STATUS AND USE OF INFORMATION COMMUNICATION TECHNOLOGY IN UGANDA SECONDARY SCHOOLS: TEACHERS' COMPETENCIES, CHALLENGES, DISPOSITIONS, AND PERCEPTIONS

by

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Abstract

This study explored teachers' competencies, dispositions, perceptions, and challenges in selected secondary schools in Mbale district of the Republic of Uganda. Two research questions were investigated: 1) What do teachers in Uganda perceive to be the necessary ICT competencies and dispositions in order to implement the high school curriculum? 2) What do teachers perceive as challenges to implementing ICT in curriculum and instruction? Within a sequential explanatory mixed methods research design, 243 teachers were surveyed and nine were interviewed and observed in classrooms. Exploratory factor analysis loaded six significant factors: (1) Computer use as competency indicator ($\alpha = .89$); (2) Communication enhancement ($\alpha = .76$): (3) Effective mediator of teaching and learning ($\alpha = .73$); (4) Drafters and preparatory tool ($\alpha = .72$); (5) Performance indicator ($\alpha = .64$); and (6) Computer-centred pedagogy ($\alpha = .59$). Computer use as competency indicator was the best predictor of the teachers' perceptions. Qualitative thematic analysis yielded six major themes: (1) Competencies in ICT Use Depend on Training Received; (2) ICT Use is Enhanced by Teacher Characteristics or Identity; (3) ICT Use Depends on Availability of ICT Infrastructure; (4) ICT Use is Beneficial to Lesson Planning and Instruction; (5) Teacher Collaboration through ICTs has Implications for Performance; and (6) ICT-enhanced Pedagogy Requires Extra Effort and Time. Teachers indicated their competencies were hampered by the lack of technology training and adequate trainers. Teachers also indicated: resources in general were needed at the schools to enable them to integrate ICTs; and IT departments were sometimes hindrances to their efforts to adopt technology. Teachers also agreed that at times they did not use technology because it would take too much time. Implications for practice and policy touch on six main areas: (1) Enhancing classroom uses of technology; (2) providing technology training; (3) providing technology infrastructure and

resources; (4) providing time; (5) modifying the school curriculum; and (6) adopting technology plans for schools. Findings suggest the Uganda government needs to commit significant funding to equip schools with resources. At the same time, findings indicate that availability of technology resources does not guarantee teacher change or student learning.

Lay Summary

This study explored teachers' competencies, dispositions perceptions, and challenges in selected secondary schools in Mbale district of the Republic of Uganda. Two research questions were investigated: 1) What do teachers in Uganda perceive to be the necessary ICT competencies and dispositions in order to implement the high school curriculum? 2) What do teachers perceive as challenges to implementing ICT in curriculum and instruction? Teachers indicated that their competencies were hampered by the lack of technology training and that the trainers were not adequate. They also indicated that resources in general were needed at the schools to enable them to integrate ICTs. Teachers also agreed that at times they did not use technology because it would take too much time. Findings suggest that the Uganda government needs to commit significant funding to equip schools with resources. Findings also indicate that availability of technology resources does not guarantee teacher change or student learning.

Preface

This research project was originally conceptualized by the author, Stella Maris Namae. The author is also solely responsible for writing this thesis, under the guidance of the Supervisor, Dr. Stephen Petrina and oversight of the committee. Ethics approval for this research was provided by the University of British Columbia Behavioural Research Ethics Board: certificate #H06-80670.

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Dedication

To my family.

Chapter 1: Introduction and Background to the Study

The 21st century came with rapid growth in information and communication technologies (ICTs) (World Bank, 2016; UNESCO, 2011; United Nations, 2010; World Economic Forum, 2017). ICTs have driven economic development and social change worldwide, including educational change in most countries (Millennium Goals, 2010; UNESCO, 2011; Vanderlinde, Van Braak, & Dexter, 2012). Connectivity through social networking platforms is now reliable and common in urban areas and much improved in many rural regions. There is no doubt, therefore, that ICTs have changed how we learn, work, and go about our daily lives. With such transformations, it would logically follow that ICT integration within the field of education would be flourishing and having a significant impact on learning, motivation, and pedagogy (International Society for Technology in Education (ISTE), 2016; Voogt & Roblin, 2010).

An important research problem of ICTs in schools is how teachers use them regularly in their teaching and the impact on the existing curriculum. Heitink, Voogt, Verplanken, Van Braak and Fisser (2016) and Voogt and Roblin (2010) contend that successful implementation of technology into school programs depends strongly on teachers' support and attitudes. According to Bisaso, Kereteletswe, Selwood, and Visscher (2008) and Shulman (1992), teachers are constantly required to shift and evolve their knowledge from different domains including knowledge of student thinking and learning, knowledge of subject matter and, increasingly, knowledge of technology (Koehler & Mishra, 2009; Mishra & Koehler, 2006). The International Society for Technology in Education (2016) notes that meaningful technology integration in education is dependent on how teachers plan for and use ICTs. Today's teachers, specifically those in urban areas of North America, interact with students who spend an average of eight

hours each day using entertainment media primarily outside the classroom (Rideout, Foehr, & Roberts, 2010). When the same teachers do not effectively integrate all aspects of technology in the educational process, the students are not fully engaged and miss out on authentic learning experiences like collaboration, creativity, and innovation. Consequently, teachers must be prepared to provide technology supported learning opportunities for their students. While technology is no magic cure-all for education, it does have positive effects when combined appropriately with pedagogy and content (Beglau et al., 2011; Rosenberg & Koehler, 2015; Tsai, 2015; Voogt & Roblin, 2010; Walk et al., 2013).

Okaka (2011) and Selvi (2010) emphasize that being prepared to use technology and knowing how that technology can support student learning must be an integral skill in every teacher's repertoire. According to Galanouli, Murphy, and Gardner (2004) and Zhao and Cziko (2001), the key to understanding the use and integration of ICTs into classroom teaching lies in perceptual control. Perceptual control theory, as conceived by Powers (1952), views people as purposeful. It holds that people target certain variables for control and compare perceptions of the current state of those variables with their goal state or reference condition for those variables. If unacceptable gaps exist, people behave in ways that serve to close those gaps. Accordingly, it is that behaviour that serves to control people's perceptions. Perceptual control theory considers teachers' interest, attitudes, and beliefs of integrating ICTs in classroom teaching and learning, suggesting that when it comes to issues use in the classroom, teachers tend to focus on confidence, control, and competence.

Background of the Research Problem

Countries across Africa have been integrating ICTs in varying degrees into classrooms across the continent (UNESCO, 2015). During the 2016 pan African forum hosted by the African Development Bank and UNESCO in Ivory Coast, the opening session highlighted progress made by countries such as Kenya, and the benefits that have followed with integration of technology into classrooms. It was agreed upon that many developing countries witnessed a considerable commitment and huge investments by national governments and their partners to improve technology use and access. Attaining these commitments has not been easy for many African governments. Africa is plagued by poverty, poor infrastructure, disease, low income levels, and poor education, and there is the possibility that technology could be part of the solution (UNESCO, 2015). The digital revolution in the region has led to a boom in trials using ICTs in education, both within and outside of the classroom (Okaka, 2011; Palumbo, 2014; Wagner, 2017). Access to digital communication is now a key part of people living in Africa, even for those from rural areas (Bryson, 2011; Okaka, 2011; Porter, 2012).

History has shown that mass communication was the principle technology in Africa since the 1960s, with countries using radio and television to promote basic education, improve teacher training, and teach pupils directly. Computer technology was prevalent in the 1990s, and many governments and non-governmental organisations started directing their efforts to equipping schools with computers to facilitate digital education and offer new educational media in the form of software and CD-ROMs. These trials, however, were launched without clear pedagogical objectives and state-defined policy frameworks (Wamakote, Ang'ondi, & Onguko, 2010). Access is facilitated by affordable mobile telephones, low calling rates, and mobile

internet. The rapid expansion of mobile Internet services contributes to economic and social development.

Uganda as a country has enormous advocacy for ICTs in teaching and learning coupled with donations for equipment. The country launched its first National ICT policy in 2003 and in the same year, presented an education sector ICT policy before parliament for approval. Emphasis was placed on the importance of integrating ICTs in teaching and learning (Uganda Communications Commission, 2014). It is important for 21st century teachers to be sound pedagogically and confident users of ICTs in their teaching and learning activities. Teachers in Uganda, similar to many other countries in the developing world, are grappling with being ICT literate and competent (Bisaso et al., 2008; Hennessy et al., 2010; Newby, Hite, Hite, & Mugimu, 2013). These challenges are partly due to constraints related to skills, expertise, finance, and computer equipment (Mutonyi & Norton, 2007; Newby et al., 2013; Player-Koro, 2012). Fabry and Higgs (1997) argue for institutions to make any significant change in technology integration, focus must be directed on time, money, and resources in areas that can have the greatest impact for students and teachers. However, critics of educational technology continue to question increased funding of resources in schools at the expense of teachers (Keengwe, Onchwari, & Wachira, 2008). The availability of ICTs in schools does not guarantee teachers will integrate them into their daily classroom instruction. They propose, that such funding should be directed to support teachers' professional development programs since teachers who receive higher levels of appropriate technology training are better prepared to integrate ICTs into their curriculum. This argument resonates with Makerere University's (2004) ICT policy that suggests the need for effective training for teachers to implement ICTs in their different functions (Makerere University, 2014). Skills practice helps teachers feel more secure

in their ICT use during lessons and gives them the courage to experiment more and consequently integrate them into their lessons.

Traditionally, teachers' expertise was grounded in content knowledge which Shulman (1987) describes as knowledge of the subject to be taught. Later teachers' expertise shifted more to pedagogy (Ball & McDiarmid, 1989). Shulman then proposed teacher knowledge as a link between pedagogy and content as a model he called "Pedagogical Content Knowledge" (PCK). Later, other aspects of psychological knowledge (Voss & Kunter, 2013) and knowledge of context were added (Grossman & Stodolsky, 1995).

With the advent of technology, Mishra and Koehler (2006) elaborated on Shulman's model, adding technology to PCK, arguing teachers should stay up-to-date with how technology should be pedagogically implemented to teach content. The authors named the model Technological Pedagogical Content Knowledge (TPACK). The lack of teacher competencies related to the use of ICTs in teaching can be perceived as major barriers to technology integration. This deficit in teacher competencies not only includes the lack of PCK and skills but also the lack of TPACK and related classroom management knowledge and skills (Hew & Brush, 2007).

Statement of the Problem

Experts agree that Uganda lags behind several other African countries in the use of ICTs in education (World bank, 2016; Guimón, 2013). Despite increased ICT awareness and implementation among the general public coupled with ICT requirements in official school curricula in Uganda, there has been a slow adoption of ICT in schools by the majority of the teachers (Bryson, 2011; Kivunike, Ekenberg, Danielson, & Tusubira, 2011; Newby et al., 2013;

UNESCO, 2015, Bagarukayo, 2018). This is a typical scenario in many developing countries because teachers are not fully ICT literate and do not believe that advantages outweigh disadvantages of technology in their classrooms (Ale & Chib, 2011; Çapuk & Kara, 2015; Dominic & Sumner, 2016; Dubey, 2016; Newby et al., 2013). Some reports paint a promising picture of classroom teachers' efforts in using technology to support student learning in many developing countries, especially in Africa (Kyobe, 2011; Padayachee, 2017; UNESCO, 2015; Wamakote, Ang'ondi, & Onguko, 2010). Studies in Uganda reveal a gap between the technology available in classrooms and teachers' abilities to use these technologies (Nakintu & Neema-Abooki, 2015; Andema, Kendrick, & Norton, 2013; Luwangula, 2011). Additionally, teachers were found to be lacking in digital skills to utilise even the available ICTs (Bagarukayo, 2018; Wamakote, 2010; Nakabugo et al., 2008). This observation accentuates the question many have asked: how prepared are teachers for new ICTs across the Ugandan educational landscape? The Ministry of Education and Sports (MoES) in conjunction with Uganda Communications Commission (UCC), through UCC's Rural Communications Development Fund (RCDF), supported the establishment of ICT laboratories in over 1,027 secondary schools to enhance usage and integration of in secondary schools in Uganda. The venture suffered a setback when schools especially those in the rural areas did not have qualified ICT teachers, computers, and electricity (Uganda Radio Network, 2012). Meanwhile, Ndiwalana and Tusubira (2012) found the lack of effective ICT policies to guide the shift from traditional teaching and learning practices to digitally enhanced classrooms. In 2017, workshops for tooling and retooling were organized for teachers in the use of ICTs. It is from this background that my study was framed to investigate the status and use of ICT in Uganda secondary schools focusing on teachers' competencies, perceptions, dispositions, and challenges.

The government of Uganda has been on the forefront in providing partnership environments for local and international collaboration with schools and software companies to implement technology in schools. Such partnerships include: "Badiliko Project," in which the British council and Microsoft, together with the British and Foreign Schools Society pilot projects for delivering mathematics and science content for secondary schools; MTN e-learning management platform (MTN Blackboard) at Kololo S.S.; and the Samsung solar powered Internet and e-board for teaching (*Business Daily*, July 17, 2012). These initiatives were setup to improve the quality of education in Uganda (Government of Uganda, 2008). Evidence from other countries worldwide, however, reveals that such commitments and investments in education do not necessarily lead to technology adoption (Unwin, 2005). Rather, technology adoption in educational settings is a complex process influenced by many other factors, including teacher-level, school-level, and system-level factors (Voogt & Knezek, 2008). It is therefore important to consider technological, individual, organizational, and institutional factors when examining technology adoption in educational systems.

It is discouraging to note the existing literature does not reveal intensive research activities in developing countries regarding teachers' skills and competencies related to technology adoption and teaching. Notable studies reveal quantitative research methods dominated this field, and so the voices of participants in the form of qualitative data are somewhat diminished. Thus, such studies result in reporting findings that are incomplete in understanding technology adoption in schools. Therefore, in this study I used quantitative data to provide a general picture of the research problem, followed by qualitative data to give insight into the statistical results by exploring the participants' views in more depth (Creswell & Plano-Clark, 2018; Goodson & Mangan, 1995).

Research Questions

1. What do teachers in Uganda perceive to be the necessary ICT competencies and dispositions in order to implement the high school curriculum?
2. What do teachers perceive as challenges to implementing ICT in curriculum and instruction?

Purpose of the Study

The purpose of this study was to examine the factors related to technology adoption among secondary school teachers in Uganda. To examine these factors, I conducted a sequential explanatory mixed-method study consisting of two phases, the quantitative phase and the qualitative phase. In the first phase (quantitative), I employed a survey questionnaire to collect data from 250 (n=243 after cleaning) secondary school teachers in Mbale Municipality in the Eastern part of Uganda. TPACK helped explain how the explanatory variables of age of a teacher, school type, Internet at home and school, educational technology in general, in-service training, and discussions about technology influenced teachers' use of technology. The second phase (qualitative) consisted of collecting qualitative data using semi-structured interviews and classroom observations to examine the extent to which the explanatory variables were related to teachers' use of technology in the classroom. The reason for the exploratory follow-up was to help explain the statistical results.

Researcher and Positionality Statement

A teacher's worldview of their place in time and their perspectives of the world around them shapes the decisions they make in the classroom (Walker, 2004). Having been raised and educated in Uganda combined with my experience as a classroom teacher of many years gives me a unique perspective of the education system. I have an experiential and research-based understanding of cultural, social, and educational settings of Uganda. My decision to investigate technology use among teachers was due to the following two reasons. First and foremost, as a high school teacher, I realised the needs of students in my classes were changing at such a fast pace that I needed to reflect on my own practice. Students are increasingly expressing themselves on social media apps such as Facebook, Twitter, WhatsApp, and blogs, and they are accessing information via Google and other search engines. I felt the responsibility to be aware of these changes as a teacher and researcher. Second, the conversation around technology integration in the classroom on the continent of Africa, and Uganda specifically, has been mixed. Some scholars suggest the country is average in usage while others consider it "lagging behind". I therefore felt it was important to investigate these contradictions and be further informed. I required additional data to contribute towards this discourse.

I seized the opportunity to conduct research in an area with practical implications, which is an important facet. Given that my literature review revealed Uganda's teachers' use of ICTs in the classrooms is unclear, I seized the opportunity to conduct research to understand how teachers can successfully integrate this key resource in their work.

Terminology

ICT Status and Use

ICT has several definitions depending on the nature of the term's usage. Some researchers may use ICT to refer to various tools and devices used to transmit, process, store, create, display, and share or exchange information by electronic means in educational settings (Bisaso et al., 2008; Jones & Jo, 2004). This may include computer hardware and software, hand held devices, mobile phones, and the Internet (Zuppo, 2012). In Uganda, technology is described by different terms that mean one and the same thing. Both teachers and students talk of computer studies, Information Technology (IT), or ICT.

For the purposes of this study, I use the words technology and ICTs interchangeably, understanding that technology encompasses a vast range of physical, digital, and bio-related tools, machines, and processes. Technology describes a collection of tools, techniques, and knowledge, such as the Internet, computer technology, word processing applications, and microscopes. Educational technologies are consequently described as a sum of tools, techniques, and collective knowledge applicable to education. ICTs generally refer to two components: hardware and software. The hardware aspect "[consists] of the tool that embodies the technology as material or physical object…and [the] software aspect, [consists] of the information base for the tool" (Koehler & Mishra, 2009; Mishra & Koehler, 2006, p. 13).

Status and Use

Additionally, I use the terms *status and use* of technology to mean technology-related affairs and ways technology has been adopted by teachers to enhance teaching and learning (Beglau et al., 2011; ISTE, 2009, 2016). In addition, the term *use* describes teachers' decisions to

employ technology for teaching in light of the TPACK concept that guided this study (Mishra & Koehler, 2006). Uganda stipulates in the national ICT plan the integration of technology in education; however, the concept is not explicitly defined. Despite this ambiguity, literature suggests that technology integration denotes a change in pedagogical practices that involve training teachers in technology and its use (Heitink et al., 2016; J. Voogt & Pelgrum, 2005).

Baylor and Ritchie (2002) emphasise the goals of professional training, especially learning how to use ICT. When learning how to use ICT, the pedagogical focus is on the use of technological products in and outside of the classroom. Spector, Merrill, Elen, and Bishop (2014) elaborate the goals of professional learning about ICT, highlighting the distinction between seeing technology as core or supplementary. A core technology role necessitates a central place when organising learning experiences whereas a complementary technology role is optional even as it may serve a valuable role, and it can be dropped altogether if not practicable.

Teachers' Technology Competencies

Jung, Rhodes, and Vogt (2006) explain that technology competence broadly includes technological literacy and technical expertise in using computer technology. They also include the aspect of openness to change. In general terms, this would mean technology competence encompasses both proficiency and the willingness to adapt in an ever-changing educational context. Similarly, Baylor and Ritchie (2002) operationalized teacher technology competence as being able to use different software and solve general computer related problems, and also teach students about technology and use technology in instruction. In the context of this study, competencies are behaviours directly related to the nature of training and the technical proficiency required to exercise effective pedagogical control with the support of educational

technologies during instruction. ICT competency envisions sufficient skills and knowledge in the use of computers and associated devices and applications. Teachers are expected to demonstrate the ability to apply knowledge and abilities needed in ICT-related complexities. Generally, teachers' competencies affect their values, behaviours, communication, aims, and practices in school. With regards to ICT and its usage in classrooms, teacher competencies determine the use of technology to facilitate teaching and learning processes (Tondeur, Van Braak, & Valcke, 2007). Integration of technology into instruction depends a great deal on key factors, such as the contexts in which teachers interact, their beliefs, and their attitudes toward teaching and learning (Cuban, Kirkpatrick, & Peck, 2001).

Perceived Challenges with Technology Integration

Teachers generally appreciate the benefits that come with educational technologies, yet they can find effective integration challenging. The challenges range from acquisition of new technology equipment to adaptation of curricula and teaching techniques. ICT challenges hinder integration in teaching and learning activities in schools. These are conditions that make it difficult for teachers to make headway in the integration of ICT in classrooms (BECTA, 2003). Scholars classify ICT challenges into different categories. Prestridge (2012) classifies challenges as extrinsic and intrinsic. Extrinsic are first order challenges that include access, time, support, resources, and training. Intrinsic are second order challenges and include attitudes, beliefs, practices, and resistance. Challenges range from teacher-level to school level. Teacher level challenges include lack of time, lack of confidence, lack of competence, and resistance to change (BECTA, 2011). Also, the lack of effective training and access to resources and technical support contribute to the lack of confidence among teachers in the use of ICT. A survey done by

Hunt, Davis, and Pittard (2006) for the British Educational Communications and Technology Agency (BECTA) indicated that many teachers who lack confidence lacked adequate knowledge in ICT.

Teachers Dispositions as Link for Technology Integration

Dispositions related to effective teaching have been defined in different ways. In the United States, The National Council for Accreditation of Teacher Education (NCATE) (2010), defines dispositions as the values, commitments, and professional ethics that influence behaviours, perhaps toward an innovation, which affect student learning, motivation, and professional growth. Dispositions, according to NCATE, are steered by attitudes and beliefs. Smith, Schugar, and Moyer (2017) add that dispositions reflect a pattern of behaviour that is frequent and absent of coercion. Teachers' dispositions significantly influence their integration of ICTs into classroom instruction as this reflects their personal beliefs regarding the potential benefits of the technology. Teachers who demonstrate strong motivation to use computers for their personal and professional purposes believe that ICT integration will support their students' learning (Vannatta & Fordham, 2004).

Having a disposition toward technology use requires mindfulness of the complexity of teaching. An effective teacher requires the temperament or disposition necessary to step back and analyse the context of their practice in order to improve the quality of their practice (NCATE, 2010; Wadlington & Wadlington, 2012). Lian, Chang, Chang, and Lin (2012) discussed the role emotions play in a creative disposition, that is, the ability to endure painful struggles in thoughts, feelings, and emotions during creative activity. Zeichner (2005) endorses the above authors'

work as the capacity to view differences and difficulties as resources for learning rather than difficulties to overcome.

How Perception Informs ICT Use

In this study, perception refers to a teacher's sense of using ICTs in the classroom. For any system to adopt a technological innovation, the role of the user must be considered in the acceptance process. User perceptions about the use of technology are related to satisfaction and comfort without excessive effort. Heitink et al. (2016) defined teachers' perception as a learned predisposition to respond to an object or class of objects in a consistently favourable or unfavourable way. Integration of ICTs into teaching and learning largely depends on teachers' perception, which is a key factor in acceptance in pedagogical practices (Baylor & Ritchie, 2002). Teachers' perception about ICTs could be influenced by truth or mere opinions, prejudice or stereotypes, or by factors such as gender, level of education, training and subject specialization, character, and even relationship with others. So, for teachers to embrace ICT, they must view it as an effective means to achieve pedagogical objectives with respect to their current teaching practice (Ajzen & Fishbein, 2005; Baylor & Ritchie, 2002; Fishbein & Ajzen, 1975).

It is essential that more attention be focused on training pre-service and in-service teachers on how to integrate ICTs effectively into curriculum. Dominic and Sumner (2016) contend that positive attitudes towards ICTs are positively correlated with teachers' perceptions. The amount of confidence a teacher possesses in integrating ICTs in teaching may greatly influence her or his effective implementation and therefore improve their instruction.

Summary of Theoretical Framework

As indicated, this study draws on two theories: TPACK and PCT. TPACK addresses the special knowledge required by teachers to effectively support instruction through the use of new technologies (Mishra & Koehler, 2006). PCT addresses teachers' behaviours in the use of technology by examining their perceptions of technology in relation to their hierarchy of teaching goals. These theories are elaborated in Chapter 2.

Limitations of the Study

This section addresses three limitations of the study:

First, the survey questionnaire was adapted from a developed country, and the questions may not capture all the variables related to teachers' technology adoption and use in the Ugandan school context. Self-reporting on the survey questionnaire might have resulted in unverifiable information, which may have affected the findings of the study.

Second, time is a significant element in any process of adopting a new practice. However, time in my study was a methodological challenge because it was hard to measure the rate of technology adoption from when individuals decided to adopt technology, particularly through the survey instrument used to collect data (Mahroum & Al-Saleh, 2013; Rogers, 1995). I relied entirely on what the teachers told me during the interviews and their responses to the survey.

Third, the perceptions and experiences of students, school principals, and ministry officials were not examined. The findings of my research are teacher-centred. If there were suggestions of blame for a lack of integration of ICTs, individual blame-bias was not adequately addressed. Therefore, the findings may have failed to capture all the factors related to technology adoption in the Uganda education context.

Chapter Summary

Technology has become pivotal in educational change worldwide. Most countries in Sub-Saharan Africa, Uganda included, have introduced reforms with the hope that education shall transform the lives of people and their economies to match those of developed countries. Recently, the Uganda government launched Vision 2040 with the goal that the country will transform to a middle-income economy by the year 2040.

Considering the Uganda Vision 2040 requires skilled personnel to become a reality, the government is well aware of the current status of education as not having the ability to support its objectives. This problem points to a lack of ICT integration as a stumbling block in the process of educational development at personal and national levels. ICT skills promote sharing information that are useful to the education sector and the employability of youth, and also the professional development of teachers and other professionals. To overcome this challenge, the government and education stakeholders have started to commit technological resources in a hope that technology will help to overcome the challenges. Evidence from other countries in the world, however, reveal that such initiatives do not necessarily lead to technology adoption by teachers because the availability of technology alone does not guarantee that teachers will use them to support instruction. Rather, technology adoption is a complex process that is influenced by many factors, including those at the teacher level, school-level, and system-level (Heitink et al., 2016). In this case, researchers have indicated that to understand technology adoption in an educational system, and the extent to which these factors were related to teachers' decisions to adopt or not to adopt technology, need to be investigated. My review of literature demonstrates

there have not been extensive studies in Uganda examining why teachers choose to adopt or not adopt technology in their teaching and learning activities.

Dissertation Overview and Structure

This dissertation is divided into five chapters. Chapter 1 provided an overview of the background to the study, statement of the problem, research questions, purpose of the study, brief definition of core terms, summary of the theoretical framework, and limitations**.** Chapter 2 discusses the theoretical framework used to study technology adoption in schools and the related literature. Chapter 3 discusses the research methodology for the study. Chapter 4 reports the results from question 1 and question 2. Chapter 5 summarizes the study by drawing on TPACK and PCT literature, and makes conclusions, practice and policy implications, limitations, and recommendations for future research.

Chapter 2: Theoretical Perspectives and Literature Review

In this chapter, I provide a review of literature relevant to central and core concepts in the theoretical framework for the study. Literature is drawn from developed and developing countries with particular emphasis on secondary school teachers. The chapter is organized as follows: (1) theoretical perspectives used to investigate technology integration; (2) Perceptual Control Theory (PCT); (3) Technological Pedagogical and Content Knowledge (TPACK); (4) characteristics of the meaningful use of technology in the classroom; (5) debates on technology in education; (6) research on the factors that were related to teachers' effective integration of technology; and (7) research on technology adoption in schools in Uganda.

Models of Technology Adoption

Technology adoption theories examine individuals within a population and the choices they make to either accept or reject a particular innovation. Rogers (1995) defined an innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (p. 137).

Adoption or Rejection

According to Rogers (1995), deciding whether or not to adopt an innovation involves a five-stage process (p. 20). These five stages probably apply across the board to almost any new technology made by an individual or a social system. The stages are: (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation.

Knowledge

This is the first stage where potential adopters are first exposed to the innovation and gain some understanding of how it works. Adopters gain awareness, how-to knowledge and principles knowledge. For teachers, this can be through training workshops, hands-on experiences, and communication through peers.

Persuasion

During the persuasion stage, the potential adopters receive more information, perhaps on why the innovation is worth adopting (Rogers, 1995, p. 20). Depending on how they perceive the characteristics of the innovation, the adopters then form either a positive or negative attitude towards the innovation.

Decision

At this stage, the potential adopter decides to accept or reject the innovation depending on the attitudes developed (Rogers, 1995, p. 20). It is possible for an adopter to be "persuaded" out of necessity, which affects the decision stage. Rather than choosing to adopt the technology, the adopter believes there is no other choice. It then becomes an adopt-or-perish mindset that pushes the adopter to make a decision, which is really a non-decision. Pushed into a corner by, i.e., government policies, job security, or peer pressure, the choice is circumstantial. For teachers who see no other way, the adoption of ICTs could really be the manifestation of humble acceptance, resentment, frustration, or even desperation.

Implementation

Once the decision to adopt the innovation is made, the adopter must put it to use (Rogers, 1995, p. 20). However, putting the innovation to use is often harder than deciding to adopt it in the first place, especially in the use of digital technologies.

Confirmation

At this point, the adopters assess the impact of the innovation and seeks reinforcement for the decision already made. They may decide to either keep the innovation or forget about it altogether. As Rogers (1995) explains, "confirmation occurs when an individual (or other decision-making units) seek reinforcement of an innovation-decision that has already been made, but the individual may reverse this previous decision if exposed to conflicting messages about the innovation" (Rogers, p. 20).

A range of theoretical frameworks have been employed to examine factors that influence educators' technology adoption decisions (Petrina, 2010; Petrina, Feng, & Kim, 2008). Some theories informing research into the use of technology in education include: (1) Activity theory; (2) Instrumentalism; (3) Technology Adoption Model; (4) Stages of Concern; (5) PCT; and (6) TPACK. For my research, I integrated PCT and TPACK into a theoretical framework that informed the research design and analysis.

This is not to say the range of theories researchers used is inadequate. Rather, PCT and TPACK were the most informative and responsive to this dissertation research project. Briefly, Cole and Engeström (1999) evolved traditional Cultural-Historical Activity Theory (Leontõev,

1979; Luria, 1976; Vygotsky, 1978) to inform ICT integration. Considering instrumentalism, Trouche (2004) introduced the term "instrumental orchestration" to refer to teachers' role in guiding students' adoption of ICTs. Davis (1989) introduced the popular Technology Acceptance Model (TAM) to inform ICT integration work environments. Specific to teachers, the Stages of Concern Questionnaire (SoCQ) has offered researchers a widely used scale with which to gauge ICT adoption (Hall, 1987) (Hall &, Hord 1987). Similarly, a wide range of localized scales and theories have been used to inform teachers' adoption of ICTs (Petrina, Bartosh, Guo, & Stanley-Wilson, 2008; Petrina & Guo, 2007). I considered a range of theories in my review of literature, and the balance of this chapter focuses on PCT and TPACK.

Perceptual Control Theory

PCT was conceived by Powers in the 1950s and 1960s. The theory contends that humans behave the way they do by invariably comparing their perceptions to perceptual reference standards (goals) within their senses rather than external stimuli (Kuhn & Powers, 2006; Powers, 1973). This means humans always strive to preserve their perceptions match these reference conditions. In this sense, teachers purposefully respond to internalized feedback. We target certain variables for control, and we compare our perceptions of the current state of those variables with our stated goal or reference condition for those variables. If unacceptable gaps exist, we behave in ways that serve to close those gaps. There are, however, other actors at work influencing the same variables we are trying to control.

In PCT, control does not necessarily indicate an effortful, deliberate, or constraining process. Rather, PCT represents an intrinsic property essential to all living things (Cziko, Gary A, 2007; Powers, 1973) that serves as a perceptual reference standard. PCT does not interpret

behaviour as simple responses to immediate stimuli but the maintenance of established states in the nervous system in the face of variations or disturbances in its immediate surrounding. On occasion they can prove overwhelming. From a PCT perspective, three conditions are necessary for teachers to use technology: (1) Teachers must believe that technology can effectively meet a higher-level goal than what has been used; (2) Teachers must believe that using technology will not cause disturbances to other high-level goals they consider to be more important than the one being maintained; and (3) Teachers must believe that they will have sufficient ability and resources to use technology. Figure 1 provides a representation of a negative feedback loop comprising of the three major components PCT, i.e., perception (or input function), comparison (comparator function), and action (output function).

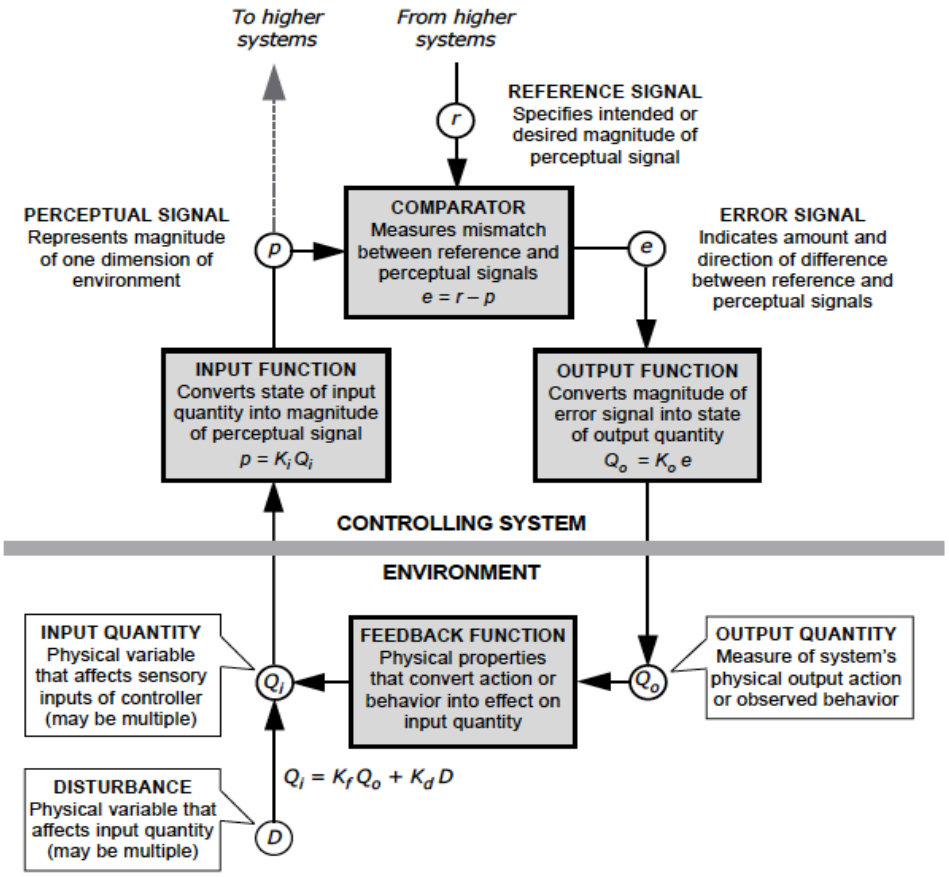

Figure 1: The basic organization of a negative feedback control system. Loop functions are shown in gray. Variables D, Q_i, *etc. are employed in the fundamental algebraic equations of negative feedback control theory, as described in the text. The reader is invited to explore the functions and relationships interactively in the Live Block demo (one of the LCS3Programs set—see the Resources section below).*

Figure 1: A basic perceptual control system unit. Figure and caption reproduced from Powers, et al. (2011)

PCT and Technology use in Teaching

The question of why educators may be failing to embrace technology in the classroom is related to factors such as perception, inhibition, inexperience, and goals or purposes. People tend to cling to what they know best, which can result in making changes a difficult undertaking. When people transition from the use of traditional technologies to more advanced digital

technologies, dissension and strife are often involved. A teacher's mindset should be considered when assessing motivation towards ICTs in the classroom (Govender, 2016). Studies show that to understand why teachers would accept or decline using ICTs in the classroom, researchers should focus on their inner impression of a new innovation (Govender, 2016; Zhao & Cziko, 2001). This assertion is informed by PCT (Powers, 1973), as applied to the framework of my study.

Understanding Purposeful Behaviour in Teachers use of Technology

PCT contends that human beings and all other living organisms control perceptual input or reference conditions, not motor output. People seek to achieve goals with individual actions aligned with reference conditions coordinated with their consciousness. Perceptions are determined when reactive responses interact with prevalent environmental agitation. People's mind-sets are designed to attain achievement in a hierarchical manner, with low-level goals being manipulated to attain a more focused end result (Powers, 1989). Understanding the theory that humans, and specifically in reference to this study teachers, interact with innovations based on a set of hierarchical goals is critical to comprehending the concept of PCT. In today's knowledge-based society, digital technologies are regarded as an asset to enhance teaching and learning experiences. Teachers have a responsibility to create and present practical and relevant information to their students. The spoken and unspoken demands to use ICTs can be viewed as an invisible monitor on their work; hence making teachers judge their current teaching on the benefits presented by contemporary technology advocates and companies. Govender (2016) and Govender and Govender (2014) argue that teachers feel they are being scrutinized in addition to feeling their career security being threatened. Therefore, the ability of teachers to embrace new technologies is largely contingent on the sense of being in control. A teacher having the ability to

be in control means two things, a structure which allows for perceptions, comparison, and action when required and accessibility to required resources, which enables the ability to act and control.

Research suggests teachers are reluctant to incorporate ICTs into instruction due to a perceived conflict with their goals at a higher level (Bryant & Hunton, 2000; Lawless & Pellegrino, 2007). One must eventually realize technology can only benefit and does not act detrimentally, as many educators are led to believe. Case studies and true-life testimonials can serve to eradicate myths associated with technology in the classroom. Certainly, there are countless cases of detrimental effects of ICTs in classrooms. Denigration of traditional teaching methods in education should not be excluded when incorporating new technologies. As with other elements of society, change does not come easily; it needs to be gradually and gently eased into the mind-set of educators (Mumtaz, 2000).

Tools and accompanying technical support for the benefit of educators can put control back into their hands and reduce or eliminate potential anxiety. Several elements and criteria of a PCT-based framework for comprehending issues associated with educator adoption of technology have been addressed in Chapter 1. PCT contends that to seek resolution one must take the perspective of educators as the lead, instead of attempting to address a solution to a problem. The framework discussed here views technology as a possible way for educators to achieve their higher-level goals. However, the goal of using technology needs to be maintained by varying lower-level systems. As indicated, within PCT there are three conditions technology use by a teacher: (1.) Sustaining higher-level goals; (2.) Reducing agitation of these higher goals; and (3.) Empowering the teachers.

PCT as an interdisciplinary theory with foundations in psychology was deemed fit for this study to understand teachers' use of technology in secondary schools in Uganda. PCT and TPACK were integrated within a theoretical framework to inform adoption of technology by these teachers (Figure 2).

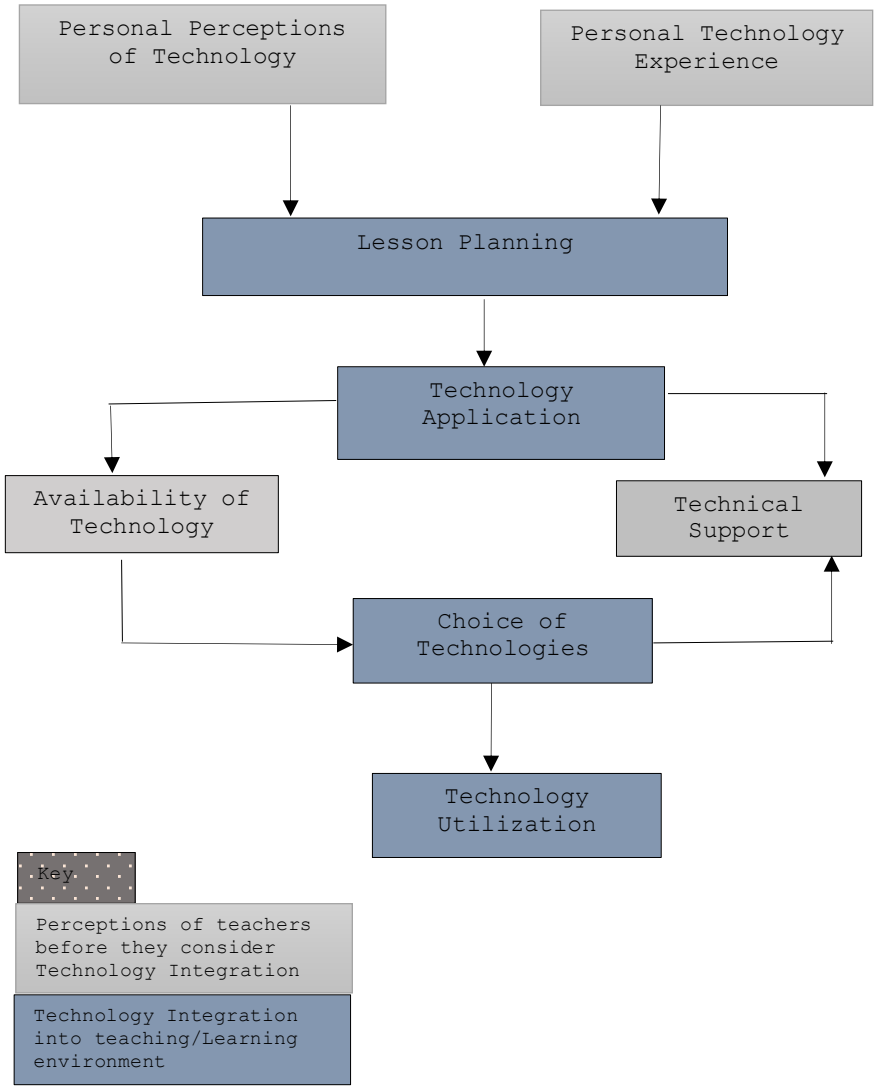

Figure 2: Conceptual framework of teachers' perceptions.

Technological Pedagogical Content Knowledge (TPACK)

TPACK's origins can be found in Shulman's (1986) Pedagogical Content Knowledge (PCK). TPACK emerged from a design experiment by Mishra and Koehler to understand teachers' development of using technology while at the same time helping them develop their teaching with technology (AACTE, 2010. p.13). TPACK stems from three core components; Pedagogy, Content, and Technology are at the heart of good teaching with technology. Graham, (2011) adds, that the interactions between and among the same components, play out differently across diverse contexts, accounting for wider variations seen in educational technology integration. The fundamental principle of TPACK is that a teacher's knowledge regarding technology is multidimensional, and the best mix for the classroom is a balanced combination of technology, pedagogy, and content (Harris, Mishra, & Koehler, 2008; Koehler & Mishra, 2009; Koehler et al., 2014; Mishra & Koehler, 2006a). The overlap of the three domains, technology, pedagogy, and content is represented in Figure 3.

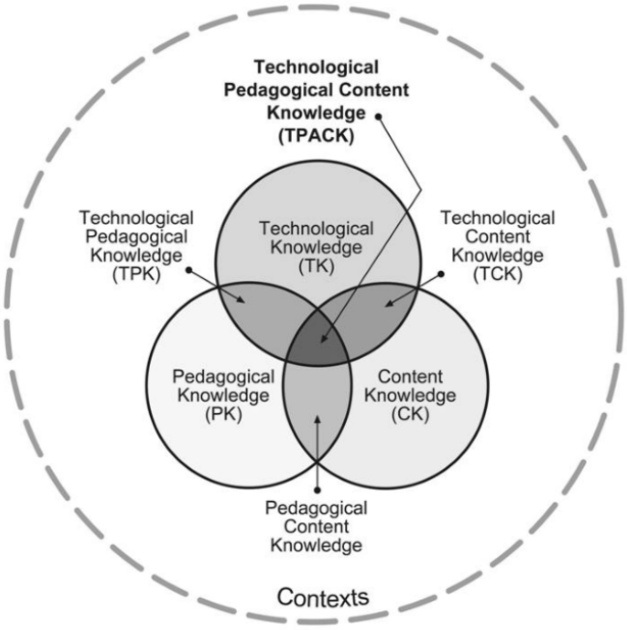

Figure 3: TPACK framework.
Adapted from Mishra and Koehler (2006).

The overlap of the three domains was not a totally new concept before Mishra and Koehler's work, but they were the first to clearly articulate interrelationships between the three, including the unique pairings among them. The complex interrelationship depicts a teacher's understanding of the subject matter, choice of instructional methods, and use of technology (Mishra & Koehler, 2006). In other words, teachers with advanced TPACK systematically think about and use technology as a part and enhancement of their pedagogical methods in teaching content. Thus, the proponents of this model expect teachers to be aware of ways technology can support high quality teaching in different curriculum areas (Prestridge, 2012).

Using TPACK to Understand Teachers' Use of Technology

TPACK has gained popularity in the recent years as a way of exploring teachers' use of digital technologies in their instruction. While TPACK has often been used as a framework to measure teachers' knowledge and to explain teachers' use and non-use of digital technologies, there is inadequate attention to the ways in-service teachers develop their TPACK. Rittel and Webber (1973) describe teachers' use of digital technologies in classrooms as a wicked problem, considering the complexity and ever-changing interdependencies between technological, pedagogical, and content knowledge (Archambault & Crippen, 2009; Cox, 2008; Mishra & Koehler, 2006b; Mumtaz, 2000; Shulman, 1986; Somekh, 2008). Studies investigating these complexities provide contradicting reports with others indicating that technology integration is indeed happening, but too slowly, or with little or no effect on students' learning (e.g.,Campuzano, Dynarski, Agodini, & Rall, 2009; Cuban et al., 2001; Cuban, 1993; Howley, Wood, & Hough, 2011; Selwyn, 2010).

TPACK provides a lens through which researchers view the complex, interdependent relationships. Whereas the theory informed numerous studies examining teachers' professional knowledge (Abuyeka, 2014; Jordan & Dinh, 2012; Kamau, 2014), few studies focused on in-service teachers working in secondary schools, with only one of these (Guzey & Roehrig, 2009) considering in-service teachers' perceptions of TPACK development. As such, in-service teachers' TPACK, particularly in Sub-Saharan Africa, remains comparatively unexplored.

TPACK initially focused on two research questions: (1) What do teachers need to know about technology?; and (2) How can teachers acquire this knowledge? Responses from the first question have informed both theory and practice and are based on the argument that good

teaching results from the interaction among the three TPACK components. However, the interactions between and among these components play out differently across diverse contexts, which accounts for the wide variations in ICT integration (Graham, 2011). The interactions between and among the core components of TPACK are examined below as I delve into individual elements and characteristics.

Components of TPACK

Pedagogical Knowledge

Pedagogical Knowledge or PK refers to basic, generalizable teaching strategies. According to Shulman (1986), pedagogical knowledge is a combination of many components, including classroom management and organization, instructional models and strategies, and classroom communication and discourse. Pedagogical Knowledge is a more generic form of knowledge that transcends disciplines and involves all issues of student learning. It includes knowledge about techniques or methods used in the classroom, the nature of the target audience, and strategies for evaluating student understanding. A teacher with deep PK understands how students construct knowledge and acquire skills, develop habits of mind, and positive dispositions towards learning (Graham, 2011). In agreement, Morine-Dershimer and Kent (2006) add that personal beliefs, practical experience, and reflection also play a large role in shaping Pedagogical Knowledge.

Content Knowledge

Content Knowledge or CK is the second core component in TPACK and involves knowledge about the actual subject matter or concepts related to a specific academic discipline. Additionally, a teacher with CK also understands the structures of their subject matter (Shulman, 1986). This subset of the framework refers to tasks such as knowing how to write a five-paragraph essay, reciting the periodic table of elements, properly solving mathematics problems, etc. Shulman (1986) indicates teachers must know and understand the subjects they teach, including knowledge of central facts, concepts, theories, and procedures within a given field, knowledge of explanatory frameworks that organize and connect ideas, and knowledge of the rules of evidence and proof. The content to be covered varies greatly by age level and subject matter.

Additionally, teachers must also understand the nature of knowledge and inquiry in different fields. Teachers who do not have these understandings can misrepresent CK to their students (Cox, 2008). Gardner and Galanouli (2004) view teaching disciplines as the single most important and least replaceable purpose of schooling as they are like "mental furniture" (Gardner, 2006). According to Gardner (2006), disciplines provide knowledge (facts, concepts & relationships), methods (knowledge creation & validation processes), purposes (reasons why the discipline exists), and forms of representation (genres & symbol systems). Disciplines are powerful because they allow us to see through a process of developing knowledge, methods, purpose, and representations (Gardner, 2006).

Technology Knowledge

Technology Knowledge or TK encompasses teachers' knowledge about different technologies. TK refers to the ability to use technology to manipulate programs and hardware to produce desired results. This includes traditional technologies, like chalk and blackboards, books, and projectors, and digital technologies such as interactive whiteboards, digital video, and the Internet. TK incorporates skills required to operate particular ICTs often referred to as digital literacy e.g., (Angeli & Valanides, 2009; Archambault & Crippen, 2009; Archambault & Barnett, 2010; Cox & Graham, 2009). Mishra and Koehler (2006) summarise TK as:

> the knowledge of operating systems and computer hardware, as well as the ability to use standard software tools including web-browsers, email programs, and word-processors. It includes basic knowledge about installing and upgrading hardware and software, maintaining data archives, and staying up to date about ever-changing technologies. (p. 1027)

In addition to the skills outlined above, Mishra and Koehler (2006b) argue that teachers require "a deeper, more essential understanding and mastery of information technology for information processing, communication, and problem solving than does the traditional definition of computer literacy" (p. 1027). In contrast to a superficial level of technological literacy, teachers with a deeper understanding of TK are able to effectively apply technology to their work and personal lives through the recognition of when technology could assist or hinder the achievement of a goal (Mishra & Koehler, 2006). TK of "wicked problems" (Borko et al., 2009) confronting teachers' integration of technology is not static and evolves all the time.

Intersecting Knowledge

Areas of overlap or intersection in TPACK are of equal importance as the interactions between and among these components, play out differently across diverse contexts, accounting for wide variations in educational technology integration (Graham, 2011, p. 3). Through a thorough examination of these intersections and components, may enable us to better understand teachers' integration of technology.

Pedagogical Content Knowledge

Pedagogical Content Knowledge or PCK is based on the work undertaken by Shulman (1986) and refers to the idea that pedagogy and content are interwoven. Shulman (1986) defines PCK as "subject matter knowledge for teaching" (p. 607). This domain refers to the ability to combine teaching methods (PK) and curricular understanding (CK) with knowledge about learners and learning and with an understanding of educational goals and assessment to communicate information effectively and efficiently to students (Morine-Dershimer & Kent, 2006; Nashon & Anderson, 2013). For example, social science teachers use primary source documents to obtain first-hand accounts of events and to make historical eras come alive. When examining the relationship between pedagogy and content, Mishra and Koehler (2006) consider the question of "how disciplines differ from each other and whether disciplines can or should be taught through the same instructional strategies." (p. 6). The supposition is that if disciplines are the same or similar, then instructional strategies from one discipline could be used effectively in another. The alternative to this suggestion was explored by Donald (2002) who following her survey of the ways different disciplinary perspectives led to different ways of thinking, offered

six fundamental and general thinking processes of students and experts in different disciplines. Donald's (2002) six processes describe the changes taking place as individuals learn and think in specific disciplinary contexts:

1. *Description* of context, conditions, facts, functions, assumptions and goals.
2. *Selection* of relevant information and critical elements.
3. *Representation*: organizing, illustrating and modifying elements and relations.
4. *Inference*: drawing conclusions, forming propositions.
5. *Synthesis*: composing wholes from parts, filling gaps, developing a course of action.
6. *Verification*: confirming accuracy and results, judging validity, using feedback.

While these six processes are generic as they apply to all disciplines, Donald's (2002) work indicates that different disciplines emphasise certain processes and under-emphasise others. In addition, she argues that different emphases have significant implications for instruction, and then offers a strong critique of content-neutral, simplistic, one-*size-fits-all* educational strategies that would apply equally to all disciplines.

Following Donald's (2002) view that instructional improvement develops from tasks, knowledge, and the ways of thinking characteristic to each discipline or field, Mishra and Koehler (2006) develop their own understanding of PCK that occurs at the intersection of PK and CK and is "one in which teachers interpret subject matter, find multiple ways to represent it, and adapt instructional materials to alternative conceptions and students' prior knowledge" (p. 7). This construction of PCK is consistent with Shulman's (1986) approach as knowledge of pedagogy that is applicable to teaching specific content

Technological Content Knowledge

Technological Content Knowledge or TCK refers to understanding which technologies are appropriate to use in various disciplines, whether in the classroom or on the job. Inherent is the understanding that technology may require a compromise of content or may enhance representation of content (Harris et al., 2008; Koehler & Mishra, 2005; Mishra & Koehler, 2006b). For example, designers Computer-Aided Design (CAD) programs to help them complete projects, and medical doctors use heart monitors to track the progress of patients (Petrina, 2003). The ITEA's (2000) *Standards for Technological Literacy* and ISTE's (2016) *Standards for Teachers* are good examples of TCK. Inherent here, too, is the understanding that technology may require a compromise of content or may enhance representation of content, a notion Graham (2011) describes as the two either "influencing or constraining one another" (p. 7). This is a complex and symbiotic relationship between technology and content.

In addition, Mishra and Koehler (2006) argue that understanding the impact of technology on the practices and knowledge of a given discipline is critical for teachers to develop appropriate technologies for educational purposes. The choice of technologies affords and constrains the types of content ideas that can be taught while also constraining the types of representations possible. Conversely, technology affords the construction of newer and more varied representations whilst also providing a greater degree of flexibility in navigating across these representations. In light of this complex dualism, teachers need to master more than the subject matter they teach; they must also have a deep understanding of the manner in which the subject matter can be enhanced by the application of technology. Teachers need to understand which specific technologies are best suited for addressing subject matter learning in their

domains and how the content dictates or perhaps even changes the technology or *vice versa* (Graham, 2011, p. 7).

Technological Pedagogical Knowledge

Technological Pedagogical Knowledge or TPK refers to a general understanding of the application of technology in education without reference to a specific content. TPK also includes the ability to creatively use available technologies in a pedagogical context (Harris & Hofer, 2011). This domain is apparent in generic papers on effective technology integration and may include such applications as how to use digital cameras in the classroom or principles of effective online education. Teachers' development of TPK would include an understanding of the pedagogical affordances and constraints of a range of technologies as they relate to disciplinary and developmentally appropriate pedagogical designs and strategies. This would, in turn, require the development of a deeper understanding of the constraints and affordances of technologies and the disciplinary contexts within which they function (Cox, 2008).

Technological Pedagogical Content Knowledge

Technological Pedagogical Content Knowledge or TPACK refers to the complex interrelationship between a teacher's technology use, instructional methods, and understanding of the subject matter (Mishra & Koehler, 2006). Teachers who possess TPACK think about and use technology as a part and enhancement of their pedagogical methods when teaching content. Thus, proponents are asking teachers to be aware of ways technology can support high quality teaching in curriculum areas (Loveless & Ellis, 2001). TPACK, therefore, is knowledge and

application of technology to support classroom instruction (Koehler & Mishra, 2009). Various researchers argue that TPACK is the ability to "develop meaningful learning experiences for students that integrate technology use effectively" (AACTE, 2008) or "good teaching with technology" and, or "effective teaching with technology" (Mishra & Koehler, 2006).

Inherent in the TPACK acronym is the idea that this construct is composed of three distinct knowledge domains, technology, pedagogy, and content. The complexity of this relationship has been described in the literature with terms such as *dynamic*, *transactional*, *mutually reinforcing*, *synergistic,* and *interdependent* (Archambault & Barnett, 2010). The give-and-take relationship in TPACK as described by McCormick, and Thomann (2007) is about "the combination of choosing the appropriate pedagogy for teaching content and the appropriate technology for the content" (p. 116) The interdependency within TPACK influences a teacher's choice of methods and technologies to realize pedagogical goals within a given subject area. The technology comes with certain limitations, requirements, or features that may affect which content is covered or how it will be taught (Archambault & Barnett, 2010; Mishra & Koehler, 2006b).

Utilizing TPACK can change the way teachers teach their subjects (Voogt & Knezek, 2008; Voogt & Pelgrum, 2005). Additionally, TPACK has been found to improve teachers' cultural sensitivity (John & Sutherland, 2004; Leendertz, Blignaut, Nieuwoudt, Els, & Ellis, 2013). Foster and Mishra (2011) argue that TPACK would improve the quality of educational activities. However, understanding how to balance all three domains in a way most effective for learners is a difficult skill (Kit & Chee, 2010; Niess, 2011; Walk et al., 2013). TPACK is particularly difficult to master, first because of the complex relationships and second because of the continually changing nature of technology, making every integration problem a unique one

(Koehler, Mishra, & Yahya, 2007). Hence, simply teaching technology skills is not enough (Koehler & Mishra, 2007).

Teacher educators are beginning to stress the need for TPACK development in pre-service programs (Niess, 2011), an indication that TPACK impacts pre-service teacher education. Mishra and Koehler argue that TPACK is best developed in a context of learning technology by design (Jordan & Dinh, 2012; Koehler & Mishra, 2005; Mishra & Koehler, 2006b). This instructional approach is based on the idea that the design of educational technology is an authentic learning context for teachers (Mishra & Koehler, 2006). Design in this context requires participants to weave technology, content, and pedagogy together to create an open-ended final project (Koehler & Mishra, 2005).

Researchers have made various attempts at measuring the development of TPACK in learning technology by design course experiences (Doering, Koseoglug, Scharberg, Henricksong, & Lanegrang, 2014; Kit & Chee, 2010; Leendertz et al., 2013; Stoilescu, 2011). Predominant in the methods of these studies is the use of document analysis, using projects, progress reports, recorded interviews, papers, observation field notes, etc., to monitor students' progress (Koehler, Mishra, 2006; Koehler, Mishra, & Yahya, 2007). Other researchers also venture into using a survey instrument to track TPACK development. For instance, the survey by Cox and Graham (2009) attempted to measure pre-service teachers' self-efficacy in performing TPACK-related tasks. The survey findings showed that pre-service teachers explored more with technology in their practicum classes than when they graduated and begun their practice in schools.

TPACK has been adopted in studies examining effective teaching with technology as it proposes a structured way to approach the complexity of ICT and learning (Koehler, 2009; Webb

& Cox, 2004). As such, the impact of TPACK has been profound, with the model used in hundreds of studies examining teachers' professional knowledge (Graham, 2011), with the majority of these studies using surveys to measure the extent of teachers' TPACK (Jordan & Dinh, 2012). With such a proliferation of TPACK-based research, it is not surprising there is marked variation in the contexts in which investigations have examined TPACK, including international investigations of TPACK development of pre-service teachers (Jamieson-Proctor, Finger, & Albion, 2010), online educators (Archambault & Crippen, 2009) and primary teachers (Chai, Koh, & Tsai, 2013). While these investigations made valuable contributions to our understanding of the interplay between forms of professional knowledge in a variety of settings, in-service teachers' use of TPACK remains under-explored. Of the hundreds of studies using TPACK as a theoretical frame (Graham, 2011), Jordan and Dinh's (2012) review of TPACK conference and journal papers published between 2006 and 2016 found only 28 papers examining in-service teachers' TPACK, with none from Uganda.

Uganda's ICT Initiatives

Surveys conducted by ICT experts from Kyambogo University under the Millennium Science initiative project (2007-2013) in Uganda found that a majority of teachers in Eastern Uganda lack basic ICT skills needed in a modern teaching environment. Findings show that only 10 out of the 140 teachers tested at Mbale Senior secondary school could start and use a computer. Several teachers who participated in the pilot study preferred writing assignments by hand to using the computer. This result has been blamed on lack of reliable computers and laboratories, electricity, telecommunication facilities, and Internet access. Researchers are

equally worried that the lack of ICT literacy among teachers could stall efforts intended to promote E-learning through ICTs.

Over the past two decades, various large-scale initiatives were introduced to develop Uganda's ICT industry along with ICT literacies of students and teachers. Uganda's Ministry of ICT developed a five-year Plan (ICT SIP) (2015/16-2019/20) aligned with the Uganda Vision 2040 and National Development Plan (NDP) (2015/16-2019/20). The ICT SIP's mission is "to provide leadership and enabling environment for promotion of ICT as an industry, and enabler for transforming Uganda into a knowledge-based society" (p.44).

Technology-enhanced learning is a priority theme

In technology-enhanced learning projects, teachers are seen as both content producers and teachers. Universities such as Kyambogo received funds to build on previous successes. For instance, under the Millennium Science initiative program (2007-2013), Kyambogo University implemented one of the projects managed and administered by the Uganda National Council for Science and Technology (World Bank, 2016). Kyambogo embarked on upgrading the learning of mathematics and science by incorporating ICTs through open distance and an E-learning program. Obwoya, the principal investigator, stated the project was intended to demystify the teaching of mathematics and sciences through ICTs. The project including upgrading the training of teachers by incorporating ICTs through open distance and E-learning in Uganda was co-funded by the Government of Uganda and the World bank (2016).

Lubega, Deputy Dean of Graduate Studies and Research at Kyambogo University, says the introduction of ICTs is essential in training a critical mass of mathematics and science teachers in Uganda. This, he says, also improves the quality of the teaching of undergraduates in

mathematics and science teachers. The program targeted both private and government secondary schools to demonstrate competences in the use of ICTs as a teaching resource. ICT competence requires a set of skills: knowledge of digital hardware, and software, pedagogical skills, and content knowledge skills (Mishra and Koehler, 2006).

The government of Uganda sought to embrace ICT with the hope that it would enable the country to improve and sustain development and poverty reduction (Uganda Ministry of Works, 2003). In pursuit of these aims, national ICT policy advocates for the integration of ICT in mainstream education. Accordingly, in the early 2000s, the Ministry of Education and Sports (MoES) developed a policy for ICT in education to help guide the integration of ICT into education. Uganda's policy for ICT in education recognizes the crucial role of teachers in implementing any education reform initiative and as such points out that, in ensuring that the best use is made of ICT, the key focus must be on teachers and the curriculum that they are to follow (Uganda MoES, 2005). Consequently, the policy states that computer awareness should be introduced into teacher training colleges progressively, starting from primary teacher colleges till university in teacher training programs. However, although such a promising policy is in place, implementation has been the major hurdle.

Makinde (2005) argues that national policies and programs are very important to the realization of ICTs in education. He identified a number of key operational components essential for ICT integration including teacher-training programs. Successful ICT integration in education undoubtedly depends on teachers' ability to use them. Clearly, Uganda's policy for ICT in education takes into account the importance of teachers in the implementation of ICT in education. Considering the status of ICT in African countries, the United Nations Economic Commission for Africa (UNECA, 2006), situated the development of ICT in Education policies

of Sub-Saharan African countries on a continuum of steps, i.e., no policy yet, emerging policy, applying policy, infusing policy and transforming policy (Tilya, 2003; Voogt, Tilya, & Van den Akker, 2009). According to Luwangula (2013), Uganda is at the stage of applying policy. This argument, however, begs the question of how the policy is being implemented in order to prepare teachers to use ICTs. Makinde (2005) observes that policy implementation is the major challenge confronting developing countries. Often, good policies are articulated but the lack of stakeholders' commitment and political will as well as resource constraints hinder implementation.

Tooling and Retooling of Teachers in ICT

In 2003, the Uganda Communications Commission (UCC) and Ministry of Education, partially through the Rural Communications Development Fund (RCDF, 2014) introduced an initiative to prepare teachers in ICT. Hundreds of in-service and pre-service teachers attended "ICT teacher retooling" workshops (RCDF, 2014) as shown in Figure 4. Reports show direct impacts of attending these workshops included teachers teaching ICT as a subject in at least 50% of government secondary schools as well as the establishment of over 1,027 ICT laboratories in government secondary schools around the country (UCC report, 2019). The Mbale sub-region in Eastern Uganda had a five days tooling and retooling workshop in 2018 focusing on teachers who had pedagogical skills but lacked the necessary ICT competencies, and teachers with pedagogy skills but lacked technological skills to effectively teach.

This initiative continues today, as indicated in a headline story in the *PML Daily* on August 21, 2019: "UCC launches countrywide capacity building drive to retool ICT teachers".

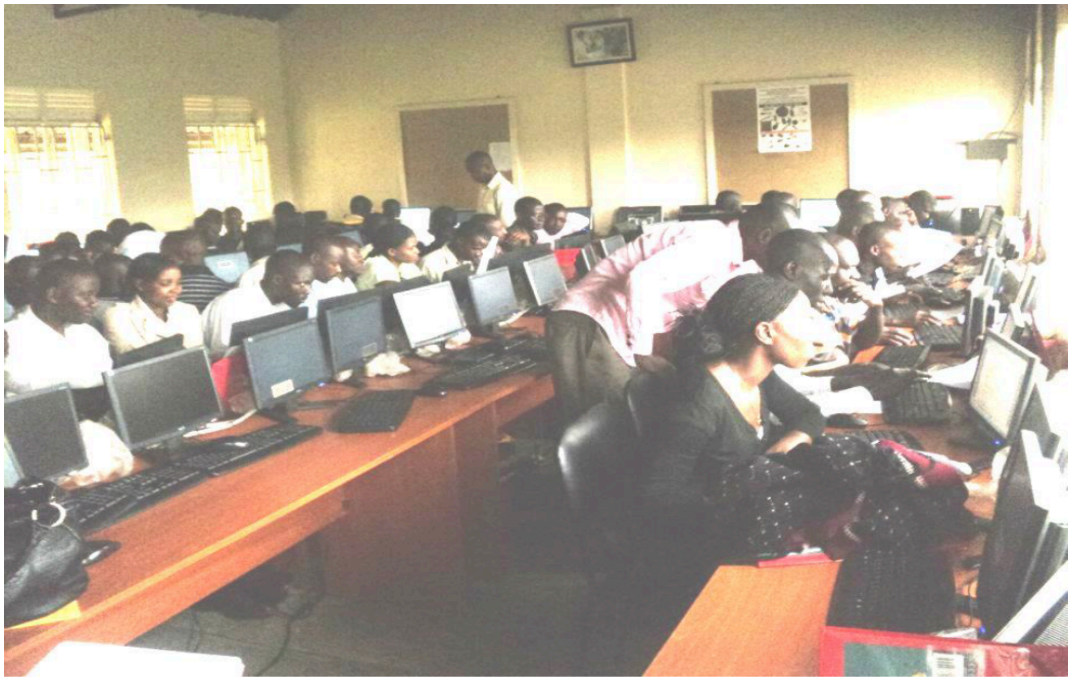

Figure 4: ICT teacher retooling workshop
Photo from RCDF (2014, p. 31). Public domain.

The metaphor of "retooling" is recognized by Kennedy (2005) as a model of Continuing Professional Development (CPD) for teachers, where skill levels are "topped up" to augment existing practices. In educational jargon, retooling is called staff development or pro-D. The term gained attention within the education realm with a focus on creating "change" or "revising" education practices. In addition to the *PML Daily*, a search of the word disclosed articles such as:

1. "Retooling teachers" (Lourdes Monteagudo, *Chicago Tribune*, March 9, 1994)
2. "Retooling education" (Montgomery, *Communication news*, July 1997)
3. "Retooling for the new marketplace" (EdNET, September 28, 2010)
4. "Retooling the future of education" (EdTech workshop, May 18, 2017)
5. "Re-educating and retooling educators" (Valderama, November 7, 2017, *Manila Times*)
6. "Drive to Retool ICT Teachers" (Ssebwami, August 21, 2019, *PML Daily*)

In all the above articles, central points of discussions are around retraining educators to acquaint them with new technologies, teaching approaches, and new solutions to meet the challenges of a new era. However, there are debates around retooling as professional development of teachers. The funding and time may not be sufficient in preparing teachers to produce the workforce for the new century. Monteagudo (March 9, 1994) argues that a three-hour workshop does not result in any changes when teachers return to their schools and continue their previous practices, a situation in which teachers in Uganda find themselves. Any retooling efforts must produce actual change which involves a new and different way of teaching.

Fisher et al. (2006) compare retooling to an industrial production line where attempts to maintain a continuity of good practices outside the context in which they were developed in order to refresh the educational process. Triggs and John (2004) and Watson (2001) advocate for approaches that generate professional engagement in authentic, relevant, and changing situations; a structure that Fisher, Tony and Higgins (2006) describe as a "renaissance". This is not to suggest that retooling initiatives are misdirected. Rather, this review of the literature and theoretical framework suggest a range of initiatives are needed, from one-day workshops to long-term teacher support.

Framework Summary

Teachers are the main gatekeepers as they are the ones who allow innovations into the classrooms. Therefore, key factors for effecting an integration of ICTs in teaching lie with the teachers. This requires teachers to be trained adequately to handle and manage resources in their daily practices. Technology use is determined by factors such as a teacher's personal experience with technology and their perceptions concerning the usefulness of different technologies for a

given lesson (Kafyulilo, Fisser, & Voogt, 2016; Kafyulilo & Keengwe, 2014; Mumtaz, 2000). Teachers tend to ask questions such as, Will the students achieve the desired learning outcomes?, Will the new technology enhance my pedagogical objective?, and Will it be innovative? A teacher's perceptions will determine whether they will use technology. Hence, the way a teacher perceives how technology can impact their instructional activities and learning as a whole is critical to this study.

Zhao and Cziko (2001) identify three conditions necessary for teachers to use technology effectively. These include: teachers must have the confidence that the use of the technology will meet the existing and higher-level learning goals; they must have the expertise and sufficient ability to use the technology effectively; and using the technology will not disturb the perceived equilibrium of the classroom and will not compromise learning goals. Teachers normally are concerned about having control over the learning outcomes and also being in control of the direction of the lesson. Various researchers categorize technology competence ranging from simple to advanced (Algozzine, Bateman, Flowers, Gretes, & Hughes, 1999) to more nuanced groups with several levels of proficiency to represent the technology using skills of participants (Angeli, 2005; Hanson-Baldauf & Hassell, 2009). A teacher with simple to moderate competency levels would have the ability to use ICTs (like cell phones) and the Internet in their personal use but with limited to no use within the classroom. Whereas, a teacher with high competency technology level would show extensive use of ICTs for both personal and classroom use (Algozzine, Bateman, Flowers, Gretes, Hughes, & Lambert, 2011; Algozzine et al., 1999; Guzman & Nussbaum, 2009).

Mishra and Koehler (2006), through TPACK, suggest ways teachers cope with the uncertainties about how to use technology in their pedagogical activities, including the need to

be well prepared in building good pedagogical practices, technical skills and content knowledge, as well as how these concepts relate to one another. It can be agreed that teachers' lack of ICT skills and knowledge affects their competency in integrating technology in their teaching and learning activities. As Newhouse (2011) stresses, many teachers without skills and knowledge are not enthusiastic about integrating ICT in their teaching activities. Teachers with no experience with ICTs do not want to work with them because they do not want to appear defeated in front of their students. Such teachers avoid completely integrating ICTs into their teaching and learning activities (Aldunate & Nussbaum, 2013).

Chapter Summary

Despite the ability to advance 21st century learning skills and contribute to workforce preparation, technology integration in schools remains oversold and underused particularly for teachers in Sub-Saharan Africa, including Uganda. A review of the hinderances to competent technology use among teachers takes into account both the teachers' beliefs and manifestations of these practices. PCT and TPACK provide a framework to understand how teachers' beliefs and attitudes about technology influence their use. Teachers' levels of competence, their beliefs, and attitudes play an important role in determining how, how much, and what kinds of technologies are integrated into classroom teaching.

The review of literature in this chapter points to inadequate instructional resources and a high student-teacher ratio in Uganda's schools. To overcome this challenge, the government and the education stakeholders have begun to commit resources in the hope that ICTs will help overcome these challenges. However, evidence from other countries world-wide, reveals such initiatives do not necessarily lead to adoption by teachers because the availability of ICTs alone

does not guarantee teachers will adopt them to support students' learning. Rather, technology adoption is a complex process influenced by many factors, including those at the teacher-level, school-level, and system-level (Blamire, Roger, Balanskat Anja, 2003; Wastiau et al., 2013).

In this case, researchers indicate that to understand technology adoption in an educational system, the extent to which these factors are related to teachers' decisions to adopt or not to adopt technology must be investigated. The review of the literature suggests a lack of extensive studies in Uganda examining how technological, individual, organizational, and institutional factors relate to teachers' decisions to adopt or to not adopt technology. Addressing the research questions for this dissertation research will contribute to the body of research in education about what may inhibit or enable teachers to apply technology in classrooms and provide Uganda teachers and other stakeholders with a suitable model to support technology adoption. Researchers from other developing countries who have investigated technology adoption in schools have primarily used quantitative research designs without taking into account the voices of the participants through qualitative data. Chapter 3 discusses the research methodology for the study.

Chapter 3: Methodology and Research Design

The purpose of this study was to investigate the status and use of ICTs among secondary school teachers in Uganda with a focus on competencies, dispositions, perceptions, and challenges. This chapter provides an overview of the research design, restatement of the research questions, philosophical premises of mixed methods, setting, participants, and sample selection, data collection procedures, data analysis procedures, reliability, validity and credibility issues, and ethical considerations.

My study uses a sequential mixed methods research design to collect quantitative and qualitative data to understand the problem. The first phase, the major component, collected quantitative data from teachers through a survey instrument with the goal of identifying the factors related to technology adoption among teachers. The second phase, which was the minor component, collected qualitative data using classroom observations and semi-structured interviews from nine teachers to build on and explain the statistically significant factors drawn from phase one. Procedures included exploratory factor analysis for quantitative data and open coding and thematic analysis for qualitative data. The theoretical framework explained in Chapter 2 informs how the following explanatory variables influenced teachers' decisions to adopt or not adopt technology: age of a teacher; school type; Internet at home and school; educational technology in general; in-service training; and discussions about technology.

Mixed Methods Research Design

The rationale for using a sequential mixed methods research design was based on the understanding that quantitative data and subsequent statistical analysis provide a general

understanding of the research problem (Creswell & Plano-Clark, 2018). Qualitative data and thematic analysis refine and explain the statistical results by exploring participants' views in more depth (Wooddell & Kaplan, 1997). Despite the flourishing of mixed methods research since the 1970s and the 1980s, the debate for and against combining qualitative and quantitative research methods in a single study continues to elicit controversies among the proponents of quantitative and qualitative research paradigms (Johnson & Christensen, 2000; Johnson & Onwuegbuzie, 2009; Osborne & DeCuir–Gunby, 2011; Sale, Lohfeld, & Brazil, 2002). According to (Creswell & Plano-Clark, 2010), these controversies range from "defining and describing mixed methods, to philosophical debates, and on into the procedures for conducting a study" (p. 269). As a consequence, the following sections will highlight (1) the philosophical debates surrounding quantitative, qualitative, and mixed methods research designs, and (2) the procedural issues surrounding a sequential explanatory mixed methods research design.

With the goal of understanding teachers' acceptance and perceptions of technology use among secondary school teachers in Uganda, exploratory factor analysis (EFA) was used to discern the underlying structure of observed variables (Fabrigar, MacCallum, Wegener, & Strahan, 1999; Hooper, 2012). EFA is a powerful way to summarise and interpret underlying relationships and patterns in the data. Given that I did not have prior expectations about which measured variables would be influenced by the same common factors, EFA was appropriate to reveal underlying dimensions (Fabrigar et al., 1999).

Research Questions

To restate, two questions guided this research:

1. What do teachers in Uganda perceive to be the necessary ICT competencies and dispositions in order to implement the high school curriculum?
2. What do teachers perceive as challenges to implementing ICT in curriculum and instruction?

Philosophical Premises of Mixed Methods

With regard to philosophical debates, each paradigm takes on unique assumptions about the ontology, epistemology, and axiology of a given methodology. Positivism and post-positivism worldviews are often associated with quantitative research approaches; the constructivism worldview is associated with qualitative research approaches; and pragmatic worldview is associated with mixed methods research. On one hand, post-positivism knowledge claims are based on cause-effect thinking, identifying variables to interrelate, observing and measuring variables, and testing theories (Creswell & Clark, 2010). On the other hand, constructivism knowledge claims are based on participant views shaped by social interactions and participants' personal histories. From this standpoint, Creswell and Plano-Clark (2018) claim that philosophically oriented authors question the possibility of mixing post-positivist and constructivist worldviews where researchers adhere to rigid paradigm boundaries.

Controversies involving mixing quantitative and qualitative research approaches were highlighted by Howe (2012), who described the peripheral role played by qualitative research in mixed methods designs. According to Howe, mixed methods designs favour quantitative

research by elevating quantitative-experimental research in the "methodological hierarchy" (p. 53). Similar views were highlighted by Norman and Denzin (2006) who argued mixed methods research removed qualitative research from its "natural home" (p. 9). They argued that in the natural home, participants become active participants in qualitative research, where their voices can be heard. In trying to argue for mixed methods approach, Creswell and Plano-Clark (2010) affirm there are many uses of qualitative data, and there are no instances when qualitative research has been undermined.

Thus, this study was based on the assumption that it is productive to mix qualitative and quantitative research methods, while at the same time acknowledging different paradigm perspectives. Creswell (2018) emphasises that the main reason for combining both quantitative and qualitative methods is to provide a better understanding of a research problem. He denotes that "pragmatism opens the door to multiple methods, different world views, and different assumptions as well as different forms of data collection and analysis in the mixed methods study" (p. 12).

Understanding how quantitative and qualitative research methods work is important in mixed methods research design. Researchers using mixed methods require an elaborate knowledge of a fundamental principle (Johnson & Turner, 2003). This principle acknowledges that all research methods are subject to weaknesses and strengths. In this regard, Johnson and Turner argued that when this principle is used in data collection, it means that "data collection methods should be combined so that they have different weaknesses and that the combination used by the researcher may provide convergent and divergent evidence about the phenomenon being studied" (p. 299). Thus, the eventual goal of mixed methods research is to draw on the strengths while minimizing the weaknesses of both the quantitative and qualitative research

methods within a single study (Johnson & Onwuegbuzie, 2009). Despite this, mixed methods research comes with the challenges of determining the procedures of the quantitative and qualitative data collection and analysis (Ivankova, Creswell, & Stick, 2006).

Procedural Issues in the Sequential explanatory design

A sequential explanatory mixed methods design responds to the purpose and problem of this study. A two-phased mixed methods research design was used where qualitative data helped explain or build on quantitative results (Creswell & Plano-Clark, 2010). The sequential explanatory design was chosen based on the fact the study variables were largely known in the literature and statistical techniques were needed to identify these variables in the Ugandan context. Then qualitative data were required to illuminate the statistical results from the quantitative phase. However, I had to deal with procedural issues of priority, implementation, and integration of the quantitative and qualitative research approaches (Creswell, 2003; Ivankova et al., 2006).

Priority: In designing a mixed methods research study, one must consider priority of a particular method. Priority refers to the decision of giving more attention to either quantitative data or qualitative data or both during the data collection and analysis process (Creswell, 2003; Morgan, 2007). For instance, in sequential explanatory designs, priority is given to the quantitative approach because quantitative data collection comes first representing a major aspect of the study, while a smaller qualitative component follows in the second phase of the study (Ivankova et al., 2006). However, priority of what phase comes first might change either before data collection, during data collection, or during data analysis depending on the goals of

the study and the research questions to be addressed (Morgan, 2007; Morse, 2003). This implies that in a sequential explanatory design, the qualitative phase may turn out to be the main component of the study, as opposed to the quantitative phase. In this study, I gave priority to the quantitative method. Examination of data from the survey instrument revealed that the data qualified for factor analysis were core to the research questions.

The qualitative phase of the study involved exploring and explaining statistical results obtained from EFA. I analysed data from nine teachers collected through interviews and classroom observations to enhance a deeper understanding of each of the emerging factors. I converted the semi-structured interviews and classroom observation notes into a word document to ease analysis. I then analysed the transcribed data using open coding procedures in order to identify themes and categories across all the nine teachers that could give insight to the quantitative results.

Implementation refers to whether the qualitative or quantitative data come first, second, or concurrently in the data collection (Creswell, 2003). In the sequential explanatory design, a researcher first collects quantitative data, and the qualitative data is collected in the second phase of the study with the intention of explaining the results from the quantitative phase. I collected the quantitative data using a self-administered survey questionnaire. The goal was to identify potential factors that could best predict and explain teachers' competencies, dispositions, and perceptions of technology and its use among secondary school teachers in Uganda. In the second phase, I collected and analysed qualitative data to help interpret the outcome of the EFA that had been performed on the data set from the survey instrument.

Integration refers to when data are linked during the design phase of the study, the data collection and analysis phase, or during interpretation of the findings (Johnson & Turner, 2003). In the sequential explanatory design, a researcher connects the quantitative and qualitative phases when designing research questions for the qualitative phase, while selecting participants based on the statistical results, when developing interview protocols, and when interpreting the findings (Creswell, 2003)**.**

In my study, I connected both the quantitative and qualitative phases at three stages. The first connection occurred during the design phase of the study when creating research questions. The qualitative phase was based on the anticipated results of the quantitative phase. The second connection occurred during data collection when I selected participants for the qualitative phase from the ones who had completed the survey instrument. The third connection was when developing an interview protocol for collecting qualitative data based on the preliminary findings of the exploratory factor analysis.

Site, Participants, and Sample Selection

Research Site

In research, setting or site selection, time, events and sampling of participants are essential particularly if the researcher seeks an in-depth understanding of the problem under investigation (Creswell & Plano-Clark, 2010; Merriam, 1988; Morse, 2003; Spector et al., 2014). The choice of site therefore should reflect the purpose of the research. The research site for my study was selected because of convenience to reduce costs and increase efficiency in data collection. The site was Mbale, Uganda, a city with a wide distribution of secondary schools, which provided sufficient numbers for the large sample size required for my study. Also, most

urban schools in Uganda have a better financial standing when compared to rural schools, which also determines the availability of ICTs.

The selected schools include both government and private schools located within a radius of three kilometres from the central business district of Mbale town. These schools were as follows: Lwoba High School; Doho High School; Kasanvu High School; Majanga High School; Masaba High School; Wagagai High School**;** Sono Comprehensive High School; Namba High School; and Mooni High School. The research sites were then categorised depending on the technology infrastructure available, namely equipped with either high, moderate, or low technology. Schools with high technology infrastructure had computer laboratories with functional computers, laptops, interactive white boards, digital calculators, smartboards, Internet. The moderately equipped schools had a computer lab with approximately 20-50 functional computers, five to 10 laptops, one to two smartboards, Internet, and the low technology equipped schools had a room that served as a computer lab with 10-15 functional computers, a modem for internet connectivity, one to two school laptops. In Uganda, it is common for high school classroom technologies to be limited to books, notebooks, and desks as shown in Figure 5. Schools equipped with computers often have a lab in which students take IT courses as shown in Figure 6.

Figure 5: St. Jude High School (not included in this study). Public domain (Classrooms for Africa) http://www.classroomsforafrica.org/news

Figure 6: Well-equipped schools had larger computer labs and Internet connectivity. Photos taken by the researcher.

Sample Selection for the Quantitative Phase

The selection of participants and the sample size for the study depended largely on the goals and choice of analysis procedures. I used a simple random sampling procedure (Creswell, 2010) to select secondary school teachers. The sample size for the quantitative phase

needed to be addressed beforehand because factor analysis requires a large number of participants. Thus, to select a suitable sample size for the study, I employed the following considerations: (1) a favourable sampling error; and (2) a statistical data analysis technique. Fowler (2009) developed criteria for choosing sampling errors and confidence levels in survey research. Using these criteria, I chose a sampling error of 4% and a confidence level of 95% for this study in order to yield a sample size of at least 100 participants. However, factor analysis requires that for an interpretable factor to emerge, at least five to 10 participants should respond to a single variable. In light of this, Gudgeon, Comrey, and Lee (2006) and Nunnally (1978) recommend a sample size of at least 300 participants. However, Guadagnoli and Velicer (1988) proposed that if the data set has several high loading scores, then smaller sample sizes are acceptable. I therefore administered a 50-item survey questionnaire to two hundred and fifty (250) secondary school teachers, which was sufficient for factor analysis.

Sample Selection for the Qualitative Phase

Maximum Variation Sampling Strategy

This is a purposeful sampling strategy that aims at heterogeneity. According to Creswell (2010), the maximum variation sampling strategy is a purposeful sampling procedure for selecting participants in which "the researcher samples cases or individuals that differ on some characteristics or trait" (p. 206). The researcher seeks to understand how a phenomenon is seen and understood among different people, in different settings, and at different times. Participants can differ in age, gender, education level, or location. In my study, I used maximum variation sampling based on these criteria: (1) teacher's TPACK; (2) willingness to participate in the

study; (3) schools with technology resources and infrastructure; and (4) demographic characteristics such as gender.

Teacher's TPACK: A teacher's TPACK was dependent on technology knowledge and use from the survey instrument. Based on these criteria, I recruited nine teachers teaching varied subjects but having knowledge of using ICT in their instruction.

Willingness to participate in the study: In compliance with ethical considerations and respect for participants, I ensured all participants provided informed consent to be interviewed. Therefore, participants who did not wish to be interviewed were not included in the study. When I contacted some teachers during the initial stages, they were keen to participate in the study. However, later when I attempted to contact them, their phones were either off or they did not answer my calls. Similarly, some teachers consented to meet me for an interview, but they did not.

Schools that had substantial technology resources*:* I ensured study participants taught in schools with technology resources and infrastructure. Having access to technology enabled me to assess the teachers' disposition towards using technology or not and the rationale behind their decisions.

Demographic characteristics*:* To gather multiple perspectives on teachers' perceptions of technology, I included different categories of teachers based on gender, age, and type of the school (government or private). In the initial stage of participant selection, only the male teachers were willing to take part in the study, and even the female teachers introduced to me suggested

their male counterparts. However, to avoid researcher partiality, the maximum variation sampling strategy was useful in selecting teachers based on gender and school (government or private) as shown in Table 1.

Table 1: Data Sources and Participants

	Name of Teacher	*Name of High School*	*Years of Teaching Experience*
1	Komakech	Lwoba High School	31
2	Watera	Sono High school	18
3	Masinde	Doho High School	11
4	Akite	Kasanvu High School	15
5	Nabatanzi	Kasanvu High School	02
6	Ochom	Majanga High School	20
7	Mugidde	Namba High School	28
8	Farida-Dida	Wagagai High School	14
9	Mafabi	Mooni High School	07

Data Collection

This section describes quantitative and qualitative data collection procedures for the study. I describe these procedures in each phase.

Quantitative Phase

The study's data collection involved distributing copies of the cover letter introducing the study, the informed consent form (Appendix A, B and C) and paper-based survey instruments to teachers in secondary schools in Mbale municipality (Appendix D). To achieve a response rate of 70% and above, the survey instrument was administered to secondary school teachers over a two-months period. I collected the questionnaires after completion with the help of contact teachers from the different schools.

Survey Questionnaire

The questionnaire for this study was adapted from a previously developed instrument by the centre for the study of learning and performance (CSLP) at Concordia University in Montreal, Quebec, Canada. Overall, the instrument includes items on teachers' competencies, dispositions, and perceptions on the use of ICTs in teaching and learning (Appendix D). The first set of 25 items seek to understand teachers' perceptions of computer technology use in the classroom. Items 26-32 address teachers' social demographic data; their preferred teaching style, and years of teaching experiences. Items 33-37 focus on teachers' dispositions to use ICTs. Items 38-47 explore teachers' technology use in the classroom. The last three open ended items seek teachers' opinions of the best use of ICTs in the classroom and what they consider ideal technologies for instruction. A six-point Likert scale was used for respondents to rate the extent they agree or disagree with items in the questionnaire. Items 1-25 are Likert ratings ranging from Strongly Disagree (1) to Strongly Agree (6), Demographic data is addressed in items 26-32. The balance of items have adjusted six-point Likert scales: Ratings ranging from Extremely Poor (1) to Excellent (6), from Not at all (1) to All the Time (6), from None (1) to 8 hours or more (6), from Unfamiliar (1) to Expert (6), TPACK ratings from Awareness (1) to Expert (6), and from Never (1) to Almost Always (6). Each response was scored on the range of 1to 6.

Qualitative Phase

As indicated, the study's qualitative data were drawn from nine teachers to provide a broader perspective of the statistical results from the quantitative phase. The qualitative data collection techniques involved semi-structured interviews and classroom observations of

teachers at nine secondary schools. Classroom observations provided the groundwork for interviews, with teachers who agreed to be interviewed being the ones whose lessons I observed.

Classroom observations: I observed at least two lessons for each of the nine participating teachers. The purpose of the classroom observations was to provide supplemental data in addition to generating interview questions and probes. I planned to use a classroom observation protocol guide for the observations. However, I did not find the guide useful for this study, and therefore I did not refer to the protocol. During the observations, I wrote field notes about the lesson launch, the teacher, the students, technologies (if there were any that were used), tasks, challenges students were facing, questions asked in class by the teacher and the students, and social dynamics that occurred in the classroom. I used these data to reconstruct classroom dynamics during data analysis. Spradely (2016) noted that the process of observation is funnel shaped in that the initial observations start with broad questions, describing the settings and participants, directing attention to the people, behaviours, and feelings, generating research questions, and then focusing on certain elements for theory building (Classroom observation data are reported in Chapter 4).

***Semi-structured interviews*:** Following the classroom observations, I conducted semi-structured interviews "probing areas that were too sensitive to explore in the early research" (Taylor, Bogdan, & DeVault, 2015). Some of my questions on the school or the government officials required confidentiality to protect the teacher. Such information required I interview the teacher rather than ask the teacher to reveal such information on the survey questionnaire. Thus, I audiotaped each participant for a period not exceeding 60 minutes using an interview protocol framed on the quantitative results. I also gathered data about participants' experiences and

perceptions regarding technologies and other artefacts, and the factors that influenced them to use ICTs in their teaching.

Data Analysis

The qualitative and quantitative data analysis procedures are briefly discussed in the following section. First, I discuss the quantitative data analysis and follow with a discussion of the qualitative data analysis.

Procedure for Quantitative Data Analysis

Data Cleaning

To eliminate possible errors in the dataset, a three-step approach was followed. From a total of 250 questionnaires, seven were discarded because of a large number of missing data or the participants did not complete the survey questionnaire in accordance to the guidelines I had put in place. The remaining 243 questionnaires were entered into the SPSS version 23 statistical program for analysis. Visual examination of the dataset was done to ensure that all entries were done correctly and in the right boxes. Lastly, I checked if the coding was done correctly and corresponded to the intended items.

The parametric nature of each item was also inspected. Based on the parametric properties of each item as seen in the Table 2 below, items 2, 8, 11, and 44 were removed from further statistical analyses because they had a skewness and Kurtosis value over the absolute value of 1 and so considered ‘not normally distributed’ for factor analysis (Field, 2013).

Table 2: Pre-factor analysis - descriptive statistics for all survey items (n=243)

	Item	N	Mean	Std. Deviation	Skewness	Kurtosis
Item 1	Increases academic achievement (e.g. grades).	243	4.59	1.570	-.994	-.077
Item 2	Results in students neglecting important traditional learning resources (e.g. Library books).	243	4.05	1.684	-.483	-1.027
Item 3	Is effective because I can implement it successfully.	243	3.98	1.575	-.408	-.922
Item 4	Promotes student collaboration.	243	4.47	1.552	-.877	-.224
Item 5	Promotes the development of communication skills (e.g. Writing and presentation skills).	243	4.37	1.565	-.820	-.391
Item 6	Is too costly in terms of resources, time and effort.	243	4.63	1.614	-1.023	-.117
Item 7	Is successful if teachers have access to a computer at home.	243	4.63	1.447	-1.090	.430
Item 8	Makes teachers feel more competent as educators.	243	5.35	1.323	-2.233	4.125
Item 9	Is successful if there is adequate teacher training in the use of technology for learning.	243	4.72	1.625	-1.070	-.179
Item 10	Gives teachers the opportunity to be learning facilitators instead of information providers.	243	3.42	1.697	.011	-1.187
Item 11	Is successful only if technical staff regularly maintains computers.	243	4.04	1.778	-.475	-1.118
Item 12	Is unnecessary because students will learn computer skills on their own, out of school.	243	5.07	1.234	-1.684	2.670
Item 13	Enhances my professional development.	243	4.56	.918	-1.037	2.150
Item 14	Eases the pressure on me as a teacher.	243	4.32	1.599	-.738	-.566

Table 2: Pre-factor analysis - descriptive statistics for all survey items (n=243) (cont'd)

	Item	N	Mean	Std Deviation	Skewness	Kurtosis
Item 15	Is effective if teachers participate in the selection of computer technologies to be integrated.	243	4.58	1.493	-1.006	.168
Item 16	Motivates students to get more involved in learning activities.	243	5.00	1.333	-1.520	1.758
Item 17	Will increase the amount of stress and anxiety of students' experience.	243	3.56	1.393	-.249	-.839
Item 18	Is effective only when extensive computer resources are available.	243	4.37	1.725	-.735	-.785
Item 19	Requires extra time to plan learning activities.	243	4.16	1.610	-.546	-.872
Item 20	Improves student learning of critical concepts and ideas.	243	4.85	1.406	-1.316	1.038
Item 21	How would you rate Student access to computer technology in your school?	243	3.05	.967	.307	.590
Item 22	How would you rate teachers access to computer resource personnel in your school?	243	3.02	1.223	-.045	-.919
Item 23	How often do you integrate computer technologies in your teaching?	243	2.19	1.140	1.115	1.142
Item 24	On average, how many hours per week do you spend using a computer for personal use outside of teaching activities?	243	3.20	1.425	.297	-.965
Item 25	How would you describe your proficiency level as a user in relation to computer technologies?	243	3.59	1.151	.108	-.280
Item 26	Use tutorials for self-training.	243	3.11	1.521	.080	-.826
Item 27	Have students use tutorials for remediation.	243	2.06	1.517	1.404	.750
Item 28	Use e-mail to communicate with other teachers.	243	2.87	1.586	.236	-1.162

Table 2: Pre-factor analysis - descriptive statistics for all survey items (n=243) (cont'd)

	Item	N	Mean	Std Deviation	Skewness	Kurtosis
Item 29	Use e-mail to communicate with students.	243	1.87	1.330	1.573	1.782
Item 30	Use e-mail to communicate with parents.	243	2.00	1.432	1.278	.560
Item 31	Use LCD projector (a projector connected to a computer) in class.	243	2.33	1.480	.769	-.534 .555
Item 32	Create PowerPoint presentations to use in class.	243	2.47	1.632	.734	-.712
Item 33	Keep track of student grades or marks.	243	4.07	1.652	-.657	-.747
Item 34	Prepare handouts, tests/quizzes, and homework assignments for students.	243	3.78	1.731	-.421	-1.114
Item 35	Create lesson plans.	243	3.70	1.655	-.262	-1.125
Item 36	Create charts or graphs.	243	3.17	1.709	.134	-1.234
Item 37	Analyse data.	243	3.40	1.657	-.104	-1.187
Item 38	Have students use 3-D modelling software or simulations (in class/school lab)	243	2.16	1.543	1.199	.258
Item 39	Use drawing or paint programs.	243	2.58	1.582	.621	-.695
Item 40	Scan pictures or images.	243	2.77	1.568	.361	-1.100
Item 41	Use digital video, digital cameras.	243	2.52	1.573	.623	-.838
Item 42	Use a word processor.	243	3.51	1.792	-.106	-1.325
Item 43	Maintain an on-line journal or discussion board.	243	1.45	.531	.542	-1.000
Item 44	Use digital portfolios	243	1.39	.567	1.670	5.618
Item 45	Search the Internet for information for a lesson.	243	3.98	1.750	-.472	-1.067

Table 2: Pre-factor analysis - descriptive statistics for all survey items (n=243) (cont'd)

	Item	N	Mean	Std Deviation	Skewness	Kurtosis
Item 46	Access CD-ROM reference material.	242	3.38	1.737	-.070	-1.330
Item 47	Total amount of in-service training you have received to date on using computer technology in the classroom.	243	2.78	1.445	.114	-1.360
Item 48	Stage that best describes your level of integrating computer technology in your teaching activities.	243	3.56	1.339	-.208	-.908

Note. The *SE* of Kurtosis is = 0.29; *SE* of Skew is 0.14.

Exploratory Factor Analysis

I used Exploratory Factor Analysis (EFA) to answer research question one. EFA is a statistical method that examines the inter-correlations that exist between a large number of items by reducing the items into smaller groups known as factors (Gudgeon et al., 2006; Kim & Mueller, 1978; Tabachnick & Fidell, 2007; Yong & Pearce, 2013). The factors contain correlated factors that are similar in terms of content and meaning. EFA is "exploratory" in nature on the assumption that covariance among measured variables arise from a smaller set of latent factors which are associated, to varying degrees, to each observable variable known as the common factor model assumption. EFA is commonly utilized when there is little to no *a priori* knowledge about the latent structure associated with variables and have been employed across a variety of scientific domains. EFA is a useful technique when the

objective is to find out whether the items evaluated by respondents through the questionnaire measure a single or multiple construct (or dimensions). EFA is also useful in reducing large numbers of items to smaller numbers (Fabrigar et al., 1999; Hooper, 2012). Often in social sciences, when researchers want to measure latent variables (i.e., variables that cannot be directly measured), EFA is used (Guadagnoli & Velicer, 1988; Hooper, 2012; Lian et al., 2012). Limitations of EFA arises with the difficulty of deciding on which factor model to utilize and how many factors (m) to incorporate. Determining the number of factors to include can be a difficult problem as any change in m can largely impact the results and interpretations of the analysis, and the choice of m itself can be very difficult.

These challenges were addressed by employing strategies suggested by Field (2013); Tabachnick and Fidell (2007), and Yong and Pearce (2013). Hence;

1. an adequate sample size comprising of n=250 was used (n=243 after cleaning);
2. only factors with an eigenvalue higher than 1.0 were accepted as common factors;
3. only factors that appeared above the “elbow” of the scree plot were retained; the rest were rejected;
4. proportion of variance accounted for by a given factor had to be greater than 5%;
5. each factor had at least three items with loading greater than 0.10 and these items measured the same construct.

A Scree Plot was used to display the eigenvalues for successive factors. Cattell (1966) proposed that a scree plot can be used to graphically determine the optimal number of factors to retain. The scree test involves finding the place where the smooth decrease of eigenvalues appears to level off to the right of the plot. To the right of this point, presumably, we find only "factorial scree". This is a geological term referring to the debris

that collects on the lower part of a rocky slope. Thus, no more than the number of factors to the left of this point should be retained. Scree plots can be difficult to assess, and it is not clear from the literature where the cut off should be (Yong & Pearce, 2013). Cattell (1978) originally suggested that the first factor on the straight line be the cut-off factor. Later, he revised this rule to be the number of factors that appear prior to the beginning of the straight line (Cattell & Jaspers, 1967). Several authors notably Gudgeon et al., (2006) and Tabachnick and Fidell (2007) suggest that if the cut off for the number of factors is unclear; the researcher might find it useful to undertake several factor analyses with different numbers specified.

Reliability of the Instrument

Before analysing data for the study, I checked for reliability of the instrument. According to Cronbach (1951), a coefficient alpha (α) score equal to or exceeding 0.70 indicates a strong reliability on a scale of 0 to 1. Cronbach's alpha is a common measure of a questionnaire's internal consistency and indication of reliability of the instrument (Oppenheim, 1994). Different levels of reliability are required depending on the nature and purpose of the scale. However, Nunnally (1978) recommends a minimum of .7. Table 3 shows that all Likert items had Cronbach Alpha (α) of .864, which indicates high consistency of data and its validity for factor analysis.

Table 3: Cronbach's alpha for the Questionnaire

Reliability Statistics

Cronbach's Alpha	Number of Items
.864	44

*Note: Items 2, 8, 11, and 44 in Table 2 were removed due to skewness and Kurtosis value.

Test of Adequacy of Sample Size

The adequacy of sample size was determined using Meyer-Olkin measure of sampling (KMO) and Bartlett's test. The acceptable KMO value must be ≥ 0.6 and Bartlett's Test of Sphericity must also be $p < .001$ (Field, 2013; Hair, Black, Babin, & Anderson, 1998; Yong & Pearce, 2013). As Table 4 below shows, the KMO test value is .824 and the Bartlett's Test of Sphericity is $p < .001$, which is highly significant, for carrying out EFA.

Table 4:Sampling adequacy

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.824
Bartlett's Test of Sphericity	Approx. Chi-Square	3730.889
	df	946
	Sig.	.000

Procedure for Qualitative Data Analysis

I converted the field notes generated through audio interviews and classroom observations into Word documents for qualitative data analysis (QDA) using open coding (Glaser, Strauss, Glaser, & Strauss, 2019). By QDA, I mean a process of systematically searching and arranging the interview transcripts, field notes, open ended responses from the questionnaire and other materials to generate themes and findings. Taylor, Bogdan, and DeVault (2015) are of the view that QDA is an ongoing process that involves coding, developing descriptions and themes, connecting related themes, understanding data in context, and reporting findings. I coded the text data to identify themes using Creswell's (2010) criteria, which involved identifying code words from the data, then grouping similar codes, and looking for redundant codes with the intention of reducing the codes to a smaller, more manageable number. Using this refined list, I went back to the data to find if there were any emerging codes, and then reduced the codes to common themes supported by evidence. I identified the following themes from the quantitative data analysis: computer use as competency indicator; communication enhancement; effective mediator of teaching and learning; drafter and preparatory tool; performance indicator; and computer-centred pedagogy. Lastly, I built a portrait of each individual teacher based on these themes and described their classroom experiences with or without technology in detail, guided by the interview questions and observation data. At this stage, I also embarked on further reading and understanding literature on PCT and TPACK to help me to understand teachers' competencies, dispositions, perceptions and challenges of technology use in the classroom.

Reliability, Validity, and Credibility

As indicated, the instrument was adapted from a valid questionnaire developed at Concordia University. Cronbach's alpha (α) for the Likert-type of questions was .86, an indication that the adapted instrument was reliable. This implied that the results of this study could be replicated in a similar setting using the same methodology. I established validity in three ways, content, criterion-related, and construct validity. Content validity showed the extent of representation of all the possible instrument items relating to technology adoption by evaluating the objective of the instruments, wording, and level of difficulty of the items. To ensure that content validity was up to standard, I conducted a pilot study of the survey instrument at the University of British Columbia among graduate students from East Africa (Uganda, Kenya, Tanzania) who have teaching experience in secondary schools and understood the context of the study. The students suggested rewording some of the items, eliminating others, and adding some information to the survey questionnaire.

The criterion-related validity determined whether the scores from the instrument indicated an effective explanation of the actual survey results. I established criterion-related validity by comparing the questionnaire's consistency results to existing instruments that measured factors influencing effective technology adoption in schools. Among them were instruments used by Kamau (2014) and Srisurichan (2012), who in their studies found availability of technology and in-service training were related to computer usage among teachers. Class size, school support, and instructional styles were not related to teachers' computer usage. My findings were consistent with these studies. Clearly, there is evidence to suggest findings in the current study are valid and reliable. I then determined whether the

construct validity was legitimate, and whether the scores were significant, meaningful, useful, and had purpose (Creswell, 2003).

Credibility

To report credible and dependable qualitative findings, I drew upon Guba and Lincoln's (1994) framework for trustworthiness. Using this framework, I reviewed the semi-structured interview data to confirm or reject evidence provided in the survey questionnaire. I also used field notes, transcripts, and memos to cross-check and confirm correct data interpretation. In addition, I used triangulation of data, member checking, and external audit (Creswell, 2003) to ensure the findings were accurate. Triangulation involved multiple sources (survey data, classroom observation data, and interview data). These data provided information and evidence to support each theme. Member checking involved sending transcripts to some study participants to check for accuracy of the information. Also, external audits were conducted by the thesis Supervisory Committee.

Ethical Considerations

The study's data collection involved human beings, and therefore my research committee and the Behavioural Research Ethics Board (BREB) of the University of British Columbia evaluated my methods and instrument, as well as the Ministry of Education in Uganda. Bogdan and Biklen (2007) highlighted that it is the participants' rights to: (1) know about the research interests; (2) give the researcher permission to proceed with the study; (3) give written consent; and (4) not to be lied to or recorded without their knowledge and consent. As such, all the

participants were provided with the necessary information about the study. Data collection through the survey questionnaire and semi-structured interviews were susceptible to a breach of confidentiality. I reminded the participants they should not include names, and they were free to provide only the information they felt was not sensitive about themselves, the school, or the government during interviews. However, to reduce the risk of breach of confidentiality, I delinked the identity of the teacher from the completed survey questionnaires using a participant's mobile phone number and a numeral as opposed to a participant's name or school. In addition, I used pseudonyms to identify the participants during interviews. Lastly, I ensured safekeeping of all files in this study and, in compliance with UBC's BREB, committed to destroying data within five years after analysis and report writing are completed. I tried to report honest and accurate findings in a simple language.

Chapter Summary

This chapter detailed the research methods used to address the study's research problem and purpose. I summarized philosophical debates surrounding mixed methods research. These debates are centred on the protagonists of quantitative and qualitative paradigms. I addressed procedural issues in the sequential mixed methods research with a discussion of priority, implementation, and integration. In the research design, quantitative data collection came first, and I used qualitative data to explain statistically significant variables. I selected 243 participants for the quantitative phase, using a random sampling procedure. I selected nine participants for the qualitative phase using the maximal variation principle for interviews and classroom observation. I discussed the survey instrument and presented data analysis procedures for both quantitative and qualitative data. I checked for reliability and validity of the quantitative data,

and credibility issues for the qualitative data. I concluded the chapter with ethical considerations, including confidentiality and anonymity. Chapter 4 presents the analysis of data and findings.

Chapter Four: Data Analysis and Findings

This study used a sequential explanatory mixed methods research design to investigate secondary school teachers' competencies, dispositions, perceptions, and challenges in the use of ICTs in select secondary schools in Uganda. A total of 250 secondary teachers from Mbale municipality, Uganda, participated in the survey (n=243 after data cleaning). Nine teachers from this pool were interviewed and observed during lessons. The study's quantitative phase was the major component and enabled identification of factors related to technology use in teaching. The qualitative phase was the minor component that built on quantitative findings. Exploratory Factor Analysis was used for quantitative data, and open coding and thematic analysis were used for qualitative data. This chapter reports the study's results and findings and is organised as follows: (1) descriptive statistics; (2) exploratory factor analysis and results from the survey, addressing research question 1; and (3) themes from interviews and classroom observations, addressing research question 2.

Descriptive Demographic Statistics

Using descriptive statistics, the composition of the final sample (n=243) was examined. Details about respondents' gender, age group, education level, years of teaching experience, the subject areas the teachers taught, and the average class size were obtained through the questionnaire. Table 5 depicts statistics related to these variables. Both genders were fairly represented with 48% of the participants female and 52% male. The sample comprised of teacher from different age groups with those in the range of 20-29 years making 33%, 30-39 years 38%, 40-49 years 18%, and 50-59 years 11%.

The education levels ranged from teachers with a college diploma 20%, bachelor's degree 64%, and graduate degree 14%. Teaching experience data for these teachers indicated that most of teachers had 10 or fewer years in the classroom teaching 53%, some had 11-20 years 29%, and the rest had above 20 years 18%. In addition, teachers taught within the following subject areas: languages 16%, sciences 23%, humanities 16%, technical subjects 19%, cultural subjects 13% and mathematics 13%.

Class sizes ranged from 10-15 students 1%, 16-25 students 4%, 26-35 students 12%, 36-45 students 25%, 46-60 students 50% and over 60 students 8%. Regarding the preferred teaching methodology, teachers reported using purely teacher-directed lecture 3%, largely teacher-directed 19%, more teacher-directed than student centred 19% even-balance between teacher-directed and student-centred activities 52%, more student-centred than teacher-directed 6%, and largely student-centred teaching style such as cooperative learning and discovery learning 2%.

Table 5: Full sample descriptive statistics

		f	%
Gender	Male	126	51.9
	Female	117	48.1
Age	50-59 Years	26	10.7
	40-49 Years	44	18.1
	30-39 Years	93	38.3
	20-29 Years	80	32.9
Level of Education	Master's degree	27	11.1
	Bachelor's degree	181	74.5
	Diploma	35	14.4
Years of teaching completed	Over 30 Years	14	5.8
	21-30 Years	34	14.0
	16-20 Years	36	14.8
	11-15 Years	42	17.3
	6-10 Years	43	17.7
	1-5 Years	74	30.5
Current teaching subject area	Mathematics: (Math, Additional Mathematics)	31	12.8
	Cultural Subjects: (Art, Music, Health educ, Clothing &Textile, Food & Nutrition, Home Mgt).	34	14.0
	Technical subjects: (Woodwork, TD, Metal work, B&C, IT, Electricity & Electronics, power & Energy)	46	18.9
	Humanities: (History, Geography, Religious studies).	39	16.0
	Sciences: (Biology, Chemistry, Physics, General Science, Agric.)	55	22.6
	Languages: (English, Swahili, Luganda, German, French	38	15.6
Average class size that you teach.	Over 60 Students	17	12.8
	46-60 Students	121	14.0
	36-45 Students	70	18.9
	26-35 Students	28	16.0
	16-25 Students	6	22.6
	10-15 Students	1	15.6

Quantitative Phase

Preliminary Analysis

As reported in Chapter 3, the suitability of data for factor analysis was assessed. First, consideration was made for the sample size and number of items included in EFA. After excluding questionnaires with missing data, (n = 7) the final number was 243 out of 250 questionnaires, where each questionnaire comprised 44 Likert scale items. The ratio for this EFA was 5:1, an acceptable ratio for factor analysis.

This was followed by determining the questionnaire's reliability using Cronbach alpha resulting in $\alpha = 0.864$. The Kaiser-Meyer Olkin Measure of Sampling adequacy was checked and found to be .824, exceeding the recommended value of .6 (Kaiser, 1974). Additionally, a significant Bartlett's Test of Sphericity (Bartlett, 1954) should be < .05 and this study has met this criterion as the test is significant at $p < .001$.

Research Question 1: Exploratory Factor Analysis (EFA)

EFA was conducted to obtain early dimensionality (Pallant, 2013; Tabachnick & Fidell, 2007) using SPSS 23 on a sample of n = 243. As discussed in Chapter 3, EFA requires careful consideration and making sound decisions at each step. Consistent with principles outlined in literature on EFA, a four-step procedure was implemented as indicated in Table 6 below (Cattell, 1978; Fabrigar et al., 1999; Field, 2013; Hair et al., 1998; Kim & Mueller, 1978; Yong & Pearce, 2013).

Table 6: Steps in conducting Exploratory Factor Analysis

	Procedure	*Description*
Step 1:	Check initial issues	Suitability of Sample size. Sampling Adequacy. Appropriateness of applying factor analysis to the data set.
Step 2:	Conduct Factor Analysis	Select Extraction Method. Decide number of factors to extract. Choose factor rotation method.
Step 3:	Interpret EFA Result	Interpret the components/ factors and explain their meaning as applied to this study.
Step 4:	Evaluate Scale Reliability	Calculate Cronbach's α for each sub-scale to check for its consistency.

Deciding on the Number of Factors to Extract

The number of dimensions selected was based on a range of criteria. This stage took on an exploratory approach by exploring with different numbers of factors (Fabrigar et al., 1999; Tabachnick & Fidell, 2007). The initial evaluation of EFA using Kaiser's criterion (Pallant, 2016) identified 14 factors with eigenvalues greater than 1, explaining 65.3% of the variance cumulatively. Three of the factors had two or less items loading on a factor, indicating that the full solution is not optimal (Pallant, 2016). This is shown in Table 7 below.

Table 7: Unrotated solution

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.593	19.529	19.529	8.593	19.529	19.529
2	3.308	7.517	27.046	3.308	7.517	27.046
3	2.041	4.639	31.685	2.041	4.639	31.685
4	1.957	4.449	36.134	1.957	4.449	36.134
5	1.741	3.956	40.090	1.741	3.956	40.090
6	1.536	3.492	43.582	1.536	3.492	43.582
7	1.403	3.188	46.770	1.403	3.188	46.770
8	1.300	2.955	49.725	1.300	2.955	49.725
9	1.288	2.927	52.652	1.288	2.927	52.652
10	1.208	2.745	55.397	1.208	2.745	55.397
11	1.179	2.679	58.076	1.179	2.679	58.076
12	1.118	2.541	60.617	1.118	2.541	60.617
13	1.061	2.412	63.029	1.061	2.412	63.029
14	1.004	2.282	65.312	1.004	2.282	65.312
15	.970	2.204	67.515			
16	.921	2.094	69.609			
17	.871	1.980	71.589			
18	.826	1.878	73.467			
19	.806	1.832	75.299			
20	.776	1.763	77.061			
21	.740	1.682	78.743			
22	.690	1.569	80.312			
23	.665	1.512	81.823			
24	.616	1.401	83.224			
25	.597	1.357	84.580			
26	.563	1.281	85.861			
27	.520	1.182	87.043			
28	.497	1.129	88.171			
29	.470	1.067	89.239			
30	.442	1.005	90.243			
31	.427	.971	91.214			
32	.413	.939	92.153			
33	.404	.918	93.071			
34	.387	.880	93.951			
35	.373	.847	94.799			
36	.324	.737	95.536			
37	.318	.723	96.259			
38	.291	.662	96.921			
39	.289	.656	97.577			
40	.277	.630	98.207			
41	.238	.542	98.749			
42	.212	.481	99.230			
43	.185	.421	99.651			
44	.154	.349	100.000			

Note. Extraction Method: Principal Component Analysis.

However, to further identify potential meaningful factors, the Cattell's scree test was examined (Cattell & Vogelmann, 1977) as shown in Figure 6. There was a noticeable break in 'the elbow' or point of inflexion after six factors. This supported the appropriateness of rotating these 6 factors, specifying a six-factor solution. The scree test graphically presents the eigenvalues as shown below.

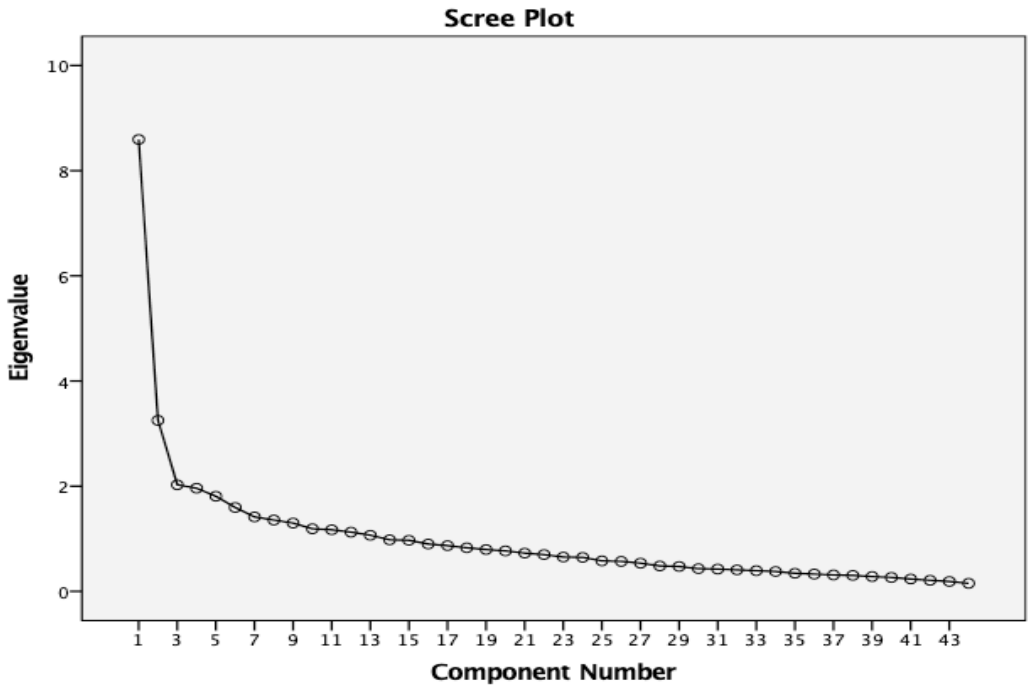

Figure 7: Scree plot based on Principal Components Analysis (PCA)

From the scree plot, the most probable number of principal components is 6. However, it was important to explore how items would load on 5-factor solution and 7-factor solution. The 5-factor solution explained a total of 40.0% of the variance whereas, the 7-factor solution explained 46.7% of the total variance as found in Tables 8 and 9.

Table 8: Factor rotation on a Five-factor solution

Rotated Component Matrix[a]

Question/Statement	Component				
	1	2	3	4	5
How would you describe your proficiency level as a user in relation to computer technologies?	.816	.024	.090	.286	-.033
Access CD-ROM reference material.	.705	.145	.072	.081	-.019
Use a word processor.	.696	.247	-.016	-.037	.061
Stage that best describes your level of integrating computer technology in your teaching activities.	.679	.149	.060	.106	.174
Use tutorials for self-training.	.628	.326	.195	.052	.111
Use digital video, digital cameras.	.620	-.041	.006	-.193	.116
Search the Internet for information for a lesson.	.606	-.131	.139	.276	-.071
Use LCD projector (a projector connected to a computer) in class.	.598	.315	-.027	-.161	.119
Have students use tutorials for remediation.	.595	.077	.023	.166	-.120
On average, how many hours per week do you spend using a computer for personal use outside of teaching activities?	.585	.172	-.061	.273	-.007
Create PowerPoint presentations to use in class.	.582	.485	-.060	-.207	.192
Total amount of in-service training you have received to date on using computer technology in the classroom.	.574	.231	-.013	.233	.087
Scan pictures or images.	.573	.365	.072	.051	-.149
Analyse data.	.570	.459	.052	.440	.119
Use e-mail to communicate with students.	.220	.726	-.004	-.146	.012
Use e-mail to communicate with parents.	.128	.713	-.054	-.129	-.068
Have students use 3-D modelling software or simulations (in class/school lab)	.257	.564	.088	-.005	.070
Use e-mail to communicate with other teachers.	.374	.548	.136	.205	-.084
Create charts or graphs.	.370	.528	.044	.339	-.051
Use drawing or paint programs.	.302	.373	-.029	.166	-.040
Is effective because I can implement it successfully.	-.014	-.033	.656	.033	-.074
Is successful if teachers have access to a computer at home.	.057	.126	.597	-.041	.007
Improves student learning of critical concepts and ideas.	.118	.017	.581	.107	.029
Promotes student collaboration.	.067	.199	.548	.059	.118
Motivates students to get more involved in learning activities.	.204	-.204	.545	.133	-.054
Increases academic achievement (e.g. grades).	.221	-.158	.545	-.026	.068
Is successful if there is adequate teacher training in the use of technology for learning.	-.045	.095	.525	.141	-.302
Is unnecessary because students will learn computer skills on their own, out of school.	-.113	.030	.522	-.086	-.121
Eases the pressure on me as a teacher.	-.045	.017	.501	.004	.191
Is effective if teachers participate in the selection of computer technologies to be integrated.	-.029	-.021	.384	.375	.024
Is successful only if technical staff regularly maintains computers	-.041	.256	.334	.022	.020
Is too costly in terms of resources, time and effort.	.078	-.144	.211	-.201	-.101
Requires extra time to plan learning activities.	-.010	-.122	.175	-.071	-.085
Keep track of student grades or marks.	.269	.289	.001	.648	-.043
Prepare handouts, tests/quizzes, and homework assignments for students.	.293	.196	.104	.636	.012
Create lesson plans.	.267	.425	-.088	.530	.021
How often do you integrate computer technologies in your teaching?	.095	-.060	.033	.291	.112
Will increase the amount of stress and anxiety of students' experience.	-.012	-.099	-.012	.284	-.021
Enhances my professional development.	.004	.085	-.051	-.249	.173
How would you rate teachers access to computer resource personnel in your school?	.025	.027	-.023	.052	.822
How would you rate Student access to Computer technology in your school?	.065	.065	.031	.025	.789
Maintain an on-line journal or discussion board	-.032	-.242	-.087	-.079	-.324
Promotes the development of communication skills (e.g. Writing and presentation skills).	.088	-.098	.021	-.039	.314
Is effective only when extensive computer resources are available.	.070	.038	.142	.014	-.219

Notes. Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 5 iterations.

Table 9: Factor rotation on a seven-factor solution

Rotated Component Matrix[a]

Question/Statement	Component						
	1	2	3	4	5	6	7
How would you describe your proficiency level as a user in relation to computer technologies?	.806	.009	.085	.279	-.022	.112	.082
Access CD-ROM reference material.	.713	.168	.106	.009	-.021	-.153	.131
Use a word processor.	.687	.254	-.031	.020	.065	.092	-.076
Stage that best describes your level of integrating computer technology in your teaching activities.	.681	.124	.064	.131	.167	.003	-.059
Search the Internet for information for a lesson.	.630	-.143	.203	.144	-.095	-.273	.179
Use tutorials for self-training.	.621	.307	.185	.127	.118	.082	-.114
Use digital video, digital cameras.	.618	.030	.005	-.270	.118	-.007	.104
Use LCD projector (a projector connected to a computer) in class.	.592	.272	-.040	-.002	.090	.062	-.363
Have students use tutorials for remediation.	.590	.073	.019	.181	-.113	.091	.036
On average, how many hours per week do you spend using a computer for personal use outside of teaching activities?	.566	.113	-.049	.328	-.017	-.014	-.069
Total amount of in-service training you have received to date on using computer technology in the classroom.	.545	.204	-.006	.248	.095	-.015	.036
Create PowerPoint presentations to use in class.	.542	.449	-.089	-.012	.177	.117	-.383
Scan pictures or images.	.498	.414	.091	.006	-.122	-.082	.188
Analyse data.	.478	.394	.081	.463	.133	-.137	.068
Use e-mail to communicate with students.	.201	.728	-.025	.004	.037	.062	-.169
Use e-mail to communicate with parents.	.122	.709	-.037	-.024	-.062	-.154	-.135
Have students use 3-D modelling software or simulations (in class/school lab)	.239	.586	.065	.062	.115	.097	.029
Use e-mail to communicate with other teachers.	.370	.569	.158	.181	-.043	-.107	.207
Create charts or graphs.	.368	.460	.055	.439	-.037	-.026	-.059
Use drawing or paint programs.	.293	.403	-.031	.146	.004	.012	.211
Is effective because I can implement it successfully.	-.009	.003	.682	-.079	-.059	-.083	.172
Is successful if teachers have access to a computer at home.	.054	.061	.589	.086	-.015	.098	-.344
Improves student learning of critical concepts and ideas.	.119	-.011	.584	.113	.030	.045	-.058
Increases academic achievement (e.g. grades).	.228	-.162	.558	-.068	.052	-.020	-.052
Promotes student collaboration.	.066	.197	.554	.044	.136	-.013	.025
Motivates students to get more involved in learning activities.	.201	-.182	.541	.053	-.035	.115	.147
Is unnecessary because students will learn computer skills on their own, out of school.	-.119	.088	.527	-.163	-.095	.006	.150
Is successful if there is adequate teacher training in the use of technology for learning.	-.057	.100	.514	.155	-.271	.157	.058
Eases the pressure on me as a teacher.	-.051	-.049	.472	.121	.181	.191	-.297
Is successful only if technical staff regularly maintains computers	-.036	.270	.361	-.024	.034	-.158	.093
Keep track of student grades or marks.	.278	.194	.028	.673	-.027	-.076	.109
Prepare handouts, tests/quizzes, and homework assignments for students.	.300	.104	.119	.656	.030	-.006	.102
Create lesson plans.	.271	.337	-.074	.598	.040	-.044	.038
Is effective if teachers participate in the selection of computer technologies to be integrated.	-.029	-.091	.377	.410	.037	.122	-.019
Will increase the amount of stress and anxiety of students' experience.	-.009	-.138	-.014	.282	-.015	.053	.057
How would you rate teachers access to computer resource personnel in your school?	.046	-.027	-.012	.023	.805	-.185	-.063
How would you rate Student access to Computer technology in your school?	.075	.027	.021	.018	.788	-.053	-.057
Maintain an on-line journal or discussion board	-.019	-.290	-.056	-.028	-.387	-.117	-.251
Is effective only when extensive computer resources are available.	.024	.083	.039	.122	-.147	.639	.033
Requires extra time to plan learning activities.	-.046	-.104	.082	.046	-.044	.567	-.105
Is too costly in terms of resources, time and effort.	.041	-.016	.128	-.245	-.026	.488	.246
Promotes the development of communication skills (e.g. Writing and presentation skills).	.060	-.029	-.062	-.058	.381	.432	.189
How often do you integrate computer technologies in your teaching?	.091	.024	.029	.089	.185	.031	.578
Enhances my professional development.	.011	.036	-.044	-.139	.124	-.090	-.368

Notes. Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 7 iterations.

After exploring the two factor solutions (5-factor solution and 7-factor solution), the results indicated several items did not contribute to a simple factor structure as evidenced by low communalities under .3 and factor loadings under .3. In this study, for a factor to be accepted, it must have 3 or more items with each item loadings at .3 or more (Kaiser, 1974; Mvududu & Sink, 2013; Thurstone, 1954). The scree plot provided an estimated number of factors, usually the number of points around the elbow. A decision was then made to use a 6-factor solution. The rotated solution revealed the presence of simple structures (Thurstone, 1954), with all the six factors having three or more variables loading on a factor.

Interpretation of the component's matrix reveals similar structures for all the six factors, though several items had cross loadings on multiple factors. In the case for cross loadings, items were selected to belong to a factor where they loaded highest (Thurstone, 1954).

Each of the 44 items representing the 6 factors and their loadings are presented in Table 10. The six-factor solution explained a total variance of 43.5%. Factor 1, labelled *computer use as competency indicator*, represented by 14 items with loadings ranging from .50 to .83, accounted for 19.5% of the total variance. Factor 2, labelled *communication enhancer*, represented by 6 items with loadings ranging from .52 to .74 accounted for 7.5% of the total variance. Factor 3 was represented by 10 items, labelled as e*ffective mediator of teaching and learning,* with loadings ranging from .52 to .69, accounting for 4.6%. Factor 4, labelled *drafters and preparatory tool*, was represented by 7 items with loadings ranging from .55 to .66, accounted for 4.4% of the total variance. Factor 5, labelled *performance indicator*, represented by 4 items with loadings ranging from .71 to .80 accounted for 3.9% of the total variance. Factor 6 labelled, *computer centred pedagogy*, represented by 3 items with loadings ranging from .49 to .61, accounted for 3.4% of the total variance.

Table 10: Factor Rotation on a 6-factor solution and Interpretation

Rotated Component Matrix[a]

Question/Statement	Component 1	2	3	4	5	6
How would you describe your proficiency level as a user in relation to computer technologies?	.836	.042	.073	.312	-.016	.116
Access CD-ROM reference material.	.818	.144	.111	.057	-.038	-.181
Use a word processor.	.784	.270	-.030	-.008	.077	.097
Stage that best describes your level of integrating computer technology in your teaching activities.	.775	.153	.056	.114	.181	.020
Use digital video, digital cameras.	.681	-.029	.017	-.209	.089	-.053
Search the Internet for information for a lesson.	.670	-.147	.194	.225	-.109	-.274
Use tutorials for self-training.	.653	.338	.182	.080	.140	.101
Have students use tutorials for remediation.	.583	.100	.012	.194	-.106	.098
Use LCD projector (a projector connected to a computer) in class.	.582	.341	-.049	-.124	.140	.138
On average, how many hours per week do you spend using a computer for personal use outside of teaching activities?	.571	.181	-.064	.293	.010	.027
Total amount of in-service training you have received to date on using computer technology in the classroom.	.566	.231	-.010	.243	.102	-.018
Create PowerPoint presentations to use in class.	.561	.512	-.091	-.157	.228	.178
Scan pictures or images.	.533	.370	.110	.046	-.148	-.144
Analyse data.	.503	.437	.077	.439	.144	-.143
Use e-mail to communicate with students.	.196	.741	-.006	-.105	.056	.055
Use e-mail to communicate with parents.	.119	.713	-.017	-.123	-.049	-.159
Have students use 3-D modelling software or simulations (in class/school lab)	.237	.569	.084	.027	.109	.048
Use e-mail to communicate with other teachers.	.369	.538	.178	.202	-.066	-.174
Create charts or graphs.	.349	.577	.050	.369	-.008	-.002
Use drawing or paint programs.	.293	.524	-.015	.178	-.021	-.058
Is effective because I can implement it successfully.	.001	-.056	.690	-.003	-.083	-.119
Improves student learning of critical concepts and ideas.	.116	.007	.675	.108	.048	.075
Is successful if teachers have access to a computer at home.	.044	.130	.672	-.015	.042	.196
Promotes student collaboration.	.068	.177	.589	.048	.135	-.027
Increases academic achievement (e.g. grades).	.232	-.168	.580	-.046	.060	.009
Is unnecessary because students will learn computer skills on their own, out of school.	-.106	.020	.572	-.102	-.121	-.041
Motivates students to get more involved in learning activities.	.205	-.206	.566	.133	-.047	.099
Is successful if there is adequate teacher training in the use of technology for learning.	-.060	.105	.563	.171	-.265	.159
Eases the pressure on me as a teacher.	-.061	.015	.553	.036	.231	.270
Is successful only if technical staff regularly maintains computers	-.031	.229	.525	-.009	.018	-.193
Keep track of student grades or marks.	.256	.272	.012	.661	-.008	-.062
Prepare handouts, tests/quizzes, and homework assignments for students.	.278	.180	.100	.654	.050	.011
Create lesson plans.	.249	.412	-.085	.605	.063	-.032
Is effective if teachers participate in the selection of computer technologies to be integrated.	-.043	-.031	.356	.599	.063	.161
Will increase the amount of stress and anxiety of students' experience.	-.019	-.102	-.027	.576	-.007	.066
How often do you integrate computer technologies in your teaching?	.104	-.084	.050	.567	.105	-.124
Enhances my professional development.	.006	.085	-.053	-.553	.167	-.008
How would you rate teachers access to computer resource personnel in your school?	.046	-.033	-.015	.000	.805	-.194
How would you rate Student access to Computer technology in your school?	.075	.017	.019	-.005	.788	-.072
Promotes the development of communication skills (e.g. Writing and presentation skills).	.067	-.084	-.052	.010	.748	.345
Maintain an on-line journal or discussion board	-.026	-.222	-.077	-.083	-.714	-.011
Is effective only when extensive computer resources are available.	.019	.097	.039	.128	-.142	.614
Requires extra time to plan learning activities.	-.051	-.072	.073	.025	-.023	.585
Is too costly in terms of resources, time and effort.	.056	-.103	.148	-.143	-.071	.490

Notes. Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 7 iterations.

Reliability of Factors

Alpha coefficients were computed on the specific items comprising each derived factor. Factor 1 (*computer use as competency indicator*) produced a Cronbach alpha of .89. The reliability of factor 2 (*communication enhancer*) was .76. The reliability for factor 3 (e*ffective mediator of teaching and learning*) was .73. The reliability coefficient for factor 4 (*drafters and preparatory tool*) was .72. Factor 5 (*performance indicator*) yielded a reliability coefficient of .64 and factor 6 (*computer centred pedagogy*) had a Cronbach's alpha .59. Therefore, the internal consistency of each derived factor was adequate, ranging from .61 to .89. This demonstrated acceptable internal consistency and factorial validity.

Significant Factors

Factor 1: Computer Use as Competency Indicator

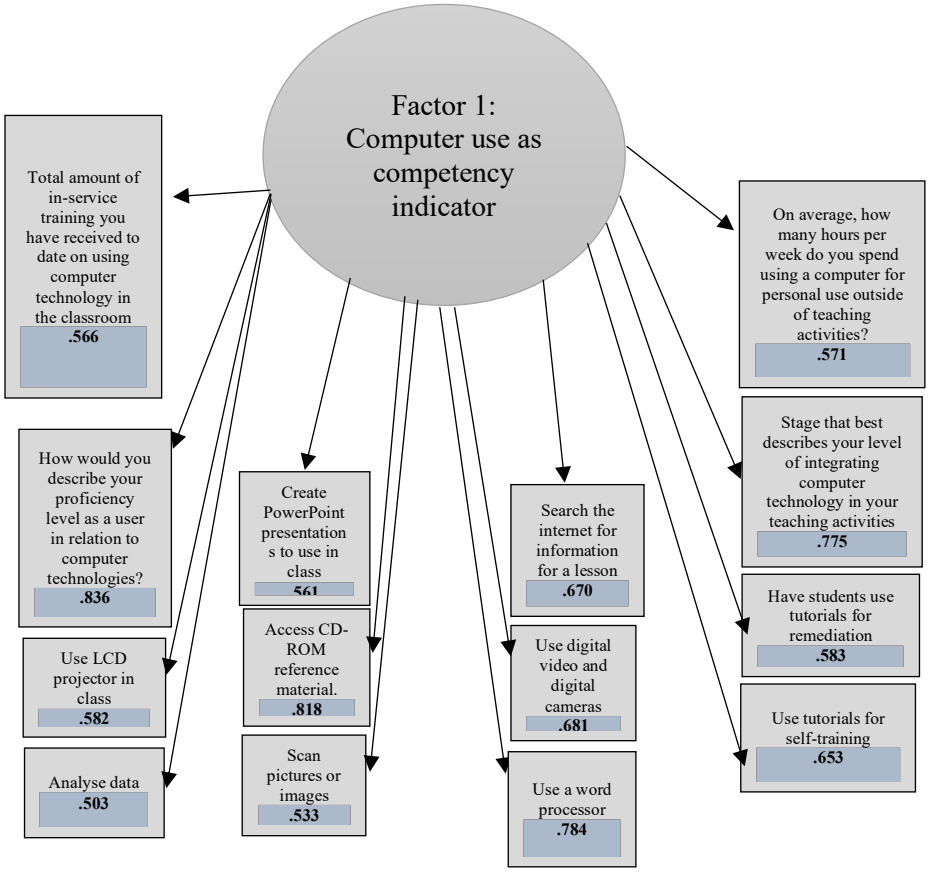

Figure 8: Factor 1, Computer use as Competency indicator

This factor consists of 14 items that relate to *computer use as competency indicator* among secondary school teachers in Uganda. All the factors loaded adequately on this factor with the highest loading items asking how teachers would describe their proficiency level as users in relation to computer technologies (.836) and access to CD-DVD ROM material (.818). The other items loaded as follows: Use a word processor (.784), Stage that best describes your level of integrating computer technology in your teaching activities (.775), and Use digital

video and digital cameras (.681), Search the Internet for information for a lesson (.670), Use tutorials for self-training (.653), Have students use tutorials for remediation (.583), Use LCD projector in class (.582), On average, how many hours per week do you spend using a computer for personal use outside of teaching activities? (.571), Total amount of in-service training you have received to date on using computer technology in the classroom (.566), Create PowerPoint presentations to use in class (.561), Scan pictures or images (.533), and Analyse data (.503).

Proficiency level as a user in relation to computer technologies comes through clearly as a theme in this factor. Of the 14 items, 11 items concern the direct use of technologies by teachers either in or out of the classroom for either personal use or preparation for lessons. One item addressing students' use (Have students use tutorials for remediation) also loaded on this factor even as it does not directly show competence in teachers. Another item on this factor pertains to in-service training in the use of computer technologies. An overall Cronbach's alpha of .894 for all 14 items seen in Table 11 implies an acceptable level of reliability for these items as a subscale (Tavakol & Dennick, 2011). Factor 1 and the respective factor loadings are shown in Figure 8.

Table 11: Reliability for factor 1

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.895	.898	14

Factor 2: Communication Enhancer

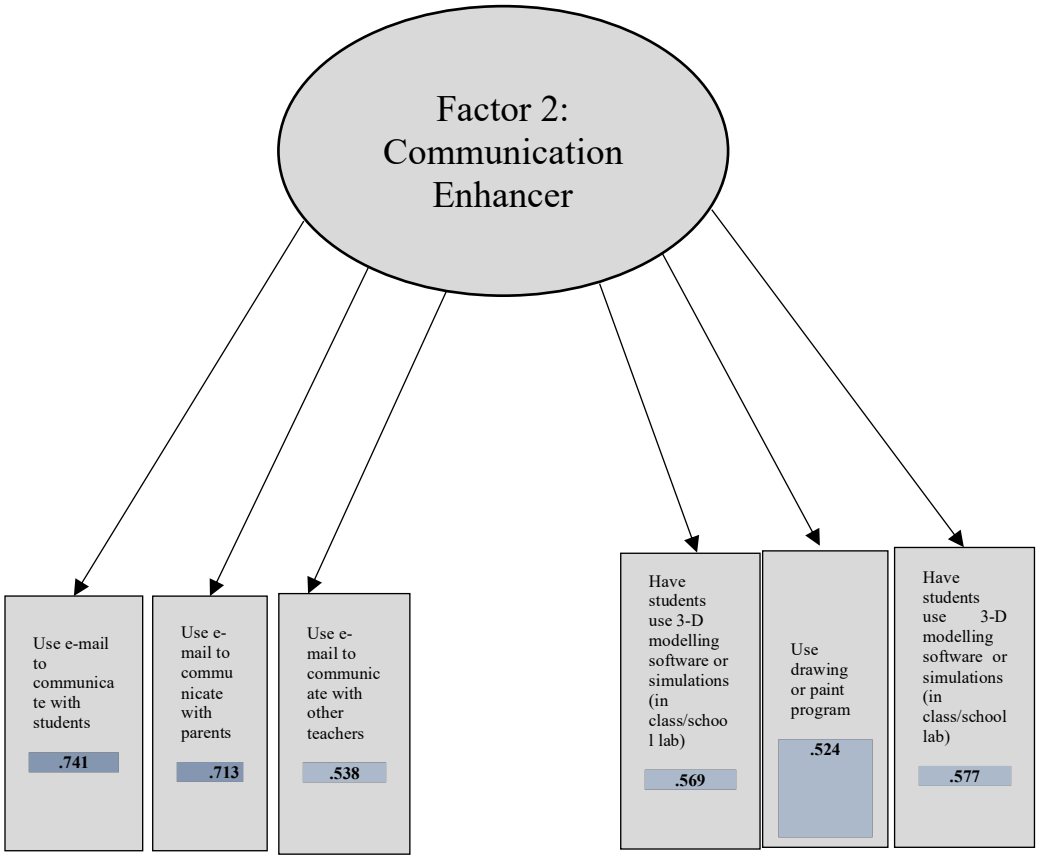

Figure 9: Factor 2, Communication enhancer

This factor includes six items, each of which pertains to the role of the teacher as a communicator. Three items in this factor highlight the teachers' use of email to communicate either to students, parents, or fellow teachers. These three items provide an important opportunity for teachers to practice their technology skills through communication. The other three items (Have students use 3-D modelling software or simulations (in class/school lab), (Create charts or graphs), and (Use drawing or paint programs) speaks to the role of the teachers as facilitators that direct use of technology. Though the wording in each of the three statements does not explicitly classify them under communication, the fact they loaded strongly on this factor implies there

may be an element of decision-making on the part of the teacher in giving instructions and illustrations in the classroom. Cronbach's alpha of .765 for the six items as depicted in Table 12 suggests an acceptable value (Tavakol & Dennick, 2011). Factor 2 is shown with all factor loadings in Figure 9.

Table 12: Reliability for Factor 2

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.765	.767	6

Factor 3: Effective Mediator of Teaching and Learning

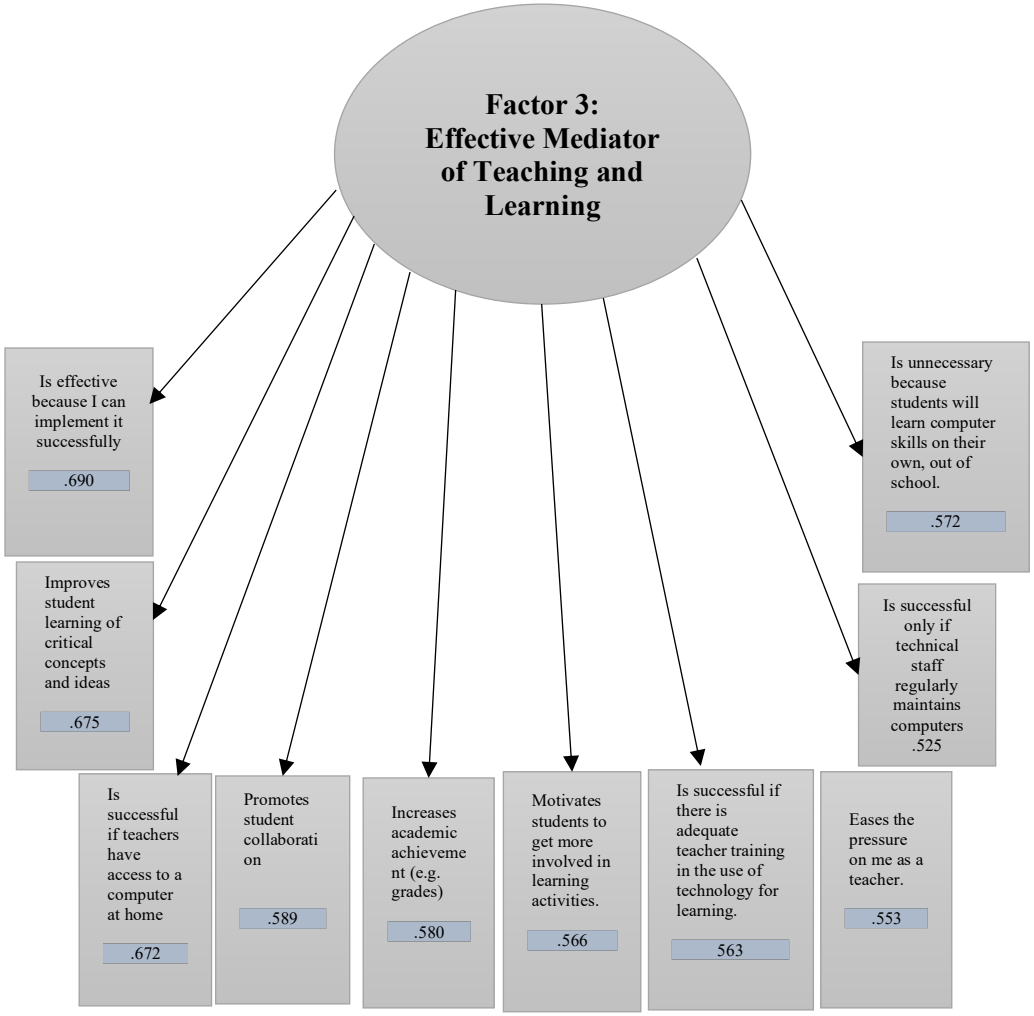

Figure 10: Factor 3, Effective Mediator of Teaching and Learning

Factor 3 contains 10 items with a Cronbach's alpha of .737 as shown in Table 9. These items directly demonstrate technology as a tool that enhances teaching and learning. The first three items under Factor 3 i.e. (Is effective because I can implement it successfully .690), (Is successful if there is adequate teacher training in the use of technology for learning .563) and (Eases the pressure on me as a teacher .553), pertains to the confidence that supports the teachers' decision to use technology in the classroom. The second set of items, improves student

learning of critical concepts and ideas .675, Increases academic achievement (e.g. grades) .580, Promotes student collaboration .589, Motivates students to get more involved in learning activities .566, speaks to the importance of how teachers use technology to supports students learning. Two items, Is successful only if technical staff regularly maintains computers .525 and Is successful if teachers have access to a computer at home .672, speak to the importance of external factors such as on-site support and affordability to support teachers' use of technology in the classroom. The final item on the factor, is unnecessary because students will learn computer skills on their own, out of school .572, seems out-of-place on this factor as it captures the negative sense of teachers' perceptions of technology as an effective mediator of teaching and learning. However, there is an implication of a style of avoidance from teachers in the use of technology. Teachers would typically distance themselves from computers and computer related activities if they thought students would learn on their own. Factor 3 and the respective factor loadings are shown in Figure 10.

Table 13: Reliability for factor 3

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
.737	.742	10

Factor 4: Technology as Drafter and Preparatory Tool

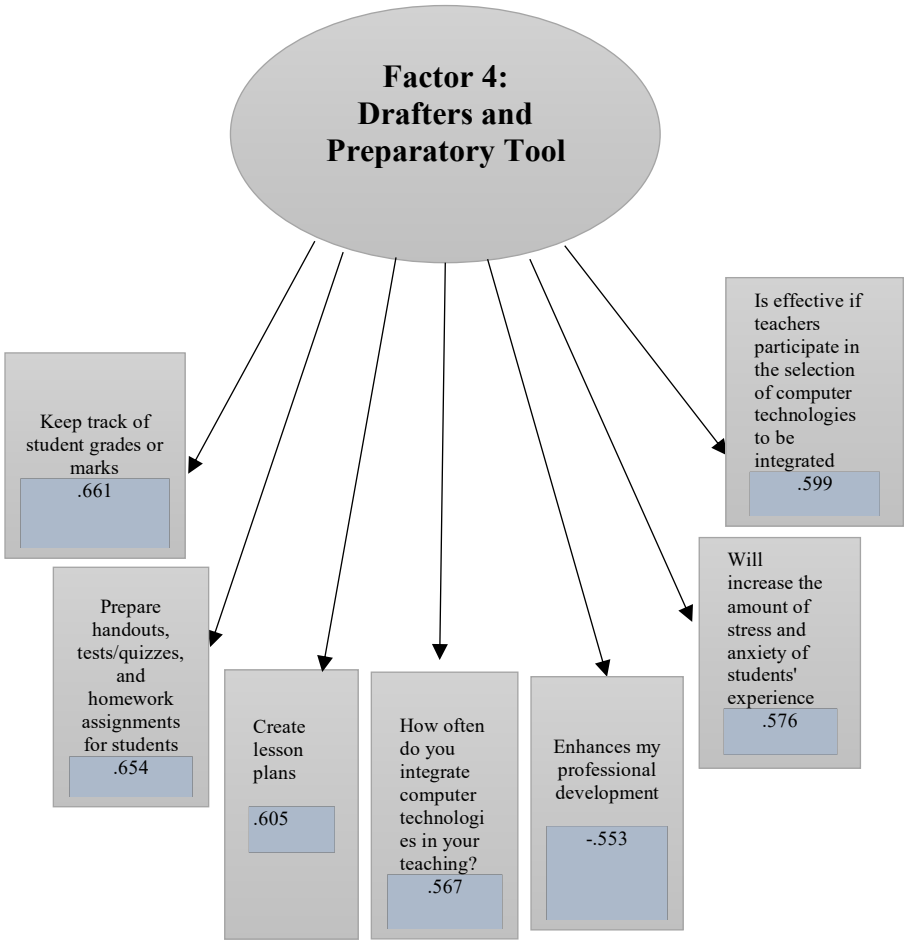

Figure 11: Factor 4, Drafters and Preparatory Tool

The fourth factor includes seven items with a Cronbach of .72 as shown in Table 14 that concern the role of technology as drafter and preparatory tool. Specifically, this factor includes items that pertain to the role of the teacher as a planner using technology. Three items on this factor speak directly to practical adaptation where teachers embrace computers in their schools and their activities such as consistent use, preparation, and delivery of planned lessons. These

items include: Prepare handouts, tests/quizzes, and homework assignments for students .654, Create lesson Plans .605, and Keep track of student grades or marks .661. Another item, enhances my professional development .567, corresponds with the question, How often do you integrate computer technologies in your teaching? .567. These two items point to the change in teachers' professional knowledge and how teachers make rational choices about technologies they want to use. Planning to work with technology confirms teachers' beliefs about technology. The item, is effective if teachers participate in the selection of computer technologies to be integrated .599, also loaded on this factor. Similar to teachers' professional knowledge and making choices, this statement concerns the teachers' role in the school as a contributor to innovations. The item, Will increase the amount of stress and anxiety that students experience .576, loaded on factor four yet it is different from the other items (Figure 11). The statement conveys a negative expression about technology that does not fit the description of technology as drafter and preparatory tool.

Table 14: Reliability for factor 4

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
.592	.450	7

Factor 5: Performance Indicator

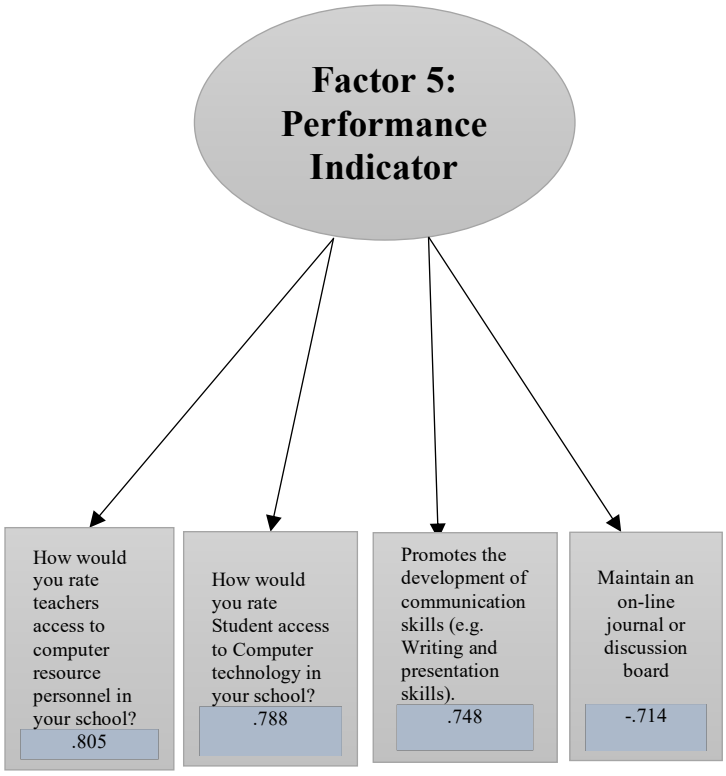

Figure 12: Factor 5, Performance Indicator.

Factor five contains four items that address access to and performance with computer technologies. This performance indicator comes through clearly as a theme for this factor. It follows that successful integration of technology addresses components of access to resources and ease of use. The two items from the subset that speaks to access, How would you rate teachers access to computer resources in your school? .805 and, How would you rate Student access to Computer technology in your school? .788, both loaded quite high on the factor. The other two, Promotes the development of communication skills, e.g., Writing and presentation

skills .748 and Maintains an online journal or discussion board .714, pertains to beliefs and skills. Factor 5 and the individual factor loadings are shown in Figure 12.

Table 15: Reliability for factor 5

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
.311	.203	4

Factor 6: Computer-centred Pedagogy

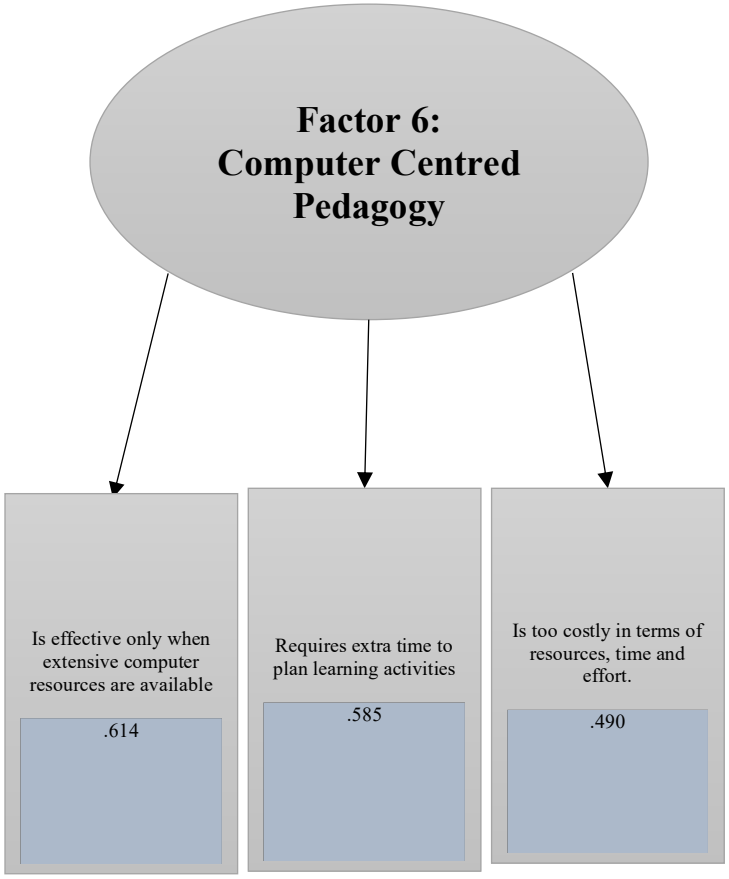

Figure 13: Factor 6, Computer-centred Pedagogy

The sixth factor is the weakest of all as evidenced by Cronbach's alpha of .589 for the three items as shown in Table 16. Even though all the items did not contain high loadings, it is possible that the low Cronbach's alpha is due to the small number of items included in the reliability analysis (Tavakol & Dennick, 2011). These items highlight teachers' beliefs about technology and how these plays into integration and pedagogy. The unifying theme among the three items pertain directly to what makes use of technologies probable in schools and classrooms. The three items, Is effective only when extensive computer resources are available

.614, Requires extra time to plan learning activities .585, and Is too costly in terms of resources, time, and effort .490, speak to the importance of pedagogy as being about teachers' perceptions of how challenges around technology are controlled. Factor 6 and the respective factor loadings are shown below in Figure 13.

Table 16: Reliability for Factor 6

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.401	.400	3

Qualitative Phase

Teachers' Profiles and Perceptions

This section presents findings from teacher interviews and their lesson observations. My discussion of teachers' use of technology is based on observed and perceived pedagogical practices and emerging themes from the data, addressing competencies and perceptions, and whether the teachers used or did not use technology during instruction. Out of the nine teachers interviewed, six identified themselves as active users of technology, and three were non-users.

The users of technology were Mr. Komakech, Mr. Masinde, Ms. Akite, Mr. Ochom, Ms. Nabatanzi, and Mr. Mafabi. The non-users were Ms. Farida-Dida, Ms. Watera, and Ms. Mugidde. The six active users are profiled in the following sections. One non-user (Farida-Dida) has been profiled because she expressed interesting opinion towards technology in the classroom.

Mr. Komakech's Profile and Perceptions

Komakech had been teaching for 31 years at the time of the interview. He graduated with a Bachelor of Education in physics and mathematics. He was hired soon after graduating from university because of the high demand of mathematics and science teachers. After five years in the teaching profession he went on to study for a postgraduate degree diploma in computer science and thereafter a master's degree in educational administration. After his master's degree, he was hired by Holy Mount high school, one of the top private schools to teach mathematics and IT. He was the head of the IT department. Komakech used technology nearly on a daily basis in his classroom since technology made up the content of his IT lessons.

Komakech told me his teaching philosophy was about "imparting knowledge" and making a difference in students' lives. His goal was to make students understand what he was talking about and why they were learning particular content. He said that completing a post-graduate diploma in IT gave him an upper hand in supporting students' learning in a broader way. For instance, he found it easy to help students navigate new software and applications. He is a member of the Microsoft Educator programme that allows members to take courses on professional development and how to use Microsoft technology in the classroom. According to Komakech, his teaching style involves giving students a few examples followed by some

exercises. He said, “you introduce a topic, give them examples and then you let them work it out”. He said IT is more project-based and that students always “cope because the work is build-up from their everyday activities outside school” (Komakech, Interview Data, Lines 29-30). He implied that he expected students to have some basic knowledge in technology given the ubiquitous presence of technology outside of school.

I observed Komakech teach an IT lesson on how to develop a PowerPoint presentation. The lesson was hands-on since the school had enough computers, and some students owned laptops. It was difficult to gauge whether that was technology use in class or simply technology and pedagogy transposition. In this case, technology became the content and all the content became the technology. Typically, IT as a subject in Uganda describes technology as curriculum. Using a smart board, he demonstrated how to create a PowerPoint presentation. He started by teaching the basic rules and concepts of a good PowerPoint presentation. After approximately ten minutes, he asked students to prepare a presentation using a guiding statement on “protecting the environment”. I determined the students found the task very easy as I observed that most produced very colourful slides with just the right amount of text, colours, pictures, and transitions. The teacher walked around the class to observe students’ work and provide on-the-spot feedback.

Such was a typical IT lesson where Komakech’s application of technology was more curriculum-based content. His rationale for using technology was to give students hands-on practice and facilitate aspects of IT use. I considered the students in Komakech’s class a fortunate lot because in a class of approximately 60 students, each had either a desktop or laptop to themselves. I observed the teacher played the role of giving feedback and reinforcing students as he circulated, making reference to the exemplar on the smart board. Komakech was

enthusiastic in “imparting” knowledge, skills and understandings related to technology. Developing IT knowledge and skills and other aspects of IT use is considered a worthwhile investment for future technology use among the students.

Lwoba was in the category of well-equipped schools in terms of technology infrastructure. The school had three computer laboratories, each with one hundred functional computers, and each computer room had a smartboard. Two other smartboards were located in the school hall and the library. The school was equipped with wireless Internet and students working on their laptops had access within a 20 metres radius. Komakech said, “It was easy to work with the A-level students as most of the IT and Science students had their own laptops” (Observation Notes, lines 37-39). Thus, he continually made reference to the previous lessons and encouraged students to always make connections every time. He noted, “some are lazy and make no effort to link this knowledge. They think everything stands alone” (Komakech, Observation Comments, lines 61-69). Komakech noted, students did not follow the rules because to them the technology world was their world. According to Komakech, “they need support from technology distraction” (Observation Notes, lines 70-79).

Mr. Masinde’s Profile and Perceptions

Masinde graduated with a bachelor’s degree in mathematics and physics more than two decades ago. He then completed a master’s degree in administration and management. Masinde taught at four different schools in the past 22 years, including ten years at Doho high School where he was Head of the mathematics department and the Coordinator of the mathematics curriculum. His duties included guiding curriculum implementation, documentation, and

ensuring completion of the syllabus in good time. Masinde was also in charge of the examinations department where he coordinated the running of all examinations with other teachers. I observed Masinde teach two lessons, one where he used technology, and the other where he did not. In each of the lessons, there were about 40 students. The following discussion highlights Masinde's experiences and perceptions of technology in teaching mathematics.

When I asked Masinde to talk about his teaching, he told me his philosophy was centred on students' excellence in education. He stated, "it becomes very unfortunate when you have given your best and the results are not reflective" (Masinde, Interview Data, lines 25-26). Masinde implied his teaching philosophy was based on whether his students succeeded in school or not. He told me his school's performance had not been good for two reasons. First, the school was transformed from a day school six years ago, and the "transition mentality" from a day school to a boarding school took time to establish. Second, he told me that most students who enrolled at Doho High School came from poor families who lived in the locality. As such, Masinde believed teachers at the school spent more time dealing with discipline issues than supporting students' learning.

When I asked. Masinde about his teaching style, he told me he tried to practice a student-centred approach, but it did not work for him because his school had minimal instructional resources to facilitate satisfactory teaching practices. He stated, "you like them to do things, but if you remember in my class there is a question I asked, and the students started moving. This was because of the ratio of the books. It is supposed to be one to one" (Masinde, Interview Data, lines 58-61). In his responses, Mr. Masinde implied there were many students who did not have textbooks and that inhibited him from practicing a student-centred approach. In fact, when I observed Masinde's lesson when he did not apply technology, I noted "the class was

disorganised, and students were not well prepared to learn. Lack of books and geometrical sets revealed a deeper problem within the school, particularly, in the provision of learning resources to the students" (Masinde, Classroom Observation Notes, lines 30-34). Evidence of inadequate instructional resources was also apparent when I observed him apply technology in his second lesson. The students were in a small room with insufficient numbers of seats and desks. I surmised a lack of adequate learning resources obstructed Masinde's teaching goals.

Mr. Ochom's Profile and Perceptions

Ochom graduated with a bachelor's degree in geography and history in the year 2000 and then completed a master's degree. By the time of this interview, he had 12 years of teaching experience that included five years as Head of the geography department at Majanga High School. He was also involved in the Ministry of Education as an ICT trainer. He supervised six secondary schools in his constituency focusing on training teachers to adopt technology in teaching and learning. Ochom taught geography to three different groups of students that included Form III, and IV in ordinary level (O'Level) and Form V and VI in advanced level (A Level). The number of students in these groups ranged from 50 to 60 per class. He told me he used technology to teach geography, but during the time I observed his class, he did not use technology because the projector was broken. The following discussion highlights Ochom's experiences and perceptions of technology in teaching and learning.

Ochom told me his teaching philosophy is grounded in "learning how they learn". He told me he finds ways of looking back at his teaching and adjusting his instructional approaches accordingly to suit his students' learning needs. He found this approach challenging: "finding ways of making them learn is what interests me … so that makes me a reflective practitioner. I

have to find a way of looking back to what I have done and being able to adjust accordingly" (Ochom, Interview Data, lines 34-37). According to Ochom, reflection and adjustment of teaching practice is guided by "what others say" about the practice of teaching. He noted, "currently the emphasis is we move from being teacher-centred, that is what was seen before… to interactions between our teachers and students, and move to learner-centred" (Ochom, Interview Data, lines 39-41).

Ochom believed a student-centred approach to learning was best for him. He told me he was making efforts to practice this type of learner-centred approach in his teaching because he realized this teaching method enabled students to become independent learners, "they become independent; they don't depend on anyone. They can learn on their own and therefore they are able to learn everything, not just the subject I teach. This is something I have picked from my class" (Ochom, Interview Data, lines 50-53).

Ochom noted how technology had changed his teaching approach. He stated, "my pedagogy cannot remain the same because I have a new tool that enables facilitation of learning and therefore, I have one or another to change from an instructor telling, telling everything" (Ochom, Interview Data, lines 357-360). Therefore, he needed to learn how to use technology, how to facilitate, and how to make technology be understood by others. He went on to tell me that technology also guides "how to approach a particular concept because there are a number of options, such as photographs, simulations, videos… sometimes using them for different sessions, sections, units, makes me change, I cannot approach things the same way" (Ochom, Interview Data, lines 366-370). However, Ochom noted he tried to cope with limited technology skills which caused him to delay how he planned to implement technology in his instructional goals.

Ms. Akite's Profile and Perceptions

Akite had been a geography and history teacher at Kasanvu High School since 2012, and she taught at other schools from 2003 to 2011. She has a Bachelor of Education degree in history and geography, and a master's degree in administration and management. Akite did not use technology in her lessons despite having substantial technological resources for teaching and learning at her school. She told me she was aware of the benefits of technology but chose not to implement it. The following is a discussion with Akite on her views about technology in teaching.

When I asked Akite what motivated her everyday classroom practice she stated, "the students' discussions; if the students are receptive and they are willing to communicate… but if the concept is not sinking in, sometimes I get a bit demoralized. I don't know how to simplify it" (Akite, Interview Data, lines 10-11). Akite noted she enjoyed teaching and the feedback from her students motivated her to keep going. She told me she had different types of students each year and changed her instructional approaches to suit their learning needs. When I asked about her teaching style, she stated she preferred a balance between teacher-directed and student-centred instructional approaches. She noted, "I feel that if it is teacher-directed, I will not be able to know if the child is getting what I am saying. Lecture method, you know, the child is left with the problem" (Akite, Interview Data, lines 222-224). Her perception was the lecture method leaves many unanswered questions for the learner, and if some things are not corrected and clarified, that is not helpful to the learner.

During my first classroom observation session in Akite's class, I learned the goal of the lesson was for students to complete a revision question to prepare for an examination that the

following day. The teacher asked the students if they had any questions and whether they had any challenges in photographic interpretation. She distributed copies of photographs to the students with the following directions: Draw the landscape of the area shown in the photograph and on it, mark and label any two physiographic regions, any forms of land use; and Describe the influence of relief on land use in the area shown in the photograph. I observed the teacher did not solve this problem for the students. A student volunteered to work on this problem on the blackboard, and they received support from the teacher and the other students. The whole class worked together and corrected any mistakes.

During my observations of Akite's classes, I noticed students were enthusiastic, jovial, and ready to learn geography. When I asked her how she managed to bring her students to this level of excitement and motivation, she noted, "I guess… you know, I remember when I started teaching, they used to say that paper 1 geography was hard, and the teachers are very stone faced [laughs], that they never smile, and all that" (Akite, Interview Data, line 75-76). According to Akite, she managed to change this belief and ensured her students enjoyed her paper 1 geography lessons. Paper 1 geography in Uganda examines map reading, photographic interpretation, and some quantitative statistics. She noted that sometimes when she makes mistakes, she jokes about it, and "they feel free, even when they make a mistake; they are not shy. I try to make them know that we all learn by making mistakes. They become freer. They feel secure" (Akite, Interview Data, lines 79-82).

In this way, Akite informed me, no student laughs at another student when they are struggling. She stated she managed to create a learning community where strong students supported weaker students. When I observed Akite's class, I realized the students appeared confident when questioning other students about their work. I asked her during the interview

how that worked for her students. Akite told me working in groups enabled them to become better students. She stated, “they need to go into groups and, you know in these groups, I have arranged them— this is a strong child or average— so they can try to help one another (Akite, Interview Data, lines 98-99).

Accordingly, Akite tried to extend students’ group work outside the class for students to support each other. However, these groups did not work as well as she would have liked. Akite attributed this to lack of time. She told me students complained to her their other subjects hindered them from working effectively because they did not have the time. However, she also blamed herself and other teachers because they had not taken serious initiatives to follow up on the students’ groups outside the classroom. She suggested, “that maybe the other way I can do it … maybe in a lesson that is set aside for discussion, but I have never done it. I know it works” (Akite, Interview Data, lines 107-109). Our discussion revealed Akite to be an enthusiastic teacher committed to her students’ learning. However, technology was secondary in her instructional goals.

Ms. Nabatanzi’s Profile and Perceptions

Nabatanzi graduated with a Bachelor of Economics and Technology in 2014. By the time of this interview, she was only two years in the field as a teacher. She was hired at Kansavu High, a private school to teach IT, even though she taught economics in a neighbouring government school with the hope of getting hired as a teacher. Nabatanzi was the IT teacher for all classes in the school, ranging from Ordinary level (O level) Advanced level (A level). Her O level classes, were very big. Senior one and two ranged from 50 and 60 students per class. She

used technology to teach, and just like in the case of Komakech, technology is the subject and curriculum.

Nabatanzi said the need to prepare her students for a technological world was the focus of her philosophy. She finds ways of adjusting her instructional approaches to suit all her students.

> I always say to my students: life outside school will force you to be a part of technology: communication, money in banks, mobile money systems, security cameras in business premises, writing receipts etc. so I try to find ways of making them learn and be interested … I encourage them all the time. (Nabatanzi, Interview Data, lines 37-40)

She clarified, "in our school, the students are not from affluent backgrounds…they don't have everything, that is why, you have to support them as much as you can" (Nabatanzi, Interview Data, lines 43-44). She felt that adopting a relaxed style of teaching was the best for her. She told me that with this approach of teaching, she realised that her students were free and more relaxed to approach her on any technology task in school and even outside of school. She realized that her students were becoming more independent learners: "they have become independent; they do things for fun and yet they also learn. They can learn on their own and they are able to learn everything" (Nabatanzi, Interview Data, lines 45-48).

Nabatanzi noted that it was different when IT is your teaching subject: "my approach is totally different, say, when I teach IT from when I teach Economics. IT is hands-on and [Economics] uses technology as a tool. Therefore, in my IT lessons, everything is like project work…we do everything" (Nabatanzi, Interview Data, lines 107-112). She went on to tell me that technology comes in different forms: "using the phone, taking photographs, simulations, videos … all these ways improve skills. For me, I don't do things in the same way" (Nabatanzi,

Interview Data, lines 201-203). However, Nabatanzi noted that she had learned to cope with limited technology resources and that this had caused her to delay implementing her workplans.

Mr. Mafabi's Profile and Perceptions

Mafabi graduated with a Bachelor of Education degree in mathematics and geography in 2008. After his graduation, he taught for a short time in a rural school until he came to Mbale where he had been teaching at Mooni High School for the last six years. In a typical week during the school term, Mafabi taught approximately 23 lessons, which included two mathematics classes in Senior three and Senior four, and senior five and six classes. He noted that the Ministry of Education recommends a teacher teach 28 lessons per week; for him 23 lessons were manageable. Besides being a classroom teacher, Mafabi was also the school's soccer coach, patron for the journalism club, and the Master of Ceremony during school functions. The following discussion highlighted Mafabi's views on technology adoption in teaching.

Mafabi stated that he believed in assigning students a great deal of homework. He also noted he made every effort to complete the syllabus as early as possible to prepare his students for the national examination. When I asked about his teaching style, he stated, "basically, I always try to get attention on the board and the best method that works is basically the lecture method where you explain and you give them a chance to respond" (Mafabi, Interview Data, line 31-33). This teaching style was evident when I observed him teach the concept of ratio, rates, and proportion. He began the lesson by giving notes, followed by examples, and then exercises for students to practice in class. As the students worked on these problems individually, Mafabi walked around the class checking students' work. Thereafter, he gave students opportunities to work on mathematics problems on the blackboard. He insisted students needed to explain their

answers to the class and noted that peer teaching may indeed support students in understanding mathematics. Mafabi told me he adopts this approach because his language might be advanced for his students, and they may not understand everything he says. He stated: "but when they sit together, two or three, they are able to understand each other" (Mafabi, Interview data, lines 44-45).

Mafabi also believes in teacher collaboration in the classroom. This way, certain teachers who are experts in teaching certain topics may work with students of other teachers. He noted, "we do that at least three times a week, sometimes I invite him [a teacher] to take a topic in my class and then I can take a topic in his class. We do a lot of interaction" (Mafabi, Interview Data, lines 227-232). Mafabi stated his personal teaching goals included: (1) completing the syllabus as early as possible; (2) giving students a lot of work to practice; (3) peer teaching for students; and (4) teacher collaboration to support weak students and learn from expert teachers. My conversation with Mafabi also revealed he believed in the lecture method teaching style where he leads the lesson, then partitions the lesson in instances when students can work on mathematics problems on the blackboard.

Ms. Farida-Dida's Profile and Perceptions

Farida-Dida graduated in 2002 with a Bachelor of Education degree in physics and chemistry. Her first job, beginning in 2003, was teaching chemistry at a girls' school in the central region of Uganda. She worked there until 2010 and was then employed at Wagagai High School to teach chemistry. When I first met Farida-Dida, she talked of how proud she was because her students from the 2014 class scored straight A's in the Uganda National

Examination. The following discussion highlights important views on how Farida-Dida feels about technology adoption in teaching.

During my interview with Farida-Dida, she told me how she worked hard to become a medical doctor and sadly missed the admission into medical school by one point because she did not pass her English examination at a high enough level to meet the requirements. She was then admitted to a university to prepare for a career in teaching. She stated, "I was so sad. I felt the worst thing, 'Now a teacher!' So, I decided, 'Fine, this is what you want me to do? Go for it!' … I decided in the classroom, 'I can mould this life'" (Farida-Dida, Interview Data, lines 29-35). According to Farida-Dida, she did not want to become a teacher. She was called to teaching by circumstances beyond her control, and she had no choice but to accept. When I asked about her teaching philosophy, she stated she learned to motivate her students to overcome social and life challenges so they could exceed expectations and become self-reliant citizens. Accordingly, she had great passion for the girls to excel in science subjects, which were traditionally reserved for boys. "It opens many open doors" (Farida-Dida, Interview Data, line 10-11). According to Farida-Dida, success in sciences may lead to great careers for these students.

She described the type of students she received from primary schools: "They are great children. They join senior one after scoring distinctions in primary leaving examination; I want them to leave this school with an A" (Farida-Dida, Interview Data, lines 43-44). Farida-Dida noted that students were fortunate to be in that school, "in case they forget who they are" (Farida-Dida, Interview Data, line 48). She stated that most of the students came from poor families, and they needed support to become successful in school. She mentioned prominent Kenyans who graduated from Wagagai High School in the past and now they dominate numerous professional fields in the country. She attributed the success of the former students to

the school's high academic standards. "When they arrive in senior one, I ask them, 'What do you want to become?' Then they say, 'Surgeon, doctor, analytical engineer, lawyer,' just the professional jobs" (Farida-Dida, Interview Data, line 35-40).

Farida-Dida stated she guided her students to ensure they achieved their goals in life and taught them how to succeed. She noted she loved teaching chemistry and that is why she volunteered to take part in the interview. In essence, her students were the driving force which sustained her in the teaching profession, and she wanted them to become successful in life. She also told me she teaches her students good character: "I tell them, 'I want two grades, one distinction in the subject and another distinction for character because if you only have a distinction for academics then the character grade will destroy this other one'" (Farida-Dida, Interview Data, lines 44-47).

Farida-Dida emphasised discipline because "science [chemistry] is about discipline; when a class is unruly, the most affected subjects are maths and sciences. Any class I teach, the level of discipline is very high" (Farida-Dida, Interview Data, lines 98-101). According to Farida-Dida, her main goal was to teach chemistry and also take time to advise and guide her students for them to become successful in life. This is consistent with what I observed in the two classes she taught; students were jubilant to see their teacher that morning and they all stood up, greeted her, and welcomed her to the lesson. She appeared to have good rapport with her students. Farida-Dida stated she managed to convince her students that education is the "master key" in life. She noted that they have a saying in other classes to "dodge a lesson at your own risk" (Farida-Dida, Interview Data, line 66).

According to Farida-Dida, when students look at her, they think she is their future. Farida-Dida noted that prominent institutions are awash with exemplars where professionals

scored high in all subjects: Some students say, “I don't need math or chemistry to become a lawyer.” Here is a very open case where a lawyer needs math” (Farida-Dida, Interview Data, lines 66-72). This is one example of the real-life stories Farida-Dida tells her students. She told me when she is teaching, she tells stories to her students to get their attention, to develop a relationship with them, and to relate content to real-life situations. She noted, “chemistry is quite detailed, and I tell them these careless mistakes will kill a pregnant woman who is giving birth. If you make a mistake, the woman will die and the child. We cannot allow you to be a careless doctor” (Farida-Dida, Interview Data, lines 73-76). According to Farida-Dida, chemistry requires a meticulous mind and an eye for details.

In the classroom setting, Farida-Dida told me she had a classroom representative so whether she attended class or not, learning did not stop. She told me when she delayed coming to class, a “student stands up and corrects the work, finds out where it is difficult, and they solve the problem on the board. They do presentations by themselves and the class goes on” (Farida-Dida, Interview Data, lines 86-90). According to Farida-Dida, she intended to make chemistry learning as learner-centred as possible. When I observed her teaching how to balance chemical equations, I noted she rarely completed a problem for the students as the students did most of the work. She attributed this to the strong academic abilities of her students. As she described this to me, she reminded me that there are many ways students can solve a problem: “I let them beat me [compete with me] so they come up with formulas and all solutions so that makes it easy for me. At least I give them the foundation to learn” (Farida-Dida, Interview Data, lines 94-95). She stated her goal was to completely implement these ideas into her classroom practice.

Farida-Dida stated that if she allowed her students to explain their ideas on the blackboard, she “creates” teachers, the class becomes more united, and students do not rely on

her to learn chemistry. When I asked her if her teaching style had any relationship with the students' performance in chemistry, she responded in the affirmative: "I have been able to prove to them that chemistry is not difficult. So, if it is not difficult, it must be passed. So, in their mind they know, "I cannot fail chemistry; it is easy" (Farida-Dida, Interview Data, lines …). Early in the interview, Farida-Dida told me that approximately 76% of the students at Wagagai High School scored straight distinctions in the 2015 UCE results in chemistry. I can confirm this from the summary of performance in the notice board in the staffroom and the school's notice board.

Thematic Analysis

This section describes the six themes that emerged from the data. Not all six themes are evident across all the cases:

1. Competencies in ICT Use Depend on Training Received
2. ICT Use is Enhanced by Teacher Characteristics or Identity
3. ICT Use Depends on Availability of ICT Infrastructure
4. ICT Use is Beneficial to Lesson Planning and Instruction
5. Teacher Collaboration through ICTs has Implications for Performance
6. ICT-enhanced Pedagogy Requires Extra Effort and Time

Competencies in ICT Use Depend on Training Received

When I asked Komakech how he acquired technology skills, first he told me he completed a postgraduate Diploma in computer science, but the courses did not in any way add to technology skills for teaching. The courses focused more on software programming and data

management. However, he said he attended the tooling and retooling programme organised by the Uganda Communications Commission (UCC), in partnership with the Ministry of Education through the Rural Communications Development Fund training program. Nonetheless, he said he did not benefit because "you were crowding on one computer; like ten people on one computer and they taught the very basic skills for starters" (Komakech, Interview Data, line 98-99). According to Komakech, because of the lack of computers at the centre, he did not benefit from the training. He told me his technology skills for classroom use were self-taught from the Internet. He stated, "I have trained myself. You just go to the Internet, for example, if you have something you want to check, you go to the Internet, you Google. You check." (Komakech, Interview Data, line 105-106). When I asked him if he was knowledgeable in any specific subject software for teaching, he told me he was not.

Despite Komakech's experiences, he said technology training should be made mandatory for teachers and certification issued as evidence of training. He added that teachers need to be reimbursed when they spend money on technology training: "If you used Ugs. 500,000 and you bring a certificate, you should be reimbursed. That way, teachers will be encouraged to train. Again, it should be from a recognized university or a college. That way after capacity building, ICT integration will become very easy" (Komakech, Interview Data, Lines 334-337). He provided examples where other government ministries sponsored their employees to go to the university to study, with books and tuition fees all catered for. But in the teaching profession, "there is nothing like that. You go for masters; you pay for yourself and you support yourself. There should be incentives" (Komakech, Interview Data, lines 366-368).

Komakech indicated that time is a hindrance to technology training for teachers.

During the holidays, he told me teachers wanted to relax after working for three months. He suggested that training be made flexible so that "if they also want to train over the holiday, like those who are doing their master's degree during their holiday programs. Then those who want to train in the evening should do like that" (Komakech, Interview Data, line 349-352). According to Komakech, teachers would be free to train at convenient times for them. Additionally, he suggested starting many training centres across the country would ensure teachers attend training at any time of the year.

When I asked Masinde how he learned technology, he said he received some training during his undergraduate and graduate studies after he completed courses in SPSS and Spectrum as program requirements. In addition, he told me he attended technology training programs: "I have also taken several initiatives by attending some empowerment courses in terms of technology, in two weeks, three weeks during the holiday, some courses entirely on ICT and integration in schools" (Masinde, Interview Data, Lines 77-80). According to Masinde, he believed he benefited from the technology training provided through these programs.

I asked him about the technology applications he learned during the training related to mathematics, and he stated: "What they wanted people to learn is the use of email, and e-learning topics from the Internet. They were also exposing teachers to e-materials that the ministry of education had sent out to some schools for use in the classrooms in the sciences and mathematics. There was an element of the smartboard and how to use it, projectors, using the LCD, those are the things we learned there and we felt it was very useful" (Masinde, Interview Data, lines 199-200).

I observed Masinde during one of his classes where he used an LCD projector and CD-ROMs to teach a topic in optimization, latitude, and longitude. He observed, "when the teacher

used technology, initially he [or she] asked the students if anyone was willing to come forward and operate the projector" (Masinde, Observation Notes, lines 42-45). Masinde appeared to be no less confident than his competence suggested.

Additionally, Masinde alleged that although he experienced good technology training at the tooling and retooling of secondary school teachers, many teachers had negative attitudes towards the training during the training sessions. He noted that "the people, who are teaching you, are the same people you are with in the field. Why should I be taught by my colleague whom I think I am even more competent than, in that angle?" (Masinde, Interview Data, lines 206-209). Secondly, he told me teachers were feeling abused because they were not compensated for the cost of attending the training. He stated teachers knew the Ministry of Education officials and trainers were getting compensated, but teachers were not. "The school only catered for transport and lunch, so some teachers withdrew from the training. And accommodation was very poor, in school dormitories" (Masinde, Interview Data, lines 217-219). He told me there was no certification after the training despite teachers dedicating a great deal of time and for that reason, teachers lacked the incentive to attend technology training.

Masinde noted that because of the dynamic nature of knowledge, there is a need for teachers to embrace technology and be trained in ICTs so they are knowledgeable in these areas He gave me an example from when he bought a smartphone and realized he could download information for personal use. He stated, "if I can be able to download the whole physics syllabus content, then I will be able to teach my boys [and girls] even more effectively than the way I am doing today" (Masinde, Interview Data, lines 302-304). Masinde argued that even as the debate to train teachers continues, "the very first people who should be trained I think are the school administrators, so that they can appreciate the usefulness of technology" (Masinde, Interview

Data, lines 242-243). He implied some school administrators lacked adequate ICT skills and therefore were not aware of the important technologies teachers need.

Ochom reported he was dissatisfied with how the tooling and retooling program was carried out. He said teachers developed negative attitudes towards ICTs because "the employer used strong words 'if you don't attend, it is equivalent to forsaking your job'. So, people went there, but grudgingly" (Ochom, Interview Data, lines 188-193). According to Ochom, that statement angered teachers and when the training started, teachers felt coerced. He stated, "teachers want to see the monetary benefit 'will I gain from this training' and when they discover there is none, they forget anything in the training. But the training is intended that it will make the teacher better pedagogically" (Ochom, Interview Data, lines 194-198).

According to Ochom, despite the good intentions of developing competencies for teachers, they continued with the traditional ways of teaching. He noted that teachers would say, "after all, everybody is going on with their business as they have known how to, so why am I to do things differently? Let me continue with my normal life" (Ochom, Interview Data, lines 202-204). Ochom saw this rigidity of not wanting to adjust to something new and different as the reason teachers' competencies were lacking. In fact, he lamented that during the training, he was guided to be an ICT trainer, and noticed "fewer attended the training and so forth... some have, some have done nothing after the training and so forth … but those were the people" (Ochom, Interview Data, lines 23-25). From Ochom's experiences as an ICT trainer teacher, there was evidence that despite teachers being trained, they most likely were not confident in their competencies.

One interesting point mentioned by the other teachers interviewed was the limited skills for the trainers. Ochom explained:

> Most of the fellows [i.e., primarily men] who do the training are fellow teachers who are known by some of these teachers and if they are known, some of them are known, even their grades are known, their qualifications are known by their peers and their peers wonder which authority these fellows or expertise these fellows carry to come and tell us what they are telling us. (Ochom, Interview Data, lines 207-212)

These trainers, according to Ochom, had no idea what technology was about: "they think that training teachers on Excel, Word, that will be sufficient for integrating technology in the classroom" (Ochom, Interview Data, lines 226-228). Ochom believed the required competencies for adopting technology must be in addition to skills involved to use Microsoft Office.

Whereas some trainers taught limited technology integration skills to teachers, teachers did not see the benefits of training. Ochom stated that the trainers were not acting as exemplary teachers because during the workshop discussions, "they tell teachers something and when they have their normal discussion, they would tell them 'these things we were saying just for saying' [laughs]. But they don't themselves practice what they are talking about" (Ochom, Interview Data, lines 213-216). He continued: "If the teachers are engaged further in class, in school, so that they have someone they are walking with towards a particular pedagogical concept, which they need to work on, it will enhance the program. But since that seems not to be there, follow-up seems not to be there, it disappears" (Ochom, Interview Data, lines 218-222).

Akite said she received one in-service training session on the use of ICTs during the tooling and retooling of teachers at one of the schools that served as a training centre in the region. She described the training as not very helpful: "It was not that…, let me say it was not

that, really expansive, but... let me say quite a number of things I had already known even before" (Akite, Interview Data, lines 29-30). According to Akite, the retooling session's competencies were similar to what she acquired during her Master's degree program. She noted, "well, they actually gave us those websites [URLs], but it is not like we really used them, but they just gave us. You can go to this site and download this and that. But I did not use it actually" (Akite, Interview Data, lines 50-52). According to Akite, despite the training she received, she did not implement the skills in the classroom.

When I asked who led the technology training sessions, she responded, "the training is done by other teachers who are like us, who were trained early. Now who trained them? Actually, I cannot tell because the people who also trained them are also teachers and some of them are heads of departments" (Akite, Interview Data, line 148-151). One of the senior teachers at her school was also a trainer. This teacher, according to Akite, did not qualify to train teachers for ICT competencies. When I asked her about her competencies and how she used them in the classroom, she told me that "maybe PowerPoint to present, what else? Or online videos. But Word… unless typing the quizzes and all that" (Akite, Interview Data, line 162-163).

Nabatanzi attended the retooling workshop in 2015 and a second one that was organised at a regional level. She was dissatisfied with how the training was organised. Teachers developed negative attitudes towards technology because

> the employers especially in private schools were threatening teachers with losing jobs if they didn't attend the workshop. Well, many were present in body, but mind and spirit were absent. Or, they reported to the workshop venues, signed in and went out on private business. Teachers were crowded and nobody noticed. (Nabatanzi, Interview Data, lines 108-133).

According to Nabatanzi, using jobs as coercion angered teachers and, when the training started, they felt pressured. Thus, even though the teachers went for training, they had negative attitudes. Nabatanzi noted that what angered teachers even the more was that they were not paid any allowance and so they didn't see the need to take on extra responsibilities that did not come with compensation. She stated, "teachers want to see the monetary benefit and when they discover there is none, they don't take it with seriousness even when the training is intended to better them pedagogically" (Nabatanzi, Interview Data, lines 294-298). According to Nabatanzi, despite the good intentions of equipping the teachers with classroom skills, teachers refused to implement the skills they had learned, and they continued with the traditional ways of teaching in their subjects. She noted that teachers would say, "I don't even have a computer, I may never own one and, somebody wants me to teach with what I don't understand… [laughs], why should I stress myself" (Nabatanzi, Interview Data, lines 321-340)?

An interesting point mentioned by the other teachers interviewed was the limited skills of the trainers. She told me, "most of the trainers are colleagues who we knew…we knew they don't know a lot of things, so the predisposition of who they were, their competencies, all together did not form a good learning environment (Nabatanzi, Interview Data, lines 357-359). She noted that: training teachers on basic knowledge, like powering on a computer, MS word – with no or little practice is not sufficient for integrating technology in the classroom. (Nabatanzi, Interview Data, lines 379-383).

At the time of this interview, Mafabi had not yet received technology training for mathematics teaching. However, he told me when an interactive whiteboard was installed at his school, he was trained on how to use it, in addition to receiving some training on ICT competencies. When I asked him why he had not yet trained at the popular tooling and retooling

program for teachers, he answered that his school did not send any teacher for the training. He stated the school had some financial issues which they were trying to resolve. Mafabi also questioned the trainers' competencies, saying, "basically, I doubt if they [trainers] use [ICTs]. Basically, they encourage the use of models, use of pyramid models, especially the use of three-dimensional models" (Mafabi, Interview Data, line 70-72). I observed Mafabi had some teaching models lying on the table in his office. When I asked if he used the models, he responded, "they help students to visualize more of the content. You can imagine you are trying to draw on the blackboard and you are telling the students perpendicular height; it is a bit difficult for us. They are for the teacher to demonstrate" (Mafabi, Interview Data, lines 77-82). He elaborated: "we have just moved from doing [things] manually and [with] analogue where you have a secretary and an old typewriter and therefore, very few people understand computers" (Mafabi, Interview Data, lines 235-238). Likewise, Mafabi believed the Ugandan teachers were not ready to take up technology in the classroom because they had inadequate ICT competencies. To address this problem, he said he would challenge the government to consider:

> When you are training the teachers, can you integrate [ICTs] in teaching mathematics so that mathematics teachers, as they leave university, can be able to, one, develop the content themselves; two, they can be able to use technology themselves, so first of all they would start with university, and give them the skills. Then those who are in the field, they should roll out the in-service training. (Mafabi, Interview Data, lines 300-305)

Building on this, Mafabi observed: "Most of the young people who are coming from the university are not equipped, mathematically they are not. They can use [ICTs], yes, but mathematically they cannot" (Mafabi, Interview Data, lines 357-363). He added that a pre-service teacher may be "taught how to plan for a lesson, but practically it is on paper. He [or she]

has been trying here and there managing these times, following the schemes of work, covering [the syllabus]; that requires a lot of time, [and] is a bit of a challenge. So, he [or she] does not know how to balance all that. Again, if you introduce a new concept in [ICT], I think it will be a struggle" (Mafabi, Interview Data, lines 407-412). That is what he called the balancing act. When I asked Mafabi how he had grown as a teacher since he started teaching, he reflected:

> You know at the university we would do advanced calculus, complex analysis – most of which we do not apply here. Mostly you don't use it in daily life, and also you don't teach it. So that all that disappears, but this guy [i.e., himself] has gone so advanced, very fast knowledge, but now that fast content that he knows here (points to head), areas of difficulty to this young learner – he [or she] does not have that. (Mafabi, Interview data, lines 382-395)

Similar to the others, Farida-Dida attended the Secondary Science and Mathematics (SESEMAT), a professional training program for strengthening science and mathematics teaching and learning in Secondary Education. "At this program, they teach us how to teach science and maths using computers. It has been there for a while; sometimes we go during the holidays" (Farida-Dida, Interview Data, lines 124-127). She was taught to use "PowerPoint, how to use YouTube, to get some questions, drawing of graphs" (Farida-Dida, Interview Data, lines 128-129). Despite been trained, I did not observe Farida-Dida using ICTs during the lessons. She indicated that teachers disapproved of the kind of training teachers received from the government:

> We have told them that it cannot work. They know. Can I speak the truth? Because some people are eating [benefitting financially] from this program… the project would rather go on but not achieve its objectives. Things haven't changed at all. Teachers attend the

> workshops and come back and teach in the same old way. The project has failed. Why continue and there is no improvement. It is because it is funded and there is... money! So, it continues even with very negative teachers. They have not won us in their project and therefore cannot be implemented. (Farida-Dida, Interview Data, lines 206- 213)

Farid-Dida admitted that during these sessions, she sometimes signed-in and then eventually left. Farida-Dida appeared visibly irritated when she described her training experiences. According to her, these sessions were held during the holidays when she wanted to be with her family or when she was tutoring struggling students to gain extra income. She stated that many Ugandan students have difficulties in mathematics and sciences, and during holiday sessions teachers often help these students, and parents pay them a stipend:

> So, when you call us for an in-service where we are not earning, and we are also underpaid, we are about to go on a strike again [Ugandan teachers went on strike from 16 September 2013], then you are telling me to go for an in-service when I can teach during holidays and earn 500,000 shillings [CAD 200], I will be negative. So, I would rather be left alone [laughs]. That is a way of taking the money away from me and the salary I get; I deserve a holiday. I don't want projects; we don't earn a single cent and they are being forced on us. (Farida-Dida, Interview Data, lines 221-227)

She emphasized that teachers need to be well compensated when they attend these sessions and housed in good hotels. She alleged that some facilitators who trained teachers were selected through nepotism. When I asked her to clarify whether the facilitators, she was referring to were technology trainers, Farida-Dida stated, “Yes, they are not trained themselves... So, when they come, they don't know what to do. They start depending on the same teacher to tell them what to do, so we don't take it seriously” (Farida-Dida, Interview Data, lines 236-238). According to

Farida-Dida, because the trainers were not well equipped with technology skills, they depended on the teachers attending the training for support. She added, “At the same time, we have the challenges of the school administrators who are also not computer literate” (Farida-Dida, Interview Data, lines 260-263).

ICT Use is Enhanced by Teacher Characteristics or Identity

According to Komakech, a teacher’s age plays a predominant role in determining technology adoption. He explained, as the Head of the IT department, “when I put a notice on entering students marks in report cards and evaluations, the young ‘Turks’ are there with their marks. In fact, they come with marks already in soft copies in Excel. I just need to show them how to import, and they get down to work” (Komakech, Interview Data, lines 254-256). Accordingly, he observed, younger teachers are more enthusiastic about ICTs while working with the school’s examination system, whereas, the older teachers were more technology shy. About the older teachers, he noted, “if I had set a password for them, they never remember it. You have to reset it; you have to show every step. It is a big challenge” (Komakech, Interview Data, lines 257-259).

Regarding gender differences, he suggested that female teachers were embracing ICTs but not as quickly as their male counterparts. However, he believed it to be a matter of attitude. As he stated, “now there is a lady with a laptop; that lady is in ICT, business studies, and mathematics. I don't think there is somebody else who has a computer. Let’s say in terms of ICT we are lagging behind” (Komakech, Interview Data, lines 377-379). He implied that technology adoption was not necessarily a gender issue but rather an issue of attitude.

When I asked Masinde whether gender was correlated with ICT adoption, he agreed that he does not know of any female teacher who has taken a leading role in ICT adoption, and he noted that the field was dominated by males. On the flipside, he stated that "it depends on the exposure one gets and the attitude. Like here, I am the only male mathematics teacher. The rest are female, and they are doing very well with technology" (Masinde, Interview Data, lines 408-411). Therefore, according to Masinde, ICT adoption was a matter of attitude and the extent of exposure and not necessarily a gender issue.

When I asked Akite if she agreed with claims men were more likely than women to adopt ICTs, she responded, "I think I would agree in the sense that I find men more interested in what is happening, but us [women] we are more contented. I find that it is very hard to be investigative. I think it is true" (Akite, Interview Data, lines 122-124).

Ochom told me that along with teachers' lack of exploration of ICT adoption strategies and phobia, there was a general tendency of being "very conservative". He stated:

> We want to do things the way we know how to do, and technology has not been there, and we also teach our subjects because we learned them in school, so we basically teach like how our teachers taught us. And because we excelled with how the teachers taught us, we think anybody would pass with how my teacher taught me and that is why because my teacher never used the computer, never used technology, I have no business using technology. (Ochom, Interview Data, lines 375-381)

Ochom was convinced that despite teachers having access to ICTs, resistance to change was a main reason why teachers were not adopting.

When I asked Mafabi whether the teacher's age was a limiting factor to technology use, he stated, "Yes, yes. The older you are, the less receptive to change. I have observed that through

teaching. In fact, like the training we had here, anyone who wants to be trained on computers? No, they don't have that time, the older teachers" (Mafabi, Interview data, lines 346-349). He believed that older teachers were preoccupied with other things in life, and they were often unwilling to change practices and routines. He compared older teachers with younger teachers, whom he characterized as eager to learn new concepts, more,innovative, and likely to adopt ICTs. However, Mafabi did not find younger teachers, fresh from the university to be well equipped with ICT teaching skills. He noted that because the government had slowed their efforts to employ new teachers, there were more older teachers in schools: "The older generation is more and more in schools, and the younger generation are very few" (Mafabi, Interview Data, lines 421-422). Mafabi stated that the government only fills an opening when a teacher leaves the profession.

Mafabi proposed in-service training as a solution to teachers adopting more ICT in the schools. In his opinion, teachers "above 40 are not willing to learn, they will refuse" (Mafabi, Interview data, lines 427-428). To him, the solution was to "do some in-service, introduce it, implement it, and make it mandatory to curriculum" (Mafabi, Interview data, line 430). He took a hard line: "if you don't do it, you don't qualify to be a teacher. You are not offering what is required of you; you must make it mandatory compulsory for them to be able to use it" (Mafabi, Interview Data, lines 431-433).

Farida-Dida stated that despite many challenges inhibiting teachers' use of ICTs, their lack of interest was considerable: "I am going to be very sincere; the interest is not there. You know this better. I have not seen anybody with interest. The saying that you cannot teach an old dog a new trick; we are not old, but it is hard" (Farida-Dida, Interview Data, lines 136-137). According to Farida-Dida, it is not age alone that hindered teachers from using ICTs; rather it

was a dislike of new things: “I would rather stick to my book, go teach, just stick to the old methods of walking in the class having nice time, stories, teach, go, and [the] main one is where will they use it?” (Farida-Dida, Interview Data, lines 139-143).

ICT Use Depends on Availability of ICT Infrastructure

When I asked Komakech if his school supported him to adopt ICTs, he mentioned the four smartboards. He then noted, if the smartboard in the library was moved to a classroom, “it could be put to good use. There is a very high demand. You want to use it, another teacher has booked it” (Komakech, Interview Data, lines, 131-132). He suggested:

> Every class should have a screen and a desktop, a projector, LCD, and a desktop. So that every teacher, even those who have phobia using computer can go, maybe a topic, like just display it there. If it is a question, you display, then we encourage everybody to use technology. Or maybe the school can buy a laptop for every teacher, not free per se, but a place where you are given a computer worth Ugs. $800,000, then you pay for it in instalments. That way you cannot keep it in the house. (Komakech, Interview Data, lines 323-329)

Komakech’s views were reaffirmed by nearly all the participants when he stated ICTs should be available in all classrooms.

He described the frustrations he experienced in his efforts to seek technical support from the computer department. He relayed a story about a “good Samaritan” who donated a technology system for examinations, but the technician who doubled as an IT teacher for the lower classes was unsupportive. Because of this, Komakech took matters into his own hands: “I got some training and the system is here with us. So, the IT [technical staff] is not

supportive" (Komakech, Interview Data, lines 140-141). He concluded that technicians are overrated.

During the interview, Masinde asserted he had the necessary skills, but the school did not provide the equipment for teaching mathematics. He elaborated, "this school of ours, surely, it can afford five laptops so that at one time when you are teaching four classes every teacher goes with a laptop. But they are not ready to do that, they say it is an expensive venture" (Masinde, Interview Data, lines 247-249). He included an example of how he constantly asked the school to buy a flash storage drive rather than a CD-ROM for his teaching needs with no response. He lamented, "if the administrators could understand why I needed the flash disk [and not the CD-ROM], then they could easily get it for me … they are not expensive" (Masinde, Interview Data, lines 270-271). Masinde told me he bought his own flash disk, but that was for his own personal use. He continued, "the Internet element, the school needs to provide, not this business, a week there is Internet, next week there is none. If the school can invest a little bit more, that whenever you want to access it, there is no limitation" (Masinde, Interview Data, lines 272-275).

Also, Masinde's school lacked technology infrastructure. The classrooms did not have stable electricity and power supplies. He noted, "if you have a computer, you need power. If you need to take those LCD [projectors] to class, then you need power. There is no stable power supply because of load shedding" (Masinde, Interview Data, lines 282-284). When I observed him teach using ICTs, there was a general lack of facilities, such as desks and computers for the students. Students were seated crowded together in the room, all trying to get a glimpse of the screen. He noted,, "when you are there, you just give your input, where you know you cannot ask

a computer a question, but the students can ask you about a point here and there, how it is going" (Masinde, Interview Data, line 311-313).

Masinde looked forward to when there will be computer systems, when desks will be available for the students, and when they will be able to access the Internet. He clarified: "you can even have a system whereby, say there is a computer room, from this lesson of mine I can prepare a lesson, from here post it in their classroom, and they can even interact. I don't have to move" (Masinde, Interview Data, lines 323-325). Masinde wondered, "why are the Japanese are doing so well in mathematics … as opposed to Uganda where mathematics is a dilemma. I would like to think that technology is playing a great role" (Masinde, Interview Data, lines 333-336). He suggested that funds should be set aside that "have nothing to do with the normal recurrence expenditure in the Ministry of Education. No, like the way they are putting aside a fund for the youth and women" (Masinde, Interview Data, lines 401-403).

When I asked Ochom how his school supported him to integrate ICTs, he answered, "to some extent there is infrastructure. Because there is infrastructure, at least I can use the infrastructure in my own way" (Ochom, Interview Data, lines 241-242). He explained, "something I can do on my own, without involving somebody else, becomes easier to do than when I involve others" (Ochom, Interview Data, lines 245 246).

When I observed Ochom's class, he had a smartphone to record lessons so he could reflect in his free time. Ochom owns a laptop and a modem he uses for his classroom teaching. He noted, "basically all my lessons I have done on my laptop. Though the school has laptops, I don't think I have used the school's [laptop]. I have used my own" (Ochom, Interview Data, lines 395-397). "One of the reasons that I have not used the school computer is it is not sufficient for all of us", he explained. "And the schools will give priority to the secretary to do the

administrative duties with it rather than for learning purposes. So, it cannot be available for all of us. It seems like it is not enough, so we are competing for it" (Ochom, Interview Data, lines 399-403). Continuing, he said:

> I think the idea of bringing computers into the computer lab has also brought a wrong impression; these computers are for every teacher teaching any subject, but they are seen as those meant to teach computer studies. One subject instead of all subjects, which again is erroneous, and the teacher insists of being in charge of the computer room and when the teacher is not here, the room is locked and to access it, one has to really explain. (Ochom, Interview Data, lines 403-409)

When I asked Akite what resources she would like to have in her classroom, she answered, "maybe more laptops and projectors. We only have one projector, and I think each department has a laptop. And you know I can go to class and I have a class and another teacher has a class. There is that … maybe additional laptops" (Akite, Interview Data, lines 144-146). According to Akite, the school had one projector and every department had a laptop.

Nabatanzi reported that her school supported her to integrate technology in teaching: "there is a bit of infrastructure, though very small. It's still a budget problem to the school administrators. You need to service the computers or buy new equipment and the answer is always… 'that budget is too big' and we cannot afford, so we as teachers try to lower it" (Nabatanzi, Interview Data, lines 430-437). She had purchased her own technology to use for educational purposes because small things that one may ask from the school may take too long to be provided. Nabatanzi stated that the school's Internet service was very weak, and the school did not appear to be in any hurry to improve it. But to ensure her work did not stop, she used her mobile phone to access the Internet.

When I observed her teaching, the electricity went off a few minutes into the lesson and the school did not have an alternative power source. The lesson then continued the traditional way, meanwhile Nabatanzi referred to her smartphone all the time. In addition to the smartphone, Nabatanzi owns a laptop and an Internet modem that she uses for her classroom teaching. She noted, "basically all my lessons I have done on my laptop. Though the school has its laptops, I don't think I have used the school's [laptop]. I have used my own" (Nabatanzi, Interview Data, lines 495-497). I asked her why she does not use the school's laptop, and she answered:

> I don't use the school laptops because they are not enough for the teachers and administrators at the same time. And I think my laptop is a more updated version from what the school has. And schools give priority to the secretary to do the administrative duties with it rather than for learning purposes. So, it cannot be available for all of us as teachers. (Nabatanzi, Interview Data, lines 499-503)

Mafabi's school's computer lab, until recently, had few computers, and some were old and non-functioning. The students avoided the lab, and thus "they opted for other subjects like music and other options like agriculture and business" (Mafabi, Interview Data, lines 101-102) at ordinary level. However, the computer lab improved after a donation of 60 computers from an organization. Mafabi reported that hardware was not very useful without additional software and applications: "you try to check, especially the Uganda curriculum; if you look for what others have done, it is difficult so that you have very few points of reference… that you can base your work and time involved in preparation" (Mafabi, Interview data, lines 133-135). In the mathematics content area, for example, Mafabi noted that with existing software, "most of the concepts that were there were for lower classes of students, like the younger ages, like drawing

curves. We want very accurate curves, those ones would draw a bit inaccurate curve" (Mafabi, Interview Data, lines 137-142).

Mafabi mentioned he wanted an application for graphing: "personally, I don't know how to draw a graph if I insert it… somewhere here, real life, and you wanted to draw a graph. I don't know how to accurately plot and draw a graph. (Mafabi, interview data, lines143-147). When I asked him what software he was familiar with, he replied "basic Microsoft Word. I don't know any other apart from this software. And you realize that this is a bit clumsy, you cannot insert a video that is not done by using Windows" (Mafabi, Interview data, lines 150-152). Because of these challenges, Mafabi did not use ICTs in his classroom.

When Farida-Dida explained why she did not use ICTs in her teaching despite being trained, she replied: "there is no projector and there are not enough computers" (Farida-Dida, Interview Data, line 130). When I observed her lessons, the classroom did not have any ICT infrastructure or related resources. She stated there were 20 lessons per day, and the school had 25 classrooms. Hence vast resources would be required to acquire computers for these classrooms. Nonetheless, the school had an extensive computer lab. I asked Farida-Dida if she knew what went on in there: "Well, we have never even bothered" to look she said.

> I hear that they teach computer literacy and it is mainly for the computer department, and maybe they would not want any other department to interfere. Because you bring some information in a flash disk and they bring viruses and they complain, and I don't know what… To avoid all that, stick to your piece of chalk and textbook. So, going there, starting to request and they also have [inaudible] because every class learns computer in this program, so it is like every lesson there is computer; when will the chemistry teacher now come in? (Farida-Dida, Interview Data, lines 155-162)

From Farida-Dida's perspective, the computer department at her school is a hindrance to ICT adoption. The lab was very busy because all students were required to take a computer class. In reference to the neighbouring country of Kenya, Farida-Dida described a program of implementing laptops in primary schools, and wondered how teachers in rural schools struggled with ICT adoption. "It is the same thing here; there is no stable electricity in this country and infrastructure. Children are learning under trees. So, is it taking computers to the room, no electricity, nothing?" (Farida-Dida, Interview Data, lines 240-245).

ICT Use is Beneficial to Lesson Planning and Instruction

According to Komakech, his goal for using ICTs was to support students in understanding and having a hands-on experience. In a subject like mathematics, ICT made dealing with difficult topics easier, such as three-dimensional geometry, longitude and latitudes, and loci. When I asked how ICT helped teaching such topics, he stated, "in the case of the loci, you go to school and ask them, what it is in day-to-day life, they won't tell, and technology helps in bringing in the real world" (Komakech, Interview Data, lines 49-50). He continued, "after showing how we get the loci, we describe the loci, then you bring the video of the road. How it has [inaudible], there they will see the same thing, then the railway line. So, it helps" (Komakech, Interview Data, lines 51-53). On the blackboard, he said, "you are telling them it is a cuboid, or a pyramid, and when you try to bring the vertex in the middle, it does not work. If it is drawn using technology, you just display the diagram and use it" (Komakech, Interview Data, lines 58-60). He noted, "I can come here at 8 am, I have a class at 8:20 am and I have revision questions for the students. I just prepare and print, and the work is done." (Komakech, Interview Data, lines 269-271). Komakech implied that technology enabled him to prepare his class in as

little as 20 minutes with worksheets ready for the students. As he responded to me, he appeared visibly irritated by certain teachers who were not making efforts with ICTs.

Komakech described his frustration as the Head of the IT department as many teachers still relied on handwritten work. He stated, “before I bought a laptop, I used to pay somebody to type questions for me, at a café or a cyber bureau. You don't have time” (Komakech, Interview Data, lines 229-231). He told me that one challenge is the school has no platform for working with students online. “If we had a place where students and teachers interact online, then it would be easy to give a test and other assignments to increase the speed of working” (Komakech, Interview Data, lines 219-221).

When I asked Masinde how he thought ICTs were related to students’ learning, he suggested that ICTs would change students’ attitudes about difficult concepts in mathematics. He gave an example: “If you draw a circle on the board, it becomes very difficult to draw the spherical one. You have to do it in a circle form, but students are supposed to visualize it in a spherical form. But with the [technology], that picture is brought right in their face” (Masinde, Interview Data, lines 346-349). He made reference to the lesson I observed and how ICTs helped students visualize the distance concept: “But you know that technology can show them easily. Like if you are flying from here, it will take this time. If you move over here, it takes this time and the distance is the same. That becomes more real. That becomes more fun; it changes their attitude. It will make them love the subject” (Masinde, Interview Data, lines 353-356).

When I asked Ochom how he thought ICTs supported student-centred learning, he stated:

> In many ways … number one, technology concretizes what we call abstract learning. There are some ideas that are difficult for a learner, which may require somebody else to explain and visualize. But just an explanation by somebody else may not be clear to

> them. However, if they are able to work with technology, manipulate some of those technologies like a simulation, it is easy for the learner to see for themselves and therefore the idea becomes concrete for them without remaining abstract. (Ochom, Interview Data, lines 55 61)

Ochom reported that he selected an online video and played it for the class. He asked students what they were thinking about during the simulation. He told me the students were able to understand the concept and ask more questions for clarification. When I asked, if the Uganda Certificate of Secondary Education could be a hindrance to ICT adoption in geography, he exclaimed:

> if a teacher focuses sometimes on thinking about examinations, they are likely to be distracted and think technology does not work smoothly, but if one has to integrate, that is using technology smoothly as if it is part of the material that should be taken to class, it does not hinder. For me, it enhances coverage actually faster. In some cases, I have used technology and covered greater content in a shorter period of time, which gives me more time for assessment … just take a break. (Ochom, Interview Data, lines 103-109)

When I asked Ochom about the ICTs he used, he answered, "I have used a number of technologies. Google Earth is quite dynamic for geography and it is actually useful in many instances because one of the things with Google Earth is it can be manipulated. It can also be animated … animations are particularly very impressive to students. And when students see some motions it becomes more interesting" (Ochom, Interview Data, lines 112-116). He continued, "I have also used YouTube for teaching purposes. Some of the concepts we handle in class require that the teacher also displays a simulation for students to fully understand" (Ochom, Interview Data, lines 116-117).

I asked Akite what she thought about teachers' perceptions of technology, and she replied that teachers are very positive because they were aware of the changing world. However, she told me teachers complained about the computer studies department "not (being) very supportive. There is just one computer lab and lessons run simultaneously, and we cannot all go there, you know, those kinds of things. There is that problem" (Akite, Interview Data, lines 116-118). I asked Akite how she would use ICT to teach the lesson on drawing a cross-section which I observed. She answered:

> If I would show them the plotting points – that these two points should form a straight line. So anyway, I guess there must be something in technology to show them. They cannot see the different contour lines and elevation points; it is like drawing a line like this. They can see. I think this would help them. Constant circles are more or less the same. (Akite, Interview Data, lines 89-95)

In addition, when I asked Akite how ICT adoption in geography lessons would change her students, she asserted, "it will change them in the way they view things. There are some things that look abstract, and they will look okay. When you are talking about gradient and slope, you are seeing such kind of things. Maybe when you are talking about rotating of planets, and they can see" (Akite, Interview Data, lines 172-175). I asked how she thought ICTs would help, and she elaborated:

> I think the teacher will now be getting more prepared in the lesson. Because I can tell you, you know I have told you, I have taught for 20 years. Now tell me I go to class and I ask which topic and I go [laughs]. I will not sit to decide, I will approach it this way. But when I have the ICT with me, I have to make sure things are working, and this is how I

> am going to approach it, you know … Maybe it will just make us better prepared. (Akite, Interview Data, Lines 177-182)

After 20 years of teaching, Akite was very experienced in terms of pedagogical and content knowledge.

When I asked Nabatanzi how she thought technology would support student-centered learning, she responded:

> In many ways… like for me as an IT teacher, almost all my lessons are hands-on. And also, technology concretizes what we call abstract learning. There are some ideas that are difficult for a learner, which may require somebody else to explain and visualize. But just an explanation by somebody else may not be clear to them. However, if they are able to work with technology, manipulate some of those technologies like a simulation, it is easy for the learner to see for themselves and therefore the idea becomes concrete for them without remaining abstract. (Nabatanzi, Interview Data, lines 55-61)

When asked if the Uganda National Examination Board (UNEB) was a hindrance to ICT adoption in teaching, Nabatanzi said: "For me as an IT teacher, I have to prepare my students for UNEB. So, it is part of my work. For teachers from other subject areas, I think for many, technology is a hinderance, as they struggle to complete the syllabus before examinations time" (Nabatanzi, Interview Data, lines 114-119). Thus, Nabatanzi views technology as a subject to be passed like other subjects.

When I asked Mafabi about the benefits of ICT- enhanced instruction, he had some reservations for subjects such as mathematics. He believed in a "50-50 approach [half of the time]" where there was no break from traditional math instruction. He explained that most students "feel 'if I can key in the values and give me the correct answer then why should I

struggle, showing how I worked it out.' So, it is a big problem we are facing currently" (Mafabi, Interview Data, line 284-286). In his school students were not allowed to use the Internet. According to Mafabi, "if they were allowed, they might, I believe they would, also increase their knowledge ability and widen their scope of learning" (Mafabi, Interview Data, lines 185-187). Mafabi nonetheless found "graphing using visual [technology] is better than blackboard because you will be able to label correctly" (Mafabi, Interview Data, lines 143-146). In his response to why the Internet was regulated for students, he told me the school did not have software that limited websites. He was aware "of the negative information [students] can get from [the Internet], which needs a lot control" (Mafabi, lines 195-196).

Farida-Dida also advised caution when teaching with ICT. She feared students would not think anymore if they used ICTs to learn chemistry:

> Just key in and the computer does it for you. That, according to us, there is no learning. The child does not know how to balance a chemical equation. The computer is giving you the final answer, the child must know how they arrive at those figures. The equation, the computer solves it for you. So how will the child learn, and these are teenagers, once they know there is a loophole for just keying in information and everything is done for them, they will never learn. For instance, if I take them to the lab and then the white paper turns blue or red and the two are not [inaudible] so… the child is interested in the final result and not how to go about it… unless the testing in chemistry changes; it is about process. (Farida-Dida, Interview Data, lines 166-177)

She continued on this theme, explaining that "because it is that skill of doing that makes them good doctors, that thing of just being tough, being careful that this is negative and this was positive, that is what they will transfer in their progression in their daily life. It is not tap, tap [on

a keyboard]" (Farida-Dida, Interview Data, lines 184-187). I asked Farida-Dida if she discussed issues about ICTs with her students. She responded she had, and it was exciting.

Teacher Collaboration through ICTs has Implications for Performance

Komakech's school had a stable internet connection in the computer block housing labs and administration offices. He said "if I am preparing a lesson and I want a definition, I just Google. I prepare here in school so that it saves time" (Komakech, Interview Data, lines 175-176). When I observed his class, he showed me a collection of videos he downloaded from the Internet for IT and mathematics. He noted that videos save time because "if it is, let's say rotation in maths or something in IT, you just put it up there and the students will see it. If it is opening of common solids, you just click, they see how" (Komakech, Interview Data, lines 178-180).

When I asked Masinde how he used his mobile phone, he told me he used it to "Google" and communicate. As an example, "the other day he [a student] was asking me about the formation of an ox-bow lake in geography, and I had very little knowledge about it. I just Googled that for him and gave him the answer. He has asked me things to do with physics measurement and conversions, and Google gives the answers. (Masinde, Interview Data, lines 88-91). Masinde said school administrators were encouraging teachers to collaborate. He noted teachers responded well to this call. Outside of school he was collaborating with colleagues: "Anything I want, I will get from them, like exams they just post to me. I give it to my boys [i.e., class consisting of boys]… Wednesday this week I was doing a practical that was posted to me" (Masinde, Interview Data, lines 371-373). Below is Ochom's response when I asked about his smartphone:

> I have had the opportunity to look up information from the Internet on how to use simulations to explain concepts like continental drift theory, sea floor spreading. My phone has helped to get that information online. The same has enabled me to prepare items in Google form where learners have participated in answering questions online. And it has been because of my phone. The same has enabled me to prepare lessons using Prezi software. It is the phone that has enabled me to do that. (Ochom, Interview Data, lines 270-276)

He explained that through the use of ICTs, "you can see the teacher is being able to be supported by getting information on how to manipulate particular aspects of software in order to make learning richer. That is one way the Internet is a good resource, is an advantage" (Ochom, Interview Data, lines 296 300). In addition, he emphasized the Internet was a major contributor to teaching and learning geography because it enabled teacher-to-teacher and teacher-students collaboration using "some services online, like doing Google groups; you cannot do them offline. You do them online" (Ochom, Interview Data, lines 302-303). He explained, "one sits at their convenience [own place] to access others or members of groups they are in, or the teachers for that matter. Discussions can go on and assist other people because people comment on particular parts of that course" (Ochom, Interview Data, lines 305-308).

I asked Akite if she had access to the Internet, and she said she used the Internet for private communication and not for teaching and learning at Kasanvu High School. "The school is equipped with the computers, the Internet is there," she noted. "I am able to browse when I want. I do it in the staffroom; there are four computers" (Akite, Interview Data, lines 71-72). "I use Google and I type in the topic I want, and I print. If I want rocks, I want weathering… I have so many papers that I have downloaded. I don't key in on a particular website, but I get quite a

number of questions. But mostly I use them with those students" [she tutors during holidays] (Akite, Interview Data, lines, 36-40).

Mafabi told me that although he had a mobile phone, he did not use it to access the Internet because his school had fast and reliable Internet access. He reasoned, "if I can be able to network the computers, I will simply tell the students 'Can we go to open a certain folder?' and I place an assignment there" (Mafabi, Interview Data, line 177-181). Mafabi continued with this thought, saying, "I can share a concept I taught. Another teacher can do that– place it there and they can also be able to benefit from the content that has been done by somebody" (Mafabi, Interview Data, lines 178-180). He gave an example of a teacher who was very good at graphing: "I don't know how he was doing his graphs. There is a graph he forwarded to me that he had drawn very, very well; that one I would have loved to learn" (Mafabi, Interview Data, lines 156-157).

ICT-enhanced Pedagogy Requires Extra Effort and Time

Komakech felt he did not have enough time to prepare ICT-enhanced lessons, however teaching IT as a subject was not a problem. He found software for other subjects, such as graphing software for mathematics, to be time consuming. He elaborated, "for you to have that confidence to use some of the software, you must use it before you go to class, sometimes you don't even have time to prepare and you just go to the board and tell the students to draw" (Komakech, Interview Data, lines 73-76). He was reminded of a teacher who was using the technology at his former school, and students complained they did not want him to use technology because he did not quite understand it and was wasting time. In such a scenario, Komakech explained, the teacher would have to create time to prepare ICT-enhanced lessons and

know the approaches and the strategies to use: “if you have a lesson at 2 pm you need to be in the lab 30 minutes before. Sometimes this is not possible if lessons are back to back and another teacher is in the lab using the same equipment. That is when you don’t have time to do preparations” (Komakech, Interview Data, line 188-190).

Masinde had many obligations during the school term. He was Head of the mathematics department in addition to completing the course syllabus as early as possible. When I asked him at what point he would complete the syllabus, he replied:

> We are trying; we are actually, on the last two topics. Our objective as a school, we focus on completing the syllabus by the end of July, that is, by end of next month. But we still need to improve on that. If we can clear the syllabus by the first term of the year, in the candidate classes [senior 4 and senior 6] that would even be better, if circumstances allow. (Masinde, Interview Data, lines 140-144)

Although Masinde never mentioned how extra responsibilities at the school delayed his goals of preparing for ICT lessons, other participants like Akite and Ochom informed me how these extra duties hinder them in adopting ICTs. When I observed Masinde use ICTs in class, he asked the students if anyone was willing to come forward and operate the projector. There were some students who had knowledge of setting up the LCD projector (Masinde, Observation Notes, lines 42-48).

Ochom was an ICT trainer, so he had many obligations, and being the Head of the geography department left him with little time to prepare for ICT-enhanced lessons: “Preparation of these technology lessons takes time, which time I don't have. So, you are loaded with a lot of which you are in charge to look at. Therefore, technology sometimes is missing given that we

have begun working with technology as adults. So, it comes as a strange thing" (Ochom, Interview Data, lines 315-319).

When I asked Akite if she used project-based learning with her students, she answered "no, as I was saying because of the syllabus – we cover the syllabus during the term, so not unless we tell them to do a topic on their own – when they are going for holiday, you give them an extra topic they cover from the textbook" (Akite, Interview Data, lines 139-141). This suggests how difficult it is to complete the school syllabus on time. There was always a rush to complete the syllabus because of the national examinations, and thus time was a limiting factor for her to apply ICTs in her lessons. Akite asked, "why waste so much time doing this when I can do it in a shorter time? And again, the syllabus, after all the exam will come like this. They will not be asked anything in ICT. UNEB [Uganda National Examination Board] will not test that" (Akite, Interview Data, lines 193-197).

Akite believed students would fail the exam if she did not complete the syllabus on time. She indicated it would be a waste of time adopting ICTs to cover the same topic she was required to cover within a stipulated period of time. Akite noted that computerizing the curriculum would help. When I asked what she meant, she responded, "not the whole curriculum to be computerized, but some areas like the ones that are abstract. If they can become computerized, they would become easier" (Akite, Interview Data, lines 229-231).

Mafabi believed Ugandan mathematics teachers had not embraced ICTs for many reasons. One reason is the focus on the national examination: "If my students don't perform well because I was planning to teach them well [using technology], then I am regarded as a failure. You might use technology, and you know quality-wise these students can do a lot, but in the exam you did not get that A, that other students who got an A … are regarded as better students

than these ones who know a lot all around" (Mafabi, Interview Data, lines 241-242). Mafabi did not use ICTs in teaching because he felt there was no time for preparing lessons: "It is a bit difficult; it is easier when you are doing texts than when dealing with numbers, inserting fractions; you are a bit slow in doing that" (Mafabi, Interview data, lines 120-122). However, he noted that he would use ICTs if he were teaching other subjects: "Basically, I would use it more for geography, geography, like doing photography work; that one I would use it a lot … I would use it mostly, explaining some of concepts that are a bit difficult so viewing them would be easier" (Mafabi, Interview Data, lines 109-113).

Farida-Dida gave varied reasons why she had not adopted ICTs in her classroom, but she emphasized one in particular: "the main reason why we don't bother, and me as a person, is because the Uganda National Examination Board (UNEB) does not require me to do it. And UNEB cannot measure whether I used a computer or not. You will just see the distinctions the school has got" (Farida-Dida, Interview Data, lines 150-153). Building on this, Farida-Dida noted, "the exam comes from UNEB. It has nothing to do with computers. After all, I will be measured with the distinctions I get. How I get them, the end justifies the means [laughs]. And I have been getting distinctions without computers" (Farida-Dida, Interview Data, lines 145-147). She continued, "I have 22 lessons in a week so before you set the projector, that is time for the other class. Then with all that, then you carry from this one. Sometimes, I have back to back lessons. Unless now it is a room where teachers – this one comes, they go, this one comes they go – then carrying it the same number of classes and lessons" (Farida-Dida, Interview Data, line 130 135).

In Ugandan schools, the students remain in the classroom, and the teachers move for different lessons. She suggested that each classroom having the technology ready and working

would benefit teachers and save time. Even without using ICTs, when I observed Farida-Dida teach the second lesson, she struggled to finish because of time constraints. She appeared hurried. At around 10:40 am the bell rang, but Farida-Dida was still dictating a question to the students. Through no fault of her own, I observed there was just no time for Farida-Dida to finish and wrap-up her second lesson.

Chapter Summary

The first part of the chapter described the procedure and results of the quantitative phase analysed through EFA to address the first research question. The results revealed six factors related to technology use among secondary school teachers in Uganda. These significantly loaded on a six-factor solution for the 44 items, accounting for 43.5% of the shared variance. The factors ranged from most significant to least significant in the following order: Factor 1, computer use as competency indicator, accounted for 19.5% of the total variance. Factor 2, communication enhancer, accounted for 7.5%. Factor 3, effective mediator of teaching and learning, accounted for 4.6%. Factor 4, drafters and preparatory tool accounted for 4.4%. Factor 5, performance indicator, accounted for 3.9%. Factor 6, computer centred pedagogy, accounted for 3.4%. Therefore, computer use as competency indicator is the best predictor of teachers' perceptions of technology use in the classroom while computer centred pedagogy is the least significant factor of the block. In addition, reliability for each of the factors showed an adequate internal consistency ranging from .61 to .89, with each factor generating an Alpha coefficient in the following order: factor 1 (Cronbach alpha of .89), factor 2 (.76), factor 3 (.73), factor 4 (.72), factor 5 (.64), and factor 6 (.59).

For the qualitative phase, I analysed data using open coding and thematic analysis. I presented details of six active ICT user teacher profiles and perceptions. The following themes emerged from the data: Competencies in ICT Use Depend on Training Received, ICT Use is Enhanced by Teacher Characteristics or Identity, ICT Use Depends on Availability of ICT Infrastructure, ICT Use is Beneficial to Lesson Planning and Instruction, Teacher Collaboration through ICTs has Implications for Performance, and ICT-enhanced Pedagogy Requires Extra Effort and Time. Teachers who use technology and those who don't considered technology training as a priority area of need. They indicated their competencies were hampered by the lack of technology training, and the trainers were not adequate. They also indicated resources in general were needed at the schools to enable them to integrate ICTs. Also, IT departments were sometimes a hindrance to their efforts to adopt technology. Teachers also agreed they sometimes did not use technology because they thought it would be overly time consuming. The Internet also played a significant role in helping teachers access learning resources online and as a resource for self-training. In Chapter 5, I will draw upon the data presented in this chapter and discuss the results as well as implications and recommendations for future research.

Chapter 5: Summary, Discussion, Implications, and Recommendations

The purpose of this study was to explore the status and use of ICTs among secondary school teachers in Uganda with a focus on competencies, dispositions, perceptions, and challenges. To understand these factors, I drew on an explanatory mixed method research design with quantitative data collection followed by qualitative data collection. For the quantitative phase, teachers from Mbale Municipality in eastern Uganda completed a self-administered survey questionnaire between September and November 2017. The goal of the quantitative data analysis was to identify components that best explained and predicted teachers' technology use through exploratory factor analysis (n=243). For the qualitative phase, I collected data using semi-structured interviews and classroom observations from a subset of participants who completed the survey questionnaire (n=9). The goal of the QDA was to get a deeper understanding of the EFA results from the quantitative phase.

This chapter focuses on the summary and discussion of findings from the quantitative and qualitative phases. Discussion draws on related literature and the theoretical framework (i.e., TPACK + PCT) (Mishra & Koehler, 2006; Powers, 1973). The chapter concludes with implications for practice and policy, and recommendations for future research.

Summary of Findings

Two research questions guided this research: 1. What do teachers in Uganda perceive to be the necessary ICT competencies and dispositions in order to implement the high school Curriculum? 2. What do teachers perceive as challenges to implementing ICT in Curriculum and instruction?

The goal of the first research question was to identify the factors that best explained teachers' perceptions, competencies, and dispositions in the use of technology in the classroom using EFA. The goal of the second research question was to gain a deeper understanding of the statistical results from the quantitative phase using the qualitative data collected through semi-structured interviews and classroom observations. The questions are restated in the summary of analysis sections below.

Aligning Quantitative and Qualitative Findings

The EFA related to research Question 1 loaded six significant factors of teachers' technology use. The factors are listed in Table 17 with their corresponding Cronbach alpha. Computer use as competency indicator is the best predictor of a teacher's use of technology in the classroom and computer-centred pedagogy is the least relative important predictor. Table x also shows the alignment of factors generated from the survey through EFA and themes from thematic analysis of interviews and classroom observations. The table indicates manifestations of the factors in the qualitative data. QDA provided themes to elaborate on the EFA factors.

Table 17: Alignment of factors and themes

	Key factors from survey	*Themes from qualitative data*
1	Computer use as competency indicator (.89)	Competencies in ICT Use Depend on Training Received
2	Communication enhancement (.76)	ICT Use is Enhanced by Teacher Characteristics or Identity
3	Effective mediator of teaching and learning (.73)	ICT Use Depends on Availability of ICT Infrastructure
4	Drafters and preparatory tool (.72)	ICT Use is Beneficial to Lesson Planning and Instruction
5	Performance indicator (.64)	Teacher Collaboration through ICTs has Implications for Performance
6	Computer centred pedagogy (.59)	ICT-enhanced Pedagogy Requires Extra Effort and Time

Factor Analysis Summary

The EFA addressed Question 1: What do teachers in Uganda perceive to be the necessary ICT competencies and dispositions in order to implement the high school curriculum? Six factors resulted from the statistical model, and all significantly predicted teachers' technology use in the classroom. The factors were named based on how they explained the total variance of teachers' use of technology in the classroom, i.e., Factor 1, computer use as competency indicator, accounted for 19.5% of the total variance. Factor 2, communication enhancer, accounted for 7.5% of the total variance. Factor 3, effective mediator of teaching and learning, accounted for 4.6%. Factor 4, drafters and preparatory tool accounted for 4.4% of the total variance. Factor 5, performance indicator, accounted for 3.9% of the total variance. Factor 6, computer centred pedagogy, accounted for 3.4% of the total variance. Factor 1, Computer use as competency indicator, contributed the largest variance. Competency as an indicator of fluency in skills calls for training of teachers. The results also imply the availability of technology resources such as computer labs and relevant software, and access to the Internet need to be prioritized. The results indicated that Internet at school could be a significant step towards technology use when compared to when teachers do not have access. Overall, evidence suggests the six factors taken together accounted for 46.7% of the explained variance of teacher's technology use.

These findings suggest that technology training for all teachers, regardless of where they teach, needs to be a priority in schools. Pre-service teacher programs also need to include ICT training to ensure younger teachers leave college equipped with these skills. Providing resources such as the Internet and ICTs were significant predictors of technology adoption scores. The results also suggest providing technology resources to schools may lead to technology use. These

findings revealed evidence to suggest competence training of teachers to develop skills was the best predictor of technology use in Mbale municipality classrooms. Evidence also shows the availability of ICTs in general might significantly increase teacher's technology use. The next section summarizes the study's qualitative phase findings.

Thematic Analysis Summary

The QDA addressed Question 2: What do teachers perceive as challenges to implementing ICT in curriculum and instruction?

Competencies in ICT Use Depend on Training Received

Most of the teachers' ICT competency begins during either their undergraduate or graduate studies through government training programs (e.g., tooling and retooling). However, the teachers mentioned that despite the technology skills they acquired, they still felt unprepared to adopt ICTs in their teaching. They noted that the type of government training they acquired was below their expectations because technology trainers were not qualified. Also, teachers were trained on technology skills they already knew, or those skills they could learn by themselves such as Microsoft Office, email, and the Internet. Komakech, like Nabatanzi, was more competent in technology use than the other participating teachers, stated, "I have trained myself. You just go to the Internet, for example, if you have something you want to check, you go to the Internet, you Google. You check" (Komakech, Interview Data, line, line 105-106). To cope with the lack of training, teachers taught themselves the required skills to use technology for teaching through the Internet.

ICT Use is Enhanced by Teacher Characteristics or Identity

In the sample interviewed, male teachers are most likely to use technology compared to female teachers. When I asked Akite if she agreed with this observation, she stated, “I think I would agree in the sense that I find men more interested in what is happening, but us [women] we are more contented. I find that it is very hard to be investigative. I think it is true” (Akite, Interview Data, lines 122-124). Akite agreed male teachers were most likely to use technology in classroom compared to female teachers. When I asked Masinde whether gender is correlated with ICT adoption, he agreed but added, “it depends on the exposure one gets and the attitude. Like here, I am the only male mathematics teacher. The rest are female, and they are doing very well with technology” (Masinde, Interview Data, lines 408-411).

ICT Use Depends on Availability of ICT Infrastructure

Teachers agreed there was a general lack of educational technologies at their schools. Some participants alleged that the computer departments in their schools were a hindrance to technology use in teaching. In most cases, these teachers had no access to the computer lab, and thus they could not use technology in their teaching. However, all the teachers acquired personal Internet modems, smartphones, and some had laptops for educational purposes. Ochom stated, “Basically, all my lessons I have done on my laptop. Though the school has its laptops in all cases, I don't think I have used the school's [laptop]; I have used my own” (Ochom, Interview Data, lines 395-397). These teachers noted there was a need to equip their classrooms with projectors and computers to ensure access to technology when needed.

ICT Use is Beneficial to Lesson Planning and Instruction

All the teachers interviewed had five years teaching experience except for Mugidde, who was in her second year. They all had graduate degrees. All participating teachers use technology in their personal life, including smartphones. Regarding their perception of the effectiveness of using technology, these teachers believed technology could help their students understand difficult topics. Mafabi noted, "With the [technology], that picture is brought right in their face" (Mafabi, Interview Data, lines 346-349). These teachers believed technology enhances visualization of concepts for students and brings reality to life. Other teachers like Farida-Dida and Watera had a different perception of technology even though they owned personal technologies. Farida-Dida and Watera had some knowledge about ICTs but they had issues that were holding them from using it for classroom purposes. They used technology for social media and e-mail. Farida-Dida did use technology for private tutoring and Watera used technology purely for personal communication and private business outside school. They both had positive attitudes about student learning using technology, and they valued how technology use could support students' learning in visualizing difficult concepts. Farida-Dida noted that technology "will change them [students] in the way they view issues. When you are talking about gradient and slope, you are seeing such kind of things. Maybe when you are rotating and they can see" (Farida-Dida, Interview Data, lines 172-175). These teachers taught at two different national schools. Although Watera agreed technology was beneficial to students' learning, she believed in a "50-50 approach [half of the time]" where there is no break from the traditional way of teaching. Watera saw that the Internet can "clear up" some abstract concepts for the learners.

Farida-Dida identified as a teacher who had no specific technology skills. Her perception of technology in relation to students' learning was negative. She stated, "The child does not

know how to balance a chemical equation, the computer is just giving the final answer". She perceived technology as a hindrance to students' learning. She believed, unlike a computer, a teacher has the opportunity to ensure a student completes problems step-by-step and the teacher can find the proportion of students doing the problems and the proportion not doing the problems.

Teacher Collaboration through ICTs has Implications for Performance

The Internet plays a big role in supporting these teachers to adopt technology in their lessons. The teachers did not perceive the Internet as a hindrance to students' learning. Each of the teachers accessed videos from YouTube to download educational content. Despite limited collaboration, there are efforts among the teachers in terms of technology use. The Internet played a significant role in enabling these teachers to collaborate with teachers from other schools to share examinations and teaching and learning materials. One of the participating teachers, Masinde, stated: "Anything I want I will get from them, like exams. They just post to me" (Masinde, Interview Data, lines 371-373). These teachers used mobile phones and Internet modems to get information when their school Internet was down. Masinde noted that he used his smartphone to access information for his son: "I just Google for him and give the answer. He asked me things to do with physics measurement and whatever, conversions – Google gives the answer" (Masinde, Interview Data, lines 88-91). The teachers used the Internet to learn about technology and search for instructional materials and other information. Ironically, formal discussion with colleagues on technology does not seem to be going on within their schools.

The analysis of these data show teachers are coping with the challenge of the lack of technology skills by training themselves through the Internet, which they are also using to

collaborate with teachers from other schools. Where educational resources are not available, the early adopters have also used their personal funds to acquire laptops, Internet modems, and smartphones. These teachers perceive technology as a tool to support students' learning.

ICT-enhanced Pedagogy Requires Extra Effort and Time

Regarding time, teachers in Mbale municipality perceived that even as technology can enable them to finish a topic faster, technology-enhanced lessons required time to plan. To these teachers, there was no time to prepare lessons and complete the syllabus in time for the final examinations. Nabatanzi expressed the challenge: "being there for every technology need and at the same time teaching requires time, which time I don't have. So, you are loaded with so much, and therefore things go unattended; like supporting other teachers" (Nabatanzi, Interview Data, lines 615-619). In the same vein, teacher Mafabi agreed his school had a smartboard but he did not use it because he thought it would take too much time to type in mathematics equations and formulas. Also, he was not familiar with how to paste graphs in a Word document. Thus, the time factor was very fundamental for teachers in the use of technology for teaching.

Discussion of Findings

Competencies

The "competency indicator" factor loaded highest with a coefficient of .89, indicating predictive power for technology adoption and use. A number of studies identified training as contributing to teachers' competency in the use of technology in the classroom (reference for this please). In a study conducted by Muller et al. (2008), findings revealed that in-service training and the continuing support of good practice were among the greatest determinants of successful

technology adoption and use. In my study, the qualitative findings revealed teachers lacked adequate skills to adopt and use technology. Findings of also concur that technology training would be needed to enable teachers to adopt ICTs in teaching. These findings resonate with those of Kamau (2014), who found the teachers in his study indicated the desire to participate in technology training to gain knowledge. Consequently, teachers in my study used technology to support teacher-directed instruction and presentation (Peeraer & Petegem, 2011) as opposed to applying technology to support students' conceptual understanding.

Similarly, teachers had negative perceptions of technology related to supporting students' learning, which reflects their lack of knowledge on the usefulness of technology in student learning (Mumtaz, 2000). According to Ertmer and Ottenbreit-Leftwich (2010), technology training may support teachers in gaining knowledge, skills, and confidence for technology adoption in their classrooms. The findings also suggest teachers who occasionally used technology in their teaching and never use technology at all had not been trained adequately to integrate ICTs for pedagogical use (Slutsky, 2016). Other studies revealed similar findings (Ertmer & Ottenbreit-Leftwich, 2010; Gil-Flores, Rodríguez-Santero, & Torres-Gordillo, 2017; Player-Koro, 2012; Tasir, Abour, Halim, & Harun, 2012; Usluel, Mumcu, & Demiraslan, 2007). The findings in my study suggest that in-service training of teachers may be related to teachers' decisions to use ICTs during instruction.

According to Mishra and Koehler (2006, p. 1033), "merely knowing how to use technology is not the same as knowing how to teach with it. TPACK is not a simple combination of three independent domains; rather, content, pedagogy, and technology are interdependent, each one affecting the others (Harris et al., 2008; Herring, Koehler, & Mishra, 2016; M. Koehler & Mishra, 2009). These authors argue that learning new skills with ICTs is not sufficient to

develop adequate understanding of use in classrooms. The choice of content affects the pedagogical goals and methods as well as the technologies used, which come with certain limitations, requirements, or features that may affect which content is covered or how it will be taught (Mishra, Koehler et al., 2007). Utilizing the TPACK framework can drastically change the way teachers teach their subjects. Understanding how to balance all three domains in a way that is most effective for learners is a difficult skill to acquire (Bull, & Cisse, 2011). TPACK is particularly difficult to master because of the complex relationships and the continually changing nature of technology, making every ICT integration problem unique (Koehler & Mishra, 2005; Mishra & Koehler, 2006a). In this study, the findings clearly indicate the majority of the teachers did not know how to use technology pedagogically. It was evident that technology-based activities were not carefully designed for specific topics and objectives. As a result, teachers found it challenging to use technology pedagogically, rather, technology was their content.

In many educational systems around the world, both pre-service and in-service teachers are offered basic courses to prepare them to use ICTs in their classrooms. This was evident during interviews when teachers did not appreciate the tooling and retooling program in Uganda because it did not prepare them pedagogically. As a result, the pedagogic use of technology remains a major problem (Agyei & Keengwe, 2014; Cuban et al., 2001). Also, it was interesting to note teachers admitted having a smartphone and others had laptops, but they were still found wanting in terms of integrating ICTs into teaching.

ICT Infrastructure

The quantitative data revealed that availability of the Internet at home and at school was a predictor of a teacher's technology adoption and use. This finding suggests the availability of resources plays a significant role in teachers' process to adopt ICTs.

QDA revealed teachers used ICTs for communication via email and Facebook. However, the more frequent users went a step further to use the Internet as a medium to download videos on YouTube and collaborate with teachers from other schools. However, of more importance is the way the Internet was used for self-training on technology. Recent findings establish that having a computer at home resulted in a favourable attitude about technology use (Braak, Tondeur, & Valcke, 2004; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012). This implies that a teacher who has Internet both at home and at school might have greater opportunities to learn and use technology and accessibility to ICTs is thus not a problem. Additionally, Whattananarong (2004) found that Internet-based classroom instruction was more effective compared to traditional instruction in terms of summarizing students' work, referencing sources of students' work, and reducing the time taken to cover topics. According to Ferenchick, Fetters, and Carse (2008), the Internet greatly speeds up an innovation's rate of adoption. I found teachers did not fully embrace the Internet as a medium of instruction. The findings suggested the non-users believed the Internet was harmful to students' learning. The non-pedagogical users implemented technology in ways not related to teaching at their schools. Instead they used technology to access social media and teach other subjects, or they did not use technology at all despite the availability.

In my study, teachers suggested classrooms should be equipped with technology facilities such as projectors and computers to enable them to fully adopt technology. This finding is

consistent with previous studies, such as Akbaba-Altun (2006), who examined issues related to technology adoption in Turkey and found that technology resources were the main barriers of technology adoption by teachers. Similarly, Inan and Lowther (2010) found availability of technology was related to technology use. There was a strong relationship between technology adoption and the number of computers available in the classroom. In my study, the teachers who frequently used technology owned laptops, smartphones, and Internet modems to support them adopting technology in teaching. Such findings are consistent with Moses, Wong, Abu Bakar, and Mahmud (2011), who found owning laptops helped teachers gain confidence, have increased mastery of ICT skills, and have improved quality of instructional materials.

The teachers who used technology more frequently in their teaching, did so because they felt it was beneficial to them and their students. According to Cziko, (2007) the notion of perceived benefits of technology influenced teachers because they recognized that ICTs had relative advantages and were compatible with their classroom needs. Powers (1973) asserts "the greater the perceived relative advantage of an innovation, the more rapid its rate of adoption will be… and relative advantage is positively related to its rate of adoption" (p. 15). As individuals pass through the decision-making process, they look for information about an innovation in order to ascertain its usefulness. The teachers who used technology early recognised that technology met their teaching needs and that technology was compatible with their values and beliefs about students' learning and classroom past experiences. However, the non-users of technology did not recognise technology as having relative advantages to their teaching, or they believed that ICTs were not compatible with their teaching processes. This suggests that the availability of ICTs did not guarantee adoption (Cuban et al., 2001).

The non-users in my study did not perceive ICTs as time-savers in completing the syllabus, did not prepare students to sit for the national examination and, most of all, did not add value to students' learning. Additionally, both users and non-users believed technology was complex to use even where available. According to Cziko (2007) and Kuhn and Powers (2006), complexity of an innovation is negatively related to its rate of adoption. Data analysis revealed teachers who found technology complicated did not use it. This problem was implicated with lack of adequate technology training. Teachers commonly did not have access to technology resources in the computer departments. In consideration of Powers' (1973) attributes of experimentation and observability of an innovation, my participants did not have opportunities to experiment with technology or watch exemplar teachers try out ICTs in the computer department.

Teacher Collaboration

QDA revealed minimal collaboration was taking place within the schools over technology use. For this, teachers blamed the school managers for not encouraging collaboration. Findings indicate users of technology are implementing technology to collaborate with other teachers from schools other than their own. Collaboration through the Internet has played a significant role for the diffusion of certain innovations in recent times, including technology (Rogers, 1995). Teacher collaboration can strengthen companionship and teamwork and offer many benefits to teachers and students (Larry Cuban, 1993b; Gil-Flores et al., 2017). One of the hurdles impeding secondary teachers from collaborating is a lack of time (Kafyulilo et al., 2016). However, the Internet has provided a means for individuals to interact and communicate using tools such as email and social networking sites such as Facebook and Twitter within a short time

period (Tilya, 2008). This finding is consistent with Rogers' (1995) assertion that "the Internet allows people to reach many other people in a one-to-many process" (p. 215) Rogers argued that most individuals do not evaluate an innovation based on scientific evidence; rather, they rely on subjective evaluation from other individuals similar to themselves who have already adopted the innovation. In fact, transfer of new ideas occur most frequently between two individuals who are similar (Rogers, 1995). According to Rogers, when "people share common meanings and mutual subcultural language, they are alike in social and personal characteristics, the communication of new ideas is likely to have greater impact in terms of knowledge gain, attitude formation and change" (p. 19).

Thus, teachers who share similar attributes could end up communicating through the Internet or through face-to-face exchanges to understand ICT adoption and use. Similar perspectives were provided by other researchers reporting that teachers were influenced by colleagues to use technology (Darling-Hammond, Hyler, & Gardner, 2017; Mutonyi & Norton, 2007; Nessipbayeva, 2012). They found that some teachers were using technology to give other teachers encouragement and provide reassurance to adopt ICTs. They concluded teachers who adopted ICTs should be given opportunities to guide their colleagues.

Teacher and School Characteristics

Age of Teachers

Some studies suggest older teachers may not be as inclined to explore new technologies as younger teachers (Broady, Chan, & Caputi, 2010; Lee & Tsai, 2010; Madden, Ford, Miller, & Levy, 2005; Msila, 2015). This may also be a result of younger teachers being more likely to join

the teaching profession while already having more ICT competence compared to their older counterparts (Bull & Cisse, 2011; Horgan, 2010). These results mirror those of Msila (2015) and Ocak (2011), who found teachers in the higher age groups experienced low confidence when compared to teachers in the lower age groups, who favoured using ICTs more often.

Other studies found teacher attitudes regarding technology use differed by age (Agyei & Voogt, 2011; Prestridge, 2012; Tondeur, Braak, Ertmer, & Ottenbreit-Leftwich, 2017). Teachers below the age of 25 had positive attitudes towards ICTs and positive attitudes decreased with age. Similar findings were reported by Ocak (2011) who found that older teachers had negative attitudes towards ICT adoption (Madden et al., 2005). However, other studies indicate the contrary. Tweed (2013) found that age did not matter as respondents above the age of 45 made more frequent use of IICTs in schools. She reported that older teachers had more positive attitudes toward ICTs in education than younger teachers. Rana (2012) found that younger teachers scored lower compared to older teachers on potential to adopt ICTs. Findings on age are contradictory. Research has attempted to address such inconsistencies by suggesting that there was no correlation between use of ICTs and age (Graham et al., 2009; Koehler et al., 2014). My study revealed similar inconsistencies as seen in the QDA. Through interviews, it was revealed that the teachers who commonly used ICTs had taught for more than ten years.

School Type

During the study's qualitative data collection, I realised some schools, though they were all in the city of Mbale, did not have functional ICT infrastructure while others were well equipped. I decided to categorise them into three groups: (1) technologically well equipped (2) moderately; and (3) poorly equipped. Analysis suggests that teachers who used ICTs in teaching

were from the well-equipped and moderately equipped schools. During data collection, only one teacher from the poorly equipped schools was available for the interview. The absence of teachers in this context is a result of schools lacking technology resources and having fewer technologically skilled teachers compared to the well-equipped schools. Both government and private schools fell into the three categories. One government school that served as the regional model school and the centre for the tooling and retooling program had advanced ICT resources and infrastructure. Typically, secondary schools in Uganda have very large student populations ranging from 1,500 students 5,000 students. In consideration of school size, McDonald (2013) found large organizations tend to have members who possess relatively high knowledge and expertise and more uncommitted resources are available. However, this study demonstrates contrasting results because teachers who did not use technology in teaching also came for the big and well-equipped schools with ICT resources and infrastructure.

Implications for Practice and Policy

Implications for practice and policy address six main areas: (1) Enhancing classroom uses of technology; (2) providing technology training; (3) providing technology infrastructure and resources; (4) providing time; (5) modifying the school curriculum; (6) and adopting technology plans for schools.

Classroom Uses of Technology

Data indicate that teachers were willing to adopt ICTs in teaching to the extent that when school provided ICTs were not available, teachers used their personal ICTs for classroom instruction. If teachers had to purchase ICTs for schools, they may need additional backing

through grants and other incentives so that every teacher's technology usage can be properly supported. There were also instances where teachers failed to use technology despite the availability. Teachers who did not want to use technology indicated a lack of time to apply technology. Also, they had little understanding of how technology could transform students' learning. Yet the teachers who used technology accessed online learning materials to present and to illustrate lessons. This suggests teachers used technology to support lessons. Skills gained through technology training can support teachers to teach in environments where students can explore difficult problems and investigate multiple representations as opposed to using such tools for illustration, practice, drill activities, and teacher-centred activities such as document production and presentation. If teachers are afforded opportunities to make meaningful use of technology, students might change how they view content, particularly as technology may assist them to think critically, investigate situations, make generalizations, and see patterns.

Technology Training

The study demonstrates that in-service training of teachers is a significant factor influencing whether teachers apply technology or not in teaching. The data indicate the need for technology training for Uganda teachers is required to refine teachers' technology skills, technology pedagogical knowledge, perceptions, attitudes, and confidence to adopt technology. The training I am suggesting would involve certified technology courses at the universities or teacher training colleges funded by the Ministry of Education. Currently, teachers in Uganda go for training during school holidays, which provides too short of a time to train teachers who have no prior experience with ICTs, to understand and know how to apply ICTs in teaching. After

training, teachers can be given opportunities to practice in classrooms and attend conferences and workshops to broaden their skills.

During these workshops, technology trainers must be individuals knowledgeable of research involving students' learning in technological environments. Trainers should act as tutors leading group discussions about the pros and cons of teaching with technology. These discussions should aim at broadening teachers' knowledge and absolve fears of technology. The discussions should also encourage sharing of problems and successes unique to other content areas, which can be replicated in different subject areas. Technology training for teachers should not rely solely on Microsoft Office or Internet skills but rather, should include cutting-edge innovative apps and software in the different content areas. Teachers should also be given opportunities to learn and develop ICT informed lesson plans and curriculum to be taught at secondary schools.

In addition, the training of teachers should go beyond training centres and follow the teachers in the classroom after the training. In-service teachers should be assigned mentor and provide technical support to follow up during implementation processes. Such training would give teachers a sense of accomplishment as they have the opportunity to practice what they learned during the training without feeling abandoned. Progressively, through such support teachers would have the opportunity to practice the required skills to achieve the goal of engaging students in constructive learning.

Experimenting with ICTs and campaigning for ICT use in schools can take a long time. To overcome such challenges, teachers should be given opportunities to showcase their skills through local symposia of lessons within the school or nearby schools. Such opportunities should reward and recognize teachers who have made improvements, especially older teachers

and female teachers who could be struggling or unwilling to adopt ICTs. When teachers see the efficiencies of technology, they may change their attitudes towards technology.

The leading personnel at the Ministry of Education involved in decision making in technology adoption must be knowledgeable, qualified individuals. Such individuals must be familiar with the global trends on ICT adoption in education and teacher training models used in other developing countries. Education leaders across all levels of education should be individuals who understand why and how ICTs can benefit students' learning.

In summary, government through the Ministry of Education and Sports (MoES) and pre-service teacher programs in public universities need to consider rewarding teachers who successfully complete technology training. Teachers in Uganda need to feel valued and recognized. Government agencies need to recognize teachers who successfully complete technology training programs with a certification and a salary increment. More incentives might be offered to teachers who continue to apply ICTs in their lessons after the training. Such initiatives can motivate and encourage other teachers to attend training workshops. However, these engagements cannot be successful without adequate resources in the schools and training centres.

Infrastructure and Resources

The study findings revealed that teachers experienced challenges when applying ICTs in their lessons due to lack of resources. Some teachers interviewed suggested computer departments need to be more accessible so teachers can learn and practice with ICTs without feeling threatened. This would imply department roles need to change so teachers do not view them as an impediment to adoption. On the other side, classrooms should also be equipped with

resources so teachers can plan their lessons from their offices and retrieve them during the lesson. This can save time for the teachers who teach several lessons in a day in different classrooms.

Teachers who have access to the Internet at home and at school are more likely to adopt ICT than teachers who do not have similar access. Teachers in this study reported use of the Internet for accessing online materials, collaboration with colleagues, and self-training. This indicates evidence that the Internet is currently a significant learning resource for teachers. Therefore, the government should subsidize Internet access to make it cheaper and accessible at homes and schools. The teachers who used ICTs acquired laptops and smartphones for teaching and personal use. As not all teachers can afford technology, teachers should be given incentives and subsidies to purchase personal technology to encourage adoption and ensure uniformity.

Lastly, technology resources may support the reduction of the high student-teacher ratio. Large class sizes above 50 students, leaves the teacher with no choice but to practice teacher-centred approaches in the classroom. Technology may play a significant role in supporting individualized teaching. Some lessons can be taught in a computer lab where students can engage in exploration of concepts, and the teacher could facilitate the lesson as needed. This would help free up the time a teacher would normally spend in a traditional class dictating notes or writing on the blackboard. This could result in additional time available and also ease the burden school curriculum imposes on teachers and students.

Providing Time and Modifying the School Curriculum

One of the concerns hindering teachers from using technology was the lack of time needed to prepare for technology-enhanced lessons. Teachers suggested the school curriculum

needed to be modified to include ICT integration. Current curriculum in Uganda is not digitized and does not reflect how technology can be used to teach. In addition, the lessons should be extended from the current 40 minutes to about 80 minutes to create time for students to explore with ICTs. The current curriculum in Uganda can be a burden for teachers due to the extra demands beyond the classroom. If teachers are burdened by additional responsibilities, they may not take time to adopt ICTs, especially considering study participants indicated they are underpaid. I suggest the government commits to employing more teachers so teachers have fewer responsibilities given that class sizes would then be reduced.

National examinations are also a hinderance to ICT adoption because school managers ask teachers to complete the syllabus early to prepare students. Teachers fear being condemned if students fail the exams, hence they rush through the syllabus to allow more time for revision before exam time. In such instances, teachers would not have opportunities to adopt ICTs in their teaching. Thus, the Ministry of Education should significantly reduce the number and frequency of exams at the Ordinary level (O level) Advanced level (A level). This could remove the burden of completing the syllabus early and allow time for ICT adoption and use.

Technology Plans for Schools

The findings from this study show that schools in Mbale municipality are at uneven levels of ICT adoption. Some schools are using more ICTs for instruction than others. This discrepancy among schools can be attributed to the fact that ICT adoption in Uganda secondary schools is just beginning and many structures are not yet in place. Therefore, schools without adequate facilitates are being left behind in adoption as they struggle to build more classrooms

and additional infrastructure. That aside, even well-equipped schools with substantial technology resources appear to have uncoordinated technology adoption plans.

Schools must develop technology plans to facilitate effective ICT adoption. School managers should lead in formulating technology plans based on research and successful models. Such plans might include knowing the skills that students will need to acquire using ICTs, funding sources for resources, technical support, teachers' training needs, and structure and delivery of lessons. Technology planning committees should involve all education stakeholders including parents, students, teachers, and technical experts so that all concerns and issues are addressed in advance. When all education stakeholders are encouraged to participate in decision making at the schools, then technology adoption is likely to occur.

Recommendations for Future Research

The Uganda economic and social situation is similar to other developing countries, particularly those from the sub-Saharan Africa. Thus, the findings from this study might be valuable to these countries. The EFA model developed in this study indicates steps that may need to be taken to further research ICT adoption in other developing countries. The findings in this study may also be used to develop educational policies for ICT adoption in schools, more so for countries that have prosperity plans similar to Uganda.

As indicated above, future research should focus on the technology training of teachers and their TPACK in classroom settings. Similarly, future research should focus on in-service technology programs for teachers, particularly on TPACK for trainers. Research is needed on technology training in the pre-service teacher education programs at the public universities and diploma programs in teachers' colleges. This would focus on skills pre-service teachers bring to

the secondary school classrooms and how their skills impact ICT adoption in teaching in Uganda. There is a need to investigate how the Internet is assisting teachers in the classroom to support students' learning. Systematic research with a whole school as a case study could include the role of the computer departments in ICT adoption in Uganda secondary schools.

There are vast differences between urban and rural schools in Uganda. Research is needed on ICTs in small rural schools. Mobile devices are popular and researchers should explore creative ways in which these are being used for learning. Likewise, a mixed methods study should be designed to investigate ICT adoptions in primary schools of Uganda.

Through the 2000s, Uganda has steadily invested in science, technology, engineering, and mathematics (STEM) education. For instance, the Millennium Science Initiative Project (2007–2013) directed significant funds to postsecondary STEM education. Of course, postsecondary STEM is dependent on STEM competencies in primary and high school teachers and students. Along with the integration of ICTs into STEM teaching and learning, there is a need for research into how STEM disciplines are integrated in primary and high schools in Uganda. Integrative STEM knowledge is as important as knowledge in the individual disciplines (Wells, 2016). For this purpose, Nashon and Madera (2013) developed a "contextual learning" instrument specific to East African education.

As described in the profiles in Chapter 4, *all* participants interviewed within this research have immense expertise and experience in teaching and learning in STEM education at high school levels. For example, Komakech has deep expertise in teaching computer science and IT to young men and women, and should be recognized as a leader in STEM education in Uganda. Similarly, female teachers in this research, such as Akite, Farida-Dida, and Nabatanzi, have advanced skills and are inspiring role models for girls and young women in STEM. Case study

research of these and various other STEM teacher-leaders across Uganda is needed to document and analyse their practices in depth.

Conclusion

The main objective of Uganda Vision 2040 is making Uganda an upper middle-income country by the year 2040. Formulated in 2007, the mission statement is ambitious: "A Transformed Ugandan Society from a Peasant to a Modern and Prosperous Country within 30 years". This goal is hinged on education and particularly on innovation in STEM education. Implementation of Uganda Vision 2040 is at risk of failing to meet its mission if the current status of ICT adoption in schools is not addressed. Findings from my research may generate heated conversations between Ministry of Education officials on one hand and researchers and teachers on the other. Such debate is common in Uganda and has made our country strong. Findings in my research suggest the government needs to commit significant funding to equip schools with resources. At the same time, findings indicate that availability of technology resources does not guarantee teacher change or student learning.

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Appendices

Appendix A: Survey instrument

Teachers' Survey Questionnaire

(Adapted from Centre for the study of Learning and performance [CSLP]
Concordia University, Montreal, Quebec)

Instructions:

Thank you for considering completing this survey questionnaire. The survey instrument will not take more than 20 minutes of your time. I will request that you kindly take some time and fill this survey out honestly and accurately.
This questionnaire has five sections and consists of four printed pages. Fill in or circle the most appropriate response when answering the questions. After you have completed your responses, please return the questionnaire to your facilitator.

Clarification:
The terms ***"technology***" and ***"educational technology"*** used throughout the survey refer to an array of computer-based tools that might prove helpful in advancing student learning. These tools include, but are not limited to, software (e.g., Word, PowerPoint, Excel), hardware (e.g., Interactive whiteboards, mobile phones, computers), and Internet applications/activities or other processes using computerized data

Using the scale provided, please rate the extent to which you agree or disagree with the following statements **regarding the use of computer technology in the classroom**:

Strongly Disagree	A
Moderately Disagree	B
Slightly Disagree	C
Slightly Agree	D
Moderately Agree	E
Strongly Agree	F

The use of computer technology in the classroom…

1.	Increases academic achievement (e.g. grades).	
2.	Results in students neglecting important traditional learning resources (e.g., library books).	
3.	Is effective because I can implement it successfully.	
4.	Promotes student collaboration.	
5.	Is difficult because of the lack of computerized curriculum and text books	
6.	Promotes the development of communication skills (e.g., writing and presentation skills).	
7.	It is a valuable instructional tool.	
8.	Is too costly in terms of resources, time and effort.	
9.	Is successful only if teachers have access to a computer at home.	

1

10.	Makes teachers feel more competent as educators.	
11.	Is successful if there is adequate teacher training in the uses of technology for learning.	
12.	Gives teachers the opportunity to be learning facilitators instead of information providers.	
13.	Is successful only if technical staff regularly maintains computers.	
14.	Is unnecessary because students will learn computer skills on their own, outside of school.	
15.	Enhances my professional development.	
16.	Eases the pressure on me as a teacher.	
17	Is effective if teachers participate in the selection of computer technologies to be integrated.	
18.	Helps accommodate students' personal learning styles.	
19.	Motivates students to get more involved in learning activities.	
20.	Limits my choices of instructional materials.	
21.	Will increase the amount of stress and anxiety of students' experience.	
22.	Is effective only when extensive computer resources are available.	
23.	Is difficult because some students know more about computers than many teachers do.	
24.	Requires extra time to plan learning activities.	
25.	Improves student learning of critical concepts and ideas.	

Demographic Data (Qs. 26-35)

26. **Gender:** Female ☐ B. Male ☐

27. **Age:** Please choose the category that best describes your age group

1.	20 – 29 Years	
2.	30 – 39 years	
3.	40 – 49 years	
4.	50 – 59 years	
5.	60 years	
6.	Other (please specify)	

28**. Level of education:** Indicate your level of Education

1	Diploma in Education	
2	Bachelor's degree	
3	Master's Degree	
4	Doctorate (Ph.D. or ED. D)	
	Other	

29. Years of teaching completed

A.	1- 5 years	
B.	6 -10 years	
C.	11-15 years	
D.	16-20 years	
E.	21-25 years	
F.	26-30 years	
G.	Over 30	

30. Indicate your current teaching subject area.

1	Languages – English, Swahili, Luganda, Germany, French.	
2	Mathematics	
3	Sciences – Physics, Biology, Chemistry, General science, Agriculture.	
4	Humanities – History, Geography, Religious studies.	
5	Technical – Computer studies, Wood work, Technical Drawing, Metal, business Studies, Electricity and Electronics, Power and energy.	
6	Cultural -Art, Music, Health education, Clothing and textile, food and Nutrition, Home management.	

31. Preferred teaching methodology (choose only one)

A.	Largely teacher-directed (e.g., teacher-led discussion, lecture)	
B.	More teacher-directed than student-centered	
C.	Even balance between teacher-directed and student-centered activities	
D.	More student-centered than teacher-directed	
E.	Largely student-centered (e.g., cooperative learning, discovery learning)	

32. Average class size that you teach

A.	10 - 15 students	
B.	15 - 25 students	
C.	25 - 35 students	
D.	35 - 45 students	
E.	45-55 students	
F.	More than 30 students	

33. How would you rate student access to computer technology at your school?

Extremely Poor	A
Poor	B
Acceptable	C
Good	D
Very Good	E
Excellent	F

34. How would you rate teacher access to computer resource personnel in your school?

Extremely Poor	A
Poor	B
Acceptable	C
Good	D
Very Good	E
Excellent	F

35. Please indicate how often you integrate computer technologies in your teaching activities.

A	Not at all	
B	Rarely	
C	Occasionally	
D	Frequently	
E	Almost Always	
F	All the Time	

36. On average, how many hours per week do you spend using a computer for personal use outside of teaching?

A. None	
B. Less than 2 hours	
C. 2 hour or more, but less than 4 hours	
D. 4 hours or more, but less than 6 hours	
E. 6 hours or more, but less than 8 hours	
F. 8 hours or more	

37. How would you describe your proficiency level as a user in relation to computer technologies to determine the level that best describes you?

A. **Unfamiliar** - I have no experience with computer technologies.
B. **Newcomer** - I have attempted to use computer technologies, but I still require help on a regular basis.
C. **Beginner** - I am able to perform basic functions in a limited number of computer applications.
D. **Average** - I demonstrate a general competency in a number of computer applications.
E. **Advanced** - I have acquired the ability to competently use a broad spectrum of computer technologies
F. **Expert** - I am extremely proficient in using a wide variety of computer technologies.

For Items 38 to 60: Please indicate how frequently you use computer technologies for each of the activities listed below. Use the scale provided to indicate the appropriate response.

Never	A
Practically Never	B
Once in a While	C
Fairly Often	D
Very Often	E
Almost Always	F

38.	Use tutorials for self-training.	
39.	Have students use tutorials for remediation (in class).	
40.	Use e-mail to communicate with other teachers.	
41.	Use e-mail to communicate with students.	
42.	Use e-mail to communicate with parents.	
43.	Use LCD projector (a projector connected to a computer) in class.	
44.	Create PowerPoint presentations to use in class.	
45.	Keep track of student grades or marks.	
46.	Prepare handouts, tests/quizzes, and homework assignments for students.	
47.	Create lesson plans.	
48.	Create charts or graphs.	
49.	Analyze data.	
50	Have students use 3-D modeling software or simulations (in class/school lab).	
51.	Use drawing or paint programs.	
52.	Scan pictures or images.	
53.	Use digital video, digital cameras.	
54.	Use a word processor.	
55.	Maintain an on-line journal (diary) or discussion board.	
56.	Use digital portfolios.	

57.	Search the Internet for information for a lesson.	
58.	Access CD-ROM reference material.	

59. Total amount of in-service training you have received to date on using computer technology in the classroom:

A.	None	
B.	A full day or less	
C.	More than a full day and less than a one-month	
D.	A one-month course	
E.	More than a one-month course but less than a school term	
F.	Equivalent to a school term.	

60. Choose the stage that best describes where you are in the process of integrating computer technology in your teaching and learning activities.

A. **Awareness: I** am aware that technology exists but have not used it.
B. **Learning:** I am currently trying to learn the basics. I am sometimes frustrated using computers and I lack confidence when using them.
C. **Understanding:** I am beginning to understand the process of using technology and can think of specific tasks in which it might be useful.
D. **Adaptation:** I think about the computer as an instructional tool to help me and I can use many different computer applications.
E. **Creative Application:** I can apply what I know about technology in the classroom. I am able to use it as an instructional aid and have integrated computers into the curriculum.
F. **Expert:** I am extremely proficient in using the technology.

Section B: Additional comments

61. Suppose your school administration annually made additional resources available. In your opinion, what kinds of resources should they provide? ……

……

……

……

……

……

62. How would you like to see these resources used in order to improve your instructional use of computers?

……..

……

……

63. Please describe what you think is the ideal (best) use, if any, of computer technology in the classroom.

……

……..

……..

……

Thank you for your participation in my study.

Appendix B: Semi-Structured Interview Protocol and Observation Protocol

THE UNIVERSITY OF BRITISH COLUMBIA | VANCOUVER

Department of Curriculum and Pedagogy

Interview Questions
How We Learn (Media & Technology Across the Lifespan)

1. How long have you been in the teaching service?

2. How many years have you been teaching at this school?

3. What is your current position in this school?

4. Have you ever considered using technology in your teaching profession?

5. Where and how did you learn about various technologies?

6. What is your view on professional learning (in-service training) in the use of technology in teaching?

7. Has your level of education influenced how you adopt technology for instruction in teaching?

8. How has your teaching experience influenced you to adopt technology in teaching?

9. How long have you taught in your current position in this school? How has that position influenced you how you to adopt technology in teaching?

10. How has your typical instructional style influenced how you adopt technology in teaching?

11. How has professional learning (in-service training) supported you in adopting technology in teaching?

12. Do you feel the time you spend using technology outside the classroom influences you on how you use technology to teach? If yes, in what ways? If no, why not?

13. How has the school leadership supported you in the process of using technology in your classroom?

14. Is it possible for an instructor to try technology before adopting it in the actual classroom

setting? If Yes, how? If no, explain.

15. How has the availability of technology resources in your school enabled you or inhibited you from adopting technology in your class?

16. To what extent do you feel your knowledge of technology enables you or inhibits you to adopt technology in the classroom teaching?

17. Did you receive any instructions about effective adoption of technology before using it in your classroom? If yes, what are some of the advantages of using technology compared to other methods you have used in teaching? If no, how did you gain the skills to use technology that you use in your classroom?

18. Is it possible for an instructor to combine technology with other methods of teaching in a classroom? If yes, in which ways? If no, why not?

18. How does time (era) influence your decisions to adopt technology in your teaching profession?

19. What are the barriers that inhibit you from using technology in your teaching? How do you think you can overcome these barriers?

20. Do you think owning a technology device plays any part in influencing a teacher to use technology or not in their teaching profession? If yes, how? If not, why?

21. Do you collaborate with other people in learning how to use technology in teaching?

22. Who do you collaborate with? How is the collaboration like?

23. What else would you say about technology in a classroom?

Observation protocol

This protocol is adapted from **https://www.intel.com/content/dam/doc/design-guide/education-cloud-computing-design-toolkit-guide.pdf**

1. Description of the structure of the lesson to observe. What is happening in the classroom? What is the teacher doing? And what are the students doing?

2. How do the teachers and the students interact? Capture examples of the type of questions teachers ask students and how students respond, as well as the questions students ask teachers and the teachers' responses.

3. Do the students have an opportunity to interact with one another? If so, how do they interact?

Do they work on a task as a group? Do they provide feedback to one another?

4. Is the technology being used part of the tasks? If that is so, how, and for what purpose? Is the teacher or students experiencing difficulties in their use of the technology? Are they able to trouble shoot?

5. What other resources are used by the teacher? (e.g., visual aids, blackboard, worksheets etc.).

What other technologies are being used in the lesson?

6. What else does the teacher do? What else do the students do?

Post-observation Interview

1. How do you feel things went during the observed lesson?

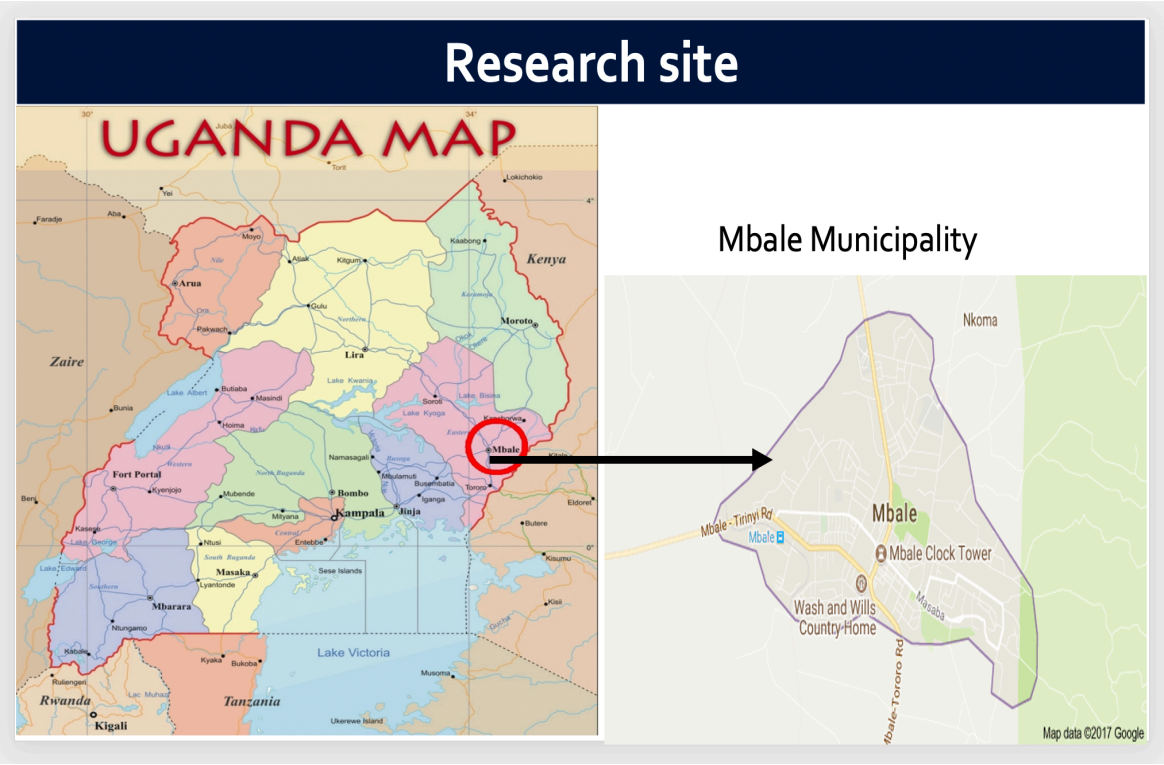
How did things compare to what you expected?

Did anything surprise you?

Were there any ways you felt challenged during this lesson?

2. Now I would like you to walk through your lesson and ask questions about specific parts.

Appendix C: Map of Uganda



Source: https://www.nationsonline.org/oneworld/map/uganda-administrative-map.htm

and https://www.google.com/search?client=firefox-b-d&q=Mbale+municipality