachers only helps them to know when, why, and how aspects of their vast range of knowledge and skills are relevant in any particular situation. Yet, it is important to synchronize the relationship which exist in the content, pedagogy and technology knowledge for effective teaching and learning in technological-rich environments (Wang, Schmidt-Crawford, & Jin, 2018).

Furthermore, educators need to frame and classify what learners should pay attention to for them to make meaning out of such knowledge. For instance, when teachers attempt to teach in technology-rich environments through use of videos, and other experiences in which students are expected to learn by observation and participation, teachers need to help students bring a mental organization to the learning experience. Similarly, Bruner (1960/1977), one of the pioneers in cognitive and developmental psychology, cited in Bransford et al, (2005) by stressing the need for knowledge organization arguing that, the curriculum of a subject should be determined by the most fundamental understanding that can be achieved with the underlying principles that give structure to the subject. He adds that teaching specific topics or skills without making

clear their context in the broader fundamental structure of the field of knowledge is inefficient.

Bruner further points out that courses are often organized in ways that fail to develop the kinds of connected knowledge structures that support activities such as effective reasoning and problem-solving. He agrees with Bernstein (1972) that, the knowledge to be taught should be prioritized (selected, classified, transmitted and evaluated) into categories that range from “enduring ideas of discipline,” to “important things to know and be able to do,” by the learners. Therefore, it is important to note that, the organization of peoples’ knowledge affects process skills such as their abilities to think and solve problems.

In a related development, information about relationships between expert knowledge and teaching abilities in technology-rich environments is very important for teachers to understand and apply as deemed necessary. At one level, educators must have knowledge of their discipline (subject) to teach effectively. They need considerable knowledge in order to answer a wide range of questions that arise from the problems always confronted by their students. In the case of technology-rich environments in teacher education, teachers need not to only appropriate technologies (van Dijk, 2012), but also make their learners appropriate them to productive use. For this matter, therefore, teachers who don’t understand much about digital technologies will often find difficulty in answering questions or applying such digital tools and therefore, may be much inclined to follow only the restricted set of activities in the textbook. Previous studies in teacher education have indicated that the use of digital technologies in classrooms has received resistance from many educators for years because they view technology as an inconvenient activity that is not aligned with their core teaching goals (Stoilescu, 2014). In Uganda, Tusiime (2021)’s study findings indicate that teachers’ traditional ideologies concerning the teaching framework, their beliefs and attitudes about the incompatibility between technology and teaching subjects have been a setback to the adoption of digital technology.

On the other hand, experts are often blind to the fact that much of their knowledge of the subject matter has moved from explicit to tacit and hence, can easily be skipped over in instruction. For instance, experts in ICT may not realize that they are failing to communicate all the information necessary to help trainees learn to construct their own knowledge (Bransford et al, 2005). The reason is that many decisions are so intuitive that the professors don’t even realize that they are part of their range. Shulman (1987) advises that, teaching requires a special kind of expertise or artistry, for which explaining and showing are central features. Like Shulman, the writers of this paper, argue that tacit knowledge among teachers is

of limited value in technology-rich environments, therefore, teachers are held responsible to explain what they do and why they do it to their students, their communities and their peers.

In addition, Shulman (1987), explains that effective teachers need to develop “Pedagogical content knowledge (PCK)” that goes well beyond the content knowledge of the discipline. He argues that PCK represents the blending of content and pedagogy into the understanding of how particular topics, problems, or issues are organized, represented and adapted to the diverse interests and abilities of learners, and it can be consequently presented for instruction. Similarly, for teachers to be able to use digital technologies in teaching, they need intensive training on the pedagogical use of such technologies for a specific subject (Aliyu, Abdulkadir, Abdullahi, Kutiriko, & Dokoro, 2020). For that matter, teacher trainers should illustrate both in practice and in theory, how technology is used in teaching so that this may provide them with direct experience. It should include an understanding of how trainees typically struggle as they attempt to master a domain and an understanding of strategies for helping them learn. Secondly, teachers should be aware that introducing digital tools in teaching not only changes the use of tools in teaching but also what we teach and how we teach, which is often overlooked (Harris, Mishra, & Koehler, 2009). Teaching technology alone doesn’t serve teachers well because they learn how to operate technology-related tools without being able to use them effectively to promote students’ learning. As such, the authority of the teacher as well as that of the textbook will be challenged (Tusiime, 2021). Basing on such experiences, it becomes very clear that, learning in technology-rich environments goes beyond digital skills, it requires one to develop an understanding of the complex relationship among pedagogy, content, the learner and ICT (Hughes, 2005). Relatedly, we discuss the position of the learner, how and why they learn in technology-rich environments for teacher education in the subsequent sections.

2.2 Tools and extent to which Technology-based learning was implemented during Covid -19 pandemic lockdown

Who learns, how and why?

In relation to learning in technology-rich environments in teacher education, several scholars have found strong correlations between teachers’ and student teachers’ fundamental assumptions about learning and ways of appropriating technologies (Aagaard & Lund, 2013;

Jimoyannis & Komis, 2007; Sime & Priestly, 2005; Jimoyannis, 2010). Jimoyannis and Komis (2007, p.152) provide an appropriate example to indicate that, “both teachers’ personal theories and perceptions about teaching and learning processes and their level of digital competence play a major role in how they implement technology and motivate themselves and their learners to use digital tools in the classroom.” In Uganda, the current debates about education propose a paradigm-shift from more subject-centered teaching-learning approaches to learner-centred approaches (Buluma, 2019; Olema, Nabitula, Manyiraho, Wambi, 2021; Atibuni, 2021). It is envisaged, therefore, that such a shift could bridge the gap between the teacher and learners hence teachers’ perceptions about their learners’ abilities could change in the classroom.

Furthermore, it has been observed that understanding learners is such a mammoth task for teachers. A Swiss Psychologist Jean Piaget argues that learners, like children of all ages, are active explorers of their worlds. The complexity of what they can understand is affected by what they already know and their development levels. Piaget postulates in his findings that even young children were active learners who explored expectations about the world and how it worked. As such, Piaget’s theory emphasizes the “constructive nature of knowing,” which refers to the idea that we all actively attempt to interpret our world based on our existing skills, knowledge and developmental levels. For that matter, therefore, understanding the processes by which students actively attempt to learn is very different from testing them on facts or skills and seeing what they don’t know! Basing on Piaget’s theory, if teachers take time to understand the processes through which and how their individual students learn, they could help them learn better by addressing the learning gaps.

In agreement to the assertions of Piaget, Doneva, Denev, & Totkov (2007) note that, technology-rich learning environments allow the formulation of some *‘specific didactic principles* definitive for such platforms. Such principles relate to; organization of content and learning process, creation of user-friendly environment for learning, effectiveness of the learning activities, participation of learners with different input, personality-oriented nature of the curriculum, activeness and independence of learners, learners’ awareness of the content and the dynamic nature of the educational curricula.

Consequently, Doneva, et al., (2007) propose that the development of technology-rich learning environments should provide for, first, for the teacher, tools for expressing the above didactical principles according to different pedagogical strategies, appropriate for the

regarded subject domain, teachers’ preferences and learner’s profile. Additionally, for the learner, possibilities for personalized, adaptive and active learning according to their knowledge level and learning results. Furthermore, teachers must make an account of students’ prior conceptions in designing instruction because those would influence what students learn for good or for bad whether or not the teacher is aware of them!

In addition, understanding students’ previously acquired knowledge can also provide a powerful boost for new learning because what is taught in school sometimes builds upon and connects with what students acquired sometime back. Bransford et al (2005) noted that many students seem to learn effectively in the context of authentic, real-life activities yet have difficulty with the more artificial tasks required in school. Therefore, teachers need to explore the benefits of increasing learner-centeredness of teaching by actively tapping into students’ previous knowledge that can act as a bridge for helping them learn at school. For example, helping students from a carpentry background to realize how skills of their parents relate to geometry. A teacher’s knowledge of their students can affect aspects of learning, including motivation for students who know that teachers care about them. The more teachers know about their students, the more they are able to connect to their specific interests and needs and explain things in ways that make sense to them. It is important that even when educators don’t know a great deal about each student, they can encourage students to think about personal experiences that they have had that are relevant to the topic being explored (Keiler, 2018). In the next section, we discuss community-centeredness as an aspect that questions the nature of environment (classroom, school, community) and how they enhance learning.

What kind of classroom, school and community environment can enhance learning?

The community-centered aspect of the HPL framework focuses attention on the social nature of learning, including the norms and modes of operation of any community we are joining. For example, some classrooms represent communities where it is safe to ask questions and others do not make it safe to ask questions where you don’t understand. Consequently, teachers are argued to create classroom environments where students are helped to “feel good” about themselves but are not necessarily held to high standards (Bransford et al, 2005). Bransford and others suggest that to be successful, learning communities should provide people with a feeling that members matter to each other and to the group, and that community-centeredness doesn’t necessarily mean that

everyone in the group simply agrees with everyone else about everything. They argue that as people share their understanding and reasoning with one another, they teach each other and solve problems together. In technology-rich learning environments, this helps students develop their digital competences as well as a store of knowledge since various skills and interests are provided for by members in the learning community.

In addition, the aspect of community-centeredness is further demonstrated through Vygotsky's concept of the Zone of Proximal Development (ZPD) which redefines everyday assumptions about "people's readiness to learn" by emphasizing upper levels of competence. He argues that, "what children can do with the assistance of others is even more indicative of their mental development than what they can do alone" (Vygotsky, 1978, p.85). Though this is true, Vygotsky advises that, educators must balance the fact that, in most classrooms, multiple learning trajectories, or zones of proximal development, must be taken into account. This would enable educators to offer different kinds of support (scaffolds) to make progress. In a technology-rich environment, a teacher with broad knowledge and professional digital competence will be in position to model subject-specific learning environments, learning activities, and learning trajectories conducive to the students' development (Lund, et al, 2014). This way, the teacher would be able to reach beyond the walls of schools to connect with students' out-of-school experiences including experiences in their homes hence, creating an enabling learning environment for their students.

2.3 Challenges associated with Technology-based learning

What kind of evidence for learning is there to see if learning is occurring?

Debates about standardized tests indicate that some teachers spend most of their time teaching to the tests, yet the tests do not assess the range of skills, knowledge, and attitudes needed for successful and productive lives in the 21st century era. With respect to technology-rich environments where learning is woven into the use of artifacts (Saijo, 2010), teachers can not only assess results or documentation of learning, but they also ought to include how knowledge is arrived at, through relevant, informed selection and use of available cultural tools or artifacts. The performative nature of learning in technology-rich environments makes it difficult for teachers to use traditional forms of assessment and criteria like use of standardized tests. In this situation, however, formative assessment and the feedback it provides

becomes extremely important for enhancing learning and the quality of assessments.

Equally, the assessment lens in the HPL framework focuses on different kinds of assessments for different purposes. Summative assessments, for example, (standardized tests) are very important and often reveal important information that teachers wish they had known earlier! However, the teacher has limited possibilities to counteract the prevailing problems that might come up as a result of the assessment. This is because most times such assessment is done at the end of a topic or unit or course. Formative assessments on the other hand are used for the purpose of improving teaching and learning. They involve making students' thinking visible as they progress through the course, giving feedback about their thinking and providing opportunities to revise (Bransford, et al., 2005).

3. Methodology

3.1 Research Design

The study adopted a phenomenological design with a qualitative approach that employed informant interviews and Focus Group Discussions to gather data from Teacher Educators (Lecturers of National Teachers' Colleges, Deputy Principals and Principals) of the same institutions. Whereas Focus Group Discussions were found suitable for Lecturers as people with similar interests, status and experience, the college administrators were subjected to informant interviews for some degree of privacy and as very busy officers with a lot of programmes to the extent that they could only be got individually for the face-to-face interviews on special appointment. For purposes of easy data presentation and reporting, the FGD schedules were labeled pseudo names; A, B, C and D. At the same time, the Interview sessions were also allocated pseudo numerical numbers; 1-6 systematically.

3.2 Population/Sample size

Following the idea of Patton (2002) regarding purpose and credibility for sample size selection, in this study, the parent population was 84 people (teacher educators) and a sample of sixty-four (64) participants of whom sixty (60) were Lecturers, two (2) Principals and two (2) Deputy Principals of National Teachers' Colleges (NTCs) were engaged in the study. The four administrators were engaged in informant interviews under four sessions each lasting 30 minutes. In addition, 60 Lecturers participated in Focus Group Discussions under six schedules, each lasting for 30 minutes. For all categories of participants, there was consent to enable the researchers have an

interaction with them and also have the interactions electronically recorded.

3.3 Sampling Techniques

The study adopted purposive sampling technique. Purposive sampling refers to a group of non-probability sampling techniques in which units are selected because they have characteristics that one needs in a given sample. In other words, units are selected “on purpose” in purposive sampling. Also called judgmental sampling, this sampling technique depends on the researcher’s judgment when identifying and selecting the individuals, cases, or events that can provide the best information to achieve the intended intention (Nikolopoulou, 2023). On that note, therefore, Principals and Deputy Principals of the National Teachers’ Colleges under study were purposively selected because they were the custodians of standards of teaching and learning in their institutions. In addition, they were directly concerned with the purchase and provisions of the required facilities and equipment necessary for use in the Technology-rich environments. At the same time, Lecturers were selected using simple random sampling (SRS) technique because they were many in number in their respective colleges. SRS technique was employed to avoid bias but also provide equal opportunities for those who belonged to that category to be selected and participate in the study.

3.4 Data Analysis

The collected data was grouped under themes and subthemes. The data was then analysed qualitatively using verbatim statements backed with direct quotations of participants. This arrangement was done in order to deeply explore the ideas, perceptions, opinions and experience of the participants.

4. Results and Discussion

The results of the study were presented following the specific objectives and research questions as indicated under the subsequent subheadings: -

4.1 Implementation of Technology-Rich Environments by Teacher Educators

In the attempt of generating responses from participants, a guiding statement was made by the researchers to the

participants in a focus group discussion, “*Talk about how teacher educators implemented Technology-Rich Environments to their trainees during the Covid-19 pandemic lockdown.*”

Consequently, during an interaction with the participants in an informant interview session, a lot of experiences were shared. In the subsequent interactions, one of the Deputy Principals in schedule D shared an experience as indicated in the following quotation:

...our Lecturers were supposed to facilitate our students on-line during Covid-19 pandemic lockdown. Unfortunately, some of the Lecturers found it very hard because some ICT applications were unfamiliar. As a result, some skilled and semi-skilled ICT people who were not necessarily trained lecturers were employed to instruct the students online. Some Lecturers who were serious, decided to obtain training from the skilled ICT technocrats and also learnt on-job so as to navigate through the process of supporting their students by use of Technology... (*Informant interviews with a Deputy Principal in session D in South-Eastern Uganda, May 2021*)

Basing on the quotation, it is very surprising but true that in the world of ICT, some lecturers had never bothered to acquire the desired skills that they would integrate their planned content with to facilitate students. The initiative of hiring skilled ICT resource persons who were not trained lecturers by background was very risky because such people could not figure out the suitable pedagogy in content delivery. The idea of integrating ICT with specific subject content is not a new story. Even far back before the covid-19 pandemic lockdown got serious and increased the demand of Technology use in teaching and learning, the ministry of education and sports had already made a lot of advocacy on the use of ICT. In addition, apart from the MoES advocacy on the integration of ICT, a number of workshops, seminars and conferences had been organised at various levels on use ICT literacy. It also quite surprising that in some institutions where lecturers lacked ICT skills, a lot of ICT facilities and equipment were in abundance!

In a related development, Principals in schedule A, were also engaged in an informant interview on how their lecturers created Technology-rich environments in their respective institutions during the covid-19 pandemic lockdown and their responses varied from one individual to another. Some fascinating experiences were shared and an example is indicated as quoted:

...alongside the hired ICT resource persons, one of our lecturers found a highly skilled trainee who was well grounded with skills of ICT and eventually used her as a co-lecturer. The

Lecturer kept preparing for teaching together with the trainee and finally, the trainee would employ her ICT skills to deliver the planned content to the peers using online platforms. As an institution, when we discovered it, we appreciated it because we thought such a scenario was somehow better than handpicking ICT skilled persons and use them as resource persons in content delivery...! (*Informant interviews with a Principal of Northern (West-Nile) Uganda in session A in May 2021*).

Following the information in the quotation, it gives a mental picture that majority of the lecturers in the area of study managed to implement the initiative of Technology-rich environments by employing ICT resource persons because they themselves had gaps in their ICT skills.

4.2 Tools used in the Technology-Rich Environments during covid-19 by teacher educators

During covid-19 pandemic in Uganda, some institutions took an initiative to create Technology-Rich Environments for their students to keep learning wherever they were under the lockdown.

According to Adrian (2014), teachers are no longer bound by the four walls of the classroom, learners have platforms like Zoom, Microsoft teams, podcasts, Google classes, e-books etc., which make learning convenient for them. During covid-19 pandemic lockdown in Uganda, tools which included cell phones, computers (Desktop & Laptops), and iPads were used by teacher educators to deliver subject-matter to their trainees. According to the findings of this study, the commonest tools used were mobile phones, Desktops and Laptop computers. Nevertheless, much as students and teacher educators possessed prior knowledge and skills of using such ICT tools, majority were short of relevant skills regarding the applications of certain online programs such as Google classes, Zoom, Microsoft team and e-book which were on dire demand during the covid-19 lockdown.

Furthermore, in the subsequent interactions with the participants, a teacher educator (Lecturer) shared an experience as indicated in the quotation:

...when some of us started discovering that some technology applications and programs such as Google classes, Microsoft-team, YouTube and Zoom were becoming sophisticated, we quickly resorted to students' emails and What's app accounts which were also helpful in making some of us to keep in continuous interaction with the students...(Focus Group Discussion with a

Lecturer from South-Eastern Uganda in schedule C, May, 2023)

Basing on the foregoing statement in the quotation, at least teacher educators struggled and created Technology-rich environments for their students during the covid-19 lockdown. It is also evident that much as majority of the teacher educators possessed sophisticated mobile phones, Desktop and Laptop computers, that was yet one effort, but it was also another to explore the various Technology Enhanced Learning applications and programs to the expectations.

4.3 Challenges associated with creating Technology-Rich Environments by teacher educators

The most effective and user-friendly Technology Enhanced Learning applications such as Google classes, Zoom, You Tube and Microsoft teams were considered sophisticated by majority of the teacher educators because they lacked skills to employ them in creating the Technology-Rich Environments for their trainees during the covid-19 pandemic lockdown.

In an interaction with one of the principals from an institution located in West-Nile, the following statement was made as quoted:

...majority of the Lecturers are mainly used to the common applications such as what's app accounts and internet surfing using email addresses. However, for applications which include Google classes, Microsoft team, Zoom and You Tube are very challenging to our Lecturers. In addition, issues of network are also crucial in our situation ... (*FGD with a Deputy Principal from Northern (West-Nile) Uganda in schedule B, in May, 2023*)

According to the statement in the quotation, Teacher educators were able to create Technology-Rich Environments for their trainees during the covid-19 pandemic lockdown but were mainly limited to a few technology applications with which they were familiar. They were not able to explore such applications like Google classes, You Tube and Zoom which would have even enabled them to watch their trainees on videos. In addition, for the minority of the teacher educators who were able to employ some of those applications like Google classes, Microsoft teams and zoom, still the interaction remained teacher-centred.

All technology-Enhanced Learning tools which included cell phones, Desktop, Laptop computers, iPads etc. which teacher educators employed in creating Technology-Rich Environments for their trainees during the covid-19

lockdown faced challenges of unreliable power supply, unstable network, high costs of maintenance and specialized skills coupled with tight security measures against thieves and thugs most especially in rural areas.

In the subsequent interview sessions with Teacher Educators (Lecturers), a lot of concentration rotted around the challenges associated with creation of the Technology-Rich Environments for their trainees. More than three quarters of the teacher educators who participated in the study shared their experiences regarding the gross underfunding which frustrate their initiatives towards creating technology-rich environments for their trainees. Most challenges were connected to inadequate deliberate training on ICT skills. In addition, apart from ICT gadgets which are donated by partners in development, individual colleges have taken very little initiative to purchase their own. For that matter, majority of the Lecturers end up using their personal ICT tools to serve the trainees. Surprisingly, no participant in the entire study made mention of any challenge associated with pedagogical integration issues in creating technology-rich environments for teacher trainees!

5. Discussion based on primary data

It was reported that majority of the teacher educators (Lecturers) hired ICT skilled and semi-skilled resource persons to support them in delivering their prepared content online to their trainees during the covid-19 pandemic lockdown. It happened so because majority of the Lecturers who participated in the study lacked specialized training in applications like Google classes, Microsoft Teams, Zoom, You Tube and others which were very pertinent during the covid -19 lockdown. Basing on the results, it was very risky for the teacher educators (Lecturers) to hire skilled ICT persons to deliver content to the trainees because such personnel lacked pedagogy since they were not professionally trained as teachers or teacher educators for that case. In addition, the practice of hiring skilled ICT personnel could not serve as a lasting solution. In fact, teacher educators ought to integrate ICT skills in their pedagogical practice. The results of this study are related to those of other related research studies in terms of putting emphasis on ICT skills. Accordingly, Jimoyiannis (2010) observes that authentic learning in the 21st century requires teachers and their learners being able to use digital technologies, not only for enhancing the memorization of facts, but also for problem-solving in real-world settings. Therefore, the need to develop subject-specific ICT training curricula by the teachers and teacher educators for technology-rich environments is intensified by the fact that technology is redefining subjects itself-in terms of their themes, tools and

vocabulary. Teachers and/or curriculum experts should ensure that such curricula are organized to enable learners acquire knowledge and skills relevant for today's dynamic world of work characterized by high-tech usage even in developing countries like Uganda.

In addition, leaving the issue of whether possessing or not possessing ICT skills by teacher educators (Lecturers) at chance may turn out to be a very serious risk on the side of our trainees because ICT is no longer an option as we get ready for the 21st century skills. At the same time, it is quite demoralizing in situations where some trainees are far ahead of their teacher educators in terms of ICT skills! Furthermore, in the entire conversation with the teacher educators, issues of pedagogy and integration are left out, an indication that it is possible teacher educators are not aware that they have gaps in their pedagogical experience in terms of creating technology-rich environments to their trainees.

Furthermore, the available tools which were used by the teacher educators to create technology-rich environments for the trainees included among others mobile phones, Desktop and Laptop computers which could conveniently allow the use of relevant applications necessary for online learning during the covid-19 pandemic lockdown. However, majority of the teacher educators were short of relevant skills regarding the applications of certain online programs like Google classes, Zoom, Microsoft-team, You Tube and e-book which were on dire demand during the covid-19 pandemic lockdown. Consequently, teacher educators and the trainees ended up concentrating on use of emails and What's app accounts as the major technology enhanced learning applications during the covid-19 pandemic lockdown. As a matter of fact, concentrating on mobile phones and emails limited a lot of interaction between the trainees and their teacher educators compared to how the arrangement should have been if they had opened up for zoom, Google classes, You Tube and Microsoft-teams. Some scholars have always advised that educators need to frame and classify what learners should pay attention to for them to make meaning out of such knowledge. For instance, when teachers attempt to teach in technology-rich environments through use of videos, and other experiences in which students are expected to learn by observation and participation, teachers need to help students bring a mental organization to the learning experience. Bransford et al, (2005) stresses the need for knowledge organization arguing that, the curriculum of a subject should be determined by the most fundamental understanding that can be achieved with the underlying principles that give structure to the subject. In other words, it all calls for teacher educators' serious need to integrate ICT skills with their subject content and pedagogy.

According to the findings of this study, a lot of challenges were reported in terms of unreliable power supply, unstable internet network, inadequate availability of technology enhanced learning tools coupled with questionable security for such tools most especially in locations without proper security. As if that was not enough, previous studies in teacher education have indicated that the use of digital technologies in classrooms has received resistance from many educators for years because they view technology as an inconvenient activity that is not aligned with their core teaching goals and areas of subject specialization (Stoilescu, 2014). In Uganda, Tusiime (2021)'s study findings indicate that teachers' traditional ideologies concerning the teaching framework, their beliefs and attitudes about the incompatibility between technology and teaching subjects have been a setback to the adoption of digital technology. According to the researchers of this paper, whereas some challenges are circumstantial, others are deliberate. The best option, therefore, is to pass a policy of ICT integration to all those who teach, beginning with teacher educators down to the trainees and eventually to the learners at grass-root levels.

5.1 Discussion based on literature review

The findings and discussion in this section are organized in accordance with the themes advanced by HPL framework in order to address the broader didactical questions of the, who, what, when, where, which, how and the why of the learning processes in technology-rich environments as explained under the subsequent subheadings: -

Knowledge-centeredness

First and foremost, findings from literature review observe that, using modern technology alone without considering learning theories will not be effective (Kerami et-al, 2013). Digital technologies sometimes encounter educational traditions that are both rich with well-established pedagogical practices and resistant to change (Lund et al, 2014). In such cases, issues about the nature of knowledge are extremely important and far from obvious as we assume most times in the teaching learning processes. For instance, it is easy for educators to assume that they should teach what they learned when they went to school. However, the world has changed and different kinds of skills and knowledge are required for successful and productive lives in the 21st century (Kivunja, 2015; Bransford et al, 2005).

With the advent of technology in teacher education, Gudmundsdottir & Hatlevik (2018) observe that, there is a mismatch between the digital challenges that newly

qualified teachers meet in their profession and the preparations they received during their teacher education. This observation relates to what Kessels & Kortagen (2001: p.28) termed as "the gap between theory and practice." Often times, teachers fail to relate knowledge of what they have learnt to the practice. Such a mismatch, in our opinion, results into possession of differing views by teachers for the purposes of education and hence the kind of things that are worth knowing. It is therefore, necessary to reflect on the existing learning traditions as educators prior to implementation of new learning arena so as to maximize the learning outcomes. The greatest knowledge gap identified in the available literature is that there isn't adequate information on how schooling in the education system of Uganda would embrace technology-rich environments in teacher education as an intervention to Covid-19 pandemic lockdown, thereby, causing a need for this study and other related studies.

Learner-centeredness

As regards Learner-centredness, research findings indicate that in developing countries, educators tend not to prioritize the learners themselves rather than solely concentrating on the subject-matter during the teaching-learning process. This pedagogical emphasis on learners is of paramount importance due to the natural tendency of teachers to form assumptions about students upon their entry into the classroom. Such assumptions are shaped by the diverse behaviors displayed by students, encompassing challenges in maintaining concentration, proclivity towards playfulness, and difficulties in task completion. Regrettably, these behaviors are occasionally misconstrued as manifestations of an inadequate upbringing or limited learning capacities. Consequently, these assumptions pertaining to students' abilities frequently manifest as self-fulfilling prophecies, influencing the nature of teacher-student interactions and ultimately impinging upon students' academic achievements (Tusiime, 2021).

Oftentimes, learning about ourselves as learners involves thinking about issues relating to transfer of learning in ways that allow us to solve novel problems that we may encounter later. The mere memorization of information is usually not sufficient to support transfer; instead, it helps also to understand what we are learning.

Community-centeredness

Findings from literature also underscore the importance of creating and sustaining learning communities that can be traced as far back as Vygotsky's theory in which culture and human interaction play a central role in the development processes. Vygotsky (1978) emphasized that learning is highly social and mediated by one's culture.

He argued that even the development of human brain is influenced by activities of the cultures within which people participate. Closely related, Saljo (2010) noted that social interaction in the context of virtual communities has exploded with the advent of technology, with sites of such activities continuing to multiply. In recent years, there have been dramatic changes in access to information; teachers and students can now connect to websites, databases, libraries and other resources in their own homes and in the classroom (Adrian, 2014). Thus, schools no longer have control over information and the information sources that people encounter and find relevant. World over, educators need to be aware and use/develop pedagogies that would tap into the diverse nature of learning environments in the 21st century, mostly created by technological advancements in education. With such an environment created, it makes it easier for the teacher educator to understand well their trainees and abilities hence, this could help in the effective assessment that we further discuss in the following subsection.

Assessment-centeredness

In relation to assessment-centeredness surprisingly, available literature indicates that, it is easy to assume that assessment simply involves giving tests to students and grading them. Nevertheless, Shulman (1987, p.6) observes that, ‘assessment of teachers in most states consists of some combination of basic-skills, an examination of competence in subject-matter, and observations in the classroom to ensure that certain kinds of general teaching behaviors are present. In Uganda for instance, such kind of assessment observed by Shulman takes the form of summative assessments that are a major form of evaluation in the education system. Though important, Shulman argues that, in this form of assessment, teaching is trivialized, its complexities are always ignored, and its demands diminished and as such, teachers themselves have difficulty in articulating what they know and how they know it. Instead, theories of learning suggest roles for assessments that involve much more than simply making up tests and grades. Firstly, teachers need to ask what they are assessing. This requires aligning their assessment criteria with the goals for their students (knowledge-centered) and the “readiness” of students in their classroom (learner and community-centered). Shulman (1987) indicated in his research findings that students achieved more when teachers explicitly informed them of the lesson’s objectives and assessment criteria. It is therefore important for educators to understand ways in which assessment practices relate to theories of transfer, particularly in technology-rich learning environments. One way to think about this issue is to view tests as attempts to predict students’ abilities to transfer from classroom settings to everyday settings.

5.2 Conclusion based on literature review

The aim of this paper was to present a debate based on available literature in addition to data obtained from primary sources of information; to address the didactical questions so as to help teacher educators understand what it is that creates technology-rich environments for students and how progress can occur in technology-rich environments for teacher education. The discussion has been organized based on the HPL framework which provides a conceptual map of components influencing learning in teacher education namely; knowledge-centeredness, learner-centeredness, community-centeredness and assessment-centeredness. Basing on the findings from reviewed literature and later on the discussion, it is prudent for teacher educators in dynamic technology-rich learning environments to recognize, give priority and equally integrate all the four components (i.e. knowledge-centeredness, learner-centeredness, community-centeredness and assessment-centeredness) of the HPL framework as explicitly discussed in this paper into planning for the teaching-learning processes. This, therefore, can enable teacher training institutions deal with dynamic changes that technology brings to our education systems and effectively integrate technology in the teaching-learning processes.

Educators and curriculum experts need to provide answers to the broader didactical questions of the; who, what, when, where, which, how and the why of the teaching/learning processes prior to implementation of technology enhanced programmes in schools. This is likely to guarantee an effective realization of learning outcomes educators set for their learners in technology-rich learning environments, to enhance lifelong learning and also be in position to analyze the quality of the various learning environments available in the 21st century era.

5.3 Conclusion based on primary data

Basing on the results and the discussion of results, conclusions were made following the specific objectives and the available related literature as indicated in the subsequent subsections:

Implementation of Technology-Rich Environments initiative

Given that the implementation of Technology-Rich Environments required Lecturers (Teacher Educators) who were ICT skilled and yet majority of them in the area

of study were not, some skilled and semi-skilled ICT resource persons who were not necessarily Lecturers by training, were employed to deliver content to the trainees electronically during the covid-19 pandemic lockdown in Uganda. In addition, for some Lecturers who were lucky to possess the ICT skills, were able to handle the initiative themselves and for those who happened to discover some skilled trainees among those who belonged to their classes, went ahead and worked closely with those trainees to deliver content electronically to their peers. However, the issue of integration and pedagogy were not paid attention to.

Tools and applications used in the Technology-Rich Environments during covid-19 pandemic lockdown by teacher educators

Majority of the teacher educators were not able to create Technology-Rich Environments for their trainees using applications like Zoom, Microsoft-teams, You Tube and Google classes due to lack of training. However, those who were able, employed mainly students' emails and What's app accounts using their mobile phones, Desktop and Laptop computers. It is therefore, hereby concluded that the Technology Enhanced Learning tools which teacher educators employed to create Technology-Rich Environments for their trainees during the covid-19 pandemic lockdown were those that never required a lot of training but those that required training were referred to by teacher educators as sophisticated applications and programs and were therefore, not explored to the expectations.

Challenges associated with the implementation of Technology-Rich Environments in selected institutions in Uganda

Majority of the teacher educators who were located in the urban and semi-urban areas reported that their trainees who were also in such locations were able to receive recorded lessons on emails and What's app accounts conveniently. On the contrary however, teacher educators who were located in rural areas reported the complications associated with scarcity of Technology Enhanced Learning tools, unreliable power supply coupled with unstable network. On that note, therefore, trainees who were in locations with reliable power supply, stable network and with full access to technology enhanced learning tools/applications were more advantaged in making use of the technology-rich environments created by their teacher educators than their counter-parts during the covid-19 pandemic lockdown.

Majority of the Teacher Educators in the area of study realized during the covid-19 pandemic lockdown that they lacked relevant technology-enhanced learning skills. Such applications like Google classes, Zoom, You Tube and Microsoft-Team were necessary to facilitate them create Technology-Rich Environments for their trainees to the expectations.

Almost all technology-enhanced learning applications which included Google classes, Microsoft Teams, You Tube, emails, internet surfing, WhatsApp accounts and Zoom needed constant power supply, stable network and specialized skills which according to the study findings of this research were reported as serious gaps in the area of study and among the teacher educators who participated in the study.

5.4 Recommendations

Basing on the Results, the Discussion and Conclusions, recommendations were made following the specific objectives and available related literature as indicated in the subsequent subsections:

Implementation of Technology-Rich Environments initiative

Gaps were identified among majority of the Lecturers (teacher educators) who were supposed to facilitate their trainees with content delivery electronically during the covid-19 pandemic lockdown because they lacked ICT skills. On that note, therefore, it is hereby recommended that all Lecturers (teacher educators) in Teacher Training Institutions be subjected to an ICT policy as a partial requirement to their jobs. In addition, it is also recommended that individual Teacher Training Institutions get encouraged to conduct institution-based workshops, seminars and conferences to enable Lecturers (teacher educators) and trainees who already possess the ICT skills to train their counterparts through a peer mentorship initiative with a lot of emphasis on integration of ICT with subject content and pedagogical concerns.

It is hereby recommended that deliberate institution-based training be organized and conducted to teacher educators on Technology Enhanced Learning applications such as Google classes, Zoom, Microsoft-Teams and You Tube which can facilitate them in creating Technology-Rich Environments for their trainees but also pay a lot of attention to integration of ITC skills with content and pedagogy.

Tools and applications used in the Technology-Rich Environments during

covid-19 pandemic lockdown by teacher educators

Research findings revealed that majority of the teacher educators were found wanting in the full exploration of the relevant Technology Enhanced Learning applications, tools and programmes such as Google classes, Microsoft-teams, Zoom, You Tube, which they ought to venture into in the creation of Technology-Rich Environments for their trainees. They also possessed gaps in how to manipulate intelligent machines like mobile phones, iPads, Desktop and Laptop computers of the latest standard. It is therefore, hereby recommended that deliberate institution-based training programs be organized for Lecturers (teacher educators) to have their capacity built in the area of technology as required. In addition, it is also important for the Principals and Deputy Principals of Teacher Training Institutions to initiate an aggressive campaign on a peer mentorship intervention so as to enable majority of the teacher educators who lack the TEL skills to obtain them from their colleagues through a peer mentorship programme

Furthermore, it is hereby recommended that the minority of the teacher educators who possessed the Technology Enhanced Learning (TEL) Skills ought to be publicly recognized and appreciated with letters of outstanding contribution during the covid-19 pandemic lockdown.

Challenges associated with the implementation of Technology-Rich Environments in selected institutions in Uganda

The most effective and user-friendly Technology Enhanced Learning applications such as Google classes, Zoom, You Tube and Microsoft-teams were considered sophisticated by majority of the teacher educators because they lacked skills to employ them in creating the Technology-Rich Environments for their trainees during the covid-19 pandemic lockdown. It is therefore, hereby recommended that deliberate training be conducted and scaled down to institution, department, learning area and class levels in order to build the capacity of teacher educators accordingly.

Teacher educators were able to create Technology-Rich Environments for their trainees during the covid-19 pandemic lockdown but those who were located in urban areas had a greater advantage over their counterparts who were located in semi-urban and rural areas. There were many parts in rural areas which had inadequate supply of power, poor internet network coverage coupled with scarcity of the latest technology enhanced learning tools.

It is therefore, hereby recommended that specific centres which are central with rich internet network coverage, latest technology enhanced learning tools be located to facilitate trainees in such remote areas gather and benefit from the Technology-Rich Environments created by their teacher educators.

All technology-Enhanced Learning tools which included cell phones, Desktop, Laptop computers, iPads etc. which teacher educators employed in creating Technology-Rich Environments for their trainees during the covid-19 pandemic lockdown faced challenges of unreliable power supply, unstable network, high costs of maintenance and specialized skills coupled with tight security measures against thieves and thugs most especially in rural areas. It is therefore, hereby recommended that solar panels be supplied and connected in some located central areas with well reinforced burglarproof structures for security.

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