Lecturers' acceptance and use of ICT tools in Ghanaian Colleges of Education

by

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Declaration

I, Emmanuel Kwasi Boateng, with student number 16284080, hereby declare that this thesis submitted for Philosophiae Doctor in Computer-Integrated Education at the University of Pretoria, South Africa, is my original work and has not been submitted for any degree or examination at any other tertiary institution. I further declare that all the sources cited or quoted in this study have been indicated and acknowledged with a comprehensive list of references.

Emmanuel Kwasi Boateng

December 2021

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Ethics Statement

The author, whose name appears on the title page of this thesis, has obtained, for the research described in this work, the applicable research ethics approval. The author declares that he has observed the ethical standards required in terms of the University of Pretoria's code of ethics for research and policy guidelines for responsible research.

Dedication

To my wife, Dorcas, and daughters, Kait and Kaitlyn.

Acknowledgements

The relevance of conducting this study goes far beyond simply finishing a doctoral thesis. Irrespective of the paths taken or the directions chosen, I have acquired a lot from this process that will guide and, eventually, develop my prospects. Through the sudden realisation of undertaking and coming to the conclusion of this study, I have gained more experience, and I am immensely thankful to several individuals for their contributions and assistance.

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Abstract

In today's modern world, technology has permeated every area of human existence. The education sector has been at the centre of technology acceptance and use. In my study, I investigated lecturers' acceptance and use of Information and Communications Technology (ICT) tools in teaching pre-service teachers at Colleges of Education in Ghana, using the Technology Acceptance Model (TAM) as the research framework. I employed a concurrent nested mixed-method research approach, in which quantitative and qualitative data collection and analysis were carried out independently yet concurrently. My research was carried out at 25 of Ghana's 46 public colleges of education. For Phase I of my study, 400 lecturers from the 25 public institutions of education were purposefully sampled using nested concurrent sampling. Out of the 400 lecturers, 136 were conveniently sampled for Phase II of my study. A survey and lesson observations were used to collect data. The closed-ended questions of the survey constituted the quantitative data for my study, whereas the open-ended questions of the survey and the lesson observations constituted the qualitative data for my study. Quantitative data collected were analysed using descriptive and inferential statistics, and qualitative data were analysed using thematic analysis and qualitative content analysis. The findings revealed that the constructs in the TAM, perceived usefulness, perceived ease of use, and attitude towards computers, were instrumental in determining the lecturers' intention to use technology. A positive attitude towards using ICT tools influenced the lecturers' intention to use technology. Moreover, each construct of TAM was shown to be real and capable of being represented by all indicators. As a result, the TAM model was found to be a valid model to explain the acceptance to use ICT tools among lecturers in Colleges of Education in Ghana. Based on the findings, it was recommended, among others, that the Ghanaian government must continue to make the necessary pedagogical ICT tools available for lecturers to use, and the

lecturers must be trained to have the knowledge and abilities essential to effectively support their students' use of ICT tools in learning.

Key Terms: College of Education, Educational technology, Ghana, ICT, Structural equation modelling, Technology Acceptance Model, Technology integration.

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List of Abbreviations

AB	Actual Behaviour
AC	Actual System Use
AMOS	Analysis of Moment Structures
ATB	Attitude Toward Behaviour
AU	Attitude Toward Use
bbe	Behavioral Beliefs and Evaluation
bboe	Behavioral Beliefs and Outcome Evaluations
BECE	Basic Education Certificate Examination
BI	Behavioural Intention
BIU	Behavioural Intention to Use
cbpf	Control Beliefs and Perceived Facilitation
CD	Compact Disc
CFI	Comparative Fit Index
CK	Content Knowledge
CoE	College of Education
CoEs	Colleges of Education
DVD	Digital Video Disc
EE	Effort Expectancy
FC	Facilitating Conditions
GFI	Goodness-of-fit Index
GOF	Goodness-of-fit
HEI	Higher Education Institution

HEIs	Higher Education Institutions
IAIN	Institut Agama Islam Negeri
ICT	Information and Communications Technology
ICTs	Information and Communication Technologies
ICT4AD	Information and Communication Technology for Accelerated Development
ICTED	ICT in Education Policy
IDT	Innovation Diffusion Theory
IPEUQ	ICT Perceive Ease of Use Questionnaire
IT	Information Technology
JHS	Junior High School
LMS	Learning Management System
LMSs	Learning Management Systems
MBA	Master of Business Administration
MM	Motivational Model
MMR	Mixed-method Research
MoE	Ministry of Education
MOOC	Massive Open Online Course
MOOCs	Massive Open Online Courses
Moodle	Modular Object-Oriented Dynamic Learning Environment
MPCU	Model of Personal Computer Utilisation
nbmc	Normative Beliefs and Motivation to Comply
NCTE	National Council for Tertiary Education
nmbc	Normative Beliefs and Motivation to Comply

PCB	Perceived Behavioural Control
PCK	Pedagogical Content Knowledge
PE	Performance Expectancy
PEU	Perceived Ease of Use
PK	Pedagogical Knowledge
PU	Perceived Usefulness
QCA	Qualitative Content Analysis
RMSEA	Root-mean-square Error of Approximations
ROM	Read-only Memory
SCT	Social Cognitive Theory
SEM	Structural Equation Modelling
SHS	Senior High School
SI	Social Influence
SN	Subjective Norm
SPSS	Statistical Package for Social Sciences
SRQ	Secondary Research Question
SRQs	Secondary Research Questions
T&L	Teaching and Learning
TA	Thematic Analysis
TAM	Technology Acceptance Model
TCK	Technological Content Knowledge
TK	Technological Knowledge
TLI	Tucker-Lewis Index

TPACK	Technological Pedagogical Content Knowledge
TPB	Theory of Planned Behaviour
TPK	Technological Pedagogical Knowledge
TRA	Theory of Reasoned Action
UA	University of Aveiro
UB	Use Behaviour
USM	Universiti Sains Malaysia
UTAUT	Unified Theory of Acceptance and Use of Technology

Table of Contents

List of Figures

List of Tables

Chapter 1: Orientation to the Study

1.1 Introduction

The education system worldwide has been altered dramatically with the advent of technology in the late twentieth century due to technology's capacity to create a constructive, easy-to-access, and all-encompassing teaching and learning (T&L) environment (Ghavifekr & Rosdy, 2015). Ghavifekr and Rosdy (2015) further stated that the provision of various facilities and training to increase the use of sophisticated technology in T&L is currently encouraged by education ministry offices worldwide. They also revealed that many governments around the world had provided several facilities and training opportunities to "enhance the use of advanced technologies in teaching and learning processes worldwide" (Ghavifekr & Rosdy, 2015, p. 177). Jamieson-Proctor et al. (2013) and Nakayima (2011) contended that governments' efforts in most countries have similar problems with teachers failing to use most of the technologies available to them. This issue has become a significant matter, as several studies have shown that incorporating Information and Communication Technologies (ICTs) into the T&L processes significantly increases students' performance (Jamieson-Proctor et al., 2013; Kimuya et al., 2021; Lekgothoane, 2021; Ma & Qin, 2021).

The use of ICTs in education, as discovered by Ghavifekr and Rosdy (2015), is growing in importance, and it has the potential to increase academic success, innovation, and students' critical thinking abilities. ICTs may play significant roles in teaching various courses and disciplines in today's classrooms and lecture halls. These include English language, science, and mathematics because examination results in these subjects at different levels of elementary, junior, and high

secondary school education suggest that students worldwide have a lot of difficulty learning and mastering these subjects (Narh, 2017).

In line with Ahmad et al.'s (2016) view, ICT applications in education add value to T&L by enhancing the efficacy of T&L or providing a dimension to T&L that was not previously accessible. ICT may also be a key motivator for students' learning and help students engage in collaborative learning (Heflin et al., 2017).

Due to the enormous benefits of incorporating ICT tools into T&L, many governments worldwide are implementing national policies on integrating ICT into education at the various school levels (Albugami & Ahmed, 2015; Blau & Shamir-inbal, 2017; Brun & Hinostroza, 2014; Drossel et al., 2017). Despite the Ghanaian national policy on ICT integration in teaching and the numerous benefits of integrating ICT into teaching (Ali, 2020; Amedeker, 2020; Goh & Sigala, 2020; Sabiri, 2020), it seems ICT has not been fully integrated into T&L by lecturers in Colleges of Education (CoEs) as expected in Ghana. The literature revealed that no study had been undertaken to understand the lecturers' acceptance and use of ICT in teaching in CoEs in Ghana. Moreover, many scholars have tried to identify what factors influence teachers' adoption of ICT in the classroom (Capan, 2012; Virkus, 2008; Zhang, 2013). This attempt by these scholars vividly portrays that the biggest impediment to the adoption of ICT is the teachers' misconception about ICT integration into teaching. Besides, previous studies have revealed a strong correlation between the teachers' beliefs and ICT adoption in teaching (Cassim & Obono, 2011; Eickelmann & Vennemann, 2017; Sinclair & Aho, 2018). For education policies to be well implemented, Teo (2009) believes that those policies have to be wholly or entirely accepted by teachers, especially lecturers who prepare future teachers for teaching. Embracing policies is important because the trainee teachers will eventually teach according to how they are trained after completing their

teacher training (Lortie, 1975; Young & Goering, 2018). As a result, it is critical to undertake such research on how lecturers in CoEs, who train student teachers to teach at the lower level of education in Ghana, embrace and use ICT in the classroom.

1.2 Problem Statement

With the realisation that ICT tools are essential in education, governments worldwide are implementing national policies on integrating ICT into education (Albugami & Ahmed, 2015; Amedeker, 2020; Blau & Shamir-inbal, 2017; Brun & Hinostroza, 2014; Drossel et al., 2017) with the government of Ghana being no exception. In Ghana, effort from successive and present governments to integrate ICT into the educational sector is enormous. A variety of reforms have been implemented to integrate ICT into the educational sector. According to Amedeker (2020), the Ghanaian National Education Reform Report of 2007, based on Ghana's 1992 constitution, proposed the provision of computer labs, internet and network connections for schools, laptops for instructors and learners, and instructor capacity building. Several steps were undertaken by the Ghanaian government as part of the process of equipping secondary (senior high) schools with current, state-of-the-art T&L tools, as stated by Amedeker (2020). The Ghanaian government's dedication to attaining ICT in education (Ministry of Education [MoE], 2015) was reflected in several policies, and these include: "(1) The Ghana ICT for Accelerated Development (ICT4AD) Policy in 2001 (2) Information and Communications Technology in Education: A Policy Framework (2002), (3) The Education Strategic Plan (2003), (4) The Ghana e-Schools Initiative High-Level Business Plan (August 2003), (5) The ICT in Education Policy (2015) and (6) Education Strategic Plan (2018 – 2030)" (Amedeker, 2020, p. 73). The use of ICT in education was advocated in each of the policy documents outlined above.

Despite all these policies, there has been little usage of ICT tools in T&L among lecturers of CoEs (Acquah-Doughan, 2015; Gyamfi, 2017; Owusu-Ansah, 2015). In September 2019, the Ghanaian government rolled out a new curriculum dubbed "Standard Based curriculum" for Kindergarten to Basic 6 (MoE, 2018). The pedagogical approaches to delivering this new curriculum are outlined in the National Pre-tertiary Education Curriculum Framework for developing subject curricula (MoE, 2018). The delivery of this new curriculum places much emphasis on "ICT use as a tool" in the delivery of instruction and encourages the teacher to make "effective use of ICT in the learning process" to guarantee that all learners succeed at a level that is commensurate with their abilities (MoE, 2018, p. 67).

After extensive discussions with education management, ICT specialists, and other stakeholders with various backgrounds, the ICT policy framework was developed. The government attaches great importance to ICT integration in T&L in building the policy framework and so providing new possibilities for teachers and learners to engage in new modes of information acquisition and analysis that would assist Ghana's economy in evolving. The policy document, according to the MoE (2018), acts as a foundation for ensuring the delivery of the following three key elements:

- "ICT as a learning and operating tool
- ICT as integrated into the teaching and learning
- ICT as a career option for learners" (MoE, 2018, p. 74).

The MoE (2018, p. 74) goes on the say that, "As a result, a renewed spirit of commitment, innovation, and investing in Science and Technology is being fostered to bend the curve of development and maintain Ghana's relevance in the global economy. The coming years will represent an important challenge for Ghana on its resolute journey towards the goal of integrating ICT in education delivery. The development and integration of persuasive features in ICT tools

used in the classroom to enhance teaching and learning will be vital if Ghana is to succeed in producing more quality products from its schools".

Lecturers in CoEs prepare pre-service teachers to teach at the lower level of education in Ghana, from kindergarten to Basic 9 (Grade 9). It is believed that most "teachers teach the same way they were taught" (Khelifi, 2013, p. 139). Therefore, it is presupposed that if lecturers are to use ICT tools in their lesson delivery in CoEs, pre-service teachers will indirectly learn the way to use ICT tools in their lesson delivery, hence joining in the implementation of the new curriculum. Accordingly, in my study, I explored lecturers' adoption and usage of ICT tools in their T&L at CoEs in Ghana.

1.3 Rationale for my Study

In my study, I explored lecturers' acceptance and use of ICT tools in teaching pre-service teachers in CoEs in Ghana. In the educational milieu, any initiatives and policies to implement technology in an educational programme depend strongly on the support and attitudes of teachers involved, and it is believed that people teach the way they were taught (Bradley & Goble; 2020; Lortie, 1975; Teo, 2009). Lortie (1975) developed the theory of apprenticeship of observation, which explains how teachers learn to teach. Lortie's (1975) theory holds that teachers teach the way they were taught. My study is of considerable importance for several reasons. To the best of my knowledge, the issues of incorporating ICT tools into the pedagogy by lecturers in CoEs in Ghana are still sparse. Tackling this new issue and surviving the problems of this new research area, and building literature for the subject area will contribute to the body of knowledge. More importantly, my study would produce empirical evidence about the status quo in ICT integration in teaching in CoEs in Ghana. This evidence can serve as a source of creating awareness of the need for ICT

integration into teaching in CoEs in Ghana. Again, it is expedient to examine if the Ghanaian government's investments in ICT in education and campaigns for integrating ICT into T&L yield any positive results. Finally, the belief is that my research will generate large amounts of data that may be utilised to support pertinent future research.

1.4 Purpose of my Research

The purpose of my study was to explore lecturers' acceptance and use of ICT tools in teaching pre-service teachers at CoEs in Ghana within the context of the Technology Acceptance Model (TAM) as a research framework. Specifically, my study sought:

Firstly, to find out which ICT tools lecturers at Ghana's CoEs employ. I set out to discover which ICT tools are accessible and used by participants/respondents to better understand how lecturers in Ghanaian CoEs accept ICT tools in teaching. Secondly, to investigate lecturers use of ICT tools in their everyday lives concerning their academic activities. In my study, lecturers' usage of ICT tools in relation to academic activities is classified into three categories: lesson preparation, lesson delivery, and personal development (self-directed professional development). The goal is to study the ICT tools employed by participants/respondents in these three categories. Thirdly, to find out which ICT tools have the greatest influence on T&L and the reason(s) for saying so, and to understand the degree to which lecturers at Ghanaian CoEs embrace ICT tools in their lectures.

Fourthly, to determine how each TAM component influences lecturers' actual use of ICT tools in Ghanaian CoEs. All measures, perceived usefulness (PU), perceived ease of use (PEU), attitude towards use (AU) and behavioural intention to use (BIU), had to be tested to determine if they were authentic and capable of capturing each TAM component to achieve this goal. Lastly, this was done to see how well the TAM can explain why lecturers at Ghanaian CoEs are willing to

employ ICT tools. To accomplish these goals, each TAM construct, namely perceived usefulness, perceived ease of use, attitude towards use and behavioural intention to use, had to be evaluated to determine if they were real and could be represented by all the measuring indicators in the survey.

1.5 Research Questions

My study addressed the following primary and secondary research questions (SRQs):

Primary Research Question

To what degree have lecturers in CoEs accepted to use ICT tools in teaching in Ghana?

Secondary Research Questions

SRQ1: What ICT tools are used by Ghanaian lecturers in CoEs?

SRQ2: How do Ghanaian lecturers in CoEs use ICT tools for academic activities?

SRQ3: Which ICT tools have the biggest impact on teaching and learning in CoEs in Ghana and why?

SRQ4: To what extent is the TAM a valid model to explain the acceptance to use ICT among Ghanaian lecturers in CoEs?

SRQ5: To what extent does each construct in the TAM affect the actual usage of ICT among Ghanaian lecturers in CoEs?

1.6 Research Design and Approach

I employed a concurrent nested mixed-method research (MMR) strategy, one in which quantitative and qualitative research methodologies are used simultaneously (Almeida, 2018). MMR is a form of study in which a researcher uses both quantitative and qualitative research methods (use of

quantitative and qualitative viewpoints, data gathering, analysis, and inference techniques are only a few examples) for achieving the primary objectives of obtaining a broad and deep grasp of the subject, as well as verification (Bentahar & Cameron, 2015; Bozdag, 2020). Concurrent nested MMR is a technique that prioritises one method and directs the project while another is embedded or nested (Almeida, 2018; Gunasekare, 2015). The nested technique addresses a different question than the prevailing one or gathers data from multiple levels. Quantitative and qualitative data collection and analysis were conducted separately but concurrently in my study. The results and findings from the quantitative and qualitative phases were then integrated during the interpretation phase of my study. The rationale for selecting MMR for my study is that the strengths of each approach can make up for the weaknesses of the other and will also provide a more complete and comprehensive understanding of the research problem than either quantitative or qualitative approaches alone (Gunasekare, 2015; Maggetti, 2020). One of the limitations of MMR is that it takes much more time and resources to plan and implement this type of research than using a quantitative or qualitative approach on its own (Maggetti, 2020). Accordingly, a lot of time was devoted to the planning and undertaking of my study.

1.7 Population

The target population for my study was all the lecturers of the 46 public CoEs in Ghana. Sampling was done to select some lecturers due to this large population size, and this is considered next.

1.8 Sampling

Nested concurrent sampling is the sampling approach that supports my study, in which non-probability purposive sampling was employed for Phase I, and convenience sampling was used for Phase II. Because of the distinctiveness of the participants, purposive sampling was employed

(Nieuwenhuis, 2019b). Convenience sampling was used to select respondents because it reduced time and money and made it easier to contact them (Cohen et al., 2018). Haphazard sampling, a type of convenience sampling (Etikan et al., 2016), was used to sample participants for the lesson observation phase. Lecturers who completed the survey (Phase I) were asked whether they would be willing to have their lesson observed (Phase II). Those who agreed were selected.

For Phase I (survey) of my study, purposive sampling was utilised to select 400 lecturers from a target population of all the lecturers at Ghana's CoEs. For Phase II (lesson observation) of my study, 136 of the 400 purposively chosen subjects were sampled synchronously using convenience (haphazard) sampling. A detailed discussion on the sampling methods for Phase I and Phase II is provided in Section 3.4.2 of my study.

1.9 Data Collection and Research Instruments

Data collection aims to acquire information that has been elicited to increase knowledge. The data collection was split into two phases, namely Phase I and Phase II since concurrent nested MMR was employed. Phase I (survey) collected both quantitative and qualitative data (open-ended and closed-ended survey questions), whereas Phase II (lesson observation) exclusively collected qualitative data. The data collection process for Phase I (survey) and Phase II (lesson observation) is described in detail in Sections 1.10.1 and 1.10.2, respectively; this is considered next.

1.9.1 Phase I (Survey): Data Collection

Online and hard copies of the survey were distributed to elicit the participants' responses to enable an objective/subjective analysis of the research questions under study. The survey, as shown in Appendix A, included five sections. Closed-ended questions were utilised for quantitative data

collection in Sections 1, 2, 4, and 5, whereas open-ended questions were employed for qualitative data collection in Section 3 of the survey. More detail regarding the survey is provided in Section 3.5.1 of this thesis.

1.9.2 Phase II (Lesson Observation): Data Collection

I concurrently observed lessons where respondents used ICT tools to teach. As seen in Appendix B, the lesson observation protocol was developed by me and checked and approved by my supervisors to record what transpires when respondents are using ICT tools during their lesson delivery. For my study, non-participant lesson observation, where I was present but without actively participating, was employed to allow for the observation of first-hand (Patton, 2015) and real-time teaching practices of respondents to understand their experiences in the use of ICT tools in teaching their students (Reddacliff, 2017). The lesson observation protocol comprises four sections with a total of 11 items. Section 3.5.2 of this thesis goes into detail regarding the lesson observation protocol.

1.10 Data Analysis

Both qualitative and quantitative data analysis techniques were employed. The results and findings were integrated during the interpretation phase of my study. The next sections delve into both methods of data analysis.

1.10.1 Quantitative Data Analysis

I used the Analysis of Moment Structures (AMOS) statistical module version 27 and the Statistical Package for Social Sciences (SPSS) version 27 as analysis tools to analyse the data from a quantitative standpoint. Descriptive statistics, correlations and SEM were used to analyse the

quantitative data collected. The quantitative data collected were summarised, described, and presented in tables using descriptive statistics (Field, 2018). Since most of the survey items were ordinal Likert-type data, the Spearman-rank correlation coefficient (r_s) was used to find significant correlations between variables. SEM was used to measure the extent of the lecturers' ICT adoption and the usage of these ICT tools in teaching.

1.10.2 Qualitative Data Analysis

Qualitative data collected using the open-ended questions of the survey on how lecturers implemented ICT tools in their teaching were analysed using thematic analysis (TA) and qualitative content analysis (QCA) (Vaismoradi & Snelgrove, 2019). I analysed the non-participant lesson observation data using QCA, whereas the qualitative data from the observation checklist was analysed thematically. TA and QCA have many similarities but are different, and these similarities and differences are considered in Section 3.6.2.

1.11 Definition of Key Terms

The meanings of words are clarified in more detail later in my study, but brief definitions are provided here.

College of Education (CoE): A CoE is a post-secondary educational institution that provides students with the knowledge, skills, and training necessary to become self-sufficient teachers (Nwalado & Oru, 2016).

Educational technology: Educational technology is described as a component that aids in teaching students in ways that would be impossible without using that technology (Malz, 2021).

Information and Communications Technology (ICT): ICT refers to technological devices such as computers and other resources for the acquisition, creation, organisation, storage, retrieval, and dissemination of information (Adekoya, 2018; Bello & Ezeri, 2020). ICT tools, technologies, and ICTs were used interchangeably to convey the same meaning in my study.

Learning Management System (LMS): An LMS is defined by Alias and Zainuddin (2005, p. 28) as "a software application or web-based technology used to plan, implement, and assess a specific learning process. Typically, a learning management system provides an instructor with a way to create and deliver content, monitor student participation, and assess student performance online". Ain et al. (2016) mention that an LMS facilitates e-learning and provides education with no constraints regarding time and place and lists some popular examples of LMS being WebCT, Blackboard, Modular Object-Oriented Dynamic Learning Environment (Moodle) and Desire2Learn. For my study, we listed the LMS examples as Google Classroom, Edmodo, Moodle and Blackboard in the survey, as these are well-known LMSs within a South African context.

Structural Equation Modelling (SEM): "Structural equation modelling (SEM) is a statistical methodology that takes a confirmatory (i.e., hypothesis-testing) approach to the analysis of a structural theory bearing on some phenomenon" (Byrne, 2016, p. 3).

Technology integration: Technology integration is described as introducing technology into the classroom to assist students in learning in ways that would be impossible without it (Malz, 2021).

1.12 Structure of my Thesis

The chapters of this thesis are structured as follows:

Chapter 1: Introduction

Chapter 1 contains the introduction of my research, the problem statement and rationale, the definition of key terms, and the purpose of my research. Chapter 1 also presents my research questions under investigation, my research design and approach, my study's population and sampling methods. I also briefly discussed the data collection instruments used for my study and the data analysis strategies employed in my research.

Chapter 2: Literature Review

I presented the literature review and theoretical context for my thesis in Chapter 2. The theoretical framework underpinning my study is the TAM. An in-depth discussion is made on the four constructs of the model, namely perceived usefulness, perceived ease of use, attitude towards use, and behavioural intention to use. Chapter 2 further reviews related literature that dives into ICT integration in education, the relevance of ICT integration in education, ICTs in teacher education (pre-service teacher education), and the reasons for implementing ICTs in pre-service teacher education. Furthermore, I discussed factors that influence the adoption of ICT into education. Additionally, I discuss lecturers' acceptance and use of ICT in T&L in detail.

Chapter 3: Research Methodology

After a brief overview, I discuss essential aspects of the research methodology (research philosophy, research design, target population and sampling, and participant profile) used for my study in Chapter 3. The data collection methods and techniques used for analysing both the quantitative and qualitative data gathered are discussed further in this chapter. The quality assurance criteria for quantitative and qualitative phases are then discussed, followed by ethical considerations and a chapter summary.

Chapter 4: Data Analysis and Interpretation

I present my study's data analysis and results, and findings in this chapter. This chapter begins with a brief introduction. The quantitative results and qualitative findings are presented under each of the secondary research questions, respectively. The quantitative data were analysed using descriptive statistics, correlations, and SEM, while the qualitative data were analysed using thematic analysis.

Chapter 5: Discussion on Results and Findings

This section entails my study's summary, a discussion of the results and findings, conclusions, and recommendations based on the results and findings. It also discusses my study's delimitations, limitations, and further studies recommendations.

1.13 Chapter Summary

Chapter 1 provided my study's problem statement, rationale, purpose, and research questions. These sections were followed by short discussions on the research design and approach, sampling techniques, data collection procedures and data analysis strategies for my study. Chapter 1 also provides the structure of this thesis.

Despite the efforts and policies enacted and the amount of investment pumped into integrating ICT into the educational sector in Ghana, teachers are not utilising ICT optimally in their classrooms. Therefore, my study aimed to explore lecturers' acceptance and use of ICT tools in teaching pre-service teachers in CoEs in Ghana. The research sought to address one primary research question and five secondary research questions to help achieve the aim of my study. An MMR approach was employed in my study. Two sampling methods were utilised in the nested concurrent sampling, namely purposive sampling and convenience (haphazard) sampling, to sample 400

participants from the targeted population of all lecturers in the CoEs in Ghana. Purposive sampling was used to sample participants for Phase I (the survey) of my study, while convenience (haphazard) sampling was synchronously used to sample respondents for Phase II (lesson observation) of my study. I discussed the quality criteria and ethical considerations, after which I presented the structure of my study.

Chapter 2: Theoretical Framework and Literature Review

2.1 Introduction

This chapter reviews related literature on using ICT tools by lecturers in higher education institutions (HEIs), particularly in CoEs. I provide the theories and associated concepts that support the current research. I also report empirical investigations on the issue under inquiry and the conceptual model for my study and hypothesis development. I explored lecturers' acceptance and use of ICT tools in teaching pre-service teachers at CoE in Ghana within the context of the TAM as a research framework supported by the Unified Theory of Acceptance and Use of Technology (UTAUT), Theory of Reasoned Action (TRA), and the Theory of Planned Behaviour (TPB).

2.2 Theoretical Framework

I present the theoretical basis for my study in this section. I discuss the theories and assumptions pertinent to my research and the applications and critiques. The TAM (Davis et al., 1989) served as a theoretical framework for my study. A succinct narrative of hypotheses and models preceding its manifestation is required to achieve a clearer understanding of the conditions underlying the TAM's evolution; this is particularly important now that technology has permeated every area of human existence, making it necessary to comprehend whether technology is opposed or adopted (Marangunić & Granić, 2015). The fundamental theories include the TRA, the TPB, the TAM, and the UTAUT.

2.2.1 Theory of Reasoned Action (TRA)

Ajzen and Fishbein (1980) developed the TRA, as shown in Figure 2.1, to model and comprehend human actions and attitudes. Instead of looking at behaviours as predictors of attitudes, the TRA

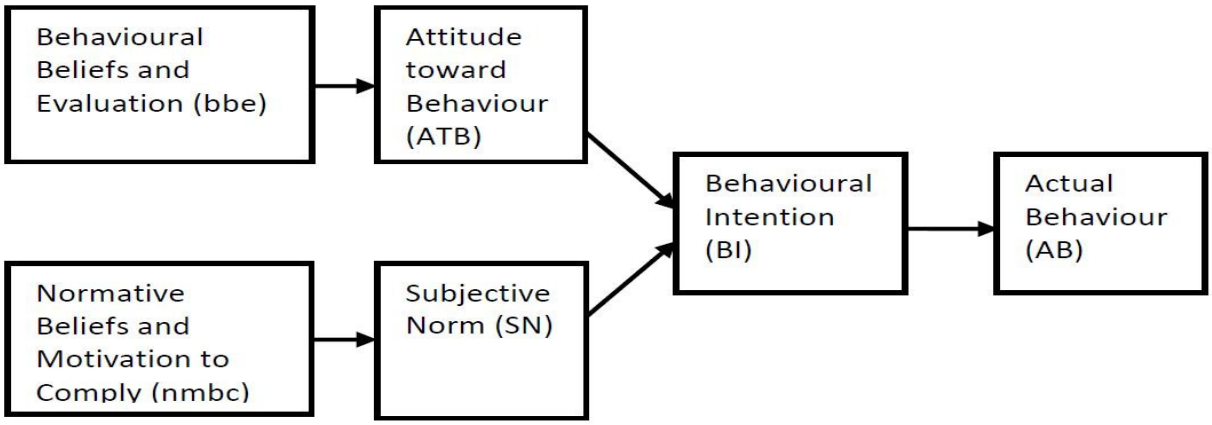
model looks at behavioural motivations. It also implies that previous expectations and beliefs about the expected behaviour will influence actual behaviour (Fishbein & Ajzen, 2010).

TRA is a widely used theory that describes the factors that influence the outcomes of deliberately planned actions (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). According to the theory, a "person's performance of a specific behaviour is determined by his/her behavioural intention (BI) and BI is in turn influenced by the person's attitude and subjective norm (SN) concerning the behaviour in question" (Davis et al., 1989, p. 983). Behavioural intention assesses a person's willingness to engage in a specific behaviour (Fishbein & Ajzen, 1975). An individual's positive or negative sentiments (evaluative effect) about executing the goal activity are characterised as attitude (Fishbein & Ajzen, 1975).

The term "subjective norm" refers to "the person's perception that most people who are important to him think he should or should not perform the behaviour in question" (Fishbein & Ajzen, 1975, p. 302). "One's attitude toward a behaviour is determined by his or her salient beliefs (bi) about the consequences of performing the behaviour multiplied by the evaluation (ei) of those consequences", according to TRA (Davis et al., 1989, p. 984). Beliefs refer to "the individual's subjective probability that performing the target behaviour will result in consequence" (Davis et al., 1989, p. 984). "The multiplication of one's normative beliefs and his or her motivation to comply (mci) with these beliefs" determines the subjective norm (Davis et al., 1989, p. 984). TRA has been adopted as a theoretical framework to examine human behaviours connected to ICT use over the years. According to Yuen and Ma (2008), the most important factors of the intention to use technology are attitude and subjective norm. The theory of reasoned action is depicted in Figure 2.1. The framework explains the drivers of actual intention, focusing on behavioural intention influenced by the underlying variables.

Figure 2.1

Theory of Reasoned Action Framework



Source: Ajzen and Fishbein (1980, p. 17, Figure 1.2)

According to Chan and Lu (2002), TRA has been criticised for not adequately explaining when behaviour is not under an individual's control, despite its usefulness in predicting social behaviours. The TPB was therefore designed to resolve such deficiency in the TRA.

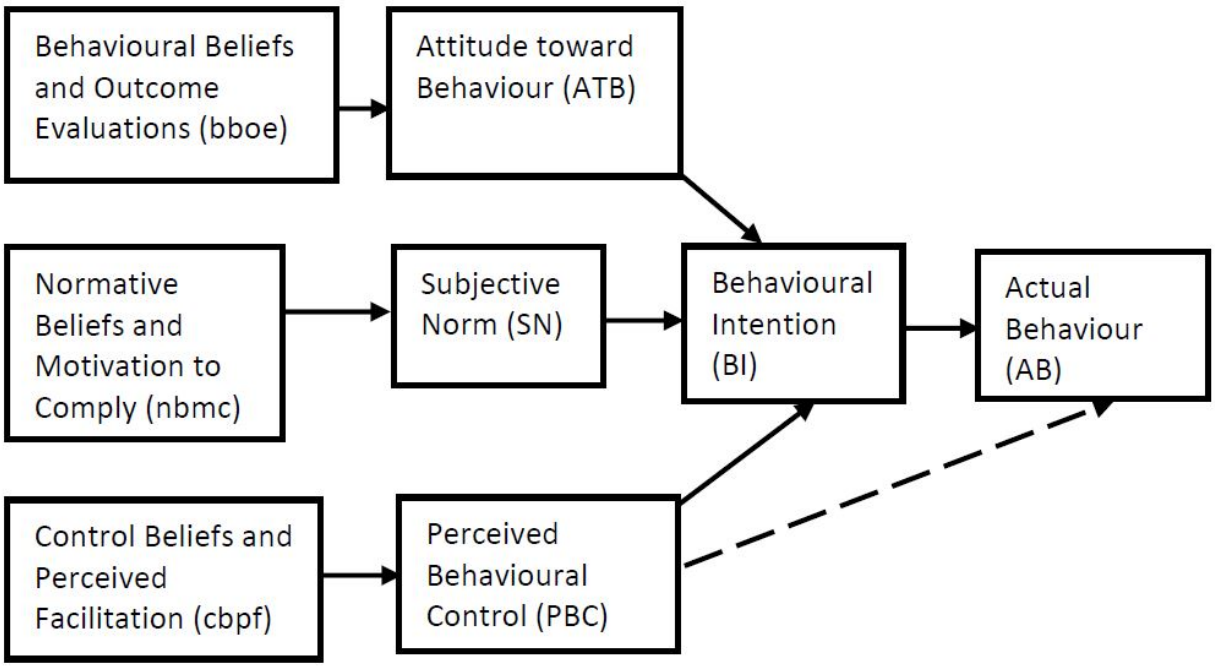
2.2.2 Theory of Planned Behaviour (TPB)

Fishbein (1967) developed the TPB, as shown in Figure 2.2, to explain why TRA failed to predict human behaviour. The inherent flaws in Fishbein's (1967) TRA, which stated that people make aware and intentional judgments based on available knowledge, prompted the development of the TPB (Leroy et al., 2009). The TPB is a theory "that links beliefs and behaviour" (Dzulkipli et al., 2019, p. 2). Because behaviour could be deliberative and planned, the TPB predicts intentional behaviour (Khurana & Kaur, 2017; Odede, 2021; Ukenna et al., 2018). A few variables, including perceived behavioural control, were added to strengthen the TRA's predictive ability. It is

presumptively true that an individual is in charge of their behaviour and that this behaviour may be predicted by knowing the individual's purpose to act (Ajzen & Fishbein, 1980).

Figure 2.2

Theory of Planned Behaviour



Source: Ajzen (1991, p. 182, Figure 1)

Azjen (1991) believes that intention is the most accurate predictor of behaviour. Intentions refer to a person's desire, willingness and eagerness to put forth the effort necessary to carry out the behaviour (Ajzen, 1991). Behavioural intention, according to Triandis (1980), is defined as "instructions that people give to themselves to behave in certain ways" (p. 203). Individuals are involved in planned behaviour when their goals are founded on their attitudes and are later converted into action (Leroy et al., 2009).

The TPB tries to predict people's plans to engage in such behaviours at a specific location and time and define all activities they influence (Ajzen, 2006). Figure 2.2 depicts the association among the variables defining the TPB. It illustrates the effect of attitudes, subjective norms and perceived behaviour on intention and behaviour.

2.2.3 Technology Acceptance Model (TAM)

The TAM (Davis et al., 1989) served as a theoretical framework for my study. The TAM was proposed by Davis et al. (1989) to explain users' intentions and behaviour regarding ICTs usage. According to Portz et al. (2019), the TAM is an information technology (IT) framework that has been explored in older populations to better understand users' acceptance and use of new technologies, particularly in the workplace.

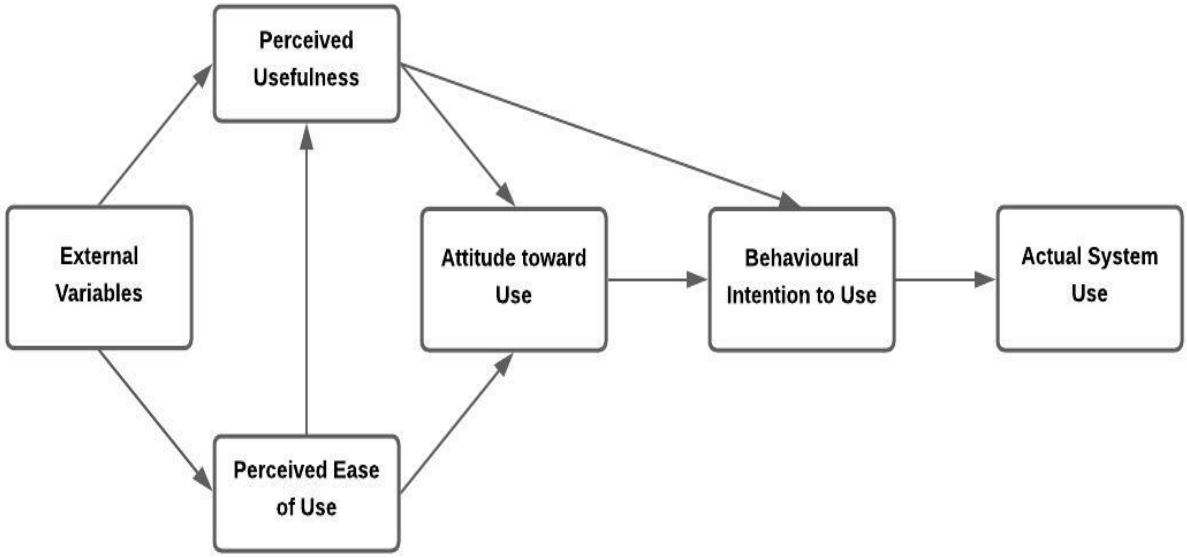
According to the theory, a person's intent to use (technology acceptance) and usage behaviour (actual use) of technology is determined by their views of the technology's usefulness (benefit from utilising the technology) and ease of use. Two belief constructs influence the desire of users to utilise technology in TAM: PU and PEU. These two constructs are described in detail in Sections 2.2.3.2 and 2.2.3.3, respectively. Here, we briefly mention what each construct represents in layman's terms in connection to ICTs. PU relates to the user's belief that ICTs can improve their work performance, and PEU relates to the belief by the user that ICTs will be easy to use. Theoretically, PEU influences perceived utility (Davis et al., 1989). Holden and Rada (2011) discovered that incorporating perceived usability (an external variable) into the TAM explained more variance and had a greater influence on TAM elements than leaving it out. Holden and Rada (2011) demonstrate the importance, positive influence, and necessity of evaluating usability when studying educational technology acceptance and usage behaviour.

Different technology adoption studies employed the TAM to predict user intent and offer additional evidence and validation (Vahdat et al., 2021). Some of these technology adoption studies included school teachers (Pynoo et al., 2011), virtual learning environments (Rienties et al., 2016), pre-service teachers (Teo, 2010b), e-learning (Yuen & Ma, 2008), and perceived usability and self-efficacy on teachers' technology acceptance (Holden & Rada, 2011). Although it was created to investigate technology acceptance in corporate and commercial contexts, it has now been discovered to be a cost-effective model for application in educational settings (Drennan et al., 2005). TAM has also become a common approach for analysing technology uptake and user involvement in innovation initiatives (Rahi et al., 2017, 2018a, 2018b).

TAM was developed by Davis et al. (1989) from the TRA (Ajzen & Fishbein, 1980). TAM was used by Davis et al. (1989) to explain the factors that influence user acceptance of a wide range of end-user computer systems. According to Granić and Marangunić (2019), the TAM, which has its roots in TRA psychology, has grown into a significant model for predicting human behaviour toward possible technological adoption or rejection.

Figure 2.3

The Technology Acceptance Model



Source: Davis et al. (1989, p. 985, Figure 2)

2.2.3.1 External Variables

External variables are external factors that may affect the users' PU and PEU, such as system characteristics, environmental characteristics, convenience, and user habits, which directly or indirectly affect the users' cognitive beliefs (Kuo et al., 2020). Many factors that affect how people embrace technologies have been identified in previous studies. In e-learning contexts, self-efficacy was discovered to be a major factor in influencing knowledge exchange by Hosseini et al. (2014).

The TAM's external factors significantly influence how people adopt the technology. It is a framework that depicts the reciprocal interaction regarding external variables that influence a user's adoption of technology and factors that affect actual behaviour (Hong & Yu, 2018). The

TAM proposes some interaction among external factors such as PU and PEU (Hong & Yu, 2018) and their ultimate effect on attitude towards use and behavioural intention to use, as depicted in Figure 2.3.

2.2.3.2 Perceived Usefulness (PU)

PU is the "prospective user's subjective probability that using a specific application system will increase his or her job performance within an organizational context" (Davis et al., 1989, p. 985). It has been posited that their belief influences a person's tendency to use or not use technology to the extent to which using technology would enhance job performance (Davis et al., 1989), including decreasing the time for doing the job and achieving more efficiency and accuracy. Masango (2019) mentions that PU relates to teachers' and students' belief that ICTs would provide a better T&L experience within a classroom context.

2.2.3.3 Perceived Ease of Use (PEU)

Perceived ease of use refers to "the degree to which the prospective user expects the target system to be free of effort" (Davis et al., 1989, p. 985). In layman's terms, perceived ease of use relates to the belief by the user that the use of ICTs will be easy. The relation between perceived usefulness and perceived ease of use is that perceived usefulness mediates the effect of perceived ease of use on attitude (Teo et al., 2008). In other words, while perceived usefulness directly impacts attitude, perceived ease of use influences attitude indirectly through perceived usefulness.

2.2.3.4 Attitude Toward Use (AU)

Attitude guides behaviour and refers to how an individual responds to and is disposed towards an object (Ajzen & Fishbein, 2005). This response or disposition may be negative or positive. The

successful integration of technologies into educational programs relies much on teachers' attitudes (Kisanga, 2016; Teo & Ursavaş, 2012). Liaw et al. (2007) argued that "no matter how advanced or capable the technology is, its effective implementation depends upon users having a positive attitude toward it" (p. 1069).

2.2.3.5 Behavioural Intention to Use (BIU)

Behavioural intention to use measures a person's strength of intention to perform a specific behaviour or adopt a behaviour system (Bundot et al., 2017). The TAM implies that two behavioural beliefs, perceived usefulness and perceived ease of use, influence the behavioural intention to use. In contrast to perceived usefulness and perceived ease of use, which refer to outcome expectancy and process expectancy, respectively (Liaw, 2002), behavioural intention to use leads to the actual use of technology. These relationships have been demonstrated across various contexts where technology was used (Chau, 2001; Fusilier & Durlabhji, 2005; Teo & Ursavaş, 2012).

2.2.3.6 Actual System Use (AC)

According to Khairani et al. (2020), actual system use is "the indicator to find out if the respondents are using the application frequently or in their daily basis" (p. 5). Furthermore, behavioural intention to use, or the intentional inclination to use information technology, influences actual system use. The perceived ease of using information technology and PU, which refers to the benefit gained by users of the relevant information technology tool, influences behavioural intention to use (Nugroho et al., 2021).

2.2.4 Unified Theory of Acceptance and Use of Technology (UTAUT)

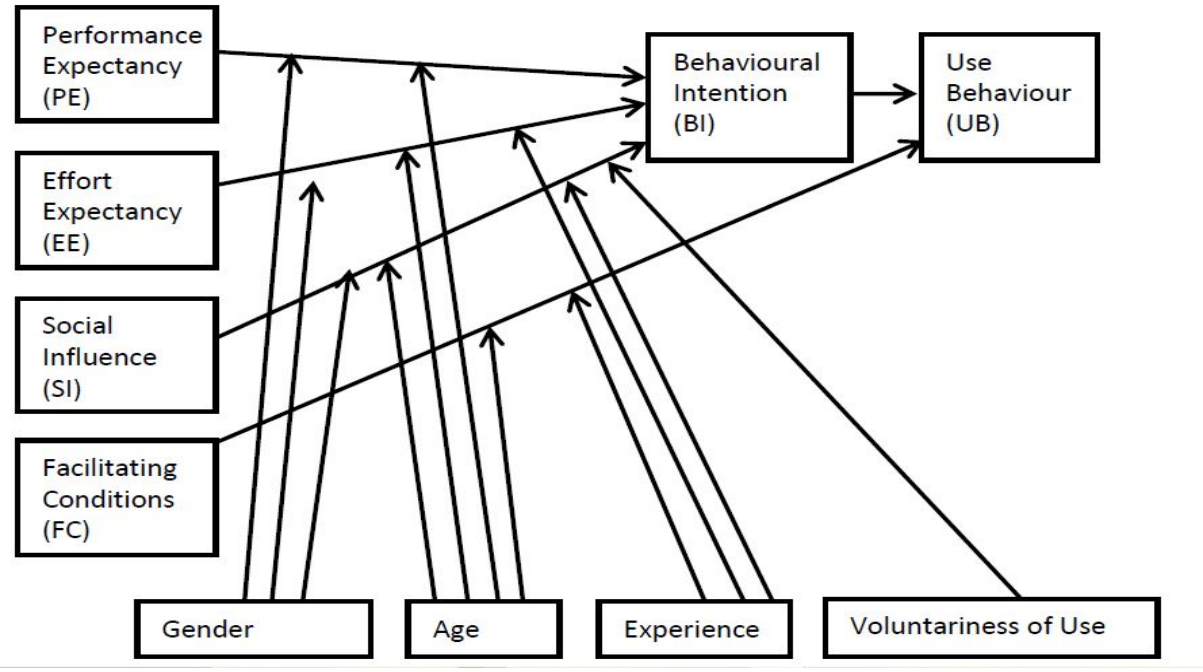
Venkatesh et al. (2003) propounded the UTAUT framework through the amalgam of existing constructs adopted in eight earlier robust frameworks, namely the Motivational Model (MM), the TRA, the TPB, the TAM, the combined theory of TPB/TAM, the Innovation Diffusion Theory (IDT), the Social Cognitive Theory (SCT), and the Model of PC Utilisation (MPCU). Accordingly, Venkatesh et al. (2003) borrowed heavily from the abovementioned models to create four distinct constructs as the direct factors accounting for acceptance of technology. These four constructs are:

- Performance expectancy - the system's usability to satisfy consumer demand
- Effort expectancy - the degree of ease associated with device operation
- Social influence - the perception that other users in society viewed the system's usefulness
- Facilitating conditions - the degree to which the user perceives organisational tools such as technological infrastructure as sustaining the system

The researchers argued that the four constructs are moderated by gender, age, experience, and device usage voluntariness. Another inherent factor found in the model is behavioural intent to follow a structure which, in turn, depends on the conditions that promote it (see Figure 2.4).

Figure 2.4

UTAUT Framework



Source: Venkatesh et al. (2003, p. 447, Figure 3).

Venkatesh et al. (2003) found about 70% of shifts in the intention to adopt and use a method derived from the constructs mentioned above rather than those opined by the eight frameworks, making it the most accurate predictive model. According to the proponents of the new theory, the three leading predictors are PE, EE, and SI, with the last one (FC) manifesting its effect through behavioural intent.

The theoretical assumption of the UTAUT system was confirmed by Amos-Abanyie (2019) on the intention to adopt a technology. Apart from validating the theory by empirical analysis, it sounds authentic in describing the desire of individuals to embrace and use a method, making this empirical investigation the most appropriate structure. Another rationale for my study's drawing

on this theory was that the constructs adopted by Venkatesh et al. (2003) were based on MM, TPB, TRA, TAM, IDT, SCT, TPB/TAM, and MPCU assumptions.

2.3 Conceptual Framework and Development of Hypotheses

Of the four system acceptance models reviewed above, I deployed the TAM in assessing lecturers' acceptance and use of ICT tools in teaching pre-service teachers at CoE in Ghana but added some user demographic features such as age and gender, taking a clue from the UTAUT to arrive at a much more interactive and general outcome. Figure 2.5 presents the TAM conceptual framework, as reported in Davis et al. (1989). The authors of TAM modified the TPB to anticipate new technology acceptance or rejection. TAM has been widely used to predict technology adoption and use (Al-Gahtani, 2016; Hidayanto et al., 2014; Lee et al., 2014; Ogbonnaya, 2019). King and He (2006) performed a meta-analysis and learned that using TAM had positive results. In King and He's (2006) study, which included 88 research papers, TAM was found to be highly accurate in predicting users' acceptance. As a result of their testing, TAM was found to be a "fair and consistent model" (King & He, p. 740).

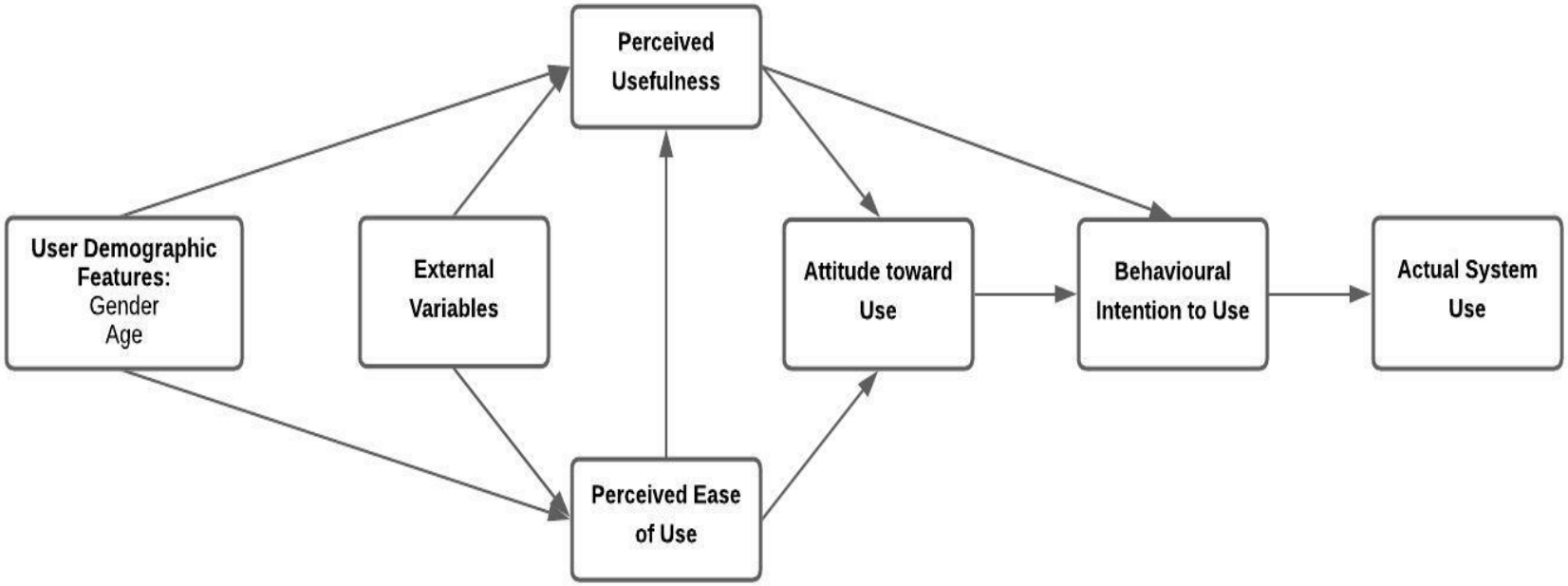
According to Teo (2009), two relevant beliefs were identified in the TAM, perceived usefulness and perceived ease of use, as the primary predictors of users' attitudes or overall effect toward technology usage. It is posited that user attitude influences behavioural intention to use, which influences actual system use behaviour (Teo, 2009). The TAM can explain user behaviour across many end-user computing technologies and user populations (Legris et al., 2003; Teo, 2009, 2010a).

Figure 2.5 presents the modified version of the TAM, including the user's inherent features or demographic characteristics such as age and gender. As applied in this context, the TAM has seen

similar modification by adding user demographic features like age and gender, taking a clue from the UAUT (Venkatesh & Davis, 2000; Venkatesh et al., 2003), to provide a much more interactive and general outcome. The inclusion of such socioeconomic characteristics has, over the years, received attention in several system acceptance studies (Matikiti et al., 2018; Mtebe, 2014; Ouedraogo, 2017; Oye et al., 2011) such as the TAM and the UTAUT.

Figure 2.5

Conceptual Model



Source: Author's construct

2.3.1 User Demographic Features

2.3.1.1 Age

With the assumption that users' perception of a technological system or tool varies across age groups, my study included it in the framework to arrive at individual age differences in predicting PEU and PU. Aspasia and Ourania (2014) reported that age is one of the main characteristics influencing the adoption and usage of new technologies. According to Porter and Donthu (2006), older individuals lack adequate skills to use the Internet and its related technologies, and they are likely to have self-efficacy worries about learning how to use the Internet.

2.3.1.2 Gender

The inclusion of gender in the conceptual model was done to determine how individual gender differences might affect technology adoption among lecturers in CoEs. Sánchez-Prieto et al. (2018) wanted to determine how gender affects secondary pre-service teachers' intentions to use mobile devices in their future teaching practice. The results from their study showed that, whereas gender has historically been seen to have a role in technology acceptance, this was not valid in the case of mobile learning. Drabowicz (2014) emphasised the importance of gender as an essential moderating element since gender equality has become very sensitive. However, my study presents gender as a determinant of PU and PEU of a system.

2.3.2 Hypotheses

Following the extensive literature review on the variables underlying the specific objectives of the studies and conceptual framework produced above, I developed hypotheses in response to the questions outlined in Chapter 1. My study explored lecturers' acceptance and use of

ICT tools in teaching pre-service teachers at CoE in Ghana within the context of the TAM as a research framework supported by the UTAUT, TRA, and the TPB. Relying on various findings from the existing studies, I formulated the following hypotheses for empirical testing:

Hypothesis 1: Gender has a significant effect on perceived usefulness.

Hypothesis 2: Gender has a significant effect on perceived ease of use.

Hypothesis 3: Age has a significant effect on perceived usefulness.

Hypothesis 4: Age has a significant effect on perceived ease of use.

Hypothesis 5: Perceived ease of use has a significant effect on perceived usefulness.

Hypothesis 6: Perceived usefulness has a significant effect on attitude towards use.

Hypothesis 7: Perceived ease of use has a significant effect on attitude towards use.

Hypothesis 8: Attitude towards use has a significant effect on behavioural intention to use.

Hypothesis 9: Perceived usefulness has a significant effect on behavioural intention to use.

Hypothesis 10: Behavioural intention to use has a significant effect on actual system use.

2.4 Literature Review

This section examines the most pertinent available literature for this study. The Ghana Education System, Ghanaian CoEs, and Ghana's ICT in Education Policy are all included in this review. This section also looks at ICT in education, ICT tools in higher education institutions, ICT tools and implementation in HEIs, and using ICTs in pre-service teacher education. The final component of this section examines the validity of the TAM and the extent to which each TAM construct influences lecturers' actual use of ICT tools.

2.4.1 The Ghana Education System

Since the 1987 revisions, Ghana's education system (see Table 2.1) has been divided into four stages: two years of preschool, six years of primary school, three years each for both Junior High School (JHS) and Senior High School (SHS), and four years of further education

(Bachelor's degree programmes). This system is referred to as the 2-6-3-3-4 education system in West Africa (Armah, 2017). Master's degree programmes typically take one or two years.

Primary school (preschool, primary, and JHS), high school (SHS, vocational/technical institutions), and special schools are the three levels of pre-tertiary education in Ghana. Ghana provides free basic and secondary education to its citizens. The cornerstone for this education at no cost is the "Free Compulsory Universal Basic Education (FCUBE)" programme, which began in 1996 (Anlimachie, 2019, p. 43). The primary objective of this policy strategy was to guarantee that every school-aged child received first-class elementary schooling. Ghana has made preschool compulsory, which includes crèches (for children aged three to four) and nursery schools (for children aged 4 to 6).

The primary goal of preschool education is to promote mental and physical well-being. Language acquisition, mathematics, handwriting, and sketching are just a few of the disciplines included in the curriculum. All Ghanaian children must attend elementary school (Armah, 2017) beginning at six years of age. There are two sections to elementary education: a three-year lower primary phase and a six-year upper primary phase.

Ghanaian children are usually twelve years old when they complete elementary school and proceed to Senior High School. In Ghana, senior high school education is divided into two three-year phases (a junior phase and a senior phase). The compulsory school years come to an end with the senior high phase. The students are, on average, 15 years old at this point (Armah, 2017). JHS is for three years, after which students "write the high-stake Basic Education Certificate Examination (BECE) at the end of the third year and provide the opportunity for students to discover their interests, abilities, aptitudes, and other potentials" (Armah, 2017, p. 4). The BECE certificate enables the students to progress to the SHS level.

Students in the SHS level attend school for three years and take the school certificate examination to acquire the West African Senior School Certificate examination at the end of the third year. The West African Examinations Council is in charge of administering this examination. Students that pass this examination go on to post-secondary institutions.

Students are generally 18 years old when they complete SHS and enrol in post-secondary schools, technical universities, or conventional universities. A CoE is a post-secondary institution that prepares teachers to teach in primary schools (Nwalado & Oru, 2016). Ghana now has 46 public CoEs (Ananga, 2021; Sam, 2021). These CoEs currently offer Bachelor's degree programmes in education.

Table 2.1

The Structure of Education in Ghana

Cycle	Level	Institutions	Age (in years)	Number of years
Tertiary Education	Tertiary	Universities/ Polytechnics Professional Institutes CoEs Nursing Training	19+	3-4
Second Cycle Education	SHSs	Grammar/Technical /Vocational/Agriculture/ Apprenticeship programme	16-18	1-3
First Cycle Education	Basic Education	Junior High School	12-15	3
		Primary	6-11	6
		Kindergarten	4-5	2

Source: Armah (2017)

2.4.2 Colleges of Education in Ghana

The educational systems of different countries are not the same and alter in response to national development goals and will continue to do so as long as governments seek new schemes and policies to enhance people's living conditions (Mereku, 2019). According to Mereku (2019), such changes in educational systems have affected the growth of educational opportunities in Ghana, resulting in the rise of teacher education institutions over the years.

The first teacher training institution was established in Akropong (Akwapim) in 1848 by the Basel Mission (Filson & Agyekum, 2014; Mereku, 2019). To meet the demands of middle schools, in 1965, nine teacher training institutions that offered two-year specialised teacher training courses for certified teachers in geography, mathematics, English, history, and other disciplines were established in Ghana (Filson & Agyekum, 2014). These specialised teacher training institutions merged to establish the "Advanced Teacher Training College in Winneba, Ghana, in 1966" (Filson & Agyekum, 2014, p. 8). According to Filson and Agyekum (2014), in 1966, when it was found that about two-thirds of primary school teachers were not trained, the government created 35 additional teacher training institutions to augment the 45, bringing the number to 80. However, by the end of 1981, 35 new teacher training colleges had closed. According to Filson and Agyekum (2014), the Ghanaian government adopted a strategy that would make all pre-university teacher training institutes tertiary institutions in 2007, with the National Council for Tertiary Education (NCTE) playing a key role in its implementation. Act 847 of the Parliament of the Republic of Ghana was passed in March 2012, establishing CoEs as tertiary institutions in the nation (Filson & Agyekum, 2014). The colleges have provided a variety of programmes throughout the past six decades, as a result of changes in the nation's teacher education system and steady development of its facilities (Filson & Agyekum, 2014; Mereku, 2019), including:

i. "2-Year Post Primary Certificate 'B' Programme
ii. 4-Year Post Primary Certificate 'A' (conventional) Programme
iii. 4-Year Post Primary Certificate 'A' (modular) Programme
iv. 2-Year Post-Secondary Programme
v. 2-Year Specialist Training (Geography and Visual Art Education) Programme
vi. 3-Year Quasi Specialist Post-Secondary Programme
vii. 3-Year Post-Secondary Programme (Generalists)
viii. Untrained Teachers Diploma in Basic Education (UTDBE) Programme
ix. College of Education Programme" (Mereku, 2019, pp. 70-71)

Ghana's pre-service teacher education system has experienced some improvements in the past six decades in an endeavour to guarantee that pre-service teachers have the academic and professional skills necessary to work successfully and professionally as teachers (Mereku, 2019). According to Mereku (2019), these modifications impacted the structure, content, and organisation of the programmes at the CoEs.

There are now 46 public CoEs in Ghana, all responsible for educating teachers for a career in the country's basic schools (Sam, 2021). Five of the 46 public CoEs are specifically for women, only one for men, and the rest accommodate mixed genders.

These colleges were all formerly diploma-awarding until they were recently upgraded to a tertiary status in implementing the Bachelor of Education programme, which began in the 2018 academic year (Sam, 2021).

2.4.3 Ghana ICT in Education Policy

The Ghanaian government is dedicated to transforming the "agro-based economy of Ghana into an information rich and knowledge-based economy and society using ICT" (Tamakloe, 2014, p. 4). The government has recognised the relevance of ICT education and training in the education system. Consequently, the Ghanaian government is committed to a holistic strategy of rapid distribution and use of ICT tools in education, which will revolutionise the educational system and, as a result, improve the lives of the citizens (Banji et al., 2020).

During the last decade, the Ghanaian government has promoted ICT tools in education to improve academic attainment. According to Natia and Al-hassan (2015), the Ghana Education Service's Education Strategic Plans 2003-2015 and 2010-2020 highlighted the necessity for ICT in education to accomplish the Education Strategic Plan's objectives. As a result, the Ghanaian government established the "ICT for Accelerated Development (ICT4AD) Policy (2003), which explicitly outlined the plans and strategies in a framework of how ICTs can be used to facilitate the national goal of transforming Ghana into an information and knowledge-driven ICT literate nation" (Natia & Al-hassan, 2015, p. 2).

Ghana developed its initial ICT in education policy (ICTED) in 2003, revised it three times between 2006 and 2008 before it became the present ICTED, which was accepted in 2015 (Banji et al., 2020). This policy was designed to serve as a blueprint for utilising ICTs more effectively and coordinated. As a result, this policy statement tries to give policy direction for what needs to be done and the general framework for how it will be done.

Four essential factors are considered critical in ICTED for ICT planning in the educational sector. These four key elements are: "Equity, access to ICT infrastructure, capacity building, and norms and standards" (MoE, 2008, p. 15).

Strategic resource allocation decisions must be made to employ ICT tools in education effectively. The equity concept is supposed to guide decisions and serve as a foundation for allocating these resources. According to the MoE (2015), informed decisions on resource allocation(s) must be made, with caution needed to prevent scenarios where technology exacerbates existing digital disparities within a country. Gender and special needs education are additional concerns that must be addressed. According to the MoE (2008), "End-users (learners, teachers, managers and administrators)" (p. 15) will be heavily reliant on inexpensive and constant "access to hardware, software and connectivity" (p. 15), which, in turn, will be contingent on the availability of enough physical infrastructures, such as computer laboratories and power sources.

According to the MoE (2015), ICT tools can only be utilised effectively when the targeted users are competent, according to worldwide lessons learned through ICT in education efforts. This issue indicates that the user needs to possess the necessary abilities, knowledge, and attitudes for doing the tasks at hand. Pedagogical strategies that incorporate technology into the curricula and professional development must be addressed (MoE, 2015).

To attain the purpose of the ICT in Education Policy, "Seven (7) thematic areas outlining guiding principles, objectives and associated strategies have been identified" (MoE, 2008, p. 18). These themes have been defined as "Education Management – Ministry/Agencies and Educational Institutions, Capacity Building, Infrastructure, E-readiness, and Equitable Access, Incorporating ICT into the curriculum, Content Development, Technical Support, Maintenance and Sustainability, and Monitoring and Evaluation" (MoE, 2008, p. 18).

According to the MoE (2008), the standard by which education management can be evaluated or measured includes the use of computerised management tools and "availability of timely,

accurate and reliable data can enhance administrative capacity for informed and effective decision making" (MoE, 2008, p. 19). According to Endarto et al. (2020), the act of improving or modifying the behaviour of individuals, organisations, and community systems to achieve set goals effectively and efficiently is known as capacity building.

The MoE (2008) emphasises the capacity building thematic area including using ICT tools to transform T&L through the ICT in education policy, stating "systems to meet the challenges of the knowledge economy, and the introduction of ICT in the Education Sector necessitates the training of all persons involved in the educational service delivery" (p. 21), to mention a few.

The guiding principles of "infrastructure, E-readiness, and equitable access", according to the MoE (2008, p. 23), governing the ICT in education policy, include the "availability of appropriate infrastructure is key to facilitating the deployment of ICT at each level, ICT equipment should be deployed according to internationally acceptable standards, and Students' user access to up-to-date computer-based tools" (MoE, 2008, p. 23).

"Curriculum reform is necessary for ICT to be introduced and utilised effectively in the classroom, exploitation of ICT in teaching improves students learning and thus develops skills necessary for the competition in the knowledge economy and information society, the integration of ICT in the education system can boost the economy of the country because it can enhance productivity, and curriculum content must address the ICT needs of the labour force" according to the MoE (2008, p. 25). These are some of the guiding principles governing the incorporation of ICT into the curriculum.

Content development is defined as the "Sequencing movement tasks in a manner that has a potential to facilitate learning" (Rink, 2014, p. 84). According to the MoE (2008), the factors that influence content development as one of the main theme areas include the development

of digital material to encourage the "use of indigenous culture in the education system" because digital information is essential to e-Education, "easier and less expensive to update and distribute", and can help students learn more effectively (p. 27).

Technical support, maintenance, and sustainability, according to MoE (2008), are governed by guiding principles such as managerial support and commitment, technical support and regular maintenance, and appropriate financing for the resources required to achieve the aims of ICT-based educational programs. ICT equipment replacement and maintenance plans and good monitoring of ICT inventory and maintenance are other concepts that can help sustainability.

According to Simon and Mwenda (2021), "monitoring and evaluation is defined as the process of regular and systematic collection, analysis, and reporting of information about a project's inputs, activities, outputs, outcomes, and impact" (p. 32). To achieve the goals set for ICT in Education Policy, the monitoring and evaluation guiding principles, objectives, and associated strategies undertake "to perform ongoing assessment and evaluation of the extent and impact of the implementation of the strategies in the ICT plan, regular review and revision of ICT policy and practice keep the process more current and in line with both management and technological trends, and continuous Research in ICT related issues is necessary, given the volatile and everchanging nature of modern technology" (MoE, 2008, p. 30).

2.4.4 Integration of ICT in Education

Hughes (2013) defines the integration of technology in T&L as the use by teachers and students of digital ICT tools that support the constructivist T&L process. The significance of ICT integration in education is critical because, with the aid of technology, T&L can take place not only in the classroom but even when teachers and students are physically separated (Ghavifekr & Rosdy, 2015).

Some governments worldwide recognise the need to integrate ICT tools into education, and as a result, they invest significant sums of money in ICT-related activities in schools (Albugami & Ahmed, 2015). These governments believe that the deployment of substantial ICT tools is adequate to propel the country's education toward producing human capital for economic growth.

In Ghana, the effort by successive and present governments to integrate technology into the educational sector is enormous. A variety of reforms have been implemented to integrate ICT into the educational sector. In Ghana, the National Education Reform Report of 2007, based on Ghana's 1992 Constitution, proposed the provision of computer labs, internet and network connections for schools, laptops for instructors and learners, and instructor capacity building, among the recommendations (Amedeker, 2020).

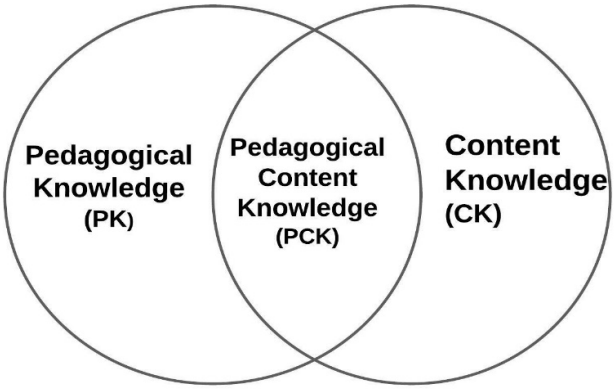
To meet these governments' aims of producing human capital for economic growth in their respective countries, these ICT tools procured by the governments with a considerable sum of money must be successfully integrated into teacher training. Integrating ICT tools in pre-and in-service teacher training presents several opportunities and constraints in the educational setting. According to previous studies, how teachers are educated to integrate technology into their T&L influences their ability to build a relationship between content, pedagogy, and technology (Niess et al., 2009; Voogt et al., 2013).

It should be possible to use the TPACK model, which is based on the core criteria connected to technology, pedagogy, and content knowledge, in teacher training, according to Li et al. (2019). The acronym TPACK stands for "Technological Pedagogical and Content Knowledge" and is a technology integration paradigm. Mishra and Koehler (2006) introduced this paradigm in 2006. Their findings expand on Shulman's (1986) work which developed the PCK paradigm where PCK stands for "Pedagogical Content Knowledge". The pedagogical

and content contexts were important to Shulman's early conceptualisation of the PCK paradigm (Mishra & Koehler, 2006). The PCK model (see Figure 2.6) emphasises how educators teach and what they teach, both of which must be equally represented to provide the best learning experience possible.

Figure 2.6

The PCK model

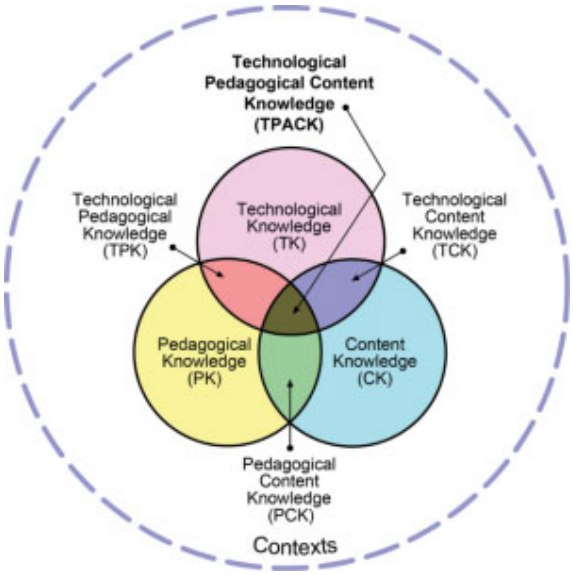


Source: Mishra and Koehler (2006, p. 1022, Figure 2)

Mishra and Koehler (2006) updated Shulman's (1986) work by including the technological repercussions of a more current learning environment and pedagogical style (Koh et al., 2014). The TPACK framework depicts where the three fundamental components of technological implementation and integration into a learning environment intersect (see Figure 2.7). Koh et al. (2015) state that "TPACK is created when teachers employ their technological knowledge, pedagogical knowledge, and content knowledge to create specific ICT-integration strategies. Teachers' ICT-integration strategies reflect their consideration of content, pedagogy, learners' characteristics, and technology in relation to school and classroom contexts" (p. 537).

Figure 2.7

The TPACK Model



Source: Mishra and Koehler (2006)

The TPACK model is represented by an overlapping Venn diagram in which various types of knowledge combine to provide an ideal experience in which pedagogical, content and technological knowledge are all balanced (Koh et al., 2014). Each component of knowledge plays a critical role in successfully integrating technology into the classroom. According to Koh et al. (2014), Technological Knowledge (TK) is an interesting part of this model to define because of the constant change of new and emerging technologies. Due to the ever-changing dynamics of technology available to learners and teachers, educators must have a broad understanding of both existing and emerging technologies and how they can be productively integrated into the curriculum (Mishra & Koehler, 2006).

Pedagogical Knowledge (PK), according to Mishra and Koehler (2006), is the ability of an educator to present knowledge effectively to their learners while also resolving difficulties or misconceptions from learners. They go on to define PCK as "knowing what teaching

approaches fit the content, and likewise, knowing how elements of the content can be arranged for better teaching" (p.1027).

Content Knowledge (CK) is defined by Mishra and Koehler (2006) as "knowledge about the actual subject matter that is to be learned or taught" (p. 1026). Educators must be specialists in the field of study they teach at the level of complexity of the material they deliver to the student.

It's critical to emphasise that in the TPACK model, each construct is dependent on the others. On its own, a construct cannot work effectively, according to Mishra and Koehler (2006). For example, while it is crucial for an educator to be exceedingly well informed about the topic they are teaching, establishing content-based expertise without a pedagogical grasp of presenting or teaching the material in a meaningful way defeats the purpose of teaching. The intersection of pedagogical, technological, and content-based knowledge within the classroom constitutes an ideal balance (Mishra & Koehler, 2006).

John Dewey famously said, "if we teach today's students the same way we taught yesterday's students, we deprive them of tomorrow" (Bărbuceanu, 2020, p. 136). In today's educational environment, this sentiment resonates strongly. Educators must be forward-thinking in their approach to teaching. Curriculum development and execution that incorporates 21st century skills has become increasingly important (Koh et al., 2014). Integrating technology and technological literacy has an ever-changing scope within the current curriculum and learning environment.

2.4.5 ICT Tools adopted in Higher Education Institutions

The significance of ICT tools for education cannot be overstated, and they have undoubtedly influenced T&L, in addition to research. According to Agbo et al. (2021), several studies have

demonstrated and confirmed the benefits of adopting and using different ICT tools in HEIs to improve educational quality worldwide. A review of these studies is examined in the next paragraphs.

Noskova et al. (2019) carried out an international study, including respondents from Spain, Ukraine, and Russia, on academic instructors' usage of ICT tools. Their study focused on the authors' typology of ICT tools, dividing them into three groups based on instructional objectives: information, communication, and management. A survey with prior validation by independent experts was used, in addition to statistical analysis (the hierarchical cluster analysis technique) and a comparative qualitative analysis of data for three groups of participants. Noskova et al. (2019) applied normalised indices to characterise complicated elements of the practical deployment of pedagogical ICT tools as variables. Their results show that instructors use information, communication, and ICT management tools with varying degrees of intensity. They employed various ICT tools to create digital learning resources to present students with a diverse range of educational possibilities in an e-learning setting. When providing digital material for varied learning goals, teachers frequently consider students' preferences. The range of ICT tools available is heavily dependent on instructors' expertise; nevertheless, a university's educational policy, which establishes corporate requirements for ICT competencies and regulates the use of e-learning, is no less important. Teachers are still a long way from using most of the benefits of the e-learning ecosystem.

Ashaver and Igyuve (2013) examined the usage of audio-visual materials in the Katsina-Ala CoE in Benue State, Nigeria. They distributed two sets of questionnaires to lecturers and students and visited the college to observe what audio-visual resources were available. Their study's population included all lecturers and students at the CoE and a sample of 100 staff and students selected for their study. Data were collected through the research questionnaire, and

observations were organised and analysed using statistical techniques such as percentages, frequencies, and means.

They found that the college lecturers seldom employed audio-visual materials in their classes. The chalkboard is the sole audio-visual material that the lecturers often use. The adoption of audio-visual aids in college is hampered by non-availability, a lack of supporting infrastructure, and human factors.

Apriani and Hidayah (2019) evaluated various types of ICT tools used by English lecturers for non-English Study Program students at Institut Agama Islam Negeri (IAIN) Curup university and the roles of these ICTs. A descriptive quantitative method was employed in their study since the findings were reviewed and given in the explanatory form. A questionnaire was used as the data collection instrument covering ICT tools adopted by English lecturers for non-English Study Programme students at IAIN Curup and the role of ICT for English lecturers. In their study, five procedures were used to analyse data from questionnaires: data management, reading and memorisation of results, description of results, classification of results, and interpretation of results. Their findings revealed that lecturers always employed three types of ICT tools in the classroom while teaching English: the speaker, educational games, and internet resources. They chose three types of ICT because they were simple to use and inexpensive. The instructors' views on the importance of ICT in boosting learning activities differed on employing it. The role of ICT in the T&L system is concerned with the use of ICT in motivating, recruiting, and increasing the achievement of English learners.

Aminatun (2019) explored how university lecturers embraced technology in teaching using descriptive qualitative research that discussed the ICT tools employed by university instructors. The sample consisted of 15 English lecturers from various HEIs and universities

throughout Indonesia, including Lampung, Banten, Jakarta, Central Java, East Java, and Yogyakarta. The lecturers were between the ages of 20 and 40 years of age, and they were in charge of various courses at universities and implementing the use of ICT in classroom T&L. The data were gathered primarily through a questionnaire as the primary instrument. In addition, an interview was also conducted to aid in the confirmation of the data. There were 22 questions and statements about the use of ICT in the T&L process in the questionnaire. The items ranged from closed-ended to open-ended questions. Aminatun (2019) reports that the types of ICT tools being used by lecturers ranged from simple to sophisticated ones. Some lecturers use the ICT tools provided by their university, while others bring their equipment to optimise their teaching. While all lecturers have embraced ICT for teaching, the results revealed that they still appeared to require traditional media such as a whiteboard since ICT was also lacking in some areas.

Tor et al. (2020) studied the use of ICT skills in teaching and research by academics at selected Nigerian universities. A cross-sectional survey design was used. Their study population was lecturers in the three universities in Benue State, namely, University of Agriculture, Makurdi, Benue State University, Makurdi, and the University of Mkar, with 1,537 lecturers. Three hundred and six lecturers were chosen as a sample for their study from this population. For sample selection, cluster and simple random sampling were used. The instrument for data gathering was a questionnaire. The data gathered from participants were analysed using mean and standard deviation, while inferential statistics in the form of a one-way analysis of variance was employed to test two null hypotheses. They found that university lecturers in Benue State use ICT skills in their teaching to some extent, and they use ICT skills in their research moderately. The results of the two hypotheses revealed that there is a differential in the extent of ICT skills adoption in teaching by lecturers in the Federal, State, and Private Universities in Benue State, whereas there is no significant difference in the level of ICT skills

application in research by faculty members in the Federal, State, and Private Universities in Benue State.

Gombe et al. (2016) investigated the prevalence of ICT usage among federal university lecturers in North-western Nigeria. A sample of 350 lecturers was chosen randomly using a multi-stage cluster technique. Data were obtained using an online survey named the "ICT Perceive Ease of Use Questionnaire (IPEUQ)", with an 85.7% response rate. SPSS was used to analyse the data, and the results indicate that lecturers are personally committed to acquiring ICT skills to enhance their competence, to the point that they cover the expense of training without any interference from the authorities.

Hidayat et al. (2018) investigated the readiness of lecturers and college students to use ICT in the learning process. Their investigation was based on a sample of lecturers and students from one faculty at Universitas Sultan Ageng Tirtayasa (Untirta), a developing Indonesian university. The authors (Hidayat et al., 2018) used a survey approach to determine the university's preparedness to use ICT in T&L. The instructor and student questionnaires and an interview were utilised to gather data in this study. Cluster random sampling was used to collect the data. According to their findings, both instructors and students are eager to add integrated ICT into the learning process. The major issue that was raised by the professors was a lack of lecturers' technological abilities.

2.4.6 Factors Influencing Adoption of ICT Tools by Lecturers in Higher Education Institutions

The effectiveness of ICT adoption by lecturers in HEIs is a multi-layered path determined by its uniqueness and the relationships between human resources and the educational contexts (Mustapha et al., 2020). Various factors were recognised as influencing ICT adoption by lecturers. Institutional, personal, and technological factors were identified by Liu et al. (2020)

to be major factors in the adoption, deployment, and use of ICT tools in an educational setting.

For Simmons and Martin (2016), an institution's attitude toward ICT usage is one of the major factors influencing the lecturers' adoption of ICT tools in that particular institution. Lecturers tend to feel unsupported in their desire to integrate technology when the institution administrators do not value the importance of technology in education or do not use technology in the everyday operations of the institution (Simmons & Martin, 2016). Lecturers will not only feel unsupported, but they will also embrace the administration's attitudes and refuse to incorporate technology or will continue to do so at a low level (Metcalf & LaFrance, 2013; Simmons & Martin, 2016). Furthermore, lecturers are faced with a hectic work schedule set out for teaching, seeing students, preparing, marking, and other administrative activities in a rigorous educational setting such as a CoE. The lecturers claim that there isn't enough time to properly absorb technology while fulfilling other educational goals (Heath, 2017; Metcalf & LaFrance, 2013). As a result, administrators must be realistic about the amount of time that should be set aside for lecturers to undergo professional development to familiarise them with new technologies and become comfortable and confident with technology-based and enhanced approaches before integrating any new classroom technology.

The success of ICT integration can also be influenced by personal factors such as users' attitudes, perceptions, and intentions to use ICT tools (Heath, 2017; Seifu, 2020). Lecturers having positive attitudes toward using ICT in their curriculum delivery can help to encourage the use of ICT tools in their classrooms. According to Heath (2017), teachers do not consider themselves computer knowledgeable or technology leaders. Teachers indicate a lack of trepidation about employing technology to deliver their lessons (Aldunate & Nussbaum, 2013).

Another key personal factor impacting integrating new technology into teaching methods is the lecturer's age (Aspasia & Ourania, 2014). Lecturers are unsure whether the technology would make them more effective lecturers since they have not been able to experience and comprehend the benefits of new classroom technology and be mature users and explorers of pedagogies. The influence of age on technology adoption is additionally muddled by the lecturer's years of teaching experience (Long et al., 2019). For example, in contrast to experienced lecturers who have been teaching with traditional chalk and blackboard for many years and are hesitant to change, lecturers with fewer years of teaching experience may be more willing to incorporate technology into their teaching. The converse may also be true– experienced lecturers who are very familiar with and have tested and experimented with many different instructional and pedagogical methods may feel more comfortable embedding technologies into their instructional models because they have more self-efficacy (Long et al., 2019).

Availability and accessibility of ICT tools can also influence ICT educational use (Razak et al., 2018). Lack of access to computers, or the awkward positioning of ICT equipment, for example, might influence ICT integration in the classroom. For Onuoha et al. (2016), scarcity of computer technicians to address technology-related issues can also cause people to lose faith in new technologies. These technical elements will, in the end, have a detrimental influence on lecturers' readiness to use new or current technology in their classroom instruction. For the effective acceptance of technological advancements, access to ICT tools and support services must be convenient and straightforward, especially when lecturers utilise new technology for the first time and want to practise and familiarise themselves with it.

ICT accessibility, according to Goh and Sigala (2020), is also crucial for students (who are the end-users of educational ICT tools). Students' ICT adoption can be a deciding factor for

lecturers when deciding whether or not to employ ICT in their classes. For example, students may find technology difficult to use or perceive that ICT does not enhance their learning or have limited access to ICT or support for ICT. The lecturers may then decide not to utilise the new technology to prevent student disillusionment and bad feedback or evaluation. As a result, educational institutions must provide sufficient technical availability and assistance so that lecturers and students alike may feel confident and comfortable in their decision to include ICT into their T&L activities.

2.4.7 Using ICT in Pre-Service Teacher Education

Pre-service teacher education prepares aspiring teachers with a wide range of skills, competencies, and knowledge (Tasdemir et al., 2020). Pre-service teacher education programmes are the first type of educational training individuals undergo before entering the teaching profession. These programmes usually combine academic expertise in teaching with field-based practice experience called a practicum or teaching practice, or practical teaching. Teaching practice, also known as practical teaching or practicum, according to Amtallah (2020), is the first opportunity for pre-service teachers to put their prior pedagogical experience, classroom skills and knowledge into practice. Sabzian and Gilakjani (2013) were on the view that pre-service teacher education programme should cover how to use ICT tools and use ICT tools to improve the quality and effectiveness of their teaching. They also suggested that this training include information on how ICT might be integrated into the curriculum efficiently. Learning how to utilise various ICT tools will not necessarily result in ICT being incorporated into T&L; their use must be contextualised in a real-world classroom setting (Mulder, 2014). Therefore, lecturers of Ghanaian CoEs are expected to integrate ICT tools in their teaching for pre-service teachers to emulate.

According to Ghavifekr and Rosdy (2015), the use of ICT tools in teaching is becoming increasingly important as it can improve academic achievement, innovation, and critical thinking skills. Therefore, pre-service teachers should have the chance to put their ICT integration skills learned at college into practice, be evaluated on them to see whether they are doing well, and, if not, be provided with remediation before graduating from college (Amtallah, 2020). For Plomp et al. (1997), ICT tools can be used in three ways as part of the learning process: as an object, an aspect, or a medium. As an object, it is a term used to describe learning about ICT tools. Students become familiar with hardware and applications, such as Microsoft Word, Microsoft Excel, and other programmes. The aim is to teach people how to use computers. As an aspect, one refers to ICTs being used in education in the same way they are used in manufacturing. Computer-aided modelling and production, for example, are examples of how ICTs are being used in education. When ICTs are used to promote T&L, they are called a medium.

Çetin (2021) investigated how the digital storytelling procedure affected pre-service teachers' digital literacy abilities. The research involved 36 pre-service teachers in computer education. The study's data gathering techniques included "digital literacy assessment scale, digital storytelling assessment scale and opinion form of the digital story creation process" (p. 1). According to the findings, pre-service teachers' digital literacy skills differed considerably after the study. Digital stories received good ratings on the digital story evaluation scale. The pre-service teachers' perspectives revealed various challenges in the digital story production process while also emphasising the technique's favourable contribution in academic contexts.

Rets et al. (2020) used MMR and a robust pre-post design of TPACK in two virtual exchanges with 55 pre-service teachers to assess the influence of virtual exchange on their perceived

TPACK development. Their findings revealed that while most participants reported favourable TPACK increases, their accounts of experiences of virtual exchange varied greatly. Teotia (2020) examined the influence of ICT on primary teacher trainees' success levels and attitudes about adopting ICT-based instruction. Qualitative and quantitative data from many stakeholders were analysed and aggregated. It was discovered that using ICT in the classroom boosted the learning of all trainees, with high achievers benefiting more than low achievers. Furthermore, trainees believe that using ICT in education has a beneficial influence on their academic performance and that using technology makes learning easier. On the other hand, respondents and participants failed to acknowledge any educational benefit of employing personal computers and projectors in pre-service teacher education.

2.4.8 Impact of ICT Tools in Higher Education Institutions

Lawal and Oloyede (2013) examined the impact of ICT on the quality of T&L at a Nigerian university. In addition, they focused on the influence of ICT on students and teachers. The objectives of Lawal and Oloyede's (2013) study were accomplished relying on responses from both students and professors who have experience with the university and institutions in developed countries. The results of their study suggest a unique trend indicating that lecturers are eager to accept ICT, and students with prior educational experience believe that ICT would have a highly beneficial influence on the T&L setting in the university when incorporated. It also emphasises the importance of ICT in the university's T&L. Lawal and Oloyede's (2013) study stated that ICT has the potential to reshape T&L in Nigerian universities by exposing students to "quality and enormous learning resources, encourage learners to take control of their own knowledge by guiding them to the desired knowledge, motivates both learners and teachers alike, and encourages good communication plus collaboration among colleagues" (p. 48).

Olumade (2015) investigated the impact of ICT on the competency of lecturers in Nigerian higher learning institutions. A descriptive survey was used as Olumade's (2015) study design. Five hundred participants were chosen from ten Federal Universities with the stratified random sampling at hand. Data were collected using an instrument called the ICT integration and lecturers' proficiency questionnaire. According to the findings, ICT has a tremendous multiplier effect on university education in terms of lecturers' proficiency, which has a major impact on the institution's focus.

Shamim and Raihan (2016) evaluated the effectiveness of using ICT tools to improve T&L. Their study used a survey research design, with instructors from the Bangladesh's government polytechnic institutes serving as the population. Bangladesh has 45 government polytechnic institutes with a population of almost 1,500 lecturers. Purposive random sampling was employed to investigate a sample of 120 lecturers. According to the study's findings, incorporating ICTs into the T&L process would make the entire process easier, more engaging, and time-efficient. More than half of technical education instructors strongly felt that ICTs are critical for improving the teaching-learning process at polytechnic institutions.

Hashemi (2016) ascertained the impact of ICT on teaching college students' English by using a sample of 55 college students under a quasi-experimental study approach. The author teaches at three universities (Islamic Azad University, Payam Noor University, and Applied Science Centre), and the population of the research is made up of his three general English classes taught in the fall of 2015. Hashemi (2016) did not influence the selected students and chose three courses at random, but due to administrative constraints, he could not assign students randomly to the three groups: One control group and two experimental groups. These students majored in accounting, social studies, and medicinal plants, among other things. The sample comprised both males and females in their first year of university. One of the experimental

groups consisted entirely of males, whereas the other comprised solely of females. They were divided into three groups where the researcher utilised intervention for the two experimental groups to examine and compare the impact of the intervention on both sexes. The findings indicate that ICT improves language learning experiences and may be used effectively for both T&L.

2.4.9 Validity of the Technology Acceptance Model

Teo (2010b) conducted empirical research to validate the TAM in understanding pre-service teachers' inclination to utilise technology. Teo (2010b) looked at the self-reported intention to use the technology of a sample of pre-service teachers (n=239). The TAM was applied as a study framework, and the findings contribute to technology acceptance research by providing strong evidence in support of the TAM's appropriateness to explain technology intention among educational users, validating its superiority. A good fit for the measurement and structural models was established using SEM for data analysis. In all, the findings showed that the TAM was excellent at predicting pre-service teachers' desire to use technologies such as those of ICT in nature.

Aafaqi et al. (2007) explored if sense-making activities affect technology acceptance and whether the intensity of the link between TAM's constructs varies over time. Their study was panel-based longitudinal research in which data were gathered in three phases over a single semester. It was conducted at the School of Management, Universiti Sains Malaysia (USM). Their study population comprised USM Master of Business Administration (MBA) students. This group was chosen because the authors collected data on various factors throughout several periods and needed the same participants at each step. In response to attaining the objectives of their study, SPSS was used as the statistical tool for the data analysis using a sample of 74 students. The students were chosen from the statistics class, all under the MBA

programme. They were the most relevant group for Aafaqi et al.'s (2007) study because they were introduced to SPSS for the first time in this course, which was for the majority of the students. The primary findings suggest that sense-making impacts the TAM when activities are performed at high and low levels and influences particular TAM elements rather than the whole model. This research failed to demonstrate a substantial change in the strength of the association between TAM constructs over time under the sense-making impact, indicating that sense-making activities have no moderating effect on TAM constructs. Rather than moderating the intensity of the link between TAM constructs, sense-making works as an external variable that impacts TAM.

Napitupulu et al. (2017) investigated if the TAM is still applicable today, given the rapid advancement in ICT. The purpose of their study was to determine if the TAM measurement indicators are valid and capable of representing each dimension of the model. The method employed is a quantitative method based on a factor analysis approach. Napitupulu et al.'s (2017) methodology is a survey by a factor analysis approach. It was carried out to assess user approval of the technology in the form of an expert system application for diagnosing the types of plant pests and diseases that affect potatoes and treatment options. Purposive sampling was used to sample the participants using a questionnaire. A number of centres and areas for potato crop production in Indonesia were chosen for Napitupulu et al.'s (2017) study, namely: Garut district, sub-district Pengalengan, Wonosobo district, city of Batu Malang, Jambi Kerinci district, Berastagi city, Enrekang district and sub-district Malino South Sulawesi. Questionnaires were sent to all research subjects, namely farmers and extension workers (experienced farmers, selected and hired by the government to mentor and train local farmers) in the field, with a total response of 234 individuals. All indicators were found to be genuine and capable of representing each element of TAM, namely perceived utility,

perceived ease of use, and behavioural intention to use. As a result, the TAM model is still important for measuring the user acceptability of technology.

Saadé et al. (2007) explored the validity of the TAM in the context of multimedia learning environments. To gain more insights into human behaviours in a multimedia learning setting, the authors performed comparison research with 362 students, about three times the sample size of the previous study, who participated in testing the theoretical model. Saadé et al.'s (2007) findings indicate that TAM is a strong theoretical model of which the applicability may be extended to the multimedia and e-learning contexts. Their study offers a more in-depth look at multimedia learning platform users and is an essential step toward a better understanding of system user behaviour and a multimedia acceptance model.

2.4.10 Extent to Which Each Construct in the TAM Affects the Actual Usage of ICT Tools

Using the TAM, Bundot et al. (2017) assessed variables that impact an individual's intention to use ICT. Their study was carried out using a sample frame of Nigerian academics in the Department of Science, "the potential lecturers in Northern east part of Nigeria including Adamawa, Bauchi, Borno, Taraba and Yobe States where technology acceptance was crawling due to the resistance of western education in the region" (p. 3).

The data were analysed using variance SEM in AMOS and principal component analysis to validate the constructs. Because the nature of the research topic is deterministic, their study used a quantitative research approach based on post-positivism thought. A sample of 350 participants was chosen at random from the target demographic of potential lecturers in Northern East Nigeria, comprising Adamawa, Bauchi, Borno, Taraba, and the Yobe States, where technological uptake is slow due to hostility to western education in the region. A pilot survey analysis was carried out, and all Cronbach's alpha coefficients (hereafter Cronbach's

α for brevity) were more than the acceptable .7. In addition, standardised instruments were used in this investigation. Bundot et al.'s (2017) results, as expected, confirmed the theory's premise, as PU, PEU, and AU impacted science lecturers' intention to apply ICT.

Costa et al. (2019) investigated professors' usage and acceptance of technology in the context of T&L in an HEI. A questionnaire based on the TAM was used in the empirical investigation. They relied on professors from the University of Aveiro (UA). The data were collected via a questionnaire based on the existing literature and distributed to all 903 UA professors between March and May 2016. There were 97 responses from various scientific fields. The final questionnaire is the outcome of applying a previous version to a pilot sample of five professors and is organised into three sections: participant characterisation, characterisation of the usage and acceptance of various LMS and Web 2.0 technologies, and characterisation of the use of Massive Open Online Courses (MOOCs). The findings revealed that the most often applied technologies were Moodle, Facebook, and YouTube, and it was determined that these technologies are generally widely accepted. There were few statistically significant variations between respondents' gender, scientific fields, or ages, indicating that the usage of these technologies is already ubiquitous in the examined institution. The findings also reveal that PU and PEU are two significant drivers of Moodle's acceptability and that the majority of respondents were unfamiliar with the notion of a MOOC. PU relates moderately with Facebook and YouTube acceptability. PEU does not relate with Facebook and YouTube usage as expected.

Alharbi and Drew (2014) proposed and modified the TAM to help public institutions, notably in Saudi Arabia, forecast behavioural intentions to apply LMSs. Their study provided a theoretical framework incorporating the TAM key constructs of PU, PEU, and AU. External factors such as lack of LMS availability, experience (LMS usage experience), and job

relevancy were also included. Their study is quantitative, with data collected via an online survey. It sampled 59 faculty members from various colleges and departments who freely engaged in the online survey. All participants were professors from Shaqra University who met Alharbi and Drew's (2014) aim and setting. According to the research model, all factors stated directly or indirectly influence the overall behavioural intention to use and LMS. Initial findings indicate that TAM may be used to assess behavioural intent to use an LMS.

Furthermore, the results corroborate the conclusions of the original TAM. Alharbi and Drew (2014) added external variables such as a lack of LMS availability, job relevance, and experience with LMS application, as recommended by TAM advocates. First, the theoretical framework is influenced by the specific context in which data is collected. The lack of access to the LMS by subjects during the data collecting phase was anticipated to have a moderating influence on the link between TAM variables, especially the ease of use. The findings, however, demonstrate that a lack of LMS availability does not always imply that academics feel using an LMS is difficult. Job relevance, another external variable, has also been shown to have a high link with TAM elements. Job relevance, in particular, influenced academics' perceptions of an LMS's usefulness in the context of this study. The role of past LMS using experience was also explored. The results for both expert and beginner users corroborate the original TAM findings. In this study, novice users were more likely to be positive about LMS uptake.

Bundot (2018) investigated the link between perceptions, attitudes, and other factors influencing a lecturer's behavioural intention to use regarding implementing a computer in scientific instruction. A quantitative design was adopted to conduct the study and meet the objectives, followed by a supportive interview. Two hundred and sixty-nine (269) academics were chosen from a pool of 715 academics. A validated questionnaire was utilised in the study,

and quantitative data were acquired using the TAM inventory. SEM was used to analyse the data. A semi-structured interview technique was used to collect qualitative data to enable interviews with five purposefully chosen individuals for this phase of the study. The qualitative part of the study sought to elucidate key elements influencing the intention to utilise ICT in science education. The findings revealed that (i) perceived ease of use is related to perceived usefulness, (ii) perceived usefulness and perceived ease of use are related to attitude towards use, and (iii) perceived usefulness and attitude towards use are related to behavioural intention to use. Gender, age, and teaching experience were found to impact perceived ease of use, perceived usefulness, and attitude towards use.

Oye et al. (2011) used the TAM and UTAUT models to analyse the teachers' behavioural intention about technology adoption and usage. This research was carried out as a pilot project at the University of Jos Plateau State in Nigeria. A total of 100 questionnaires were distributed and collected. According to the poll, 57% were male, and 43% were female. Oye et al. (2011) gathered answers for a number of questions, namely: (a) Is ICT mandatory or voluntary in your institution? (b) As an academic, what are the most significant impediments to using ICT for you? Using SPSS, it was found that almost all full-time professors (89%) believe that ICT is mandatory. Concerning barriers to ICT usage, 42% of respondents stated that time is an issue, while 31% stated that training is a problem. One-fifth of respondents (20%) stated that they wanted remuneration, 4% stated that cost is a concern, and 3% stated that it did not suit their program. The mean response for performance expectancy was 4.32, with a standard deviation of .665. The constructs were found to be substantially associated with behavioural intention, which suggests that ICT makes tasks easier to do in the university, making them more efficient. As a consequence, 86.5% of those polled agreed this influences the respondents' predicted level of ICT adoption. Performance expectation was the most

influential of the four UTAUT constructs. As a result, performance anticipation is the most significant element in participants' acceptance and usage of ICT.

2.5 Chapter Summary

My study's theoretical framework and relevant associated literature were presented and reviewed in this chapter. I explored lecturers' acceptance and use of ICT tools in teaching pre-service teachers at CoE in Ghana within the context of the TAM as a research framework supported by the UTAUT, TRA, and TPB. The theories and associated concepts that support my study were discussed comprehensively. I discussed the conceptual model and hypothesis formulation of my study and empirical studies on the topic under study. This chapter reviewed the existing pertinent literature relevant to my study.

The Ghana education system, Ghanaian CoEs, Ghana's ICT in education policy, ICT integration in education, and ICT tools used in HEIs were some of the themes explored in the literature review. The factors that influence lecturers' use of ICT tools in higher education, the use of ICT in pre-service teacher education, and the effect of ICT tools in higher education were also considered. Finally, the validity of the TAM and the extent to which each TAM construct influences real ICT usage among lecturers at Ghanaian CoEs were discussed. The next chapter presents the research methodology of my study.

Chapter 3: Research Methodology

3.1 Introduction

In this chapter, I discuss the research philosophy, research design, and methodology in detail. Subsequently, I discuss my study's sampling, data collection methods, and data analysis. Finally, I consider quality assurance criteria (reliability and validity for the quantitative data and trustworthiness for the qualitative data) and ethical concerns.

3.2 Research Paradigm

A research paradigm is a technique, model, or pattern for research. According to Nieuwenhuis (2019a), a research paradigm is a collection of assumptions based on truth's fundamental aspects that lead to a precise worldview. This philosophical perspective, which relates to several theories and practices, covers a wide range of perspectives, beliefs, and insights into various concepts and activities to carry out a thorough strategy during the research process (Cohen et al., 2018).

Sections 3.2.1 to 3.2.3 explain how my theoretical assumptions provide an integrated framework for understanding insight into the nature of reality (ontology), my search for insight into the fundamental nature of truth (epistemology), and the process of obtaining general knowledge in natural settings employing naturalistic techniques (pragmatist perspective).

3.2.1 Ontological Assumption

The study of being or reality is called ontology. According to Nieuwenhuis (2019a), ontology is a set of assumptions established to comprehend reality's nature. According to Kivunja and Kuyini (2017), ontology assists in the comprehension of what makes up real-world existence. Ontology establishes standards for differentiating between different things and their

relationships. As a college lecturer, I assumed that the nature of the real world is subjectively formed based on interactions between tutors and learners in a social environment (that is, college and lecture rooms) and "a sense of understanding of the meanings imparted by people to phenomena and their social context" (Nieuwenhuis, 2019a, p. 68).

3.2.2 Epistemological Assumption

Epistemology is focused on generating new models of theories superior to competing models and theories to improve the knowledge-gathering process. According to Nieuwenhuis (2019a), epistemology is "the nature of knowledge and how it can be acquired" (p. 56), and it "relates to how things can be known - how truths or facts or physical laws, if they do exist, can be discovered and disclosed" (p. 73). This premise is based on the interrelationship between the knower and the well-known (Kaushik & Walsh, 2019; Nieuwenhuis, 2019a). Epistemology seeks to discriminate between genuine (adequate) and erroneous (inadequate) knowledge. Knowing the truth, comprehending the social settings under examination, and comprehending what works well in natural contexts are all examples of knowledge acquisition (Nieuwenhuis, 2019a). According to Yin (2016), epistemology aids in reflecting a new perspective before researching social phenomena.

I employed two different instruments for data collection to conform to naturalistic inquiry techniques through a practical approach to acquiring information. A survey for lecturers and lesson observations were involved in understanding the extent to which lecturers in Ghanaian CoEs embrace ICT tools in teaching.

3.2.3 Pragmatist Perspective

The pragmatism paradigm was chosen as the research philosophy because it helps me find practical answers to the study problems. Pragmatism as a research paradigm is based on

historical contributions to pragmatism philosophy (Maxcy, 2003) and encompasses a variety of approaches. Pragmatists believe that reality is continually renegotiated, debated, and interpreted. As a research paradigm, pragmatism is founded on the idea that researchers should adopt the philosophical or methodological approach that best suits the research topic at hand (Kaushik & Walsh, 2019). Pragmatism is frequently linked to mixed-methods or multiple-methods research (Biesta, 2010; Johnson & Onwuegbuzie, 2004; Maxcy, 2003), emphasising the study outcomes and research topics rather than the techniques.

Pragmatism is a philosophical paradigm that promises to bridge the gap between older approaches' positivism and structuralist orientation and newer approaches' naturalistic techniques and freewheeling attitude (Creswell & Poth, 2016). The participants answered a survey. Some were observed during the enactment of their lessons using ICT tools to acquire first-hand information on what ICT tools they use and how they use them to enable me to get practical answers to the research questions at stake.

3.3 Research Methodology

A research methodology comprises either a quantitative, a qualitative, or an MMR approach. My study opted for an MMR approach, a concurrent nested mixed technique to be precise, in which quantitative and qualitative data collection and analysis were conducted separately but concurrently. The findings were then integrated during the interpretation phase of this study. According to Maggetti (2020), MMR is usually understood as a research strategy that combines qualitative and quantitative analytical procedures in a single study or research project concerning data collection and analysis. MMR was a perfect technique for my study as I used a survey and lesson observations to collect quantitative and qualitative data. The closed-ended questions of the survey constituted the quantitative data for my study, whereas

the open-ended questions of the survey and the lesson observations constituted the qualitative data for my study.

One of the advantages of MMR is combining the respective strength of qualitative and quantitative analytical procedures, that is, in-depth case knowledge with generalisable insights derived from cross-case evidence (Gunasekare, 2015; Maggetti, 2020). In addition, MMR provides (more) valid and reliable results as evidence originates from different sources, and findings are based on separate analytical procedures (Maggetti, 2020). MMR is not without its drawbacks, however. One of the limitations of MMR is that it takes much more time and resources to plan and implement this type of research (Maggetti, 2020) and requires a team of researchers with strong skills and experience in mixed methods.

In my study, I used a concurrent nested mixed technique, a form of MMR. According to Gunasekare (2015), a concurrent nested design comprises a nested method that prioritises one of the techniques and drives the project, while another is embedded or nested. The qualitative approach (lesson observation) was nested inside the quantitative technique (survey) in my study. Therefore, the survey guided the project while the lesson observation was nested. The purpose of employing the concurrent nested mixed technique for my study was to obtain different but complementary data to address the same research questions and corroborate the quantitative results with the qualitative data (Der Bebelleh, 2021).

3.4 Target Population and Sample

This section explains my study's population and how I conducted the sampling. I discuss the population in Section 3.4.1 and the sampling procedure in Section 3.4.2. In addition, I discuss the profile of the participants in both the survey and the lesson observation in Section 3.4.3.

3.4.1 Population

The study population applies to the study subjects with which the testing issue is concerned (Field, 2018). The targeted population for the study was all the lecturers of all 46 public CoEs in Ghana. The rationale for selecting the lecturers is that they are professionals to understand the study instrument, and some had used a specific ICT tool at a particular time in their teaching career for lesson preparation, lesson delivery, or personal development.

3.4.2 Sampling Method

According to Sharma (2017), sampling is a method (procedure or device) used by the researcher to systemically identify, by the predetermined population, a comparatively limited number of representatives or persons (a sub-set) to serve as observation or experimental sample (data source) for their analysis. According to Nieuwenhuis (2019b), the primary objective of sampling is to gather the best (richest) data that will address the study's questions.

I used mixed nested concurrent sampling in my study. Participants selected for the lesson observation of my study were a subset of the participants selected for the survey, and the data were collected simultaneously (Johnson & Christensen, 2020). I also used non-probability purposive and convenience (haphazard) sampling within the nested concurrent sampling. The convenience sampling was embedded in the purposive sampling.

I used purposive sampling because the sample collection shared a similar characteristic and possessed qualities and uniqueness (Maree & Pietersen, 2019) required for my study. All of the participants were lecturers in CoEs in Ghana; they had an extensive understanding of the research issue (Babbie, 2017; Neuman, 2013) and provided relevant and complete discernments into the research questions (Maxwell, 2013). Furthermore, I used the maximum variation technique of purposive sampling (Namoco & Zaharudin, 2021). The participants

were included in this sample approach to maximise variations on specified parameters such as age, the course taught, or gender. Any lecturer at the CoE who was not teaching a course when conducting my study did not qualify to be a participant. This sort of sampling exposes disparities, but it may also uncover commonalities between units (Namoco & Zaharudin, 2021). I sampled 400 lecturers purposively for my study's Phase I (survey).

Convenience sampling is “a type of nonprobability or nonrandom sampling where members of the target population that meet certain practical criteria, such as easy accessibility, geographical proximity, availability at a given time, or the willingness to participate are included for the purpose of the study” (Etikan et al., 2016, p. 2). I chose a convenience sampling technique as it applies to both qualitative and quantitative studies; the subjects were readily available and easily accessible to me (Cohen et al., 2018; Etikan et al., 2016) because I’m a lecturer at one of the CoEs. Haphazard sampling, a form of convenience sampling (Etikan et al., 2016), was employed to sample participants who answered the survey to be part of my study's Phase II (lesson observation) due to their availability. The lecturers who answered the survey were asked if they would be willing to have their lesson observed. The sampling technique falls under haphazard sampling, as those who indicated consent in the survey were selected for the lesson observation. Therefore, out of the 400 purposively sampled lecturers for Phase I (survey), 136 were conveniently sampled for Phase II (lesson observation) of my study.

3.4.3 Participant Profile

I contacted some of the purposively sampled lecturers for the survey in person, others on the telephone, through e-mails, and social media to seek their consent before the hardcopy or the link to the online survey was sent to them. Anonymity was ensured as none of their personal information was captured. The response rate was 97.5%, as 390 out of the 400 purposively

sampled lecturers who were contacted returned completed surveys, either online via the e-survey or in hard copy. Only 136 out of the 390 participants conveniently and haphazardly picked for the lesson observation submitted the completed survey. Table 3.1 displays the age range of participants who returned the completed survey with their respective percentages. Table 3.1 shows that the greatest number of participants (34.9%) was between 42 and 46 years of age, with the least number of participants (0.3%).being between 22 and 26 years of age.

Table 3.1

Ages of Participants - Survey

Age range	Percentage
"Younger than 22 years	0.0%
22 - 26 years	0.3%
27 - 31 years	0.8%
32 - 36 years	4.4%
37 - 41 years	31.5%
42 - 46 years	34.9%
47 - 51 years	21.8%
52 - 56 years	5.9%
Older than 56 years" (Q1.5, Appendix A)	0.4%
Total	100.0%

Table 3.2 shows the gender of the participants who answered the survey; 61.0% were male, and 39.0% were female.

Table 3.2

Gender of Participants - Survey

Gender	Percentage
"Male	61.0%
Female" (Q1.4, Appendix A)	39.0%
Total	100.0%

I sampled 136 out of the 400 purposively sampled lecturers for the survey conveniently for Phase II (lesson observation) of my study. The age and gender breakdown of participants whose lessons were observed are shown in Tables 3.3 and 3.4, respectively. Table 3.3 shows that the greatest number of the participants whose lessons were observed (41.2%) were between 42 and 46 years of age, with the least number of participants (11.0%) being between 32 and 36 years of age.

Table 3.3

Ages of Respondents - Lesson Observation

Age range	Percentage
"32 - 36 years	11.0%
37 - 41 years	36.0%
47 - 51 years	11.8%
42 - 46 years" (Q1.5, Appendix A)	41.2%
Total	100.0%

Table 3.4 shows that the majority of the participants whose lessons were observed were male (86.0%), with only 14.0% being female.

Table 3.4

Gender of Respondents – Lesson Observation

Gender	Percentage
"Male	86.0%
Female" (Q1.4, Appendix A)	14.0%
Total	100.0%

3.5 Data Collection Strategies and Instruments

I used a structured survey to gather data for Phase I and lesson observation for Phase II of my study. More details on the survey and the lesson observation are given in Sections 3.5.1 and 3.5.2, respectively.

3.5.1 Survey

The purpose of the survey was to solicit responses from participants to address the research questions. The survey was conducted using a paper-based survey and an e-survey (Qualtrics). Surveys are often used in social and psychological research because they may be utilised in MMR and typically describe and examine human behaviour (Ponto, 2015). Surveys are also used because they make it easy to collect a large amount of data in a short period (Swanson et al., 2020) and can be distributed to participants in paper form, electronically via email using an internet-based application like Qualtrics, or a mix of both. I used paper-based and internet-based methods in my study, providing participants with choosing their preferred technique (Ponto, 2015). The use of both paper-based and internet-based survey administration also helped to assure a larger sample, which reduced coverage error (Dillman et al., 2014; Ponto, 2015). The internet-based survey has the advantage of being a low-cost, quick, and efficient way to collect large amounts of data from the lecturers who took part in the research (Check & Schutt, 2012). Although the paper-based survey does not hold the advantage of being low-cost, as printing is expensive and there were petrol costs associated with delivering and collecting them from the schools, it holds the advantage that participants who don't have access to data or the internet could complete the survey.

The survey was developed by me with help from my supervisors, to cover key areas that addressed the research questions such as the demographic information of participants, ICT tools used by the lecturers, the impact of the ICT tools on T&L, the TAM constructs, intention

to use and actual system use. The survey comprises 64 items grouped under five sections as seen in Appendix A. Section 1 consists of 6 items, Section 2 consists of 26 items, Section 3 only has 1 item, Section 4 has 28 items, and Section 5 only has 2 items. Details of each section are given in the next paragraphs. Many of the questions were closed-ended, which made the survey well-structured. The high-level structuring resulted in a high level of predictability in the data collected, allowing data to be pre-coded or categorised before processing (Plowright, 2011). The questionnaire used in the survey was divided into the following sections:

Section 1: Demographic information of participants

Section 2: ICTs being implemented by the participants in T&L

Section 3: How participants implement ICTs in their T&L

Section 4: Reasons why participants implement ICTs

Section 5: Actual and intentional use of ICTs

3.5.1.1 Section 1 of the Survey

Section 1 of the survey collected demographic information from the participants and included the region and location of the college, gender, age, department, and rank. Descriptive statistics were utilised to analyse the responses given in this section.

3.5.1.2 Section 2 of the Survey

The first part of Section 2 of the survey (Questions 2.1 to 2.23) was used to address SRQ2: "How do Ghanaian lecturers in CoEs use ICT tools for academic activities?" The following three questions were asked concerning 23 pre-listed ICT tools:

- If you have access to the ICT tools listed, please indicate how it is used - for teaching.
- If you have access to the ICT tools listed, please indicate how it is used - for lesson preparation.

- If you have access to the ICT tools listed, please indicate how it is used – for personal development.

For each of 23 pre-listed ICT tools, the respondents had to indicate either "Yes" or "No" next to a specific ICT tool for teaching, lesson preparation, and personal development, respectively; thus, it took on the form of a rubric-format question.

The second part of Section 2 of the survey (Questions 2.24 to 2.26) was used to address SRQ1: "What ICT tools are used by Ghanaian lecturers in CoEs?", where answers to the following questions were used: "Which ICT tool do you use most for teaching?", "Which ICT tool do you use most for lesson preparation?", and "Which ICT tool do you use most for personal development?". These were open-ended questions where respondents were not forced to choose from the pre-listed 23 ICT tools.

3.4.1.3 Section 3 of the Survey

Section 3 of the survey sought to elicit the impact of the ICT tools they use to teach from the participating lecturers. Section 3 consisted of one open-ended question. The participating lecturers were asked to state the ICT tool(s) that has/have the biggest impact on T&L and the reason(s) for stating that. The data collected on this survey section were used to address SRQ3, "Which ICT tool(s) has/have the biggest impact on teaching and learning in CoEs in Ghana and why?"

3.4.1.4 Section 4 of the Survey

Section 4 of the survey consisted of 28 items that measured respondents' perceived usefulness, perceived ease of use, behavioural intention to use, and attitude towards use to address the SRQ4, "To what extent is the TAM a valid model to explain the acceptance to use ICT among Ghanaian lecturers in CoEs?". For each of the 28 items, the participants were asked to select

a number that best described their level of agreement (or of disagreement) with each statement on a 5-point Likert scale, with 1 = "Strongly disagree"; 2 = "Somewhat disagree"; 3 = "Neutral"; 4 = "Somewhat agree" and 5 = "Strongly agree". A five-point Likert scale was employed because it is "a common scale used by many researchers and can be easily understood by the target respondents" (Arof et al., 2019, p. 2).

3.4.1.5 Section 5 of the Survey

This section of the survey solicited the frequency with which participants use ICT for teaching and their intention to use it in the next six months. This part of the survey helped address SRQ5, "To what extent does each construct in the TAM affect the actual usage of ICT among Ghanaian lecturers in CoEs?". The respondents had to indicate the frequency at which they use ICTs at present and during the next six months, and they had to select an option from a seven-point Likert scale, with 1 = "I am not using it at all" (at present) or 1 = "I do not plan to use ICT at all (during the next six months), 2 = "Only once", 3 = "Once a month", 4 = "Once every two weeks", 5 = "Once or twice a week", 6 = "Three to four times a week" and 7 = "Daily".

Since PEU and PU influence behavioural intention to use ICTs, which intends to influence AC (Nugroho et al., 2021), I needed more divergent views from the participants, hence engaging a 7-point Likert scale. A 7-point completely labelled scale was selected since prior studies found that it creates the most variance compared to fully labelled 5-point, 9-point, and 11-point scales (Eutsler & Lang, 2015).

3.5.2 Lesson Observation

The purpose of the lesson observation in my study was to provide first-hand insights from respondents on how they use ICT tools in their teaching. As seen in Appendix B, the lesson

observation protocol was developed by me to record what transpires when respondents are using ICT tools during their lesson delivery. After performing a thorough literature search, the lesson observation protocol was developed by evaluating and analysing any associated instruments for assessing the use of ICT tools in the classroom. As seen in Appendix B, the observational protocol was developed using the findings of that analysis that will aid in addressing the research questions. The lesson observation protocol comprises 4 sections with a total of 11 items. The lesson observation protocol includes the following sections and each section as described in the upcoming subsections:

Section 1: Background information

Section 2: ICTs being implemented by the respondents in teaching

Section 3: Competence level of respondents in using ICTs during teaching

Section 4: Students' reaction to the use of ICTs by the respondents during teaching

3.5.2.1 Section 1 of the Lesson Observation

Section 1 of the lesson observation protocol collected the respondents' background information and included gender and age (participant), date of observation, course/subject observed, duration of observation, and the total number of students present.

3.5.2.2 Section 2 of the Lesson Observation

ICTs being applied by the respondents in teaching were observed and recorded under this section. During the lesson observation, the major ICT tools used by lecturers were documented (Section 2.1, Appendix B). This question was used to address SRQ1: "What ICT tools are used by Ghanaian lecturers in CoEs?". The way(s) in which teaching activities were structured (Section 2.2, Appendix B) and the application of the ICT tools were also recorded (Section 2.3, Appendix B). The teaching activities were divided into four categories based on whether the students were taught as a complete group, small groups, pairs, or individuals (Section 2.2,

Appendix B). This section was also used to record major applications of the ICT tools during the lesson observation (Section 2.3, Appendix B). The applications were classified under presentation, drill and practice, demonstration, interaction and communication, collaboration, and assessment. Section 2.3 of the lesson observation (Appendix B) aided in addressing SRQ3: "Which ICT tool(s) has/have the biggest impact on teaching and learning in CoEs in Ghana and why?".

3.5.2.3 Section 3 of the Lesson Observation

The respondents' degree of competency in using the ICT tools during their lesson delivery was also observed and documented. The levels of competency were classified under "high level of competence (extensive experience)", "moderately high level of competence (good experience)", "average level of competence (some experience)", "low level of competence (little experience)", and "no level of competence (no experience)" (Section 3, Appendix B).

3.5.2.4 Section 4 of the Lesson Observation

Students' reactions to the use of ICT tools by the respondents during teaching were recorded under this section. Students' reactions were classified under whether they were: "confused", "doubtful", "lost", "contentment", "excitement", "nauseated", "disappointed", "frustrated", "nervous", "dislike", "infuriated", "panicked", "disturbed", "irritated", "satisfaction", or "any other reaction" (Section 4, Appendix B).

3.6 Data Analyses

In this MMR, I used both quantitative and qualitative data analysis techniques to analyse the data. I used descriptive and inferential statistical analyses for the quantitative data, while TA and QCA were used to analyse the qualitative data (Vaismoradi & Snelgrove, 2019).

According to Creswell and Creswell (2018), using only one statistical analysis method is insufficient to provide a complete view.

3.6.1 Data Analyses of the Quantitative Data

According to Park et al. (2012), descriptive statistics are mathematical assessments that characterise the data collected. They are simple analyses that do not imply that the obtained results should be applied to other situations (Park et al., 2012). The descriptive statistics used in my study were designed to explain the fundamental characteristics of the data and produce simple summaries of the sample (Bless & Kathuria, 2001). Percentage tables were employed for the descriptive statistics, while correlations and SEM were used for inferential statistics in my study. Inferential statistics were employed to derive conclusions from study results and then extrapolate those conclusions to the whole population (Allanson & Notar, 2020). Correlations and SEM were used to illustrate the relationship between the underlying determinants of the final TAM model. I used inferential statistics because of its ability to analyse and infer results from data based on the samples drawn from a population to deduce research hypotheses (Lowry, 2014).

3.6.2 Data Analyses of the Qualitative Data

I used both TA and QCA to analyse the qualitative data collected using the open-ended questions of the survey on how lecturers implemented ICT tools in their teaching. I analysed the non-participant lesson observation data using QCA and the qualitative data from the observation checklist using TA. These two approaches have many similarities but are different, and the interested reader is referred to Vaismoradi and Snelgrove (2019), who discuss these similarities and differences in detail; here quote the main similarity and the main difference as indicated by Vaismoradi and Snelgrove (2019). Both TA and QCA develop themes “on the basis of rigorous coding and analysing processes” (Vaismoradi & Snelgrove,

2019, p. 2). “The difference between QCA and TA in terms of various levels of description and interpretation can be attributed to the emphasis in QCA of a more step-by-step method of data analysis on the background, context, and thick findings under the hue of frequency of codes as a complementary to theme development. On the other hand, comparatively, TA is fundamentally an interpretative research approach, relying increasingly on the researcher’s subjectivity and personal insight to interpret data for theme development” (Vaismoradi & Snelgrove, 2019, p. 8).

3.7 Reliability and Validity of the Quantitative Data of my Study

In quantitative research, one has to establish the reliability and validity of the research instrument (Bahariniya et al., 2021). Reliability is related to reproducibility, whereas validity is tied to a scale’s accuracy (Heale & Twycross, 2015).

3.7.1 Validity

According to Zohrabi (2013), validity is concerned with the idea that the instrument is accurate and realistic and measures what it is intended to measure. Cohen et al. (2018) state that validity is “essentially a demonstration that a particular instrument in fact measures what it intends, purports or claims to measure” (p. 245) and that it is the “extent to which interpretations of data are warranted by the theories and evidence used” (p. 245). I used convergent and discriminant validity checks, also known as construct validity, to examine the survey’s validity in my research (Trochim, 2021). According to Cronbach and Meehl (1955), construct validity is the degree to which an instrument measures the construct it is intended to measure. Convergent and discriminant validity were employed to show that measures of the constructs are in reality related and, in reality, not related, respectively. Convergent validity is a construct-related validity that emphasises the correlation between the test measure and a measure of a different, theoretically related idea (Pyne et al., 2020). Kock (2020) defines

convergent validity as a criterion for measuring the quality of a measurement instrument, which is often a series of question statements. A measurement instrument has strong convergent validity of the respondents understanding the question-statements (or other measures) associated with each latent variable in the same way that the authors of the question-statements intended (Kock, 2014).

On the other hand, discriminant validity is a crucial construct validity test that evaluates a measure's capacity to react to experimental manipulation in a way that distinguishes the construct under investigation from similar or theoretically divergent constructs (Isbel et al., 2020). In my study, discriminant validity was used as a strategy in SEM to establish construct uniqueness in the research model (Afthanorhan et al., 2021).

I assessed convergent validity in my study by calculating Spearman's correlation coefficients on items loading on the same constructs and ensuring that they were high, that is, near to -1 or close to +1. On the other hand, I assessed discriminant validity using Spearman-rank correlation coefficients, as items that did not load onto the same constructs should have lower correlations than those that did (Carlson & Herdman, 2012). The convergent and discriminant validity test results of all the four constructs of the TAM are shown in Chapter 4 (Tables 4.18, 4.19, 4.20, and 4.21).

Additionally, content validity was also used to ensure that the survey correctly covered all the content related to the variables. To boost the survey's face validity and material validity, I asked some experts to evaluate the survey. Three experts with broad knowledge about ICT integration in education, TAM, and SEM were asked whether they thought the survey measured the intended variables (Heale & Twycross, 2015). According to the experts, the survey was too long to be completed in a reasonable time, and respondents dislike matrix questions; therefore, they recommended I minimise the number of matrix rows to improve

response quality and completion rates. The experts' suggestions were then applied. The final version of the survey was distributed to 400 people, with 390 of them returning completed surveys.

3.7.2 Reliability

According to Cohen et al. (2018), reliability is defined as dependability, accuracy, and comparability over time. This definition means that if research were conducted on similar groups of respondents in a comparable setting, comparable results would be obtained. Cronbach's α was used to test the reliability of the results (Cronbach, 1951) in my study. The reason is that Cronbach's α is a widely used metric to determine internal accuracy between different measures of variables (Hair et al., 2014). Cronbach's α was used to determine the survey's homogeneity (internal consistency). A Cronbach's α of .70 or greater has been accepted as a reasonable indication of the reliability of a scale (Field, 2018). However, a Cronbach's α value of .60 or greater is generally accepted by researchers in the social sciences (Ghazali, 2008). SPSS was used to compute Cronbach's α with the results for all four constructs of the TAM shown in Chapter 4 (Tables 4.12, 4.13, 4.14, and 4.15).

3.8 Trustworthiness of the Qualitative Data of my Study

Researchers can persuade themselves and readers that their study findings are worth paying attention to by demonstrating their trustworthiness (Nowell et al., 2017). Lincoln and Guba (1985) outlined four criteria for establishing trustworthiness: credibility, dependability, confirmability, and transferability. These four criteria of trustworthiness, accepted by many qualitative researchers (Connelly, 2016), are considered next, along with a discussion on how each criterium was ensured.

Credibility requires "establishing that findings are dependable, relevant, and congruent – reflecting a researcher's intended reality that is obtained from the perspectives of those who provided data" (Daniel, 2019, p. 103). As a result, credibility is concerned with the belief in data accuracy and interpretations. I spent enough time with the lecturers who took part in my study to establish confidence and have a thorough understanding of the environment in which my study was conducted. There were also several visits with the respondents, and during these visits, respondents were not manipulated in any way. Stahl and King (2020) stated that credibility could be enhanced through triangulation, and data triangulation was done in my study as I used more than one type of data; I used a survey and lesson observation.

The degree to which other researchers could replicate the findings if they conducted a comparative study is known as dependability (Mao et al., 2020). As a result, dependability refers to the data's consistency across time and under various situations. Researchers can attain dependability by ensuring that the study process is rational, traceable, and well-documented (Nowell et al., 2017). Transparency in the description of methods/procedures was achieved to assure the dependability of my study so that others may perform a comparative study. In addition, I recruited the help of another qualitative researcher in the field of education and my supervisors to double-check my study's TA, QCA, and data interpretation.

According to Nowell et al. (2017), confirmability is concerned with demonstrating that the researcher's interpretations and findings are derived from the data, requiring the researcher to explain how interpretations and conclusions were reached. As a result, confirmability concerns the findings' neutrality, which I achieved by utilising a reflexive journal to record all the processes followed during data analysis and minimising bias. The latter was accomplished by making participants feel accepted regardless of their responses (to minimise

participant bias) and starting the research with an open mind by ensuring that pre-existing preconceptions were avoided (to avoid researcher bias).

Transferability refers to "the extent to which qualitative findings have applicability in other settings or groups" (Polit & Beck, 2018, p. 416). For my study, an individual who intends to "transfer" the results to a different context is then in charge of determining whether the transfer is reasonable. To guarantee my study's transferability, I carefully detailed the observed situations, including the number of participants, the data collection techniques used, and the time during which the data were collected.

3.9 Ethical Considerations

Ethics approval was granted by the Ethics Committee of the Faculty of Education, University of Pretoria, before the commencement of my study, and the standards were followed to assure ethical compliance. All informants, including the MoE, principals of CoEs, participants/respondents, and their students, have provided their written agreement to engage in my study. The informed consent forms for principals, lecturers, and students, as seen in Appendices C, D, and E, respectively, were prepared and presented in English, and they were divided into two sections: an information sheet and a consent certificate. The information sheet detailed my study's aim and objectives, research methodologies, protocols, data collecting and storage protocols, including who had access to the data, and my study's voluntary nature. Participants in my study (lecturers and students) were given the freedom to make their own decisions, including whether to participate in my study or not (Hammersley & Traianou, 2012).

Because more extensive data regarding lecturers' usage of ICT tools in teaching were obtained, the informed consent document for participants/respondents contained more detail than the informed consent document for the MoE and the college principal. Furthermore, by

using a username and password on Qualtrics, records of the responses to the survey were safeguarded (online survey). The replies to the survey's hard copy version were also entered into Qualtrics and protected using password-protected documents.

Throughout the investigation, I followed the established research ethical guidelines put forth by the University of Pretoria. Participant confidentiality is one of the ethical considerations, which is also addressed in the informed consent document. Respondents and their students were notified of the safeguards taken to ensure the confidentiality of the data obtained throughout the informed consent procedure. The data collection instruments did not contain any element that sought any personal and identifying information about respondents or their students to ensure the confidentiality of the participants, particularly the individual lecturers. In addition, the data will be stored at the University of Pretoria for a minimum of 15 years with no unauthorised access.

During lesson observations, neither the lecturers' names nor their students' names were captured. The findings are kept anonymous by guaranteeing that lecturers cannot be linked to a specific college, principal, or colleague who took part in the study. In a similar vein, college principals were kept anonymous, guaranteeing that an individual college principal could not be traced back to a single college or lecturer. The high degree of confidentiality guaranteed that the respondents felt at ease and behaved naturally during lesson observations.

3.10 Chapter Summary

I employed a pragmatist research philosophy using an MMR strategy, with both survey and lesson observations used to obtain quantitative and qualitative data. I conducted my research at 26 CoEs in Ghana. This MMR project employed nested concurrent sampling. Out of the 400 lecturers who were purposefully sampled for Phase I (survey) of my study, 136 were conveniently and haphazardly sampled for Phase II (lesson observation) of my study. I used

thematic analysis and qualitative content analysis to analyse the qualitative data, while I used descriptive and inferential analyses for the quantitative data. Cronbach's α, convergent, and discriminant validity were employed to establish the reliability and validity issues of my study. The chapter ended with a discussion of ethical issues. In the next chapter, I give a comprehensive presentation of the results and report on my study's findings.

Chapter 4: Data Analysis and Interpretation

4.1 Introduction

In this chapter, I present the analysis of the data and results of my study as these relate to my research questions on lecturers' acceptance and use of ICTs in Ghanaian CoEs.

4.2 Presentation of Data

In this section, I present the results and findings of my study. I present the analyses of the results and findings from the quantitative and qualitative data under each SRQ sequentially. All results and findings are linked back to the literature. I end the chapter with a concise summary.

4.2.1 SRQ1: ICT Tools Used by Ghanaian Lecturers in CoEs

I used both the survey and lesson observation to address this research question. The second part of Section 2 of the survey (Appendix A) contained open-ended questions asking:

"Which ICT tool do you use most for teaching?" (Q2.24, Appendix A)

"Which ICT tool do you use most for lesson preparation?" (Q2.25, Appendix A)

"Which ICT tool do you use most for personal development?" (Q2.26, Appendix A)

Section 2.1 of the lesson observation protocol (Appendix B) was used to observe ICT tools being implemented by the respondents in teaching during the lesson observation. The responses to Questions 2.24 to 2.26 in the survey are summarised in Tables 4.1 to 4.3, respectively, while a summary of the findings from Section 2.1 of the lesson observation protocol is shown in Table 4.4. Table 4.1 shows the responses to the question, "Which ICT tool do you use most for teaching?".

Table 4.1

Responses to the Question of Which ICT Tool is Used Most for Teaching - Survey

ICT tool	Percentage
Personal Computer	35.6%
Projector	23.8%
Social Media (e.g. WhatsApp, Facebook, Twitter, Skype, Instagram, Telegram)	13.8%
LMS	6.2%
Mobile Devices	4.4%
Video Conference (e.g. Zoom, BlueJeans)	3.6%
Internet	3.1%
Microsoft Office*	2.8%
Mathematics Software (e.g. Maple, GeoGebra, Geometer's Sketchpad)	2.1%
Printer	1.8%
Video Websites (e.g. YouTube, Hulu, Netflix, Vimeo)	1.0%
Television	0.8%
SmartBoard/ Interactive Whiteboard Apps (e.g. Explain Everything, Educreations, Jamboard)	0.4%
E-Mail	0.3%
Scanner	0.3%
Total	100.0%

From Table 4.1, it can be seen that a personal computer is the ICT tool most used by the participants for teaching, with just over one-third of respondents (35.6%) using it. A projector (23.8%) is the second most widely used ICT tool for teaching, followed by social media (13.8%). The percentage used for teaching for all other ICT tools was below 10%, with the smallest percentages being e-mail and a scanner, representing 0.3% each. The results of the responses to the question "Which ICT tool do you use most for lesson preparation?" are shown in Table 4.2.

*Note that everywhere "Microsoft Office" is used in this document, it refers to all the well-known Microsoft Office applications such as Microsoft Office Word, Excel, Access and PowerPoint

Table 4.2

Responses to the Question of Which ICT Tool is Used Most for Lesson Preparation - Survey

ICT tool	Percentage
Personal Computer	42.8%
Internet	17.4%
Mobile Devices	7.9%
Microsoft Office	7.2%
Social Media (e.g. WhatsApp, Facebook, Twitter, Skype, Instagram, Telegram)	6.9%
Projector	3.8%
Video Websites (e.g. YouTube, Hulu, Netflix, Vimeo)	3.6%
LMS	2.3%
Video Conference (Zoom, BlueJeans)	2.3%
Online word processors (e.g. Google Docs, Zoho Writer)	2.1%
Mathematics Software (e.g. Maple, GeoGebra, Geometer's Sketchpad)	1.3%
Printer	1.3%
E-Mail	0.8%
Television	0.3%
Total	100.0%

From Table 4.2, it can be seen that a personal computer is the most widely used ICT tool by the participants for lesson preparation (42.8%). The Internet is the ICT tool used the second most widely by the participants for lesson preparation, with almost one-fifth (17.4%) of participants using it for this purpose. The percentage used for lesson preparation for all other ICT tools was below 10%, with the smallest percentage being television (0.3%). Table 4.3 shows the responses to the question, "Which ICT tool do you use most for personal development?"

Table 4.3

ICT Tools the Participants use Most for Personal Development - Survey

ICT tool	Percentage
Internet	23.3%
Personal Computer	22.3%
Mobile Devices	22.1%
Social Media (e.g. WhatsApp, Facebook, Twitter, Skype, Instagram, Telegram)	11.3%
Video Websites (e.g. YouTube, Hulu, Netflix, Vimeo)	4.6%
Video Conference (e.g. Zoom, BlueJeans)	3.1%
Intranet (e.g. school network)	2.6%
Microsoft Office	2.1%
Online word processors (e.g. Google Docs, Zoho Writer)	1.3%
Note Sharing (e.g. Evernote, Onenote)	1.0%
Television	1.0%
e-Portfolios	0.8%
LMS	0.8%
Printer	0.7%
Scanner	0.7%
Statistical Analysis Software (e.g. MATLAB, SPSS, Minitab)	0.7%
E-Mail	0.5%
Projector	0.5%
Cloud Storage Service (e.g. DropBox, OneDrive, iCloud)	0.3%
Mathematics Software (e.g. Maple, GeoGebra, Geometer's Sketchpad)	0.3%
Total	100.0%

From Table 4.3, it can be seen that almost a quarter of participants indicated that they used the Internet (23.3%), a personal computer (22.3%), and mobile devices (22.1%) for personal development, while cloud storage services (0.3%) and mathematics software (0.3%) were used the least.

From the lesson observation, the findings of the ICT tools used by the participants in teaching are presented in Table 4.4

Table 4.4

ICT Tools Being Implemented by the Respondents in Teaching – Lesson Observation

ICT tool	Percentage
Personal computer	37.5%
Projector	37.5%
LMS	16.8%
Microsoft Office	8.2%
Total	100.0%

From Table 4.4, it can be seen that the three ICT tools that were used most by respondents are a personal computer (37.5%), a projector (37.5%), and an LMS (16.8%). It was interesting to observe that only the four ICT tools listed in Table 4.4 were observed as being used for teaching in the classroom, whereas the responses from the survey indicated a wider variety of ICT tools being used (see Table 4.1).

4.2.2 SRQ2: Ghanaian CoE Lecturers' use of ICT Tools for Academic Activities

To address SRQ2: "How do Ghanaian lecturers in CoEs use ICT tools for academic activities?", I considered the following three questions in the survey: "If you have access to the ICT tool(s) listed, please indicate how it is/ are used – for teaching", "If you have access to the ICT tool(s) listed, please indicate how it is/ are used – for lesson preparation", and "If you have access to the ICT tool(s) listed, please indicate how it is/ are used – for personal development". The uses of ICT tools by participants for academic activities were categorised under three main headings: teaching, lesson preparation, and personal development. There were 23 ICT tools listed under each of the categories. Since there were 23 ICT tools under each category, this question took on the form of a rubric-type question (see Questions 2.1 to 2.23 of the survey).

For each of these questions, the respondents have to select "Yes" or "No" next to how a specific ICT tool is used, with the "how" being whether it was used for teaching, lesson preparation, or personal development. The summation and the percentages of the number of occurrences of "Yes" were done for each category; see Table 4.5.

Table 4.5

Responses to the Question of How ICT Tools are Used for Teaching, Lesson Preparation, and Personal Development - Survey

Uses of ICT tool	Percentage
Personal development	38.0%
Teaching	32.0%
Lesson preparation	30.0%
Total	100.0%

From Table 4.5, the responses revealed there was almost an equal distribution in the percentage of use of ICT devices for teaching, lesson preparation, and personal development, respectively.

The participants' use of ICT tools for teaching was investigated to see what they do with the ICT tools during the lesson. The last part of Section 2 (Section 2.3, Appendix B) of the lesson observation protocol was used. What was observed is summarised in Table 4.6 using QCA.

Table 4.6

Responses to Ways of Using ICT Tools During Teaching – Lesson Observation

Ways of using ICT tools	Percentage
Presentation	60.7%
Assessment	27.2%
Interaction and communication	12.1%
Total	100.0%

From Table 4.6, it can be seen that most of the time in the classroom (60.7%), ICTs were used for presentation, followed by assessment (27.2%) and interaction and communication (12.2%).

4.2.3 SRQ3: Impact of ICT tools on Teaching and Learning

To address SRQ3: "Which ICT tools have the biggest impact on teaching and learning in CoEs in Ghana and why?", Section 3 of the survey was an open-ended question that aided in addressing SRQ3. Question 3.1 (Appendix A) of the survey solicited the ICT tools that have the biggest impact on their teaching from the participants. The responses to this were analysed using QCA and are displayed in Table 4.7.

Table 4.7

Responses to the Question of Which ICT tool(s) has/have the Biggest Impact on T&L - Survey

ICT tool	Percentage
Personal Computer	22.9%
Internet	14.6%
Projector	12.5%
Mobile Devices	11.4%
Social Media (e.g. WhatsApp, Facebook, Twitter, Skype, Instagram, Telegram)	9.6%
Microsoft Office	4.6%
LMS	3.6%
Video Conference (e.g. Zoom, BlueJeans)	2.9%
Printer	2.9%
Intranet (e.g. school network)	2.6%
E-Mail	2.4%
Video Websites (e.g. YouTube, Hulu, Netflix, Vimeo)	1.6%
Mathematics Software (e.g. Maple, GeoGebra, Geometer's Sketchpad)	1.6%
Cloud Storage Service (e.g. DropBox, OneDrive, iCloud)	1.3%
Online word processors (e.g. Google Docs, Zoho Writer)	1.0%
Television	0.8%
Statistical Analysis Software (e.g. MATLAB, SPSS, Minitab)	0.8%

ICT tool	Percentage
Note Sharing (e.g. Evernote, Onenote)	0.7%
Scanner	0.6%
e-Portfolios	0.5%
SmartBoard/ Interactive Whiteboard Apps (e.g. Explain Everything, Educreations, Jamboard)	0.5%
Camera	0.3%
CD/DVDs ROM	0.3%
Total	100.0%

From Table 4.7, the responses revealed that almost a quarter of the participants claimed that a personal computer (22.9%) had the biggest impact on T&L, followed by the Internet (14.6%), a projector (12.5%), and mobile devices (11.4%). For all the other ICT devices, the percentage was below 10%, with the smallest percentages being for a camera (0.3%) and CD/DVDs ROM (0.3%).

Section 3 of the survey also sought to elicit the reason(s) for claiming that particular ICT tools have the biggest impact on T&L. The responses were analysed using thematic analysis (Braun & Clarke, 2006) since it was an open-ended question. The analysis produced seven themes and these are discussed next.

4.2.3.1 Aids in Lesson Preparation and Delivery, and for Personal Development

Most of the respondents reported that implementing ICT tools in their teaching aids them in the preparation to deliver their lesson and helps them enact those lessons. One of the participants elaborated by stating that “Internet is very convenient and supports virtual teaching and learning”. This claim was confirmed during the lesson observation. A lecturer teaching a second-year English class on the topic “Theories of Semantics” requested the students to use the internet to seek for and present information on the theories of semantics, following which there was a whole-class discussion on the theories. One of the respondents

stated that “these tools can be used to complement face-face teaching and learning”. This assertion was corroborated during the lesson observation. A lecturer of a “Databases” course taught an IT class using a personal computer and a projector to supplement the delivery on the topic “The Relational Model and Normalization”. The lecturer showed the class a YouTube video explaining the concept of “normalization”. Most of the respondents indicated that ICT tools “Promote lesson preparation and delivery”. This claim was again confirmed during the lesson observation where a lecturer delivered on the topic “linear and exponential series” in an “algebraic thinking” second-year mathematics class. The lecturer used PowerPoint to present “arithmetic and geometric sequences and series, infinite geometric sequences, and recursively defined sequences”.

4.2.3.2 Storing, Retrieving, and Sharing of Files and Information

In their accounts, most participants highlighted that personal computers facilitate storing information and files and make retrieval and sharing of that information and files very easy. One of the respondents from the Department of Education and Professional Studies, in one of the CoEs, stated that a personal computer “helps in lesson preparation and storing of information”. Another participant recounted that a personal computer also helps in “easy retrieval of information” and “useful for storing and sharing documents”. Other participants supported the assertion that a personal computer has the greatest impact on T&L by stating that a personal computer “makes retrieval of information from the web”, “enhances easy gathering of information”, “helps in lesson preparation and storing of information”, and “for storing large information”. One female lecturer said “Cloud Storage Service” also impacts T&L by stating that “Cloud Storage is used for storing personal information”. Two other respondents also supported the claim by stating that “we record live lesson with Camtasia, upload it on OneDrive and share the link with student-teachers” and “can be used to store

resource materials for future reference". Another participant was also of the view that mobile devices have the biggest impact by stating that mobile devices "assist in searching, storing and sharing texts, images, photos, and videos, for the purpose of teaching and learning and personal development".

4.2.3.3 Research

The third theme is "research". Most of the participants asserted that the internet as an ICT tool helps them search for information for their personal development and the preparation and delivery of their lessons. They also confirmed that the internet helps their students' learning in the courses they teach by stating that "the student-teacher uses this to access documents and other files on the internet easily", "enables the learners in doing their researches", "allows students and facilitators do their research", and "to make research of difficult notes". Some of the participants stated the internet is used, "For a quick research and personal development", "For a research and class presentation", "It enhances easy gathering of information", "promote research", and "gives access to a great deal of information and resources". This was confirmed during a lecture on "Historical Development of Number and Algebra" to a second-year mathematics class in a "Nature of Mathematics" class I observed. The lecturer engaged the students in doing group research on ancient numeration systems. The lecturer then used a presentation approach to explain the evolution of the Egyptian, Babylonian, Roman, and Hindu-Arabic Numeration Systems. One female languages lecturer believed that the personal computer has the biggest impact on research because it can be used "for easy research". Other participants supported the claim by stating that the personal computer "helps in the search of information" and "aids in research and preparation of lesson notes".

4.2.3.4 Easy Accessibility and User Friendliness

Participants reflected on a theme that some ICT tools can be easily accessible and are user-friendly to them and their students. One language lecturer said social media impacts T&L when it comes to easy accessibility and user friendliness by stating that social media has "ease of accessibility" capacity. Other participants supported the assertion by stating that "Everyone has access", "Students access them easily", "Almost all students have a WhatsApp account", "Easy to use, very affordable in terms of data", and "flexible to use". Some respondents attested to this assertion by stating social media "are very accessible and commonly known", "easy access to students", and "it is easy to access and not difficult to use". Some other participants believed that mobile devices impacted T&L when it came to easy accessibility and user friendliness by stating that mobile devices are "readily available for use", "easy access", "easily accessible and can be used by all", and "they are very accessible and commonly known". A number of the participants supported the claim by stating that mobile devices "can be used anywhere and also convenient" and one can "have access to it all the time". Some participants also stated that Cloud Storage Service "makes remote file access easy" and LMS are "user friendly and it is common".

4.2.3.5 Portability and Time Saving

Some respondents explained why they implemented ICT tools in their teaching due to portability and time-saving. They supported the claim by stating that "they have portability advantage", are "portable and very convenient", "it saves time and makes learning easy", "it is portable and easy to use", and "it's portable". One respondent claimed that social media is "comparatively economical", and another said that a personal computer is "portable and easy [to] use".

4.1.3.6 Increased Productivity

A number of the participants reported that some ICT tools increase their efficiencies in discharging their lecturers' duties and help their students in their learning. They pronounced that the ICT tools "increase productivity" and serve as "productivity tools that help students practice". One participant believed that mobile devices are used "for easy communication". Although mobile devices are mostly used for communication, according to Amir et al. (2020), some educators are beginning to see them as an important element of instructional activities at educational institutions that provide suitable conditions for formal and informal education. Therefore, mobile devices can be seen as an ICT tool that can increase productivity in educational institutions. Another respondent stated that a personal computer "is versatile", leading to increased productivity. According to Dhanaraj et al. (2019), a computer is a multifunctional tool that allows a user to fully use its various functions if the human-computer interaction design is flexible and resilient, which can, in turn, boost the productivity of the user.

4.1.3.7 News and Entertainment

It is also worth noting that various participants reported that some ICT tools help them get details about current developments in the country or anywhere in the world or a specific field of operation and provide entertainment or stimulation. One respondent believed that television is used "for transmission of videos". This quote confirms Molokomme's (2021) declaration that through the transmission of a range of videos to impart information, ideas, skills, and attitudes, television plays an important role in formal, non-formal, and informal education. Another respondent said lecturers and students get "updates on current issues" on social media. This assertion confirms the admission by Bergström and Jervelycke Belfrage (2018). Bergström and Jervelycke Belfrage (2018) assert that social media mimics low-control news

settings like the television news and that young people claim to obtain more news through social media than formal sources.

4.2.4 SRQ4: Extent to Which the TAM is as a Valid Model to Explain the Acceptance to use ICT Among Ghanaian Lecturers in CoEs

The items in Section 4 of the survey (Q4.1 to Q4.28, Appendix A) measured respondents' PU, PEU, BIU, and AU. The participants were asked to select the option that best described their levels of agreement (or disagreement) with each statement on a 5-point Likert scale, with 1 = "Strongly disagree"; 2 = "Somewhat disagree"; 3 = "Neutral"; 4 = "Somewhat agree" and 5 = "Strongly agree". The respondents were also asked about their frequency of use to ascertain their AC. For AC, the respondents had to indicate the frequency at which they use ICT at present, and they had to select an option from a seven-point Likert scale, with 1 = "I am not using it at all" (at present) or 1 = "I do not plan to use ICT at all (during the next 6 months), 2 = "Only once", 3 = "Once a month", 4 = "Once every two weeks", 5 = "Once or twice a week", 6 = "Three to four times a week" and 7 = "Daily". In the next section, the description of item-level results is given.

4.2.4.1 Description of Item-level Results

Since Likert-type items are classified as ordinal data, descriptive statistics such as the mean (measure of location) and standard deviation (measure of spread) are not recommended (Perera & Gamage, 2021). Descriptive statistics appropriate for ordinal data include the mode or the median (measures of location) and the frequencies or percentages (measure of spread) (Kaur et al., 2018). Tables 4.8 to 4.12 report the modes (the value on the 5-point Likert scale selected the most) and percentages for all items related to the TAM model, respectively. Table 4.8 reflects the options selected by the respondents relating to the PU construct.

Table 4.8

Modes and Percentages for the PU Construct

Item	Mode	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
"ICT tools are useful for teaching my course" (Q4.1, Appendix A)	5	0.3%	0.5%	0.3%	7.7%	91.3%
"Using ICT tools to teach will enhance learners' understanding" (Q4.6, Appendix A)	5	1.0%	1.3%	2.8%	7.7%	87.2%
"Using ICT tools to teach will make it easier to explain difficult concepts" (Q4.7, Appendix A)	5	0.5%	1.8%	2.3%	11.5%	83.8%
"Using ICT tools to teach saves time" (Q4.9, Appendix A)	5	0.3%	1.5%	2.6%	9.5%	86.2%
"Using ICT tools will increase my productivity in teaching" (Q4.10, Appendix A)	5	2.6%	0.8%	2.3%	13.3%	81.0%
"Using ICT tools will make me more creative" (Q4.12, Appendix A)	5	0.3%	1.3%	3.3%	8.5%	86.7%
"Using ICT tools will enhance my effectiveness in teaching" (Q4.13, Appendix A)	5	0.5%	1.8%	3.3%	9.0%	85.4%

From Table 4.8, it can be seen that the mode equals 5 = "Strongly agree" for all the items for the construct PU. Table 4.9 reflects the options selected by the respondents relating to the PEU construct. It should be noted from Table 4.9 that seven items were used to measure the PEU construct.

Table 4.9

Modes and Percentages for the PEU Construct

Item	Mode	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
"It is easy to use ICT tools for teaching my course" (Q4.2, Appendix A)	5	1.0%	0.8%	2.3%	14.4%	81.5%
"I have the resources necessary to use ICT tools to teach" (Q4.3, Appendix A)	5	2.8%	3.3%	4.9%	27.9%	61.0%
"I have the knowledge necessary to use ICT tools for teaching" (Q4.4, Appendix A)	5	1.3%	0.5%	3.8%	19.7%	74.6%
"A specific person (or group) would be available for assistance with difficulties when using ICT tools to teach" (Q4.5, Appendix A)	5	16.2%	5.9%	14.1%	29.2%	34.6%
"Learning to use ICT tools to teach would be easy for me" (Q4.8, Appendix A)	5	0.8%	0.5%	2.6%	15.6%	80.5%
"It is easy to use ICT tools for lesson preparation" (Q4.24, Appendix A)	5	0.3%	1.3%	5.1%	12.3%	81.0%
"It is easy to use ICT tools for personal development" (Q4.25, Appendix A)	5	0.8%	0.3%	3.8%	10.0%	85.1%

From Table 4.9, it can be seen that the mode equals 5 = "Strongly agree" for all the items for the construct PEU. Table 4.10 reflects the options selected by the respondents relating to the BIU construct.

Table 4.10

Modes and Percentages for the BIU Construct

Item	Mode	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
"I intend to use ICT to teach in the next 6 months" (Q4.11, Appendix A)	5	4.9%	1.0%	6.7%	17.4%	70.0%
"I plan to use ICT tools often" (Q4.14, Appendix A)	5	0.8%	1.8%	4.1%	13.1%	80.3%
"I only use ICT tools to teach when told to" (Q4.15, Appendix A)	1	56.2%	14.6%	8.7%	12.3%	8.2%
"I avoid using ICT tools to teach" (Q4.16, Appendix A)	1	81.8%	9.5%	3.6%	2.8%	2.3%
"I will use ICT tools regularly throughout in my teaching" (Q4.17, Appendix A)	5	3.1%	1.8%	4.1%	18.5%	72.6%
"I will not use ICT tools to teach in the next 6 months" (Q4.18, Appendix A)	1	67.4%	12.1%	6.4%	6.4%	7.7%
"I avoid using ICT tools for lesson preparation" (Q4.26, Appendix A)	1	76.7%	14.4%	3.3%	2.6%	3.1%

From Table 4.10, it can be seen that the mode equals 5 = "Strongly agree" for three of the items, and it equals 1 = "Strongly disagree" for four of the items. Before conducting further analyses on this construct, items Q4.15, Q4.16, Q4.18, and Q4.26 were reverse-scored because they are negatively phrased. Thus, in further analysis, these items will be named Q4.15RS, Q4.16RS, Q4.18RS, and Q4.26RS, where RS indicates that the items have been reverse-scored. Table 4.11 reflects the options selected by the respondents relating to the AU construct.

Table 4.11

Modes and Percentages for the AU Construct

Item	Mode	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
"Teaching with ICT tools is not fun at all" (Q4.19, Appendix A)	1	59.2%	11.5%	6.7%	6.7%	15.9%
"I like using ICT tools for teaching" (Q4.20, Appendix A)	5	1.5%	1.0%	3.3%	11.5%	82.6%
"ICT tools make teaching more interesting" (Q4.21, Appendix A)	5	0.3%	0.5%	3.1%	11.0%	85.1%
"I look forward to teaching courses that require me to use ICT tools in the future" (Q4.22, Appendix A)	5	1.0%	0.3%	4.1%	12.8%	81.8%
"I look forward to using ICT tools to enhance effectiveness of teaching courses in future" (Q4.23, Appendix A)	5	0.0%	0.5%	3.8%	12.1%	83.6%
"I like using ICT tools for personal development" (Q4.27, Appendix A)	5	2.1%	0.0%	3.1%	7.7%	87.2%
"I like using ICT tools for lesson preparation" (Q4.28, Appendix A)	5	1.3%	0.5%	3.6%	11.3%	83.3%

From Table 4.11, it can be seen that the mode equals 5 = "Strongly agree" for six of the items, and it equals 1 = "Strongly disagree" for one of the items. Before conducting further analyses on this construct, item Q4.19 were reverse-scored because it is negatively phrased. Thus, in further analysis, this item will be named Q4.19RS, where RS indicates that the item has been reverse-scored.

Table 4.12 reflects the options selected by the respondents relating to their actual use. Note that AC is not a construct, but rather two separate items where respondents supplied data in response to two separate questions, namely "Indicate the frequency with which you are using

ICT for teaching at present" and "Indicate the frequency with which you intend to use ICT for teaching during the next 6 months". As the responses to the questions differed dramatically, we don't refer to it as the "AC construct", but rather to the "AC items", as one AC item is on the current frequency of use and the other AC item is on the future intended frequency of use.

Table 4.12

Mode and Percentages for the AC Items

Item	Mode	I am not using it at all	Only once	Once a month	Once every two weeks	Once or twice a week	Three to four times a week	Daily
"Indicate the frequency with which you are using ICT for teaching at present" (Q5.1, Appendix A)	5	1.0%	1.3%	2.1%	5.6%	51.0%	29.7%	9.2%
"Indicate the frequency with which you intend to use ICT for teaching during the next 6 months" (Q5.2, Appendix A)	7	0.5%	0.0%	0.3%	0.0%	3.8%	7.2%	88.2%

From Table 4.12, it can be seen that the mode for Q5.1 equals 5 = "Once or twice a week", indicating that the majority of participants (51.0%) are currently using ICT once or twice a week. However, when asked how frequently participants intended using ICTs during the next six months, an overwhelming 88.2% of participants indicated that they would be using it "daily", whereas, currently, only 9.2% indicated that they use it "daily". These percentages indicate that although participants are not currently using ICTs daily, they would like to use them daily for teaching during the next six months.

Although it was mentioned earlier that since Likert-type items are classified as ordinal data, descriptive statistics such as the mean and standard deviation are not recommended, it should be mentioned that a composite score can be computed per construct, which has an interval measurement scale. This composite score is created by averaging over the items of a specific construct. After that, descriptive statistics such as the mean and the standard deviation can be computed. However, before creating composite scores, the reliability of the constructs needs to be confirmed. The next section presents the constructs' reliability and validity.

4.2.4.2 Reliability and Validity Analysis of the TAM Constructs

This section presents the analysis of the psychometric properties of the TAM constructs based on the measuring of items in my study.

4.2.4.2.1 Reliability Analysis

A Cronbach's α of .70 or greater is typically acceptable for internal consistency reliability (Field, 2018). It should be noted that a Cronbach's α of .60 or greater is deemed acceptable in social sciences research (Ghazali, 2008). Tables 4.13 to 4.16 show the results of the reliability analysis per construct. Note that, in these tables, r_{I-T} represents the "corrected item-total variation", which is the correlation between each item and the construct score that excludes that item (i.e. uses all other items, except that one). Items with negative r_{I-T} should be investigated and probably should have been reverse-scored or should be removed if not the case. If the Cronbach's α of a construct is unacceptable, the column containing "r_{I-T} values" and the column containing "Cronbach's α if an item is removed" should be investigated to see which items to exclude from the construct. This exclusion to improve the Cronbach's α was unnecessary for my study, as all Cronbach's α values were acceptable.

Table 4.13

Reliability Analysis for the PU Construct

Cronbach's α = .825; Number of items = 7		
Item	r_{I-T}	Cronbach's α if item removed
"ICT tools are useful for teaching my course"	.570	.808
"Using ICT tools to teach will enhance learners' understanding" (Q4.6, Appendix A)	.544	.806
"Using ICT tools to teach will make it easier to explain difficult concepts" (Q4.7, Appendix A)	.741	.771
"Using ICT tools to teach saves time" (Q4.9, Appendix A)	.615	.794
"Using ICT tools will increase my productivity in teaching" (Q4.10, Appendix A)	.349	.849
"Using ICT tools will make me more creative" (Q4.12, Appendix A)	.657	.788
"Using ICT tools will enhance my effectiveness in teaching" (Q4.13, Appendix A)	.641	.789

From Table 4.13, it can be seen that the reliability of the perceived usefulness construct is acceptable since Cronbach's α equal to .825 is typically deemed acceptable for internal consistency reliability in social sciences research (Ghazali, 2008).

Table 4.14

Reliability Analysis for the PEU Construct

Cronbach's α = .668; Number of items = 7		
Item	r_{I-T}	Cronbach's α if item removed
"It is easy to use ICT tools for teaching my course" (Q4.2, Appendix A)	.644	.577
"I have the resources necessary to use ICT tools to teach" (Q4.3, Appendix A)	.554	.574
"I have the knowledge necessary to use ICT tools for teaching" (Q4.4, Appendix A)	.517	.601
"A specific person (or group) would be available for assistance with difficulties when using ICT tools to teach"	.053	.815
"Learning to use ICT tools to teach would be easy for me" (Q4.8, Appendix A)	.479	.617
"It is easy to use ICT tools for lesson preparation" (Q4.24, Appendix A)	.496	.611
"It is easy to use ICT tools for personal development" (Q4.25, Appendix A)	.430	.628

From Table 4.14, it can be seen that the reliability of the perceived ease of use construct is acceptable since Cronbach's α equals .668, which is typically deemed acceptable for internal consistency reliability in social sciences research (Ghazali, 2008).

Table 4.15

Reliability Analysis for the BIU Construct

Cronbach's α = .699; Number of items = 7		
Item	r_{I-T}	Cronbach's α if item removed
"I intend to use ICT to teach in the next 6 months" (Q4.11, Appendix A)	.209	.714
"I plan to use ICT tools often" (Q4.14, Appendix A)	.402	.673
"I only use ICT tools to teach when told to" (Q4.15RS*, Appendix A)	.386	.682
"I avoid using ICT tools to teach" (Q4.16RS*, Appendix A)	.492	.648
"I will use ICT tools regularly throughout in my teaching" (Q4.17, Appendix A)	.451	.656
"I will not use ICT tools to teach in the next 6 months" (Q4.18RS*, Appendix A)	.570	.614
"I avoid using ICT tools for lesson preparation" (Q4.26RS*, Appendix A)	.443	.658

* Reverse-scored because the sentence is negatively phrased

From Table 4.15, it can be seen that the reliability of the behavioural intention to use construct is acceptable in social sciences research since Cronbach's α equals .699 (Ghazali, 2008).

Table 4.16

Reliability Analysis for the AU Construct

Cronbach's α = .696; Number of items = 7		
Item	r_{I-T}	Cronbach's α if item removed
"Teaching with ICT tools is not fun at all" (Q4.19RS*, Appendix A)	.191	.830
"I like using ICT tools for teaching" (Q4.20, Appendix A)	.490	.644
"ICT tools make teaching more interesting" (Q4.21, Appendix A)	.621	.633
"I look forward to teaching courses that require me to use ICT tools in the future" (Q4.22, Appendix A)	.564	.632
"I look forward to using ICT tools to enhance effectiveness of teaching courses in future" (Q4.23, Appendix A)	.650	.629
"I like using ICT tools for personal development" (Q4.27, Appendix A)	.422	.660
"I like using ICT tools for lesson preparation" (Q4.28, Appendix A)	.541	.635

* Reverse-scored because the sentence is negatively phrased

From Table 4.16, it can be seen that the reliability of the attitude towards use construct is acceptable since Cronbach's α equals .696, which is typically deemed acceptable for internal consistency reliability in social sciences research (Ghazali, 2008).

It should be noted that no Cronbach's alpha value is computed for the AC item, as it only consists of one item, which doesn't constitute a construct.

4.2.4.2.2 Validity Analysis

Convergent validity shows that items that load onto the same construct are related (Carlson & Herdman, 2012). Convergent validity can be tested by calculating Spearman-rank correlation coefficients on the items loading on the same constructs and checking that these correlations are high, i.e. close to -1 or +1. On the other hand, discriminant validity shows that items that

do not load onto the same construct are not related (Carlson & Herdman, 2012). Discriminant validity can be tested by calculating Spearman-rank correlation coefficients since items that do not load onto the same constructs should have lower correlations than those loading onto the same constructs. Firstly, Spearman-rank correlation coefficients are calculated and interpreted for convergent validity.

4.2.4.2.2.1 Convergent Validity

In this study, convergent validity was determined by calculating Spearman-rank correlation coefficients (r_s) for items loading on the same constructs and guaranteeing that they were high, that is, around -1 or near +1. Tables 4.17 to 4.20 illustrate the results in detail.

Table 4.17

Spearman-rank Correlations for the PU Construct

		Q4.1	Q4.6	Q4.7	Q4.9	Q4.10	Q4.12
Q4.6	r_s	.354***					
	p-value	<.001					
Q4.7	r_s	.445***	.656***				
	p-value	<.001	<.001				
Q4.9	r_s	.358***	.490***	.538***			
	p-value	<.001	<.001	<.001			
Q4.10	r_s	.331***	.301***	.419***	.474***		
	p-value	<.001	<.001	<.001	<.001		
Q4.12	r_s	.454***	.471***	.563***	.520***	.423***	
	p-value	<.001	<.001	<.001	<.001	<.001	
Q4.13	r_s	.537***	.476***	.552***	.510***	.47***	.653***
	p-value	<.001	<.001	<.001	<.001	<.001	<.001

* Significant p-value < 0.05
** Significant p-value < 0.01
*** Significant p-value < 0.001

From Table 4.17, all the correlations between the items of the construct perceived usefulness are statistically significant since all the p-value are less than .05, which indicates the construct validity for the perceived usefulness construct.

Table 4.18

Spearman-rank Correlations for the PEU Construct

		Q4.2	Q4.3	Q4.4	Q4.5	Q4.8	Q4.24
Q4.3	r_s	.528***					
	p-value	<.001					
Q4.4	r_s	.535***	.486***				
	p-value	<.001	<.001				
Q4.5	r_s	.070	.128*	.105*			
	p-value	.171	.011	.038			
Q4.8	r_s	.572*	.390***	.419***	.046		
	p-value	<.001	<.001	<.001	.370		
Q4.24	r_s	.623***	.450***	.499***	.091	.544***	
	p-value	<.001	<.001	<.001	.074	<.001	
Q4.25	r_s	.554***	.364***	.395***	.021	.479***	.627***
	p-value	<.001	<.001	<.001	.675	<.001	<.001

* Significant p-value < 0.05
** Significant p-value < 0.01
*** Significant p-value < 0.001

From Table 4.18, it can be seen that all the correlations between the items of the construct perceived ease of use are statistically significant since all the p-value are less than .05, which shows that the construct perceived ease of use is valid.

Table 4.19

Spearman-rank Correlations for the BIU Construct

		Q4.11	Q4.14	Q4.15RS	Q4.16RS	Q4.17	Q4.18RS
Q4.14	r_s	.488***					
	p-value	<.001					
Q4.15RS	r_s	.172**	.070				
	p-value	.001	.165				
Q4.16RS	r_s	.267***	.397***	.296***			
	p-value	<.001	<.001	<.001			
Q4.17	r_s	.414***	.623***	.204***	.402***		
	p-value	<.001	<.001	<.001	<.001		
Q4.18RS	r_s	.242***	.370***	.441***	.366***	.395***	
	p-value	<.001	<.001	<.001	<.001	<.001	
Q4.26RS	r_s	.223***	.326***	.252***	.441***	.321***	.494***
	p-value	<.001	<.001	<.001	<.001	<.001	<.001

* Significant p-value < 0.05
** Significant p-value < 0.01
*** Significant p-value < 0.001

From Table 4.19, all the correlations between the items of the construct behavioural intention to use are statistically significant since all the p-value are less than .05, which indicates that the construct BIU is valid.

Table 4.20

Spearman-rank Correlations for the AU Construct

		Q4.19RS	Q4.20	Q4.21	Q4.22	Q4.23	Q4.27
Q4.20	r_s	.220***					
	p-value	<.001					
Q4.21	r_s	.313***	.613***				
	p-value	<.001	<.001				
Q4.22	r_s	.273***	.631***	.694***			
	p-value	<.001	<.001	<.001			
Q4.23	r_s	.344***	.565***	.672***	.745***		
	p-value	<.001	<.001	<.001	<.001		
Q4.27	r_s	.240***	.530***	.524***	.489***	.535***	
	p-value	<.001	<.001	<.001	<.001	<.001	
Q4.28	r_s	.211***	.575***	.552***	.519***	.485***	.710***
	p-value	<.001	<.001	<.001	<.001	<.001	<.001

* Significant p-value < 0.05
** Significant p-value < 0.01
*** Significant p-value < 0.001

From Table 4.20, it can be seen that all the correlations between the items of the construct attitude towards use are statistically significant since all the p-value are less than .05, which indicates construct validity for the construct AU. In the next section, discriminant validity is considered.

4.1.4.2.2.2 Discriminant Validity

As previously mentioned, for discriminant validity, items that do not load onto the same constructs should have lower correlations than those loading onto the same constructs. Since we have 28 items (four constructs each containing seven items) and a 27 x 27 correlation matrix would not fit on one page, only one correlation is discussed for illustration purposes. The correlation between Q4.1 (item belonging to construct PU) and Q4.5 (item belonging to construct PEU) equals .081 with a p-value equal to .110. Since the p-value is greater than .05,

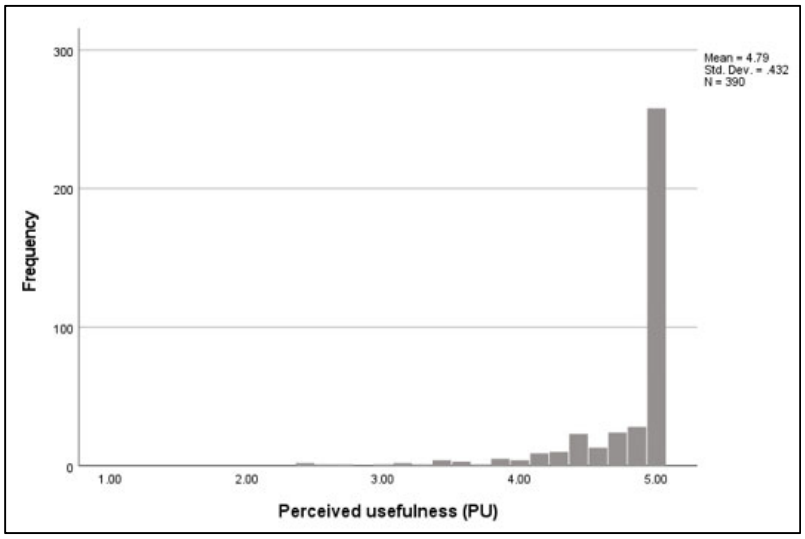
the correlation is not statistically significant, which happens in most cases where we correlated items that do not belong to the same construct. In the minority of these cases where the p-values are less than .05, the correlations are weak (close to zero), which indicates that we have discriminant validity. The next section creates composite scores for the PU, PEU, BIU, and AU constructs since all these constructs are reliable and valid.

4.2.4.3 Description of Scale-level Results

Composite scores were computed for items loading onto the same construct, and the results for each construct are then summarised in a histogram below each table. It should be noted that these histograms should not be interpreted similarly to bar graphs where one only simply investigates which bar is the highest across from which Likert value (1, 2, 3, 4, or 5). These histograms have taken items building onto the same construct and summarised the responses per construct. For example, in Figure 4.1, instead of giving seven separate bar graphs for Q4.1, Q4.6, Q4.7, Q4.9, Q4.10, Q4.12, and Q4.13, respectively, the information has been consolidated (a composite score was calculated) for the construct PU in SPSS and is presented as a histogram. The way to interpret these histograms is to investigate their shape. If a histogram is symmetric, most responses for a construct (such as PU) are around the midpoint of the Likert scale, and the mean will be close to the midpoint of three. Suppose the histogram is skewed to the left. In that case, it means that the majority of the responses are on the higher end of the Likert scale, which means that the mean will be greater than the midpoint of three, which indicates that most respondents agreed or strongly agreed with the statements. On the other hand, a histogram skewed to the right means that most of the responses were on the lower end of the Likert scale, implying that the mean will be less than the midpoint of three and that the majority of the respondents disagreed or strongly disagreed with the statements.

Figure 4.1

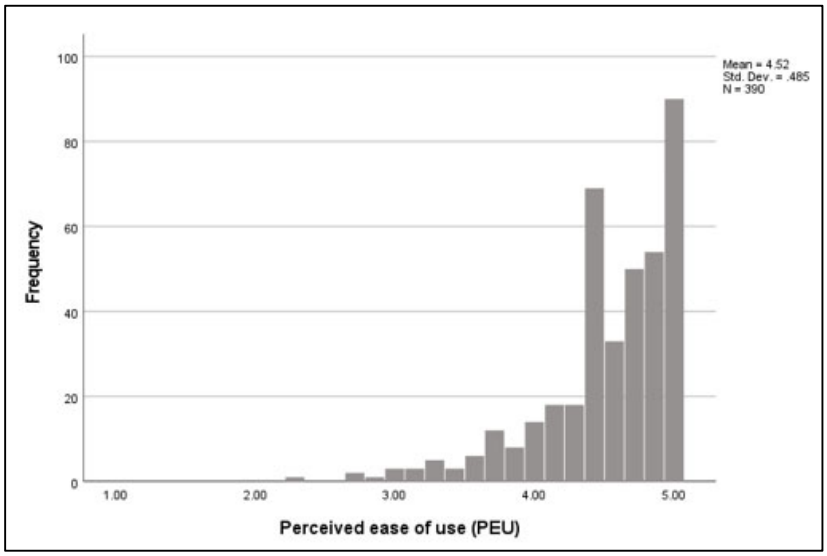
Histogram for the PU Construct



From Figure 4.1, it appears as if the histogram is skewed to the left, indicating that the majority of responses were at the higher end of the Likert scale for the construct PU, which is also evident from the fact that the mean is greater than the midpoint value of three. Thus, most participants somewhat or strongly agreed with the questions on perceived usefulness.

Figure 4.2

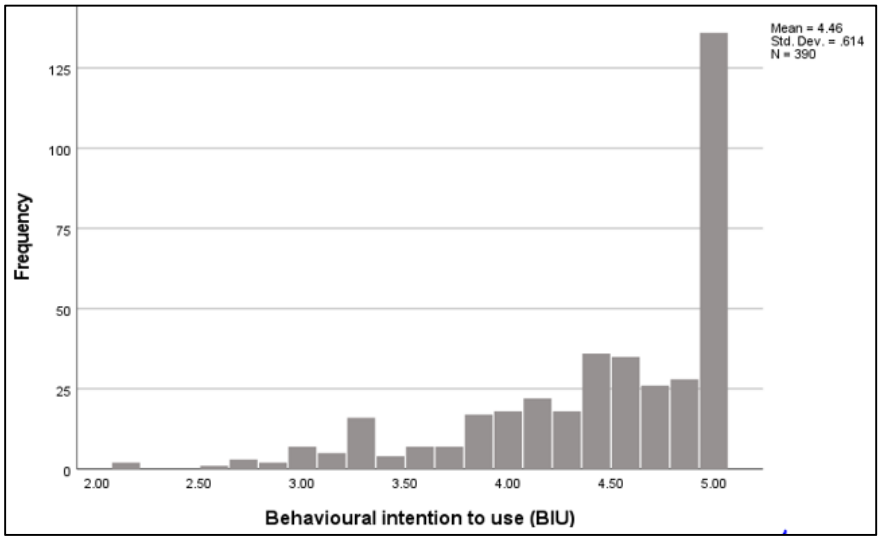
Histogram for the PEU Construct



From Figure 4.2, it appears as if the histogram is skewed to the left, indicating that the majority of responses were at the higher end of the Likert scale for the construct PEU which is also evident from the fact that the mean is greater than the midpoint value of three. Thus, most participants somewhat or strongly agreed with the questions on perceived ease of use.

Figure 4.3

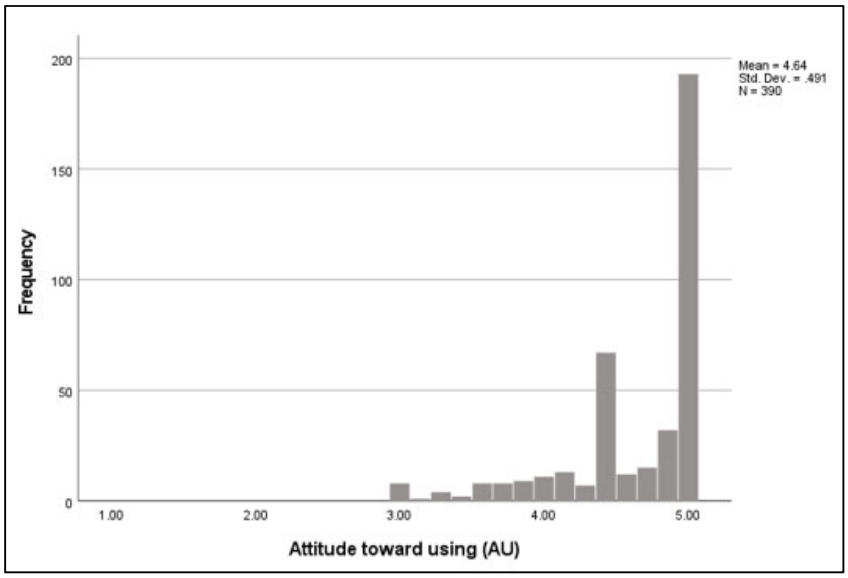
Histogram for the BIU Construct



When interpreting Figure 4.3, the reader must remember that items Q4.15, Q4.16, Q4.18, and Q4.26 have been reverse-scored because they are negatively phrased. From Figure 4.3, it appears as if the histogram is skewed to the left, indicating that the majority of responses were at the higher end of the Likert scale for the construct BIU, which is also evident from the fact that the mean is greater than the midpoint value of three. Thus, most participants somewhat or strongly agreed with the questions on behavioural intention to use.

Figure 4.4

Histogram for the AU Construct



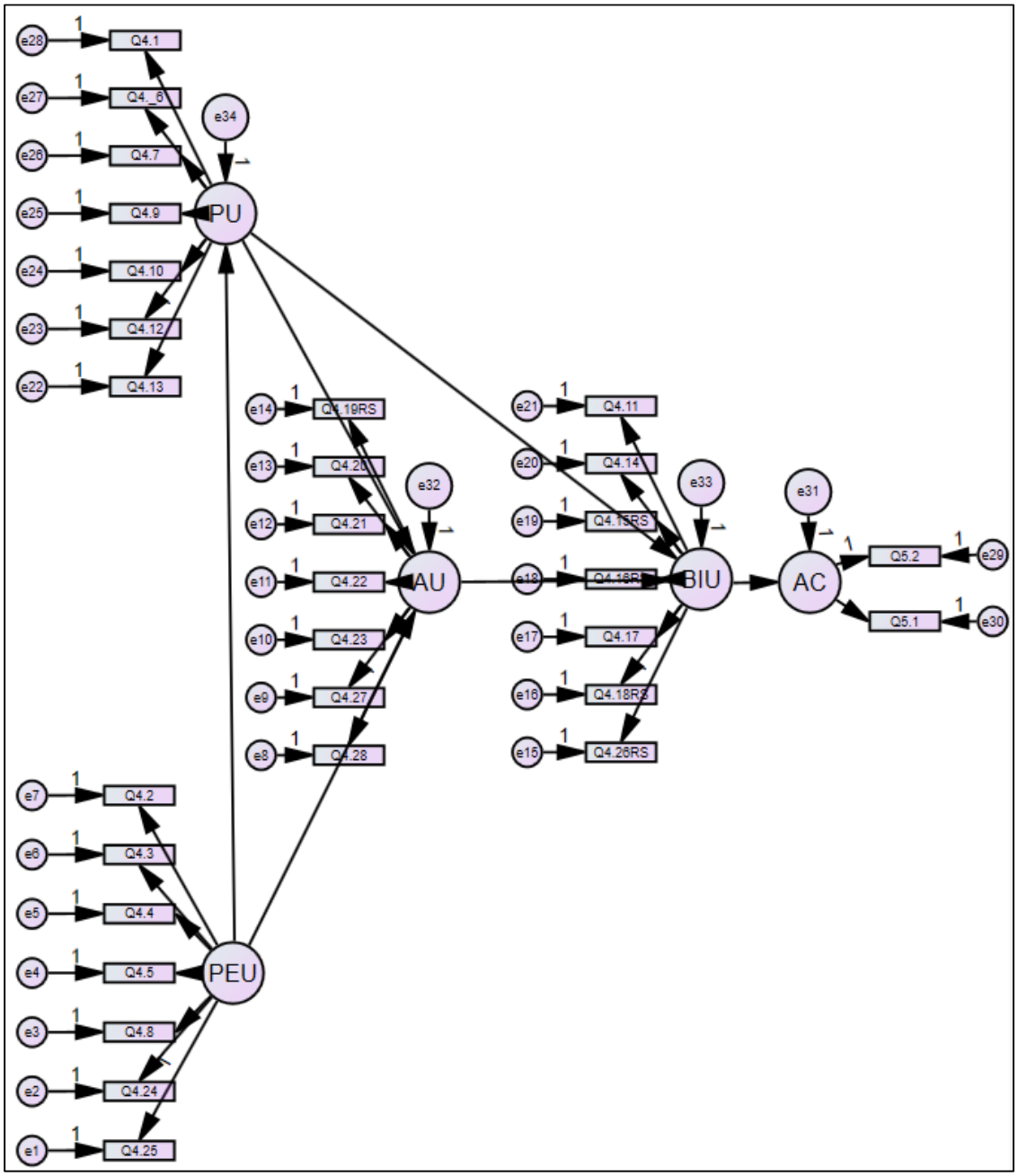
When interpreting Figure 4.4, the reader needs to remember that item Q4.19 has been reverse-scored because it is negatively phrased. From Figure 4.4, it appears as if the histogram is skewed to the left, indicating that the majority of responses were at the higher end of the Likert scale for the construct AU which is also evident from the fact that the mean is greater than the midpoint value of three. Thus, most participants somewhat or strongly agreed with the questions on attitude towards use.

4.2.5 SRQ5: Extent to Which Each Construct in the TAM Affect the Actual Usage of ICT among Ghanaian Lecturers in CoEs

Using all Likert-scale items for PU, PEU, AU, BIU, and AC, I created the following initial SEM model (Figure 4.5) using AMOS software. Each factor (oval-shaped items) is represented by several measured variables or indicators designated by a box. These measured variables were captured in the survey used by my study. Each measured variable has an error variance estimated by the software package. This section presents the complete theoretical TAM, excluding the external variables (for now), and corresponding summary statistics.

Figure 4.5

SEM for the Complete Theoretical TAM Excluding External Variables



The complete output of the regression model (containing estimated regression weights, standard errors, critical ratios and *p*-values) is provided in Appendix F. I considered placing the regression weights in Figure 4.5 itself, however, the figure was too cluttered and the

readers would not be able to see all the regression weights; thus, I opted to place this information into Appendix F. The model fit summary is presented in Table 4.21. In the past, to access goodness-of-fit (GOF), the Chi-square statistic and its corresponding p-value were used to assess GOF. However, the Chi-square statistic is very sensitive to sample size and is no longer relied upon as a basis for acceptance or rejection (Schermelleh-Engel et al., 2003; Vandenberg, 2006). As a result, the use of multiple fit indices has developed to provide a more holistic view of GOF, taking into account sample size and model complexity and other relevant issues of the study. Some of the most common GOF measures to report on are the root-mean-square error of approximations (RMSEA), the goodness-of-fit index (GFI), the comparative fit index (CFI), and the Tucker-Lewis index (TLI). The thresholds for model fit indices were taken from Ajayi and Oyedele (2018), who took the recommendations from well-known SEM authors (Chen et al., 2012; Hair et al., 2014; Kline, 2011), collated their recommendations, and presented them in their manuscript (see Table 5 of Ajayi and Oyedele, 2018) which is reflected in Table 4.22 under "Acceptable level". It should be noted that some of the older literature has stricter levels of acceptance, for example, only GFI > .8, CFI > .9, and RMSEA < .06 being acceptable (Hu & Bentler, 1999). However, Xia and Yang (2019) have recently concluded that "Strong arguments against the application of RMSEA, CFI, and TLI and their conventional cutoff values have been raised in the SEM literature (Barrett, 2007; Marsh et al., 2004; McIntosh, 2007). The consensus is that a larger RMSEA and smaller CFI and TLI values indicate worse fit" (p. 421).

Table 4.21

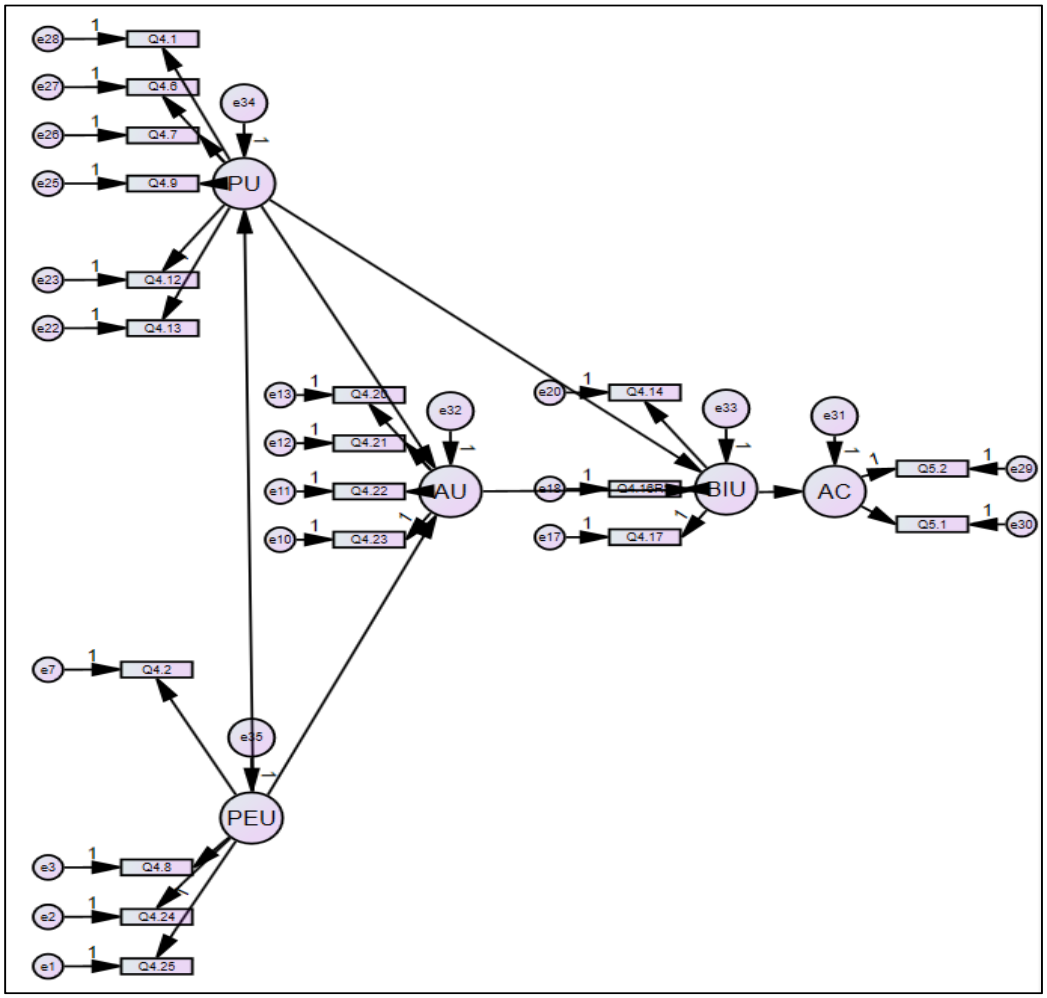
Summary of the Statistics of the Complete Theoretical TAM Excluding External Variables

Statistic	Acceptable level	Value for the complete theoretical TAM excluding external variables
RMSEA	The smaller the RMSEA, the better	.106 – room for improvement
GFI	0 (no fit) – 1 (perfect fit)	.738 – room for improvement
CFI	The larger the GFI, CFI, and TLI, the better	.688 – room for improvement
TLI		.660 – room for improvement

For the complete theoretical TAM (excluding the external variables for now), there was room for improvement when considering the GOF measures. Based on the recommendations put forward by Hair et al. (2014), several steps can be taken to improve GOF. Firstly, factors with low loadings can be dropped. I, therefore, dropped all items with low loadings from the model. The standardised regression weights in the AMOS output were investigated to find the items loading poorly. In the standardised regression weights, also known as factor loadings, the lowest loadings were deleted unless it caused the factor to have less than three items. Ideally, each factor should have a minimum of three items, although if some constructs had less than three, it would still be acceptable (Iacobucci, 2010). This process was repeated several times until a better model fit (discussed below) was reached. Since this is an iterative process consisting of numerous models being built and run, not all steps and models are shown here; only the final TAM excluding external variables is shown in Figure 4.6.

Figure 4.6

SEM for the Final TAM Excluding External Variables



The complete output of the regression model (containing estimated regression weights, standard errors, critical ratios and *p*-values) is provided in Appendix F. The model fit summary of the model shown in Figure 4.6 is presented in Table 4.22.

Table 4.22

Summary of the Statistics of the Final TAM Excluding External Variables

Statistic	Acceptable level	Value compared to the complete theoretical TAM excluding external variables
RMSEA	The smaller the RMSEA, the better	.113 – no significant change
GFI		.822 - Improvement
CFI	0 (no fit) – 1 (perfect fit) The larger the GFI, CFI and TLI, the better	.811 - Improvement
TLI		.779 - Improvement

Now, the external variables, gender and age, have been added to the model shown in Figure 4.7. The complete output of the regression model (containing estimated regression weights, standard errors, critical ratios and *p*-values) is provided in Appendix F.

Figure 4.7

SEM for the Acceptable Theoretical TAM Including External Variables

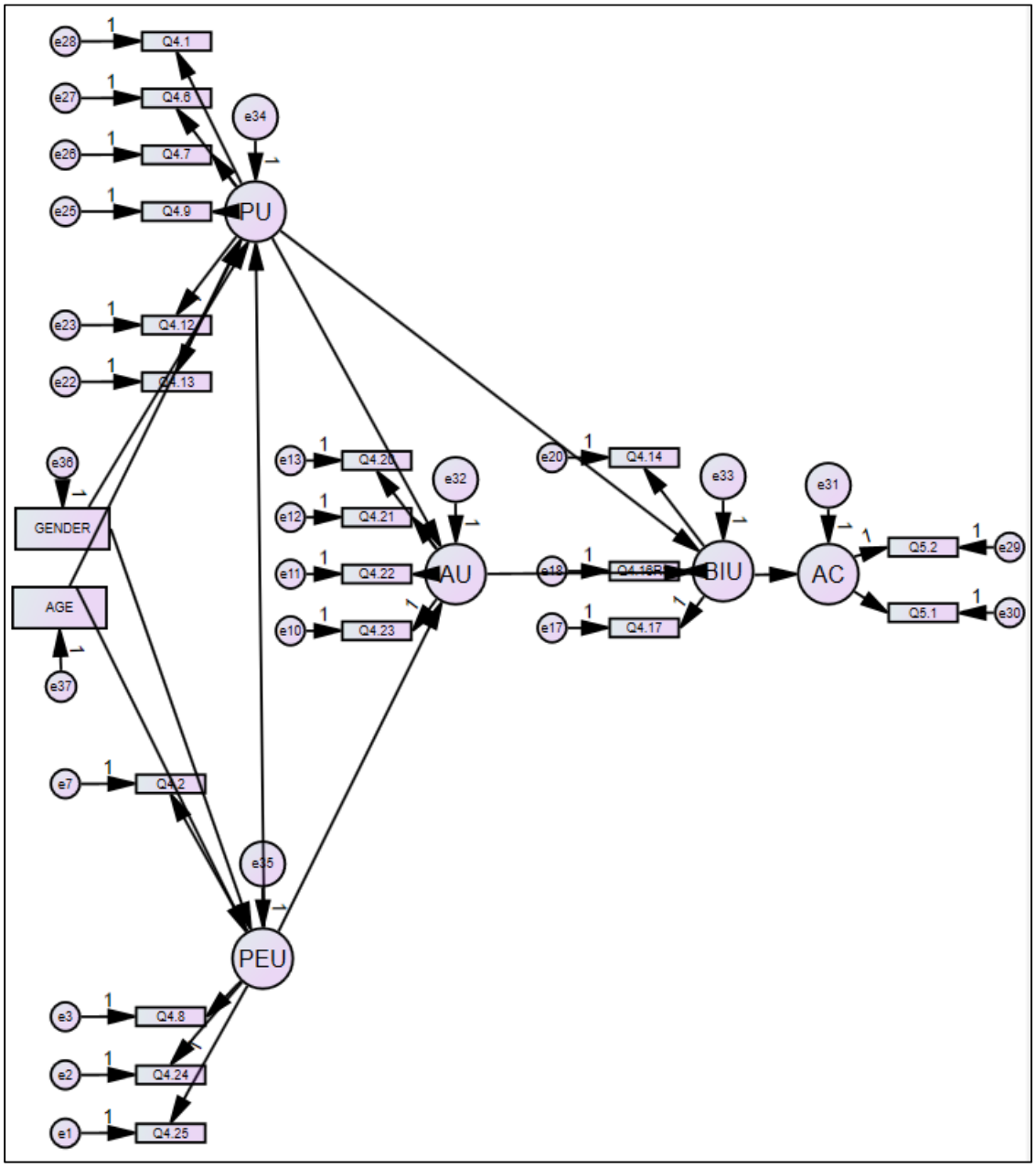


Table 4.23

Summary of the Statistics of the Final TAM Model

Statistic	Acceptable level	Value for final TAM model
RMSEA	The smaller the RMSEA, the better	.103
GFI	0 (no fit) – 1 (perfect fit) The larger the GFI, CFI and TLI, the better	.829
CFI		.809
TLI		.778

This section presents the standardised regression estimates for the final TAM model, which depicts the association between the underlying determinants. The focus of my study was to investigate lecturers' acceptance and usage of ICT tools in educating pre-service teachers at the CoEs in Ghana using the TAM as a research framework. Specifically, my study intended to determine the extent to which each construct in the TAM influences actual ICT usage among lecturers in the CoEs in the country. Table 4.24 reports the standardised regression estimates for the final TAM model. The final TAM model predicts the associations among the theoretically established constructs and measurement items with specific standardised estimates, standard errors for determining their respective t-test statistics, and the appropriate significant levels.

The results from SEM are reported in relation to the relevant hypothesis; see Section 2.3.2 for the ten hypotheses that I considered in my study. Hypothesis 1 considered whether gender has a significant effect on PU, and the results show that gender does not significantly affect PU (p=.626). Hypothesis 2 considered whether gender has a significant effect on PEU. By benchmarking against males with a zero and one for females, the results showed that females are 0.111 times less likely (p=.005) than males to agree with PEU statements. Thus, males tend to agree more with the measurement items of PEU than their female counterparts, and gender has a significant effect on PEU.

Hypothesis 3 considered whether age has a significant effect on PU, and the results show that age does not significantly affect PU (p=.714). Hypothesis 4 considered whether age has a significant effect on PEU, and the results show that age does not significantly affect PU (p=.901). Thus, age has no significant effect on PU or PEU.

Hypothesis 5 considered whether PEU has a significant effect on perceived usefulness, and this was found to be the case (p<.001). A unit increase in PEU results in a 1.309 rise in perceived usefulness. Hypothesis 6 considered whether perceived usefulness has a significant effect on attitude towards use, and this was found not the case (p=.632). Hypothesis 7 considered whether PEU has a significant effect on attitude towards use, and this was found to be p=.595. Hypothesis 8 considered whether attitude towards use has a significant effect on behavioural intention to use, and this was the case (p<.001). For every one unit increase in attitude towards use, behavioural intention to use increases by 1.180 units. Hypothesis 9 considered whether perceived usefulness has a significant effect on behavioural intention to use, which was found not to be the case (p=.703). Finally, Hypothesis 10 considered whether behavioural intention to use has a significant effect on actual system use, which was found to be the case (p<.001). For every one unit increase in behavioural intention to use, actual system use increases by 0.342 units.

Table 4.24

Standardised Regression Estimates for the Final TAM Model

Hypothesis	Constructs / demographic variables			Standardised estimate	Standard error	t-test statistic	p-value
1	PU	←	GENDER	-0.007	0.015	-.487	.626
2	PEU	←	GENDER	-0.111	0.039	-2.836	.005**
3	PU	←	AGE	0.002	0.006	0.366	.714
4	PEU	←	AGE	0.005	0.038	0.125	.901
5	PU	←	PEU	1.309	0.117	11.190	<.001***
6	AU	←	PU	-7.332	15.330	-0.478	.632
7	AU	←	PEU	10.790	20.323	0.531	.595
8	BIU	←	AU	1.180	0.180	6.555	< .001***
9	BIU	←	PU	-0.055	0.144	-0.381	.703
10	AC	←	BIU	0.324	0.067	4.810	< .001***

* Significant p-value < 0.05
** Significant p-value < 0.01
*** Significant p-value < 0.001

4.3 Chapter Summary

In this chapter, I presented the data collected and interpreted it based on lecturers' acceptance and use of ICT tools in Ghanaian CoEs. The data collected and analysed indicated that most lecturers in Ghanaian CoEs use personal computers to teach and prepare for lessons. For the most part, the lecturers use the Internet for personal development. According to the lecturers, the personal computer is the ICT tool that has the biggest impact on T&L. According to the data collected and analysed, seven themes were identified as the reasons for listing some ICT tools that have the most significant impact on T&L, namely "aids in lesson preparation and delivery and for personal development", "storing, retrieving, and sharing of files and information", "research", "easy accessibility and user friendly", "portability and time saving", "increase productivity", and "news and entertainment". The data analysis also demonstrated that each TAM construct was proved to be genuine and capable of being represented by all of the indicators, and as a consequence, the TAM model remains a valid model to explain the

acceptance and use of ICT tools among lecturers in Ghanaian CoEs. The data also showed that age has no significant effect on perceived usefulness or perceived ease of use; however, gender significantly affects perceived ease of use.

The next chapter, which is also my study's last chapter, I discuss the results and findings based on the secondary research questions related to the literature and my study's theoretical framework.

Chapter 5: Discussion of Findings, Conclusions and Recommendations

5.1 Introduction

In this chapter, I discuss the results and findings of my concurrent nested mixed study on lecturers' acceptance and use of ICT tools in educating pre-service teachers in Ghanaian CoEs. The key findings provided in Chapter 4 are then summarised, and my research questions are discussed in light of the literature findings. Finally, I discuss the delimitations and limitations of my study and offer suggestions for further research.

The purpose of my study was to look into lecturers' acceptance and usage of ICT tools in teaching pre-service teachers at Ghanaian CoEs using the Technology Acceptance Model (TAM) as a framework. My research aimed to determine which ICT tools are used by lecturers at Ghana's CoEs, investigated the ICT tools used by lecturers in their everyday life regarding academic activities, determined which ICT tools have the most significant influence on T&L and the reason(s) for saying so. In the process, the study determines how each TAM component influences lecturers' actual use of ICT tools in Ghanaian CoEs and how well the TAM can explain why lecturers at Ghanaian CoEs are willing to employ ICT tools.

My study addressed the primary research question, which states that "To what degree have lecturers in CoEs accepted to use ICT tools in teaching in Ghana?" and secondary research questions as "what ICT tools are used by Ghanaian lecturers in CoEs?", "How do Ghanaian lecturers in CoEs use ICT tools for academic activities?", "which ICT tools have the biggest impact on teaching and learning in CoEs in Ghana and why?", "To what extent is the TAM a valid model to explain the acceptance to use ICT among Ghanaian lecturers in CoEs", and "To what extent does each construct in the TAM affect the actual usage of ICT among Ghanaian lecturers in CoEs?"

I employed a concurrent nested MMR strategy, one in which quantitative and qualitative research methodologies were used simultaneously (Almeida, 2018). The survey (Phase I) and lesson observation (Phase II) research methods for data gathering were used. Four hundred lecturers from a target population of all lecturers at Ghana's CoEs were purposively sampled for Phase I of my study. One-hundred-and-thirty-six (136) of the 400 purposively chosen subjects were sampled synchronously using convenience (haphazard) sampling for Phase II of the study.

5.2 Discussion of the Secondary Research Questions

One of the main objectives of this research was to evaluate the ICT tools used by lecturers at Ghana's CoEs. My first secondary research question (SRQ1) asked: "What ICT tools are used by Ghanaian lecturers in CoEs?". According to the results and findings obtained, the majority of the participants/respondents utilise a personal computer, a projector, and social media (see Table 4.1; results from survey), and a personal computer and LMSs (see Table 4.4; findings from lesson observation) in their teaching. The results and findings from my study on this research question are inconsistent with Teotia's (2020) study. Respondents and participants of my study instead acknowledged the educational benefit of personal computers, projectors, social media, and LMSs in pre-service teacher education hence employing them in their teaching, whereas the participants in Teotia's (2020) study failed to acknowledge any educational benefit of employing personal computers and projectors in pre-service teacher education.

The study's second objective was to examine how lecturers in Ghanaian CoEs use ICT tools for academic activities. The responses to Section 2 of the survey (Appendix A) were used to address SRQ2: "How do Ghanaian lecturers in CoEs use ICT tools for academic activities?" My study considered three types of ICT use: for teaching, lesson preparation, and personal

development. The results indicated that most of the lecturers utilised the 23 ICT tools presented to them for personal development, followed by teaching and lesson preparation (see Table 4.5). The findings revealed that all of the lecturers who participated employed one or more ICT tools to present lessons to their students (see Table 4.6). The remaining lecturers employed ICT tools to assess, interact and communicate with their students during the lesson observation (see Table 4.6). Again, the results and findings that addressed my study's SRQ2 contradict Teotia's (2020) study, where respondents and participants failed to acknowledge any educational benefit of employing personal computers and projectors in pre-service teacher education.

SRQ3 asked: "Which ICT tools have the biggest impact on teaching and learning in CoEs in Ghana and why?". The results indicated that the majority of the participants claimed that a personal computer and the Internet had the biggest impact on T&L (see Table 4.7). Section 3 of the survey sought the reasons for claiming that particular ICT tools had the biggest impact on T&L from the respondents. From this open-ended question, seven themes emerged and are mentioned here briefly. According to the lecturers, ICT tools help with lesson planning and delivery, in addition to personal development. Others claimed that ICT tools are employed for file and information storage, retrieval, sharing, and research. Some participants also stated that some ICT tools have the biggest impact due to their simplicity of use, user-friendliness, portability, and time-saving capabilities. Finally, according to some participants, ICT tools boost productivity (in line with findings from other researchers such as Asongu and Acha-Anyi (2020) and Hawash and Lang (2020)), and are utilised for news and enjoyment (in line with findings from other researchers such as Adjin-Tettey (2018) and Deniz and Geyik (2015)).

SRQ4 asked, “To what extent is the TAM a valid model to explain the acceptance to use ICT among Ghanaian lecturers in CoEs?”. The final TAM model predicts the associations among the theoretically established constructs: PEU, PU, AU, BIU, and AC. The results from my study are consistent with the prediction in the TAM (Davis et al., 1989) as the underlying constructs accurately explain lecturers’ acceptance and use of ICT tools in teaching pre-service teachers at CoEs in Ghana. In a detailed SEM analysis, my study revealed various effects of gender and age on PU and PEU, respectively. My study found that females are less likely than males to agree with the statements of PEU. It implies male lecturers have a belief that the PEU of an ICT tool plays a significant role in its acceptance and usage. The finding reaffirmed several assertions about the role of gender in perceiving how useful technology is and its acceptance (Drabowicz, 2014). My study found that age did not significantly affect PU or PEU. This result contradicts reports in earlier studies (Aspasia & Ourania, 2014; Porter & Donthu, 2006). The insignificance of both gender and age in explaining PU contradict empirical findings in most existing literature (Bundot, 2018; Drabowicz, 2014).

After investigating the nexus between PU and PEU, the study reports a significant positive relationship between the two variables. An increase in PEU is capable of resulting in a rise in PU. This effect is statistically significant, consistent with the general assertion that there is a positive association between PU and PEU (Davis, 1989; Durodolu, 2016; Fu, 2013). Aggarwal (2018) also found a positive correlation between PU and PEU. The respondents and participants of my study believed that the use of ICT tools would be easy, thereby influencing their belief that using the ICT tools would provide a better T&L experience.

The study also reports the effect of PU and PEU on AU, respectively, with the results indicating no statistically significant effect. Another set of associations relevant to the TAM model assessment has to do with the influence of AU and PU on BIU. Concerning the

relationship between AU and BIU, my study found a significant positive association between them, such that an increase in AU presents a greater chance of rising BIU and is statistically significant. It implies that AU counts when it comes to predicting behavioural intention to use ICT tools among lecturers and is consistent with the findings in the existing investigations (Landry et al., 2006; Maqableh et al., 2015; Ong et al., 2004; Terzis & Economides, 2011; Wang et al., 2009). My study also found that PU has no significant effect on BIU, contradicting findings in the existing studies (Landry et al., 2006; Lee, 2008; Liao & Lu, 2008; Maqableh et al., 2015; Ong et al., 2004; Teo, 2009).

Finally, my study showed that BIU significantly affects AC, such that a rise in the former is followed by an increase in the latter. It implies that both BIU and AC move in the same direction, which is consistent with the findings in the existing literature (Alharbi & Drew, 2014; Bundot et al., 2017; Bundot, 2018; Costa et al., 2019; Olafare et al., 2017; Oye et al., 2011) and corroborates the final prediction in the TAM (Davis, 1989).

5.4 Delimitations and Limitations

In the following sub-sections, I present my study's delimitations and limitations.

5.4.1 Delimitations

The participants of this MMR included only 390 lecturers for Phase I (survey). Out of the 390 participants, 136 lecturers (with their students) took part in my study's Phase II (lesson observation). The participants were from 25 out of the 46 public CoEs in Ghana. The participants were chosen because they have used an ICT tool in one way or another in their lesson preparation, teaching, or for professional development, and I am one of the lecturers in one of the public CoEs.

5.4.2 Limitations

The resurgence of the COVID-19 pandemic impacted the data collection period since the epidemic's containment measures were carefully followed, which caused a delay in data gathering.

Only lesson observation and a lecturers' survey were used as the data collection instruments for my study. Future studies may consider the analysis of documents or a students' survey as data collection instruments to find out how the lecturers use ICT tools in teaching and whether students' believe that ICT tools in T&L benefit them.

Finally, there aren't enough open-ended questions in the survey instrument which restricts this study's qualitative knowledge. In future studies, a suggestion is that the survey should contain more open-ended questions. The interview approach might also be used in future studies to triangulate the data supplied by the lecturers.

5.5 Implications of the Findings and Recommendations

Because technology has evolved into a tool that improves students' academic performance, the changing information environment necessitates the proper use of contemporary technology in T&L. The Ghanaian government must continue to make the necessary pedagogical ICT tools available for lecturers to use, thereby changing their perceptions of ICT integration in the classroom. These tools must be made available to enhance the use of ICTs in classrooms as lecturers play a critical role in ensuring that any educational policy is implemented effectively and efficiently.

The findings from my study showed that less than 10% (9.2%) of participants are currently using ICTs for teaching daily. This low percentage could be due to a lack of training on effectively integrating ICTs in the classroom or a lack of understanding of the advantages that

ICTs hold. Workshops and seminars should be organised for all lecturers in the CoEs in Ghana on how to apply some common pedagogical ICT tools. These workshops and seminars should also highlight the advantages of ICT integration in a classroom. If lecturers have a limited level of knowledge about ICT integration and its advantages, it impacts classroom utilisation. As a result, lecturers must be trained to have the knowledge and abilities essential to effectively support their students' use of ICT tools in learning. Put another way, successful ICT integration in education depends on training and competence. These workshops and seminars may also boost the female lecturers' belief about the PEU of ICT tools. Regarding the latter, my study found that females were significantly less in agreement with the PEU items in the survey. Thus, one should consider designing specific workshops and seminars for female employees that focus specifically on illustrating the ease of using ICTs.

Furthermore, the impact of ICT on student learning depends entirely on the lecturers' attitude. This finding is from the fact that my study showed that lecturers' use of ICT tools significantly affects their behavioural intention to use it, which, in turn, substantially impacts actual use. As a result, lecturers must have a positive attitude towards ICT integration which will only happen if they are literate and have strong skills and knowledge in using ICT tools. These recommendations will enhance lecturers' teaching techniques to promote effective learning and fulfil 21st century teaching skills.

5.6 Recommendations for Further Research

While addressing ICT integration difficulties and obstacles have been the subject of numerous research studies, an in-depth examination of ICT integration in key topics in CoEs is rarely explored. It would be beneficial if more research could be done on hurdles that lecturers face while employing ICT tools in their lessons.

Furthermore, rather than just focusing on public CoEs, it is preferable to replicate this research in both public and private institutions because some colleges may have greater access to ICT tools than others. It would be ideal to compare different colleges, with the positive outcomes serving as models and the defects found being used to create changes. Aside from that, comparative studies of ICT integration in T&L between public and private CoEs are highly encouraged. It would be fascinating to examine the research results into the efficacy of ICT integration in public and private CoEs.

Finally, this study was confined to the acceptance and use of ICT tools in teaching by lecturers. A future study might focus on students' acceptance and use of ICT tools in learning.

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Appendices

Appendix A: Survey

Lecturers' Acceptance and Use of ICT tools in Ghanaian Colleges of Education

Participant Consent Form

The purpose of this survey is to explore lecturers' acceptance and use of Information and Communications Technology (ICT) tools in teaching at Colleges of Education in Ghana. This survey will take less than 10 minutes to be completed. All information provided will be treated confidentially. Your identity will remain anonymous in any report on the results of this survey. Your decision to participate in this survey is completely voluntary.

If you voluntarily agree to participate in this survey, check **I Agree** else; check **I do not agree**.

☐ **I Agree**

☐ **I do not agree**

Section 1

Demographic Information of Participating Lecturers

1.1 Region of College (*please tick*)

☐ Ahafo	☐ Central	☐ North East	☐ Upper West
☐ Ashanti	☐ Eastern	☐ Oti	☐ Volta
☐ Bono	☐ Greater Accra	☐ Savannah	☐ Western
☐ Bono East	☐ Northern	☐ Upper East	☐ Western North

1.2 Location of College (*please tick*)

☐ City ☐ Town ☐ Rural

1.3 Gender (*please tick*)

☐ Male ☐ Female

1.4 Age (*in years*)

☐ Younger than 22 years	☐ 37 - 41 years	☐ Older than 56 years
☐ 22 - 26 years	☐ 42 - 46 years	
☐ 27 - 31 years	☐ 47 - 51 years	
☐ 32 - 36 years	☐ 52 - 56 years	

1.6 Department (*please tick*)

☐ Education & Professional Studies	☐ Social Sciences
☐ ICT & Mathematics	☐ Vocational
☐ Languages	☐ Other (*please specify*):
☐ Sciences	.....

1.7 Rank (*please tick*)

☐ Assistant tutor	☐ Senior tutor	☐ Chief tutor
☐ Tutor	☐ Principal tutor	☐ Other (*please specify*):
		.....

Section 2

ICTs Being Implemented by the Participating Lecturers in Teaching

Instructions:

Please circle the response in the table that best describes your usage of a particular ICT tool.

If you have access to the ICT tools listed, please indicate how it is used.

		For Teaching		For Lesson Preparation		For Personal Development	
S/N	Type of ICT	Yes	No	Yes	No	Yes	No
2.1	Personal Computer						
2.2	Internet						
2.3	Mobile Devices						
2.4	Intranet (e.g. school network)						
2.5	Television						
2.6	CD/DVDs ROM						
2.7	Scanner						
2.8	Printer						
2.9	E-Mail						
2.10	Camera						
2.11	Projector						
2.12	SmartBoard/ Interactive Whiteboard Apps. (Eg. Explain Everything, Educreations, Jamboard, etc.)						
2.13	Microsoft Office (Word, Excel, Access, PowerPoint, etc.)						

		For Teaching		For Lesson Preparation		For Personal Development	
S/N	Type of ICT	Yes	No	Yes	No	Yes	No
2.14	Social Media (WhatsApp, Facebook, Twitter, Skype, Instagram, Telegram, Messenger)						
2.15	Video Conference (Zoom, BlueJeans, etc.)						
2.16	Video Websites (E.g. YouTube, Hulu, Netflix, Vimeo, etc.)						
2.17	Online word processors (E.g. Google Docs, Zoho Writer, ONLYOFFICE Personal, etc.)						
2.18	Learning Management System (LMS) (e.g. Google Classroom, Edmodo, Moodle, Blackboard, etc.)						
2.19	Cloud Storage Service (E.g. DropBox, OneDrive, iCloud, etc.)						
2.20	Note Sharing (E.g. Evernote, Onenote, etc.)						
2.21	e-Portfolios						
2.22	Statistical Analysis Software (E.g. MATLAB, SPSS, Minitab, etc.)						
2.23	Mathematics Software (E.g. Maple, GeoGebra, Geometer's Sketchpad, etc.)						

Which ICT tool do you use MOST for:

2.24 Teaching? _____

2.25 Lesson preparation? _____

2.26 Personal development? _____

Section 3

How Participating Lecturers Implement ICTs in Their Lecture Halls

Instructions:
Please fill in your answer to the questions below in the open spaces provided.

Item number 3:
What ICT tool (s) do you think has/have the biggest impact on teaching and learning, and why?

3.1 ICT Tool	3.2 Reason (s)

Section 4

Reasons why Participating Lecturers Implement ICT

Instructions:
Please circle the number that best describes your agreement or disagreement with each statement.

1	2	3	4	5
Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Disagree	Strongly Disagree

Item No	Statement	1	2	3	4	5
4.1	ICT tools are useful for teaching my course					
4.2	It is easy to use ICT tools for teaching my course.					
4.3	I have the resources necessary to use ICT tools to teach.					
4.4	I have the knowledge necessary to use ICT tools for teaching.					
4.5	A specific person (or group) would be available for assistance with difficulties when using ICT tools to teach.					
4.6	Using ICT tools to teach will enhance learners' understanding					
4.7	Using ICT tools to teach will make it easier to explain difficult concepts.					
4.8	Learning to use ICT tools to teach would be easy for me					
4.9	Using ICT tools to teach saves time.					
4.10	Using ICT tools will increase my productivity in teaching					
4.11	I intend to use ICT to teach in the next 6 months					
4.12	Using ICT tools will make me more creative					
4.13	Using ICT tools will enhance my effectiveness in teaching					
4.14	I plan to use ICT tools often					
4.15	I only use ICT tools to teach when told to					
4.16	I avoid using ICT tools to teach					

Item No	Statement	1	2	3	4	5
4.17	I will use ICT tools regularly throughout in my teaching					
4.18	I will not use ICT tools to teach in the next 6 months.					
4.19	Teaching with ICT tools is not fun at all					
4.20	I like using ICT tools for teaching					
4.21	ICT tools make teaching more interesting					
4.22	I look forward to teaching courses that require me to use ICT tools in the future					
4.23	I look forward to using ICT tools to enhance effectiveness of teaching courses in future					
4.24	It is easy to use ICT tools for lesson preparation					
4.25	It is easy to use ICT tools for personal development					
4.26	I avoid using ICT tools for lesson preparation					
4.27	I like using ICT tools for personal development					
4.28	I like using ICT tools for lesson preparation					

Section 5

Actual and Intentional use of ICT Tool(s)

Instructions:
Please mark (X) in the box that best describes your agreement or disagreement with each statement.

Item no. 5.1: Actual use
Please indicate the frequency with which you are using ICT for teaching at this stage.

Frequency	Marking (X)
a) I do not plan to use ICT at all	
b) Only once	
c) Once a month	
d) Once every two weeks	
e) Once or twice a week	
f) Three to four times a week	
g) Daily	

Item no. 5.2: Intention to use
Please indicate the frequency with which you intend to use ICT for teaching during the next 6 months.

Frequency:	Marking (X)
a) I do not plan to use ICT at all	
b) Only once	
c) Once a month	
d) Once every two weeks	
e) Once or twice a week	
f) Three to four times a week	
g) Daily	

Appendix B: Lesson Observation Protocol

Section 1

Background Information

1.1 Date of observation: .....

1.2 Gender (*participant*):

☐ Male ☐ Female

1.3 Age (*in years*):

☐ Younger than 22 years	☐ 37 - 41 years	☐ Older than 56 years
☐ 22 - 26 years	☐ 42 - 46 years	
☐ 27 - 31 years	☐ 47 - 51 years	
☐ 32 - 36 years	☐ 52 - 56 years	

1.4 Course/subject observed: .....

1.5 Duration of observation:

☐ 1 hour ☐ 3 hours

☐ 2 hours ☐ Other (*please specify*).....

1.6 Total number of students present: .....

Section 2

ICTs Being Implemented by the Participating Lecturers in Teaching

2.1 The *major ICTs* used during observation

1. _____
2. _____
3. _____
4. _____
5. _____

2.2 The *major way(s)* in which teaching activities were structured

☐ As a whole group ☐ As small groups

☐ As pairs ☐ As individuals

2.3 Application of the *major ICTs* used during the observation

☐ Presentation ☐ Drill & practice

☐ Demonstration ☐ Interaction and communication

☐ Assessment ☐ Collaboration

☐ Other (*please specify*).....

Section 3

Competence Level of Participating Lecturers in Using ICTs During Teaching

- ☐ High level of competence (extensive experience)
- ☐ Moderately high level of competence (good experience)
- ☐ Average level of competence (some experience)
- ☐ Low level of competence (little experience)
- ☐ No level of competence (no experience)

Section 4

Students' Reaction to the use of ICTs by the Participating Lecturers During Teaching

☐ Confused	☐ Doubtful	☐ Lost
☐ Contentment	☐ Excitement	☐ Nauseated
☐ Disappointed	☐ Frustrated	☐ Nervous
☐ Dislike	☐ Infuriated	☐ Panicked
☐ Disturbed	☐ Irritated	☐ Satisfaction

☐ Other (*please state*):_____

Appendix C: Consent Form for the Principal

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Education
Department of Science, Mathematics and Technology Education
Groenkloof Campus
Pretoria 0002
Republic of South Africa
http://www.up.ac.za
30 July 2020

LETTER OF INFORMED CONSENT: PRINCIPAL

Dear Principal,

I am a PhD student studying at the University of Pretoria and would like to collect data at your college for a research project titled ***Lecturers' acceptance and use of ICT tools in Ghanaian Colleges of Education.***

The purpose of this study is to explore lecturers' acceptance and use of Information and Communications Technology (ICT) tools in teaching preservice teachers in Colleges of Education in Ghana within the context of the Technology Acceptance Model (TAM) as a research framework. As a principal, I would like to invite your lecturers to complete a survey (10 minutes) and a lesson observation (60 minutes) to explore the ICT tools the lecturers employ during their lesson delivery. These survey s and observations will be completed during Semester 1 in your lecturers' lecture hall.

The results of this study may be presented at conferences or published in scientific journals.

Participation is subject to the Ethics Committee of the Faculty of Education at the University of Pretoria's regulations, and the following will apply:

1. The name of the college and identities of the participants will be treated confidentially and will not be disclosed.
2. The surveys and lesson observations will be treated confidentially. Only the researcher (Mr Emmanuel Kwasi Boateng), the supervisor (Prof UI Ogbonnaya), and the co-supervisor (Prof MA Graham) will have access to the surveys and the lesson observations.
3. Only the researcher (Mr Emmanuel Kwasi Boateng) will know the identity of the college, the lecturers, and the students who agreed to participate in the study.

4. The information provided by the lecturers and students will be used for academic purposes only.
5. Participation in this project is entirely voluntary. Participants have the right to withdraw at any time and without any prejudice.
6. The lecturers and the students will not be exposed to acts of deception at any point in the research study.
7. The lecturers and students will not be placed at risk of any kind.
8. The normal teaching activities will not be disturbed; in particular, no tuition time will be lost, no incentives will be offered to any of the research participants, and there will be no implications for academic assessments for participation or non-participation.
9. The data that will be collected will be stored for 15 years in the supervisors' office at the University of Pretoria as per the rules and regulations of the University of Pretoria.
10. The researcher (Mr Emmanuel Kwasi Boateng), the supervisor (Prof UI Ogbonnaya), and the co-supervisor (Prof MA Graham) would like to request your permission to use the data, confidentially and anonymously, for further research purposes, as the data sets are the intellectual property of the University of Pretoria. Further research may include secondary data analysis and using the data for teaching purposes. The confidentiality and privacy applicable to this study will be binding on future research studies.

The Faculty of Education and the Ethics Committee at the University of Pretoria have approved this study. For any further queries, you are more than welcome to contact the researcher or his supervisors.

Your support in this matter will be appreciated.

Mr Emmanuel Kwasi Boateng
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Prof MA Graham (Co-supervisor)
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Should you agree to allow the lecturers to participate in the study under the above-stated terms, please fill in the details below:

I, _____(your name only), agree to allow you to undertake the research project titled, *Lecturers' acceptance and use of ICT tools in Ghanaian Colleges of Education..*

_____ _____

Signature Date

Appendix D: Consent Form for the Participants

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Education
Department of Science, Mathematics and Technology Education
Groenkloof Campus
Pretoria 0002
Republic of South Africa
http://www.up.ac.za
30 July 2020

LETTER OF INFORMED CONSENT: LECTURER

Dear Lecturer,

I am a PhD student studying at the University of Pretoria and would like to collect data at your college for a research project titled ***Lecturers' acceptance and use of ICT tools in Ghanaian Colleges of Education***.

The purpose of this study is to explore lecturers' acceptance and use of Information and Communications Technology (ICT) tools in teaching preservice teachers in Colleges of Education in Ghana within the context of the Technology Acceptance Model (TAM) as a research framework. As a lecturer, you will be invited to complete a survey (10 minutes) and an observation (60 minutes) to explore the ICT tools you employ during your lesson delivery. These surveys and observations will be completed during Semester 1 in your lecture hall.

The results of this study may be presented at conferences or published in scientific journals. Participation is subject to the Ethics Committee of the Faculty of Education at the University of Pretoria's regulations, and the following will apply:

1. The name of the college and the participants' identities will be treated confidentially and will not be disclosed.
2. The surveys and lesson observations will be treated confidentially. Only the researcher (Mr Emmanuel Kwasi Boateng), the supervisor (Prof UI Ogbonnaya), and the co-supervisor (Prof MA Graham) will have access to the surveys and the lesson observations.

3. Only the researcher (Mr Emmanuel Kwasi Boateng) will know the identity of the lecturers and students who agreed to participate in the study.
4. The information provided by the lecturer will be used for academic purposes only.
5. Participation in this project is entirely voluntary. Participants have the right to withdraw at any time and without any prejudice.
6. The lecturers and the students will not be exposed to acts of deception at any point in the research study.
7. The lecturers and students will not be placed at risk of any kind.
8. The normal teaching activities will not be disturbed; in particular, no tuition time will be lost, no incentives will be offered to any of the research participants, and there will be no implications for academic assessments for participation or nonparticipation.
9. The data that will be collected will be stored for 15 years in the supervisors' office at the University of Pretoria as per the rules and regulations of the University of Pretoria.
10. The researcher (Mr Emmanuel Kwasi Boateng), the supervisor (Prof UI Ogbonnaya), and the co-supervisor (Prof MA Graham) would like to request your permission to use your data, confidentially and anonymously, for further research purposes, as the data sets are the intellectual property of the University of Pretoria. Further research may include secondary data analysis and using the data for teaching purposes. The confidentiality and privacy applicable to this study will be binding on future research studies.

The Faculty of Education and the Ethics Committee at the University of Pretoria have approved this study. For any further queries, you are more than welcome to contact the researcher or his supervisors.

Your support in this matter will be appreciated.

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marien.graham@up.ac.za

Should you agree to participate in the study under the above-stated terms, please fill in the details below:

I, _____(your name only), agree to take part in the research project titled, *Lecturers' acceptance and use of ICT tools in Ghanaian Colleges of Education.*

_____ _____
Signature Date

Appendix E: Consent Form for the Students

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Education
Department of Science, Mathematics and Technology Education
Groenkloof Campus
Pretoria 0002
Republic of South Africa
http://www.up.ac.za
30 July 2020

LETTER OF INFORMED CONSENT: STUDENT

Dear Student,

Why am I here?

Sometimes when we want to inquire diligently or examine to seek or revise facts, principles, theories, or applications, we ask people to join something called a research project. What you are taught and how your lecturer teaches it is based on research. To continue to improve on what you are taught and how you are taught, there are research projects to look at what happens in a typical lesson. Before I ask you to be part of this project, I want to tell you more about it first.

This project will give me a chance to look at the Information and Communications Technology (ICT) tool or tools your lecturer uses during their lesson delivery.

What will happen to me?

If you are part of the study, your lecturer will teach you using any ICT tool whilst I observe. This lesson will not last for more than 60 minutes. I will not use your name in any report, so you have to feel free and have fun.

Will the project help me?

This project might not necessarily help you immediately and directly but may help your lecturer improve their pedagogical content knowledge in terms of ICT integration into teaching and learning. This project may help your lecturer during their lesson preparation, delivery, and professional development, which will, in turn, help you to learn with ease, enhance your understanding, and improve your academic performance.

What if I have any questions?

You can ask your lecturer any questions you have about this project. If you have questions later that you do not think of now, you can call the researcher on +233246573461 or ask the researcher the next time you see him at your college.

Do I have to be on the project?

You do not have to be in this project if you do not want to. No one will be upset if you do not want to participate. You will not lose any marks if you do not participate.

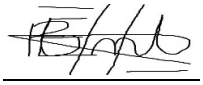
Agreement

The researcher (Mr Emmanuel Kwasi Boateng), the supervisor (Prof UI Ogbonnaya), and the co-supervisor (Prof MA Graham) would like to ask your permission to use the data that will be collected during the lesson observations to help other students in their studies, as the data sets are the intellectual property of the University of Pretoria. The confidentiality and privacy applicable to this study will be binding on future studies

Signing on this page means that you agree to be in the project and know what will happen when we do the project.

_____ _____

Signature of the student Date



Signature of the researcher — 29 August 2020 Date

Signature of the supervisor — 29 August 2020 Date

Signature of the co-supervisor — 29 August 2020 Date

Appendix F: Regression Output for SEM Models

Table F.1

Regression Weights Linked to the SEM for the Complete Theoretical TAM Excluding External Variables (Figure 4.5)

			Estimate	Standard error	Critical ratio	*p*
PU	<---	PEU	1.240	.107	11.586	<.001
AU	<---	PU	-.259	.296	-.878	.380
AU	<---	PEU	1.278	.406	3.151	.002
BIU	<---	AU	1.004	.175	5.730	<.001
BIU	<---	PU	-.045	.105	-.429	.668
AC	<---	BIU	.408	.087	4.713	<.001
Q4.25	<---	PEU	1.000			
Q4.24	<---	PEU	1.199	.105	11.442	<.001
Q4.8	<---	PEU	1.253	.101	12.352	<.001
Q4.5	<---	PEU	.166	.204	.813	.416
Q4.4	<---	PEU	1.029	.109	9.441	<.001
Q4.3	<---	PEU	1.372	.146	9.377	<.001
Q4.2	<---	PEU	1.266	.106	11.968	<.001
Q4.28	<---	AU	1.000			
Q4.27	<---	AU	.836	.103	8.083	<.001
Q4.23	<---	AU	1.085	.091	11.965	<.001
Q4.22	<---	AU	1.236	.108	11.442	<.001
Q4.21	<---	AU	1.058	.090	11.700	<.001
Q4.20	<---	AU	1.182	.115	10.307	<.001
Q4.19RS	<---	AU	1.011	.215	4.713	<.001
Q4.26RS	<---	BIU	1.000			
Q4.18RS	<---	BIU	1.460	.199	7.321	<.001
Q4.17	<---	BIU	1.266	.154	8.233	<.001
Q4.16RS	<---	BIU	1.079	.140	7.720	<.001
Q4.15RS	<---	BIU	.853	.184	4.643	<.001
Q4.14	<---	BIU	1.043	.123	8.452	<.001
Q4.11	<---	BIU	.691	.138	5.006	<.001
Q4.13	<---	PU	1.000			
Q4.12	<---	PU	.873	.062	14.116	<.001
Q4.10	<---	PU	.600	.086	6.973	<.001
Q4.9	<---	PU	.890	.062	14.380	<.001
Q4.7	<---	PU	1.021	.067	15.260	<.001
Q4.6	<---	PU	.822	.070	11.670	<.001
Q4.1	<---	PU	.544	.043	12.518	<.001
Q5.2	<---	AC	1.000			
Q5.1	<---	AC	.927	.298	3.112	.002

Table F.2

Regression Weights Linked to the SEM for the Final TAM Excluding External Variables (Figure 4.6)

			Estimate	Standard error	Critical ratio	*p*
PU	<---	PEU	1.298	.116	11.222	<.001
AU	<---	PU	-5.053	8.191	-.617	.537
AU	<---	PEU	7.733	10.808	.716	.474
BIU	<---	AU	1.221	.184	6.648	<.001
BIU	<---	PU	-.092	.147	-.624	.533
AC	<---	BIU	.325	.067	4.823	<.001
Q4.25	<---	PEU	1.000			
Q4.24	<---	PEU	1.218	.108	11.306	<.001
Q4.8	<---	PEU	1.295	.105	12.311	<.001
Q4.2	<---	PEU	1.206	.107	11.272	<.001
Q4.23	<---	AU	1.000			
Q4.22	<---	AU	1.134	.068	16.640	<.001
Q4.21	<---	AU	.969	.056	17.417	<.001
Q4.20	<---	AU	1.048	.080	13.096	<.001
Q4.17	<---	BIU	1.000			
Q4.16RS	<---	BIU	.763	.096	7.963	<.001
Q4.14	<---	BIU	.913	.086	10.584	<.001
Q4.13	<---	PU	1.000			
Q4.12	<---	PU	.904	.065	13.997	<.001
Q4.9	<---	PU	.916	.065	14.159	<.001
Q4.7	<---	PU	1.054	.070	15.043	<.001
Q4.6	<---	PU	.832	.073	11.381	<.001
Q4.1	<---	PU	.546	.045	12.071	<.001
Q5.2	<---	AC	1.000			
Q5.1	<---	AC	.880	.304	2.892	.004

Table F.3

Regression Weights Linked to the SEM for the Acceptable Theoretical TAM Including External Variables (Figure 4.7)

			Estimate	Standard error	Critical ratio	*p*
PEU	<---	Q4	-.109	.041	-2.690	.007
PEU	<---	Q5	-.014	.019	-.725	.468
PU	<---	PEU	1.243	.107	11.576	<.001
PU	<---	Q4	-.020	.027	-.732	.464
PU	<---	Q5	.002	.012	.160	.873
AU	<---	PU	-.323	.326	-.993	.321
AU	<---	PEU	1.362	.446	3.055	.002
BIU	<---	AU	.990	.173	5.721	<.001
BIU	<---	PU	-.035	.104	-.333	.739
AC	<---	BIU	.408	.087	4.708	<.001
Q4.25	<---	PEU	1.000			
Q4.24	<---	PEU	1.198	.105	11.424	<.001
Q4.8	<---	PEU	1.256	.102	12.364	<.001
Q4.5	<---	PEU	.165	.204	.808	.419
Q4.4	<---	PEU	1.028	.109	9.429	<.001
Q4.3	<---	PEU	1.367	.146	9.344	<.001
Q4.2	<---	PEU	1.266	.106	11.964	<.001
Q4.28	<---	AU	1.000			
Q4.27	<---	AU	.835	.103	8.083	<.001
Q4.23	<---	AU	1.085	.091	11.974	<.001
Q4.22	<---	AU	1.236	.108	11.453	<.001
Q4.21	<---	AU	1.057	.090	11.708	<.001
Q4.20	<---	AU	1.180	.115	10.307	<.001
Q4.19RS	<---	AU	1.010	.214	4.714	<.001
Q4.26RS	<---	BIU	1.000			
Q4.18RS	<---	BIU	1.460	.200	7.318	<.001
Q4.17	<---	BIU	1.266	.154	8.228	<.001
Q4.16RS	<---	BIU	1.080	.140	7.716	<.001
Q4.15RS	<---	BIU	.854	.184	4.644	<.001
Q4.14	<---	BIU	1.043	.124	8.447	<.001
Q4.11	<---	BIU	.691	.138	5.007	<.001
Q4.13	<---	PU	1.000			
Q4.12	<---	PU	.870	.062	14.118	<.001
Q4.10	<---	PU	.598	.086	6.959	<.001
Q4.9	<---	PU	.888	.062	14.388	<.001
Q4.7	<---	PU	1.019	.067	15.283	<.001
Q4.6	<---	PU	.821	.070	11.685	<.001
Q4.1	<---	PU	.544	.043	12.562	<.001
Q5.2	<---	AC	1.000			
Q5.1	<---	AC	.929	.298	3.116	.002