A STUDY OF E-LEARNING TECHNOLOGY INTEGRATION BY PRESERVICE SCIENCE TEACHERS

BY

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DECLARATION

I, Cecilia Temilola Olugbara, hereby declare that **A STUDY OF E-LEARNING TECHNOLOGY INTEGRATION BY PRESERVICE SCIENCE TEACHERS** is my own original work and has not been previously submitted to any other institution of higher education. I further declare that all sources cited or quoted are indicated and acknowledged by means of a comprehensive list of references.

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SIGNATURE DATE

(CT Olugbara)

DEDICATION

This thesis is dedicated to my late father, *Pa George Tanimowo Benson* a great motivator who is the architect behind what I am today. He worked tirelessly to train me up with his token resources to place me on the path of God’s divine purpose for my life. Your prayers, words of wisdom and inspirations that I should attain this highest level of citadel in education has manifested. I wish you were alive this day to witness and share in this great event of my academic achievement. To my sweet and compassionate late sister *Monisola Benson*. May their soul continue to rest in perfect peace.

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Except the LORD build the house, they labour in vain that build it: except the LORD keep the city, the watchman waketh [but] in vain-

(Psalm 127:1)

ACRONYMS

ATT	Attitude
AVE	Average Variance Extracted
CA’s	Cronbach’s Alpha
CBSEM	Covariance-Based Structural Equation Modelling
CDs	Compact Discs
CFA	Confirmatory Factor Analysis
CR	Composite Reliability
CV	Convergent Validity
DoE	Department of Education
DV	Discriminant validity
DVD	Digital Versatile Disc
ELIM	E-Learning technology Integration Model
ECT	Expectation Confirmation Theory
ESL	English Second Language
FLW	Flow
GoF	Goodness of Fit
ICT	Information Communication Technology
IT	Information Technology
INTE	Integration
INC	Innovation Consciousness
INT	Intention
LMS	Learning Management System
LV’s	Latent Variables
LISREL	Linear Structural Relationship
MSTE	Mathematics, Science and Technology Education
MOD	Moderator
NGO	Non-governmental organization
PSST	Preservice Science Teacher
PLS	Partial Least Square
QUAL	Qualitative
QUANT	Quantitative
QUC	Quality Consciousness

SEM	Structural Equation Modelling
SKL	Skill
TPB	Theory of Planned Behaviour
TV	Television
VLE	Virtual Learning Environment
WST	Will, Skill, Tool

ABSTRACT

This study investigated possible factors predicting e-learning technology integration into the teaching and learning of science subjects by preservice science teachers. An E-learning technology integration model was developed in which factors such as intention (INT), attitude (ATT), Skill (SKL) and Flow Experience (FLW) served as possible precursors of e-learning technology integration. This was done against the gap that continued to exist between *intention to integrate* e-learning technology and *actual integration* of e-learning technologies. To close the gap, the study developed a model to predict e-learning technology integration by the research sample. More specifically, the model hypothesised that *quality* consciousness and *innovation* consciousness moderated the intention-integration gap. The proposed model was first pilot-tested on a sample of 30 preservice science teachers (PSSTs) before it was applied to the main study, which comprised a research sample of 100 final year PSSTs at the University of Zululand, KwaZulu-Natal Province, South Africa.

The study was located within the mixed-methods research paradigm, based on a survey research design. Data collection was carried out using a semi-structured questionnaire which allowed for the collection of both quantitative and qualitative data. Quantitative data were analysed using the Partial Least Squares (PLS) Structural Equation Modelling (SEM), while qualitative data were analysed using a hermeneutic content analysis approach.

The results of the study were, firstly, that the proposed model explained 44% of the PSSTs integration of e-learning technologies into the teaching and learning of science subjects and that *skill* was the most significant and strongest factor predicting the PSSTs integration of e-learning technologies; *flow experience* was the second important factor predicting the PSSTs integration of e-learning technologies, followed by *intention* and lastly, *attitude*. Secondly, the study revealed that *quality consciousness* and *innovation consciousness* significantly moderated the gap between intention to integrate e-learning technologies and the actual integration of e-learning technologies, with *quality consciousness* having the stronger moderating effect. Thirdly, the study revealed that some preservice science teachers were able to utilise e-learning technologies during the period of teaching practice for instructional preparation, instructional delivery, and to facilitate learning. However, some PSSTs were unable to utilised e-learning technologies during teaching practice, ostensibly because of a lack of e-learning facilities in the schools.

Some recommendations are made based on the findings of the study. These relate to the management of e-learning at the university, schools and implications for policy.

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CHAPTER ONE

INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 INTRODUCTION

This study focused on the integration of e-learning technologies by preservice science teachers during their teacher education modules while at university and during their teaching practice in schools. This chapter begins by presenting the study background, which is followed by motivation, problem statement and research questions. In addition, it presents the research aims and objectives, brief description of the methodology, the significance of the study and the limitation of the study. The chapter concludes with the structure of the thesis followed by a conclusion.

1.2 BACKGROUND TO THE STUDY

The rapid dispersion of educational technology in education system has increased the expectations of educators to integrate it for quality and innovative teaching and learning in schools (Sulaiman, 2017). Educational technology is considered as one of the most prominent developments produced by modern technology to enhance teaching and learning. Educational technology is defined as the use of technological developments, such as digital or electronic technologies and materials, as tools to support teaching and learning (Power, Gater, Grant & Winter, 2014), which has led to the emergence of information communication technology (ICT) for pervasive use in education system. ICT is one of the prominent tools used in educational technology that has increasingly become an integral part of the education system to enhance quality and innovative teaching and learning (Saxena, Tekanpur & Gwalior, 2017).

The integration of ICT into education system across the world has brought about a paradigm shift from closed systems of education to open and innovative systems. ICT such as e-learning, is expected to play a leading role in innovative delivery of education as a service. The teacher-centric teaching pedagogy where students are passive receivers of content is rapidly paving way for innovative models of student-centric teaching and learning – which enable students to actively engage in generating, storing, transferring and sharing knowledge, thereby taking full responsibility for their learning (Dollecton, 2011). In addition, students can rely on e-learning technologies to access quality educational services anywhere, on-demand and anytime. In South Africa, the government through the Department of Basic Education (DBE) has long recognized the practical benefits of integrating ICT into the curriculum as an innovative model of teaching and learning (Meyer & Gent, 2016). The use of ICT in education is widely understood to refer to the use of a diverse set of technological tools such as video, computer and network equipment, internet, Learning Management System (LMS) and Web 2.0 tools to deliver teaching and learning (Yapici & Hevedanli, 2012). E-learning is widely accepted as key for delivering active teaching and learning in the twenty-first century and is one of the amazing innovations in the evolution of education systems across the world. E-learning provides an innovative alternative to the conventional content-based teaching and learning. In *The Draft White Paper on e-Education* (DoE, 2003:18) it is stated that "development in e-learning creates access to learning opportunities, redress inequalities, improves the quality of learning and teaching, and delivers lifelong learning".

The ability of teachers to efficaciously integrate e-learning technologies into classroom instructions is widely acknowledged as the required skill to enhance teaching and learning (Ertmer & Ottenbreit-Leftwich, 2010). The effective integration of e-learning technologies into science teaching and learning could enable teachers to create a kind of technologically based virtual knowledge sharing community of practice to effectively stimulate learning. E-learning technologies are useful for the teaching of science subjects because they combine a variety of visual means such as video, scanned images, graphics, Mp3s and animations to effectively deliver instructions. These features of e-learning technologies can help to illustrate scientific and highly abstract concepts that are difficult to comprehend by students (Shulamit & Yossi, 2011). E-learning technologies can therefore provide students with several opportunities to enhance their scientific knowledge and skills. Furthermore, it offers the following intrinsic benefits, among others (Asiri, Mahmud, Bakar & Mohd Ayub, 2012; Kubiatko & Vlckova 2010; Inel & Balim, 2010; Mayisela, 2014).

a) It eliminates geographical boundaries for students to access quality education, anywhere, anytime without resource limitations.
b) It facilitates personalised learning for students with heterogeneous education backgrounds and diverse learning styles.
c) It saves mobility costs for anyone, including students, teachers and stakeholders willing to access quality education.
d) It accommodates multiple learning styles by providing personalized education to an individual.

e) It leverages limited teaching resources as well as scales information and knowledge through collaborative resource sharing.
f) It fosters in students the ability to develop higher-order cognitive thinking skills and enables them to engage in causal reasoning skills.
g) It improves educational outcomes as well as enhancing the quality of teaching and learning.
h) It motivates teachers and students, stimulates active learning in them and removes the limitations of time and space in instructional processes.
i) It contributes to the ability to flexibly learn and it provides a solid bridge between the teacher and the students in the classroom.

From this list of possible teaching and learning benefits it is clear that e-learning instructional approaches hold a lot of promise for both effectiveness and efficiencies in delivering instruction if correctly implemented.

1.3 MOTIVATION FOR THE STUDY

The realisation of the numerous intrinsic benefits of e-learning to education systems heavily depends on its effective integration by teachers, be it science teachers or not. First and foremost, the foundation must be laid at the preservice teachers' level. For instance, the participating South African univeristy has implemented a number of e-learning technologies ranging from internet technology to the actual utilisation of a Course Management System (CMS) called Moodle (Modular Object-Oriented Dynamic Learning Environment) to help the institution achieve its vision of promoting academic excellence and making quality education easily accessible to students. The participating South African University is located in a rural community of South Africa, as a result, e-learning technologies can help to offer quality education to their students who are predominantly from resource-constrained geographical zones of the country. An e-learning technology such as this one is designed to help teachers and students create an effective virtual learning community (Al-Ajlan, 2012). It also serves as a supplement to face-to-face teaching and is most useful in creating an active learning environment that enables different kinds of student-student engagements and student-teacher interactivity (Dollecton, 2011).

Extant studies on e-learning in the context of South Africa have generally indicated that most teachers are still not integrating e-learning technologies into the teaching of mathematics and science instruction (Howie, 2009; Mofokeng & Mji 2010; Makgato, 2012). In addition, it is generally held that learning performance of students in the sciences falls below expectation, largely as a result of the highly abstract nature of science subjects (Martin-Blas, 2009). Moreover, science as a subject, includes complex relationships of unfamiliar abstract objects and theoretical concepts that are difficult to learn and to teach. This intrinsic complexity of science causes many students to experience difficulty in understanding certain concepts and forces them to learn these concepts by memorisation without having a proper understanding of what they memorise (Cepni, Tas & Kose, 2004; Çimer, 2012). To coherently address this problem, e-learning technologies are crucial for concretising abstract concepts through visualisation in three dimensional models, pictures, animations, videos and sometimes in augmented reality (Yapici & Hevedanli, 2012). Several scholars have indicated the significant roles of preservice teachers in the integration of e-learning technologies in the classrooms (Chen, 2010; Wong, Osman, Goh & Rahmat, 2013). In addition, the way preservice teachers feel about integrating e-learning technologies significantly impact on whether they will actually integrate e-learning technologies into their teaching, or not, after training. Consequently, a greater knowledge of the factors that predict the integration of e-learning technologies and their interrelationships can provide a useful barometer to a better understanding of preservice teachers' integration of e-learning technologies into the curriculum (Teo, Su Luan & Sing, 2008; Chigona & Dagada, 2011). This rationale triggered the necessity to conduct this current research study to, in particular, investigate the integration of e-learning technologies into the teaching and learning of science subjects among preservice science teachers.

1.4 STATEMENT OF THE PROBLEM

Despite several untapped benefits of e-learning technologies, research continues to report that preservice teachers are not integrating e-learning technologies in the classroom during their practical field training (Al-Ruz & Kahsawneh, 2011; Ziphorah, 2014). In the context of South Africa, many researchers have investigated the adoption and integration of ICT by secondary school teachers for instructional purposes (Govender & Maistry, 2012; Chikasa, Ntuli, Sundarjee & Chikasa, 2014; Ziphorah, 2014). In addition, researchers have investigated how lecturers in higher education institutions integrate e-learning into their academic programmes (Mlitwa, 2010) and comparing traditional education methods with the use of e-learning has been carried out (Arowolo, 2009). However, what has remained largely uncovered is whether or not preservice teachers will integrate e-learning technologies into their teacher education modules while at university and during their teaching practice in schools. It is still unclear what factors will influence the preservice teachers to integrate or not to integrate e-learning technologies while at university and during their teaching practice in schools.

Although most preservice teachers may be more familiar with ICT in general, they may, or may not, be able to integrate newer e-learning technologies. The reason for not taking a decision to integrate e-learning technologies into their teaching may be related to factors that affect the preservice teachers to integrate, or not to integrate, e-learning technologies. The literature generally reveals the existence of three important gaps, namely, lack of ICT skills (Howie, 2009; Mofokeng & Mji, 2010), lack of unified models to explain or predict the integration of e-learning technologies (Alharbi, 2010; Teo, 2011), and intention-behaviour gap (Venkatesh, Morris, Davis & Davis, 2003; Bhattacherjee & Sanford, 2009) in e-learning integration by teachers, as discussed below.

1.4.1 Lack of ICT Skills

Information and Communications Technology (ICT) skills refer to the proficiency of a teacher to integrate a diverse set of technology tools, internet and e-learning technologies in the classrooms to foster effective teaching and learning (Yapici & Hevedanli, 2012). Teachers in many schools are not willing to integrate ICT to innovate teaching and learning because they lack sufficient competencies and ICT skills to effectively deliver their classroom instructions. Previous studies have revealed that teachers are generally not competent to integrate ICT to enhance teaching and learning of mathematics and science subjects (Howie, 2009; Mofokeng & Mji, 2010; Makgato, 2012). However, to some extent teachers can use basic computer applications such as word processors and spreadsheet software for administrative purposes, which include record keeping, typing of examination papers and processing of examination results. ICT integration into the curriculum goes beyond using computers as productivity enhancement tools or using computers in the laboratory or as word processors. ICT can be said to be integrated when it is seamlessly applied to support curriculum objectives and to actively engage students in dynamic learning that may occur anywhere, anytime (Dias, 1999). The Stratford Board of Education (2014) defines ICT integration as when classroom teachers are able to use ICT to introduce, reinforce, extend, enrich and assess the mastery of curricular targets to students. Teachers with poor ICT skills and competencies are likely to perceive ICT integration as a difficult exercise compared to those with comparatively good ICT skills (Howei & Blignaut, 2009). Moreover, many of the existing ICT skill interventions for teachers only provide the basic ICT skills, which may not be sufficient to prepare them for the real ICT curriculum integration (Ndlovu & Lawrence, 2012).

1.4.2 Lack of Unified Integration Models

Many studies on ICT integration have examined diverse factors that were previously identified as influencing the propensity of teachers to integrate ICT with their teaching. These factors include attitudes toward computers (Teo, 2008; Yapici & Hevedanli, 2012), skill (Agyei & Voogt, 2011; Allayar, 2011), satisfaction with e-learning (Lee, 2010; Ramayah & Lee, 2012), flow experience (Liao, 2006; Lee, 2010), and intention (Teo, *et al.*, 2008; Teo & Lee, 2010; Teo, & Tan, 2012; Lee, Cerreto & Lee, 2010; Phua, Wong & Abu, 2012; Zhou, Chan, & Teo, 2016). Moreover, one of these studies developed a comprehensive structural model that statistically explains or predicts the relationships among some of these factors and how they influence teachers to use or integrate ICT. Some of these factors have been extensively discussed by previous researchers in the literature. However, they have hitherto not been coherently integrated into a unified structural model for predicting or explaining ICT integration. The underdevelopment in this area necessitates the need to develop and validate a unified structural model of factors predicting the integration of e-learning technologies by preservice science teachers for teaching and learning of science subjects. This research hopes to develop such a unified framework, including the identifying important factors subject to examination and validation for predicting or explaining the integration of e-learning technologies.

1.4.3 The Intention-Behaviour Gap

Extant theories on ICT usage, such as the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB) postulate that users' behavioural intention is the primary predictor of their actual usage behaviour. In contrast, there is a growing body of empirical evidence that behavioural intentions may not reliably lead to changes in usage behaviour (Davis, Bagozzi & Warshaw, 1989; Sheeran, 2002; Taylor & Todd, 1995; Venkatesh *et al.*, 2003; Bhattacherjee & Sanford, 2009). These authors point out that intention may not always influence usage of technology as expected or may do so in an inconsistent manner because of the predictive power of intention that accounts for one third of the variance in usage behaviour. This lack of consistency between users' intention and usage behaviour is called 'the intention-behaviour gap' (Amireault, Godin, Vohl & Pérusse, 2008; Bhattacherjee & Sanford, 2009). This gap is mainly caused by people who express a positive intention to use a particular ICT, but do not translate the intention into actual usage behaviours. Given the low-to-medium effect size of behavioural intention to use ICT on the actual ICT usage behaviour, there is an obvious need to go beyond extant theories of ICT usage and explore the potential influencing factors to improve such low effect size.

The main cause of the intention-behaviour gap may lie in the explanation of 'social desirability' effect. This is a situation where ICT users report favourable intentions because they do not wish to portray themselves as being in disagreement with the people championing the new system or conducting the study. However, their intentions may not be followed by real action or actual behaviour, if they are truly opposed to or are uncertain about ICT usage (Bhattacherjee & Sanford, 2009). On the other hand, the lack of consistency in the relationship between behavioural intention and integration behaviour could also be ascribed to a third variable influencing the direction and the strength of the intention-behaviour relationship. That is, the intention-behaviour relationship might vary according to different levels of a third variable, known as a moderator (Amireault, *et al.*, 2008). In light of the above mentioned reasons for the cause of the intention-behaviour gap, there is a need to design an intervention plan to help understand the gap by investigating the moderators of this relationship, which can help to bridge this gap or at least mitigate its potential effects in this study. The moderators examined in this study to moderate the relationship between intention and integration are quality consciousness and innovation consciousness. Quality consciousness refers to the awareness of the value of integrating e-learning technologies for teaching and learning, while innovation consciousness refers to the awareness of integrating e-learning technologies for creative teaching and learning. Accordingly, the research questions to be investigated in this study are enunciated in the subsequent subsection.

1.5 RESEARCH QUESTIONS

This study attempted to find answers to the following research questions:

1.5.1 What are preservice science teachers' perceptions of the educational benefits of integrating e-learning technologies in the teaching and learning of science subjects?

1.5.2 What factors best predict or explain preservice science teachers' integration of e-learning technologies in the teaching and learning of science subjects?

1.5.3 How can quality and innovation consciousness moderate the relationship between intention to integrate and the actual integration of e-learning technologies in the teaching and learning of science subjects by preservice science teachers?

1.5.4 What are the preservice science teachers' experiences with regard to integrating e-learning technologies in the teaching and learning of science subjects during teaching practice?

1.6 RESEARCH AIMS AND OBJECTIVES

The prime aim of this research study was to combine the factors that contribute to ICT integration that have been identified in the literature and to coherently unify them under a single conceptual framework. There are copious studies identifying factors relating to ICT usage or ICT integration and many structural models have been built to explain or predict factors influencing ICT integration or ICT usage in diverse application domains (e-commerce, e-banking, e-business, e-healthcare, e-government, e-learning and so on). However, the different research streams are segregated and those predicting factors identified have not been coherently unified into an overall scheme. Another aim was to investigate the perception of preservice science teachers about integrating e-learning technology in the classrooms. The final aim of this study was to assess preservice science teachers' reflections and feedback on their experience with integrating e-learning technologies during teaching practice. The specific objectives being delineated to help accomplish the aims of this research study were the following:

1.6.1 To explore the perceptions of preservice science teachers about the educational benefits of integrating e-learning technologies in the teaching and learning of science subjects.

1.6.2 To identify the factors that could best predict or explain preservice science teachers' integration of e-learning technologies in the teaching and learning of science subjects.

1.6.3 To investigate the moderating effects of quality and innovation consciousness on the relationship between intention to integrate and the actual integration of e-learning technologies in the teaching and learning of science subjects by preservice science teachers.

1.6.4 To determine the extent to which preservice science teachers are able to integrate e-learning technologies in the teaching and learning of science subjects during teaching practice.

1.7 RESEARCH MODEL AND HYPOTHESES

Research questions 1 and 4 were addressed using frequencies, percentages, descriptive statistics and hermeneutic content analysis. Research question 3 was addressed using partial least squares (PLS) structural equation modelling (SEM). However, in order to address the research question 2, some prominent factors predicting e-learning technology integration in the literature was selected to develop a new model to be known as the E-Learning Technology Integration Model (ELIM). The Warp Partial Least Squares (PLS) 4.0 which is a component-based structural equation modelling was used to identify factors that best predict or explain preservice science teachers' integration of e-learning technologies. From the preliminary literature review, and analysis of the theories upon which this study was based, the following *six apriori* hypotheses were formulated for statistical testing. These are based on the relationships amongst the factors in the proposed conceptual framework. These hypotheses were formulated to identify the factors that best predict preservice science teachers' integration of e-learning technologies in the teaching and learning of science subjects, so as to answer Research Question Two of this study.

1.7.1 Intention will be a significant predictor for integrating e-learning technologies by preservice science teachers.

1.7.2 Satisfaction will be a significant predictor for integrating e-learning technologies by preservice science teachers.

1.7.3 Flow experience will be a significant predictor for integrating e-learning technologies by preservice science teachers.

1.7.4 Skill will be a significant predictor for integrating e-learning technologies by preservice science teachers.

1.7.5 Attitude will be a significant predictor for integrating e-learning technologies by preservice science teachers.

1.7.6 There will be a significant interaction effect among attitude, skill, satisfaction, flow experience and intention on the integration of e-learning technologies by preservice science teachers.

1.8 METHOD OF STUDY

The methods of investigation followed in this study are described below.

1.8.1 Research Paradigm

The methodology of the study was empirical, utilising a blend of mixed-methods research paradigm to understand the factors predicting preservice teachers' integration of e-learning technologies in their science lessons classrooms. The added value of integrating paradigms has been well documented in the literature, to enhance the overall research design and neutralized the weaknesses of either paradigm (Creswell 2014: 52).

1.8.2 Design

By design this was a descriptive, confirmatory and cross-sectional study. The cross sectional research design was appropriate as the study investigated factors that predicted integration of e-learning technologies at a specific point in time. *Cross-sectional* was also necessary for this study as it enabled the researcher to sort out the existence and magnitude of causal relationships of one or more independent variables upon a dependent variable (William, 2006).

1.8.3 Data Collection Instrumentation

In this study, quantitative data collection was followed by a qualitative phase to provide a deeper comprehension of the factors that predict preservice science teachers' integration of e-learning technologies in the teaching and learning of science subjects. The survey data collection instrument consisted of four essential sections (ai) demographic items, (aii) the amount of time preservice science teachers spent on using e-learning technologies, and (b) preservice science teachers perceived educational benefits of e-learning technologies, (c) the ELIM scale and MOD scale (d) preservice science teachers' reflections and feedback from the teaching practice.

The first section of the survey included response-type items to determine the general demographic information of the participants (gender, year in school, age, etc.) and to verify the amount of time that the participants spent on using e-learning technologies for studying and learning sciences. The second section of the survey included some open-ended questions to solicit information and honest views of preservice science teachers regarding their perceptions of education benefits of integrating e-learning technologies in a science classroom. This approach is effective when a researcher is trying to gain deep information and digging into a rich description of phenomena under examination (Creswell, 2009).

The third section of the survey included self-reported items focusing on the ELIM scale with responses on a 5-point Likert-scale (strongly agree to strongly disagree) and MOD scale with responses on a 3-point Likert scale (yes, somewhat, no). The instrument was developed based on the literature review and previous research (Sadaf, Newby & Ertmer, 2012; Sadaf, 2013; Lee, 2010; Liao, 2006) with modifications to fit the specific context of e-learning technology integration. The self-report measure is often judged in the literature as the most cost-effective and valid means of collecting personal information about people (Baker & Branton, 1990; Glasgow, Ory, Klesges, Cifuentes, Fernald & Green, 2005). The fourth section comprised of open-ended questions to inquire the preservice science teachers' experience with integrating e-learning technologies during teaching practice. This allowed the preservice science teachers to reflect on their experiences with integrating e-learning technologies into the teaching of science subjects during the teaching practice.

1.8.4 Target Population and Research Sample

The target population of this study was the entire preservice science teachers who enrolled in a Bachelor of Science Education programme in the Faculty of Education, Kwazulu-Natal province Universities, South Africa. A convenience purposive sampling method was used to draw approximately 100 samples from the fourth year preservice science teachers. Moreover, since Warp PLS 4.0 structural equation modelling (SEM) was employed to analysed data in this study. It is recommended that a sample size of 30-100 participants should be used in order to obtain reliable results (Chin, 1998b; Henseler, Ringle & Zinkovics, 2009). Thus, based on this recommendation, the sample size used for this study was considered adequate.

1.8.5 Data Reliability and Validity

This study used confirmatory factor analysis (CFA) to test whether the measurement instrument possessed the widely accepted criteria of reliability and validity. The reliability of data is the extent to which a given instrument consistently gives the same results upon repeated applications (Imenda & Muyangwa, 2006:113). The reliability of the survey instrument was measured using composite reliability to determine the level of internal consistency of the questions in the instrument. The validity of a data instrument explains whether a measuring instrument measures what it was constructed to measure (Raykov, 2011). The validity was measured by the degree of convergent validity and discriminant validity using the procedure outlined by Bagozzi & Yi (1998). Convergent validity (CV) shows the extent to which multiple items of a specific factor converge to represent the same factor. Discriminant validity (DV) indicates the extent to which a given factor and its items differ from another factor and its items (Suki, 2011); both CV and DV were assessed by CFA.

1.8.6 Data Analysis

The data collected through the survey were analysed using Warp PLS 4.0, a component-based SEM. SEM is a statistical approach to examine the relationship between an exogenous (independent) and endogenous (dependent) variable (Hoyle, 1995). An advantage of using SEM in a research is that it allows factors to act as both independent and dependent variables in the model, irrespective of their numbers (Teo, 2011). This suggests that the factors in the research model may interact directly or indirectly with each other to predict preservice science teachers' integration of e-learning technologies in the teaching and learning of science subjects. Next, the technique of partial least squares (PLS) 4.0 was applied to test the hypotheses formulated by examining the path coefficients and the significance at the 0.05 level of significance. Since this study used mixed methods research paradigm, qualitative data (open-ended survey) were analysed using hermeneutic content analysis, wherein individual responses were encoded, rearranged into different categories, systematized, interpreted with understanding and reflection. The themes and categories that provided an explanation related to the factors predicting the integration of e-learning technologies were identified.

1.9 SIGNIFICANCE OF THE STUDY

The researcher envisaged that the findings of this study would contribute significantly to the body of knowledge, in the field of science education, in the following three distinctive ways:

a) Based on a comprehensive literature review of extant ICT acceptance and usage studies, the literature search uncovered that the set of factors predicting the integration of e-learning technologies in the classrooms varied across studies. In fact, many different sets of factors by diverse authors have been considered as influencing and predicting the acceptance and integration of ICT into teaching and learning in schools. For example, attitude, satisfaction with e-learning, flow experience and intention represent some examples of factors that have been utilized separately to predict ICT integration success. The study at hand combined all these factors and systematically unified them under a single framework to uncover a set of salient factors that would best predict preservice science teachers' integration of e-learning technologies in the classroom. However, to the best of the researcher's knowledge, the combination of these factors is seldom used to frame research studies in e-learning. This study provided a new lens by integrating these factors to create a robust and a parsimonious hybrid model in explaining the integration of e-learning technologies.

b) By investigating innovation and quality consciousness as moderators to strengthen the relationships amongst intention and e-learning technology integration, this study added value to the small number of studies examining moderators of the intention-behaviour gap relationship. It was, therefore envisaged that the findings of this study would hopefully bridge the existing lingering gap between intention and behaviour in information technology research and educational technology research.

c) In addition, it was the researcher's belief that the practical contribution of this study would be that the factors that would predict preservice teachers' integration of e-learning technologies into the teaching and learning of science subjects would constitute the most prominent issues that information and educational technology practitioners and academics could utilize when determining the success of integrating e-learning technologies in schools. Second, the researcher believed that it was important for the University to have the understanding of factors that predict preservice teachers to use or integrate e-learning technologies before investing in the development of e-learning technologies, as this would also be used as a guideline to devise more appropriate e-learning strategies and policies. If preservice teachers fail to accept and use e-learning technologies for teaching and learning, then the opportunity to use e-learning technologies to improve or innovate the standard of teaching and learning in schools would not be realized. Finally, governments, non-government organisations (NGOs), e-learning facilitators and policy makers would hopefully use the findings of this research to design and implement better e-learning strategies and policies in schools, and provide a test-bed to help them formulate policies governing ICT programmes that target teachers and other curriculum designers.

1.10 LIMITATION OF THE STUDY

The study was limited to the preservice science teachers at the participating South African University and may not represent the entire population of preservice science teachers in all South African Universities. Therefore, the generalizability of the findings of this study is limited to the participating South African University and not to preservice science teachers in all South African Universities. Nonetheless, the results of the study may be applied to related educational settings.

1.11 DEFINITION OF TERMS

For the purpose of this study, the following terms are understood as defined below:

1.11.1 Information and Communication Technology (ICT)

Information and Communications Technology (ICT) is a diverse set of technological tools (radio, television, video, DVD, phone (fixed and mobile), satellite systems, e-learning technologies, computer and network equipment, Internet, Web 2.0 tools, etc.) and resources used to communicate, create, disseminate, store, access and manage information (Yapici & Hevedanli, 2012).

1.11.2 E-Learning

E-learning has a wide variety of definitions in the literature and the conceptual differences in the notions of what e-learning is making it difficult to come up with a generic definition of e-learning. Sife, Lwoga & Sanga (2007) define e-learning as the use of ICTs to enhance and support teaching and learning processes. Martin-Blas (2009) define e-learning as a type of technology-supported learning (TSL) where the medium of instruction is through ICT. Wan, Wand & Haggerty (2008) define it in a more detailed way as a virtual learning environment in which students interact with the learning materials, peers and/or teachers through the use of ICTs. According to Shih, Feng & Tsai (2007: 955) the term e-Learning still lacks a clear definition, and "some related terms that share similar characteristics with e-learning include distributed learning, online learning, web-based learning, distance learning, network learning and technology-based learning." This list of terms ascribed to e-learning is also supported by Gremu (2012). To Wentling, Waight, Gallaher, La Fleur, Wang & Kanfer (2000, in Shih, *et al.,* 2007: 955), "e-learning is the acquisition and use of knowledge distributed and facilitated primarily by electronic means." The ultimate common feature in all these definitions of e-learning is the use of ICTs in teaching delivery, learning and interaction. E-learning functionally incorporates a wide spectrum of learning strategies, pedagogies and ICT applications for exchanging information and gaining knowledge. Such ICT applications include television and radio, Compact Discs (CDs) and Digital Versatile Discs (DVDs), video conferencing, mobile phones, web-based applications and e-learning platforms (Sife, *et al.,* 2007). This notion of a wider application of ICT to enhance teaching and learning was the perspective adopted for this study.

1.11.3 E-Learning Platforms

E-learning platforms are software packages that are designed to deliver online modules or to supplement face-to-face traditional teaching which allows interaction with students in order to enable them contribute to their own educational process (Martin-Blas, 2009). E-learning platforms are otherwise known as a Virtual Learning Environment (VLE) (Al-Ajlan, 2012), Course Management System (CMS) (Seluakumaran, Jusof, Ismail & Husain, 2011), and Learning Management System (LMS) (Asiri, *et al.,* 2012). There are many e-learning platforms available to support teaching, learning and assessment process. Some of them are commercial software such as Blackboard, WebCT and TopClasse, whereas others are free and open source software (FOSS) such as Moodle, Sakai, Ilias, Atutor and Claroline.

1.11.4 E-Learning Technology Integration

The integration of e-learning technologies refers to the use of a diverse set of technological tools such as video, computer and network equipment, internet, LMS, Web 2.0 tools as a supplement to the face-to-face method of teaching to enhance the quality of teaching and learning (Seluakumaran, *et al.,* 2011;Yapici & Hevedanli, 2012). In this study, e-learning technology integration is the innovative way of using technological tools as a supplement the face-to-face method of teaching and learning of science subjects by preservice science teachers.

1.11.5 Skill

Skill has been defined as the ability of an individual to perform a specific task (Agyei & Voogt, 2011). Computer skill is defined as the ability or skill of a teacher to handle a wide range of varying ICT applications for various tasks (Tondeur, Valcke & Van Braak, 2008). In the context of this study, skill is the ability or skill of preservice teachers to integrate e-learning technologies into the teaching and learning of science in the classrooms to foster effective teaching and learning.

1.11.6 Attitude

Attitude is a set of feelings and tendencies that influence the decision of a person towards other peoples, ideas or objects (Schafe & Tait, 1986). Ajzen & Fishbein (2005) refer to attitude as the way an individual responds to something, it is disposed towards an object and it guides behaviour. Feelings and tendencies can be positive or negative and can be formed in relation to objects or people. In this study, attitude is defined as the degree to which preservice teachers possess positive feelings about integrating e-learning technologies into the teaching of science in the classrooms.

1.11.7 Satisfaction

Satisfaction is defined as the degree to which one believes that an experience evokes positive feelings (Rust & Oliver, 1994). User satisfaction is often regarded as the feeling of an individual pleasure or disappointment resulting from comparing the performance of a product or an outcome in relation to one's expectations (Ramayah & Lee 2012). Joo, Joung & Kim (2013) refer to satisfaction as the degree to which users felt satisfied with their e-learning experience and environment as a whole.

1.11.8 Flow Experience

Flow refers to the holistic sensations that people feel when they act with total involvement (Csikszentmihalyi, 1997). People experience flow when they are completely engrossed in an activity to the point of losing sense of time and unable to recognize changes in their immediate environments. Particularly, they can be very disconcerting to other people in the degree to which they can concentrate only on their ongoing activity. Flow experience is an intrinsic motivation that can stimulate users to do an activity with inner joy (Lee, 2010). For the purpose of this study, the Csikszentmihalyi's definition will be adopted.

1.11.9 Intentions

Intentions are exact people's decisions to behave in a certain way, and they guide a person's motivation to perform behaviour in terms of direction and intensity (Sheeran, 2002). The intention is considered by Tarhini, Hone & Liu (2013) to be an immediate antecedent of usage behaviour and it gives an indication about an individual's readiness to perform a specific behaviour. In this study, the behavioural intention refers to the degree of preservice science teachers' willingness to integrate e-learning technologies into the teaching and learning of science in the classrooms.

1.12 STRUCTURE OF THE THESIS

The chapters of this study are succinctly organized as follows:

Chapter One: *Introduction*

Chapter one provides the background to the study, motivation of the study; a statement of the problem; research questions, research aim and objectives, contribution of the study, limitations of the study; methodology and finally the definition of terms.

Chapter Two: *Theoretical Framework and Review of Relevant Literature*

The literature reviews focused on four important themes such as e-learning context and an overview of classification of e-learning, e-learning in South Africa, e-learning platforms, and various research on e-learning technology integration. The theoretical framework was based on the assumptions of four models such as Will, Skill, Tool (WST), Theory of Planned Behaviour (TBP), Expectation-Confirmatory Theory (ECT), and flow theory (FT). These models guided the development of the proposed conceptual framework in this study. The chapter concludes with a summary of the chapter.

Chapter Three: *Research Methodology*

This chapter discusses the research methodology, research designs, target population and research sample, research instruments and data collection procedures, method of data analysis procedure and ethical considerations.

Chapter Four: *Data Presentation and Results*

This chapter presents the data analysis and the results obtained from this study using tables, percentages, frequencies and explanations. The chapter also answers the research questions and hypotheses formulated in this study.

Chapter Five: *Discussion of Findings*

This chapter provides a detailed discussion of the research findings presented in chapter four.

Chapter Six: *Summary, Conclusions and Recommendations*

This chapter presents the summary of the study, conclusion and recommendations that emanate from this study and also provide suggestions for future research.

1.13 CONCLUSION

The successful integration of e-learning to improve or innovate the standard of teaching and learning are becoming increasingly prominent in the educational sector across the world. Research continues to report that preservice teachers who are expected to drive ICT innovations such as e-learning technologies and e-learning platforms to transform the education system are not utilizing ICT during their field training. This challenge can be addressed by a better understanding of the factors that predict the integration of e-learning technologies in teaching and learning, as this factor can provide a useful barometer to successful integration of e-learning technologies into the curriculum. The study aimed to combine all these factors and systematically unify them under a single framework to uncover a set of salient factors that would best predict preservice science teachers' integration of e-learning technologies in the classroom. The results of this study would hopefully benefit decision making when designing and implementing ICT strategies in schools as well as when formulating comprehensive policies governing ICT programme implementation that targets teachers and curriculum designers.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter provides a comprehensive overview of the empirical literature works that are of immediate relevance to this current study, so as to realize the aim and objectives of this study. The empirical literature consists of similar studies that lay the foundation for the integration of e-learning technologies by preservice science teachers. This chapter also includes the theoretical framework and the conceptual framework designed for this study.

The chapter is succinctly organized into eight core sections. Following this introduction, Section 2.2 discusses the various definitions of e-learning and provides an overview of classification of e-learning. Section 2.3 focuses on e-learning in South Africa as a country. Section 2.4 presents the background information pertaining to e-learning platforms and discusses the most popular and active e-learning platforms used in the academic environments and their features. Section 2.5 reviews literature around the Research Questions and discusses various research on e-learning technology integration. Section 2.5.1 reviews literature around Research Question One and discusses the perceived educational benefits of e-learning technologies. Section 2.5.2 reviews literature around Research Question Two and discusses various predictors of the integration of e-learning technologies. Section 2.5.3 reviews literature around Research Question Three and presents the limitation of current research on the relationship between *intention* and *e-learning integration*. This aspect of the study is important in an effort to fill the gap between *intention to integrate* e-learning technologies and the *actual integration* of e-learning technologies because previous authors have pointed out that intention may not always influence usage or integration. In the context of educational system, it is not always the case that having the intention to integrate a particular technology implies the technology will be actually integrated into the classroom configuration. There are many factors that may inhibit or enhance the actual integration of technology. Consequently, the goal of this section is to posit whether innovation and quality consciousness as new moderators in this study would play important roles in moderating the gap between intention to integrate e-learning technologies and the actual integration of e-learning technologies. Finally, Section 2.5.4 reviews literature around Research Question Four and discusses in depth preservice teachers' preparation for integrating e-learning technologies and their experiences with regard to integrating e-learning technologies during teaching practice.

In order to provide an appropriate theoretical framework for this study, Section 2.6 presents and discusses some of the existing technology integration theories and models that guided the development of the proposed conceptual framework in this study. Section 2.7 describes the building of the proposed conceptual research framework based on the existing factors and models. Section 2.8 concludes this chapter with a summary of the literature reviewed.

2.2 E-LEARNING OVERVIEW

Driven by the increasing pervasiveness of the internet technology around the world, e-learning has become an integral part of learning activities in most learning situations (Ndlovu & Mostert, 2014). This rapid advancement of internet has led to the use of e-learning in the educational system to enhance the teachers and students in their teaching, learning and assessment processes. E-Learning has become a core element in the educational process to transform the traditional learning environments and to create more effective and attractive learning experiences. E-Learning assembles new educational contexts, creates innovative ways for teachers to carry out daily academic activities, provides more options for students to manage their learning styles as well as creates learning environments that promote and enhance the learning experience (Browne, 2014;Taha, 2014).

The proponents of e-learning integration in education have asserted that the occupation of tomorrow will require 21st century skills, such as problem solving, critical thinking, information literacy skill and collaboration (Marković, 2009). In line with this assertion, successful institutions across the world are redefining and improving their educational systems and learning objectives (Marković, 2009). This is to serve the needs of the 21st century students so that they are able to meet the complex demands of the new knowledge society in a globalized form. Previous authors have reported that e-learning provides new and creative ways of motivating, engaging, inspiring and enabling students to attain their educational potential; that it allows students to have control over the content, enabling them to tailor their experiences to meet their personal learning objectives; and support learning by providing differentiated learning (Olojo, Adewumi & Ajisola, 2012). In addition, e-learning improves educational reform by creating a paradigm shift from teacher-centred and retention-based education to a student-centred education where students work collaboratively, construct their own knowledge, and enhance their problem solving and higher-order thinking skills (Lee, Yoon & Lee, 2009; Taha, 2014).

2.2.1 Definition of E-Learning

E-learning was first coined by Cross in 1998 (Cross, 2004). However, some related terms that share similar characteristics with e-learning, include distributed learning (DL), online learning (OL), web-based learning (WBL), distance learning (DL), remote learning (RL), network learning (NL) and technology-based learning (TBL) (Shih, Feng & Tsai, 2007: 955; Gremu, 2012).

Many scholars from the fields of computer science, information communication technology (ICT), education and educational technology have contributed to the definition of e-learning. Sife, Lwoga & Sanga (2007) define e-learning as the use of ICTs to enhance and support teaching and learning processes. Functionally, e-learning functionally incorporates a wide spectrum of learning strategies, pedagogies and ICT applications for exchanging information and gaining knowledge. Such ICT applications include television and radio, Compact Discs (CDs), Digital Versatile Discs (DVDs), video conferencing, mobile phones, web-based applications and e-learning platforms (Sife, *et al.*, 2007). Martin-Blas (2009) defines e-learning as a type of technology-supported learning (TSL) where the medium of instruction is through ICT. Wan, Wang & Haggerty (2008) define it in a more detailed way as a virtual learning environment in which students interact with the learning materials, peers and/or teachers through the use of ICTs. To Wentling, Waight, Gallaher, La Fleur, Wang & Kanfer (2000, in Shih, *et al.*, 2007:955), "e-learning is the acquisition and use of knowledge distributed primarily by electronic means."

In addition, Taha (2014) defines e-learning as educational and learning instructions supported by the use of ICT tools and applications, which allow students to acquire new knowledge and skills, and support teaching and learning processes, deliver content and enhance interactive learning among students and teachers. The ultimate common features in all of these definitions of e-learning is the use of ICTs in teaching delivery, learning and interaction. This implies that a teacher uses some form of e-learning technology to access teaching and learning materials, interact with students and other teachers, and provides some form of support to students (Oye, Salleh, & Iahad, 2012).

Thus, it is quite evident that e-learning has a wide variety of definitions in the literature, and the conceptual differences in the notion of what e-learning is making it difficult to come up with a generic definition, thus, the term e-learning still lacks a clear universal definition (Shih, Feng & Tsai, 2007). However, in the context of this study, therefore, e-learning can be defined as the use of electronic tools to improve teaching, learning and assessment. The core concept of this definition is that the use of ICT must be seen to generate impacts and serve as an inspirational platform for teaching, learning and assessment, which are all important learning activities. At the participating South African University inspirational teaching normally occurs within a blended learning environment, where traditional face-to-face teaching, learning and assessment is combined with e-learning resources as a strategic priority to enable the pedagogical shift from teacher-centred to learner-centred learning. E-learning technologies in this study can include office ICT, internet, intranet, portable presentation tools for lectures, wireless network services, Learning Management System (LMS), library e-resources, email, smart phones, computer laboratories, research databases, PowerPoint slides, interactive whiteboards and institutional repository to improve teaching, learning and assessment.

2.2.2 Classification of E-Learning

Negash & Wilcox (2008) break e-learning down into the following six broad classes which are face-to-face, self-paced learning, asynchronous, synchronous, blended asynchronous and blended synchronous.

2.2.2.1 Face-to-Face

This is considered to be traditional face-to-face classroom configuration. This type of e-learning uses ICT tools such as Video clips, PowerPoint slides, Whiteboards, TV flat screens and multimedia frequently to deliver content and support instruction in the classroom. Both teacher and student are physically present in the classroom at the times of content delivery. Communication between students and teacher takes place in the classroom, teacher's office or phone calls (Negash & Wilcox, 2008). However, many face-to-face classrooms also take advantage of using e-learning technologies outside the classroom. For example, when there is interaction between the teacher and students or between students through e-mail, assignments, discussion bulletin boards, or other electronic means.

The traditional face-to-face method enables teachers to supervise the whole teaching activity, imparting systemic knowledge to students for the development of their intelligence quotient (IQ) (Liu & Long, 2014). It also helps the teachers to communicate a large amount of information to many students face to face in a large classroom to stimulate students' interest in the subject (Imenda, 2010:4). Teachers control the whole class events by exposing the students to unpublished materials and also encourage and assist students effectively and promptly when they encounter difficulties (Liu & Long, 2014).

However, the traditional method places a lot of importance on standards, curriculum and passing tests and examinations, and not on student learning. The traditional method is based on repetition and memorization of facts without a comprehensive understanding of the concept taught in the classroom, and students are unable to produce anything fruitful, except general answers to examination questions (Gupta, 2012). The traditional instruction also lacks interaction and communication between students and their classmates because the emphasis is on individual student work and projects which does not allow students to work together in teams and collaborate with their colleagues. Additionally, it places emphasis on the role of teachers as knowledge distributors and students as repositories where students are passive in the class and teachers cannot take care of every student in class who has different learning styles and interests. This approach often leaves student less attentive, less engaged and minimizes feedback from students (Imenda, 2010:4).

2.2.2.2 Self-Paced Learning

The self-learning approach takes place when students receive content through media and learn on their own. There is no physical or virtual presence of a teacher, neither is there any electronic communication between the students and the teacher (Negash & Wilcox, 2008). The student usually receives a pre-recorded module content through media such as CD-ROMs or DVDs, and communication between students and teacher is limited to support or other non-content matters like replacing damaged media or receiving supplemental material.

Self-paced learning provides an opportunity for students to develop skills for self-directed learning. It allows students to work at their own pace and in their spare time, thus, enabling them to revise the content as many times as they need to, until they understand (Wodlab, 2014). Self-paced learning encourages students to assume greater responsibility for their own learning because they are not dependent on the structure and pace established by the teacher. This makes them to be active and subsequently increases their motivation to learn (Dargham, Saeed & Mcheik, 2012; Soyemi, Ogunyinka & Soyemi, 2011).

Conversely, not every student has the necessary skills, self-awareness and motivation to learn independently. Some students may feel uncomfortable learning on their own (Magill, 2008). Lack of face to face interaction with peers and teachers can make such students feel isolated, resulting in high dropout rates from school (Magill, 2008). Too much flexibility can lead to procrastination and failure of students to complete assignments on time, which may make the learning process ineffective (Soyemi, *et al.,* 2011).

2.2.2.3 Asynchronous

In this mode of delivery, teachers and students do not meet during content delivery and there is no physical or virtual presence of the teacher. The teacher pre-records and uploads the learning content and students download and access the instructional materials at the time of their convenience. That is, content delivery and content access happen independently (Negash & Wilcox, 2008). However, there is rich e-learning among the teachers and the students about the educational process taking place at different times, irrespective of their geographical locations. The teacher and student communicate and interact frequently using a number of e-learning technologies, such as online learning, discussion forums, email, bulletin boards, smart phones, assignments and lecture notes posted by the teacher for online access. The learning resources used in asynchronous learning may include graphic, audio, video, text, animation or a combination of some or all of these features in order to make learning more exciting and easier for students (Gremu, 2012).

The utmost benefit of asynchronous e-learning is the flexibility it offers to students in terms of study time, location and availability of space. It gives students the liberty to download the module and its instructional materials, read and send messages to their teachers and classmates at their own convenient time. Students from other geographical zones can also participate in the same module and download the instructional materials at any time (Gremu, 2012). It accommodates different learning styles which allow students to learn through a variety of activities that apply to their different learning styles (Wodlab, 2014).

All discussions, materials, correspondence, and interactions in this environment are recorded and archived, thus, students who are lagging behind in the module can access the module materials, presentations and correspondence at any time, thus making it easier for them to catch up with their classmates (Gremu, 2012). Students in asynchronous e-learning environment have more control over the learning process such as times, the pace and the order in which they conduct their studies. The lack of pressure to complete a module enables students to understand the concepts better, leading to a faster learning effect. Students can also skip the module they already know and focus on what they need to learn, thus enabling them to finish a module at a faster pace (Cantoni, Cellario & Porta, 2004).

However, asynchronous e-learning environments avail a high degree of control for students. Students are challenged when managing the high degree of control they have over their studies in the absence of a teacher's direction and structure at the time they are accessing the instruction. Therefore, some students may struggle to complete the module for not finding solutions to the concept that is not clear leading to lower success rate (Negash & Wilcox, 2008). Students in asynchronous e-learning environments may feel isolated from the teacher because they access instruction material independent of the teacher and classmates. The absence of real-time interaction with the teachers did not allow students to ask questions and receive an instant response to their questions and this may delay the learning progress of the students (Wodlab, 2014). Students who participate in asynchronous e-learning environments find it difficult to manage their time to access instruction, primarily because there is no fixed-time to access instruction due to the flexibility they have in their studies (Negash & Wilcox, 2008).

2.2.2.4 Synchronous

This type of e-learning is also referred to as "real-time" delivery mode. In this format the teacher and students do not meet physically, however, they always meet virtually at the same time during content delivery (Negash & Wilcox, 2008). Synchronous e-learning environment allows the teachers and students to effectively interact and participate in the educational process concurrently without location constraint (Sife, *et al.*, 2007). Teachers and students communicate virtually by e-learning technologies such as online chats, instant messaging, internet web sites, audio or videoconferencing, teleconferencing, or even two-way live broadcasts to students in a classroom (Gremu, 2012).

Real time interactions in a synchronous e-learning environment offers students immediate feedback to their questions from teachers and other students which make learning easier for them. It also allows teachers to immediately recognize the difficulties students are facing in understanding the module materials. This rapid feedback enhances knowledge retention, allows students to be active in the learning process and to learn from their mistakes (Pappas, 2015). In addition, synchronous e-learning environment enhances learning by increasing the student motivational levels, encouraging participation from all students, including the most reserved ones. Synchronous e-learning environment eliminates the isolation experienced by students in an asynchronous environment due to limited or no interaction with other students and teachers (Elluminate, 2009; Pappas, 2015). Synchronous e-learning fosters a sense of community because students have the ability to communicate with their teachers and with other students, to discuss, exchange ideas and raise questions about the module materials irrespective of their geographical locations (Pappas, 2015).

However, synchronous e-learning is strictly based on technology. Both teachers and students need to have a certain amount of computer technical skill in order to conduct or participate in a synchronous e-learning environment. Lack of technical knowledge, poor computer skills, and inability to handle various technologies involved in synchronous learning may tremendously frustrate and discourage online students, so high dropout rates might be expected (Pappas, 2015). Furthermore, synchronous e-learning require a good bandwidth. An attempt to synchronize several different areas through technologies can be challenging, as bandwidth limitations can weaken the quality of video and audio multimedia content, causing unnecessary delays which could in turn affect students' understanding of module materials (Gremu, 2012; Pappas, 2015). When classes are being conducted online in real time, the interruption may occur due to system malfunctioning and system connectivity errors, such as video frames freezing, and audio breaking up and becoming distorted. This can distract students' attention from participating fully in the online session (Negash & Wilcox, 2008). There can also be scheduling conflicts if students and teachers live in different time zones which can create communication barriers between the students and teachers. To ensure full participation both teachers and students need to plan their online meetings because different time zones can lead to very limited time frames (Pappas, 2015).

2.2.2.5 Blended Asynchronous

This is a combination of face-to-face classroom and asynchronous e-learning (Negash & Wilcox, 2008). In this format content is delivered through occasional physical presence and meetings between the teacher and student with the extensive use of technologies for the remainder of the time. That is, some of the class sessions are conducted with physical presence (that is face-to-face classroom) and for the balance of the time, the class sessions are conducted without teacher presence (that is asynchronously) in the form of discussion boards, email, assignments and lecture notes posted or uploaded by the teacher that can be accessed online.

2.2.2.6 Blended Synchronous

This is a combination of face-to-face and synchronous e-learning. This type of e-learning can be used to facilitate effective delivery of modules that combine both the use of ICT and traditional face-to-face teaching methods (Martin-Blas, 2009). In this environment, both the physical and virtual presences occur frequently at all times between the teachers and the students (Negash & Wilcox, 2008). Some class sessions are conducted with physical presence where the teachers and students use the classroom for some of the time, and the remaining class sessions are conducted with virtual presence where the teacher and students use live audio/video for virtual meetings in the form of instant messaging, audio or videoconferencing, teleconferencing, or even two-way live broadcasts to students in a classroom (Negash & Wilcox, 2008).

Many educational researchers and teachers agree that blended learning is the most effective way of learning, for, blended learning combines the advantages of traditional classroom instruction and online learning (Chen & Lu, 2013; Jeffrey, Milne, Suddaby & Higgins, 2014). Some of the delivery methods which can be integrated are teacher-led classroom teaching, asynchronous e-learning and synchronous e-learning. The combination of traditional face-to-face instruction and e-learning helps teachers to avoid the lack of social interaction in online learning, thereby enabling high quality interactions between teachers and students through the use of communication tools like forums and face to face interactive activities (Jeffrey, *et al.,* 2014). Blended learning creates a special need to motivate the less independent students to meet and discuss virtually with their classmates. This improves their learning effectiveness through richer information contained in multimedia tools. Blended learning offers teachers the flexibility to take full advantage of choosing a delivery method that will meet the learning styles of different students such as lecture, problem solving, discussion, experimenting, discovering, using pictures and diagrams, videos and demonstrations, thereby facilitating personalized learning in students (Gremu, 2012). This can help to build students' interest in the subjects they considered difficult for them, resulting in more effective, active and dynamic learning. Moreover, blended learning helps students to develop their technology skills by navigating through online module materials, and enhancing their communication skills. Some students who were reluctant to engage in conversation began to discuss freely when speaking to their classmates (Department of Education and Early Childhood Development, 2012).

In addition, blended learning extends the reach of students and accommodates students who cannot be present physically in the class during the module delivery because of their geographical location, to access and download the module materials uploaded by the teacher (Gremu, 2012). Seluakumaran, *et al.,* (2011) assert that blending e-learning with traditional face-to-face teaching of science subjects can foster an active and deeper approach to learning that enhances student learning outcomes in science subjects.

However, it should be noted that blended learning increases teachers' workload, and it is hard for teachers to choose the right learning method and difficult to control the proportion of face-to-face learning vis-à-vis online learning. It requires teachers a lot of time to develop content for both components of the teaching (Jeffrey, *et al.*, 2014). The time allocated for the class may not be adequate enough for teachers to develop content for the two components, and this does have an influence on the responsibility and commitments of teachers. Most teachers pay much attention to the online component of the content, thus affecting students' cognitive load, working conditions and learning styles as students have their own different learning styles (Chen & Lu, 2013). However, blended learning provides students with a variety of learning resources that they can use for sharing information among their classmates and their teachers. The downside is that this can lead to plagiarism of information through copying and pasting. (Chen & Lu, 2013; Arkorful & Albaidoo, 2014).

With all these disadvantages, the effectiveness of blended learning depends on the delivery methods and good design of the module content. The chosen delivery methods should be suitable to match the subject matter and target the different learning experiences of the students (Gremu, 2012). Chen & Lu (2013) opine that there are some control measures which teachers need to consider to overcome most of these disadvantages in order to improve the quality of blended learning. Teachers can reduce the negative effects of overload by preparing classes and teaching together to reduce workload, control the proportions of both components based on the teaching content; for instance, the content which is difficult for student self-learning could be done through face to face classroom instruction. Teachers should base their delivery methods on individual student learning styles, and should strengthen the integrity of education and let the students realize that plagiarism is an offence, and use any technical means, such as anti-plagiarism software to discourage copying.

2.3 E-LEARNING IN SOUTH AFRICA

The advent of the twenty-first century has seen a number of new technological developments which affect almost every aspect of people's lives. At the core of this is the ever-growing use of Information and communication technologies (ICTs) and e-learning as a vital tool which play a number of roles in the day to day operations in education. These include administration, changing teaching practices, developing graduates and citizens required in a modern society, enhancing the quality of teaching, learning and assessment, and improving educational outcomes (Jaffer, N'gambi & Czerniewicz, 2007). The use of ICT in South African schools will not only enhance learning and teaching in education, but in the long run will give South African people a comparative advantage in coping with and competing in an ever-demanding twenty-first century labour market and finding solutions to some of Africa's developmental challenges (Mdlongwa, 2012).

2.3.1 South Africa e-Education Policy

The evolution of ICT is driving significant changes in many aspects of human endeavour throughout the world. The integration of ICTs in the education system continuously poses a remarkable pressure and challenge in most parts of the world. In response to the challenges and pressure related to technology, the South African government, like many other countries worldwide, has a strong commitment to ICT in education. This was manifested in the country's adoption of a White paper on e-Education (Department of Education, 2003) which provided the implementation strategies on how ICT was to be integrated into the teaching, learning and administration of all the schools in the country. South Africa's e-Education policy goal explicitly states that " *Every South African learner in the general and further education and training bands will be ICT capable (that is, use ICT confidently and creatively to help develop the skills and knowledge learners need to achieve personal goals and to be full participants in the global community) by 2013."* (DoE, 2003:19).

The introduction of e-learning (learning through the use of ICT) in education represents an important part of the government's strategy to improve the quality of learning and teaching across the education and training system. The South Africa e-policy intention is to focus on learning and teaching for a new generation of young people who are growing up in a digital world and are comfortable with technology. The e-Education policy intention is not just to develop computer literacy and the skills necessary to operate various types of information and communication technologies, but also to use ICTs to extend and enrich learners' educational experiences across the curriculum. The objective is to build digital and information literacy so that all learners become confident and competent in using technology to contribute to an innovative and developing South African society. Learning through the use of ICTs is arguably one of the most powerful means of supporting students to achieve the National Stated Curriculum (NSC) goals. In particular, the use of ICTs for learning encourages learner-centred learning; active, exploratory, inquiry-based learning; collaborative work among students and teachers; and creativity, analytical skills, critical thinking and informed decision-making (Department of Education, 2004:19).

As a result of the high value that the South African government has placed on e-learning in Education, the government is consistently reviewing its e-Education policy to make sure that the country is not left out technologically among the developed world and to transform the country into a "knowledge-based society" through the use of ICTs. The Africa Institute of South Africa (AISA) in its policy brief about reviewing all the government ICT policies that have been in existence since 1994 looked at some of the challenges, benefits and recommendations relating to the use of ICT as a means of enhancing education in schools in South Africa. The institute made a recommendation that the Department of Basic Education (DBE) and Department of Higher Education and Training (DHET) should play a greater role in funding ICT resources for schools with fewer resources, and in the training of teachers, to equip them with the skills required to take advantage of the immense benefits that come with the use of ICT to improve the efficiency and productivity of their teaching and the learning of the students (Mdlongwa, 2012).

2.3.2 E-Learning Initiatives in South Africa

As part of implementing e-Education in South Africa, various initiatives have been undertaken through collaboration between government, non-governmental organizations (NGOs), and business. These initiatives include the following: Technology Access programmes; E-Schools' Network; Gauteng Online; Khanya Project; Meraka Institute (part of the Centre for Scientific and Industrial Research (CSIR)); Microsoft Schools Agreement, and ASTIC; NEPAD eSchools Initiative; Shuttleworth Foundation; Tuxlabs; SchoolNet South Africa's Educator Development Network (EDN); Microsoft Partners in Learning (PiL); Thutong Portal (Isaacs, 2007). The aim and mission of the initiatives and programmes of these different organisations was to support the Department of Basic Education to meet the challenges of effective teaching and learning in schools by providing and installing ICT with educational software, internet connectivity and security in the schools, and training of teachers through the innovative use of ICT infrastructure to support teaching and learning in schools. These training programmes include basic ICT skills and ICT integration for teachers, Microsoft Partners in Learning (PiL) as one of the training provided in ICT leadership for education managers in the Department of Basic Education. These projects form the basis of the greater part of ICT access, development and practices in the country enhance teaching and learning (Isaacs, 2007:12; Education Labour Relation Council (ELRC), 2010).

Apart from the collaborative effort between government and some NGOs, the government also offers additional initiatives to improve the quality of ICT integration among South African teachers. Such initiatives include the "Laptop Initiative (TLI)" and Intel "Teach to the Future". The Teacher Laptop Initiative (TLI) was part of the South African government strategy to improve the integration of ICT in teaching and learning (DoE, 2009). The initiative was launched nationally in 2009, managed by the Education Labour Relations Council (ELRC). It aimed to address the quality of education in the country (ELRC, 2010). The purpose of the initiative was to help all school teachers in South Africa own a laptop and use it effectively in their teaching, learning and administration. The TLI started gaining momentum in July 2010.

Moreover, INTEL "Teach to the Future" is a world-wide Innovation in Education which adapted the project locally in South Africa. It is an official professional development programme of the South African Council for Educators (SACE) designed to provide insights and help for all the school teachers across the nation on how to integrate ICT into their teaching and learning, and to promote and develop 21st-century skills such as critical thinking, problem solving and collaboration among students. Participating teachers from different provinces received extensive training on how to use technology and resources to help them replicate what they gained in the training session to train other teachers at their respective workplaces (Isaacs, 2007).

2.3.3 Challenges of e-Learning Implementation in South Africa

South Africa has a well-designed e-Education policy and has laid down the strategies for the implementation of ICTs in the country. However, despite the desperate need and collaborative efforts for ICT implementation in schools to be spread across South Africa, there are gaps between the policies and the implementation (the changes in classroom practices that the policies intended to effect) (Mdlongwa, 2012). So, despite the opportunities of ICT in education, there are still schools in South Africa that do not have access to ICTs resources. Moreover, many schools that do have access to ICTs resources use them in a limited manner and only focus on learning about computers or acquiring ICT skills rather than integrating ICTs into the classroom (PanAf, 2008-2011; Nkula & Krauss, 2014). A significant body of research on ICT in South Africa argues that the problem is not always caused by the lack of resources, but the teachers are not competent to integrate the available ICT resources for pedagogical purposes. Rather, they use the ICT resources for administrative purposes such as record keeping and typing lesson plans, tests and entering marks. They are not maximising the potential of computers, especially for enhancing the actual teaching and learning of their subjects. Access to resources without improvement on the status of usage by teachers makes the instrument become redundant (Howie, 2009; PanAf, 2008-2011; Mofokeng & Mji, 2010; Ndlovu & Lawrence, 2012; Makgato, 2012). Nkula and Krauss (2014) assert that increased access to ICT resources, however, does not necessarily lead to increased integration of ICTs; there are other factors that influence integration.

In addition, another cited barrier to ICT integration is the lack of professional development or teacher training (Ertmer 2005; Du Plessis & Webb, 2012; Nkula & Krauss, 2014). Teachers in most South African public schools have attended training in the use of ICT organised by reputable NGOs and the South Africa government. Unfortunately, the training offered seems to focus on developing basic ICT skills on teachers rather than to equip teachers with the skills to effectively integrate ICTs into their subject teaching (PanAf, 2008-2011). On this basis, Ndlovu & Lawrence (2012) explain that the fact that teachers struggle to innovatively use the skills they acquired from the trainings in their lessons to improve learning is an evidence that these initiatives does not adequately address the classroom needs of teachers. They emphasised that the training must focus on giving teachers authentic and relevant experiences with the available tools in their subject teaching contexts, rather than provide them with skills that do not prepare the teachers to integrate ICTs pedagogically. On the other hand, Nkula & Krauss (2014) argue that even though some teachers have received training on ICT use and they have the knowledge on integration, they may still not integrate ICTs, because they are resilient to change their old methods of pedagogy, and this may also be associated with their individual factors such as personal preference and attitudes to ICT integration, which are not easily solved.

2.3.4 The Role of Higher Education in Integrating e-Learning in Education

Within the framework of e-Education policy, the Department of Education and the provincial education departments are directed to collaborate with higher education institutions to design and deliver in-service and preservice teachers' development programmes, so as to provide them with the knowledge, skills and attitudes required to integrate ICTs into subjects of specialisation (DoE, 2004b). This is an approach that needs to be understood and considered to support the integration ICTs to enhance teaching, learning and assessment by South African teachers. Moreover, the South African National Plan for Higher Education emphasizes the point that University activities develop an information society, through the use of innovative technology to improve education and support the new education system. Therefore, there was a need to integrate ICTs into South Africa teacher education programmes in the Universities so as to compete globally, be innovative and address the learning styles of the technology savvy students who are longing to learn in an active, authentic learning environment (Bagarukayo & Kalema, 2015).

The role of teacher education institutions is to prepare new teachers for the technology savvy students who are already comfortable and engrossed in technology, how to integrate technology to enhance teaching and learning. This entails that teacher education institutions must include ICT integration as a core part of teacher education curriculum and giving the students an authentic experience with the available tools in their subject to overcome the challenges they will most probably face in the classroom practice (Evoh, 2009; Ndlovu & Lawrence, 2012). Today's preservice teachers are expected to be part of the innovation change process for technology integration as a way to improve technology integration in the classrooms after their graduation from universities. Moreover, the preservice teachers will be able to effect the changes in the schools by demonstrating the new trends in technology to old teachers who doesn't want to change their old ways of teaching (Chen, 2010; Park, 2009; Wong, Osman, Goh & Rahmat, 2013).

In response to the South African government's e-Education policy requiring higher education institutions to introduce e-learning as an alternative delivery system, many universities in South Africa have successfully developed and implemented strategies to use educational technologies, like e-learning through different platforms as an enabler for teaching and learning for students, academic and administrative staff. Programmes are delivered by means of blended learning methods with well-tested e-learning platforms in a face-to-face contact between academic staff and students, distance learning and/or e-learning (Bagarukayo & Kalema, 2015; Tarus, Gichoya & Muumbo, 2015). Venter, van Rensburg &

Davis (2012) say that students in South African universities attach a high value to contact with lecturers and their colleagues through electronic media and they appreciate the use of educational technologies to increase their learning interests and experiences.

Czerniewicz and Brown (2008, cited in Thinyane, 2010) conducted a study to examine the extent of ICTs usage in teaching and learning in higher education institutions in the Western Cape Province of South Africa. The study revealed that only 2.15% students indicated that they never or rarely used ICT to undertake any of their learning activities. This implies that students in South African higher education institutions have experienced the use of ICT in their learning activities. The various e-learning platforms used by most South African higher education institutions to deliver their programmes are listed in Table 2.1.

Table 2. 1: Use of E-Learning Platforms by South African Universities

Universities	**E-Learning Platforms**	**Source**
University of Pretoria	Blackboard	Commercial
University of South Africa	Sakai	Open
University of Cape Town	Sakai	Open
University of Stellenbosch	Moodle	Open
Rhodes University	Moodle	Open
University of the Free State	Sakai	Open
University of Fort Hare	Moodle	Open
University of the Witwatersrand	Sakai	Open
Cape Peninsula University of Technology	Blackboard	Commercial
University of Western Cape	Sakai	Open
Nelson Mandela Metropolitan University	Moodle	Open
University of Johannesburg	Blackboard	Commercial
University of KwaZulu-Natal	Moodle	Open
Tshwane University of Technology	Blackboard	Commercial
Central University of Technology	Blackboard	Commercial
North-West University	Sakai	Open
University of Limpopo	Blackboard	Commercial
Vaal University of Technology	Blackboard	Commercial
Durban University of Technology	Blackboard	Commercial
Walter Sisulu University for Technology and Science	Blackboard	Commercial
University of the Witwatersrand	Sakai	Open
University of Zululand	Moodle	Open
University of Venda	Blackboard	Commercial

The participating South African University, which is the focus of this study, has had a number of e-learning projects since 2000 ranging from departmental websites, which hosted "virtual classrooms" to the actual deployment of various e-learning platforms including

WebCT (now Blackboard) in 2000, MyCMT, which was developed in 2002 and Moodle from 2007 as the official e-learning platform on campus with one instance installed for each faculty (Evans, 2010) to provide more constructivist learning tools such as Wiki's, blogs and forums for students. An E-learning Implementation Strategy and Plan was approved by the University's Senate in 2009 with respect to the use of e-learning in modules delivery at the University. All departments and modules were added to the dynamic Moodle e-learning platform in 2014 (Tshabalala, Ndeya-Ndereya & van der Merwe, 2014). As part of the implementation plan for e-learning in the University, a collaborative e-learning workshop on using the upgraded Moodle 2.5 e-learning platform was offered in 2014.

It is in line with this background that this research study was conducted to investigate the preservice science teachers' integration of e-learning technologies in the teaching, learning and assessment of science subjects, and explore the individual factors that could influence them to integrate e-learning technologies for teaching and learning of science subjects. Literatures affirmed that it was important to understand the importance of these factors, even though they were intrinsic in nature and more difficult to overcome than extrinsic factors such as access to ICTs resources and inadequate training of teachers to integrate e-learning for pedagogical purposes. Such intrinsic factors needed to be considered first in finding solutions to the problems of e-learning implementation at the grassroots level (Donnelly, McGarr & O'Reilly, 2011; Nkula & Krauss, 2014).

2.4 E-LEARNING PLATFORMS

According to Piotrowski (2010) e-learning platforms represent a system which provides unified support for six different activities: creation, organization, delivery, communication, collaboration, and assessment in an educational context. Typically, e-learning platforms provide technological support for teachers in their teaching, to distribute information to students and to upload materials. They provide students with instant feedbacks on their work, manage student groups, coordinate distant classes, monitor participation of students in the learning process and assess their performance. These systems also promote collaborative learning with discussion forums, allow students to access the module contents from anywhere and at any time. They also support students to dynamically interact with their teachers in real-time through message boards, forums, chats, video-conference and other types of communication tools over the internet (Costa, Alvelos & Teixeira, 2012).

There are many e-learning platforms available to support teaching, learning and assessment processes. Some of them are commercial software such as Blackboard, WebCT and TopClasse, whereas others are free and open source software (FOSS) such as Moodle, Sakai, Ilias, Atutor and Claroline. All these software applications have common features, but some are more flexible and complete in specific aspects, such as role assignments and chat management. The most common and most preferred open-source and commercial e-learning software in academic environments such as Moodle, Sakai and Blackboard are discussed below.

2.4.1 Moodle Platform

Moodle (Modular Object-Oriented Dynamic Learning Environment) is a free and open e-learning platform, which is also known as a Learning Management System (LMS). It was originally designed to enable teachers to create effective online modules to encourage effective interaction and collaborative construction of learning contents. It provides several opportunities for a teacher to transform from being the sole source of knowledge dissemination to being a facilitator, a coach or a role model in the process of knowledge and skills acquisition (Bansode, & Kumbhar, 2012). This change in role of teachers has helped students to discover meaningful experiences by constructing their own knowledge in the online module environments as opposed to traditional approaches of teaching that can lead to ineffective learning, as students ostensibly remain passive recipients of knowledge being transferred from their teachers.

The major benefit of Moodle over other LMSs is that its design is based on socio-constructivist pedagogy (SCP), which is a student-oriented philosophy in which students are involved in constructing their own knowledge towards acquiring new skills (Al-Ajlan, 2012). The student-oriented philosophy of learning believes that students learn best when they interact with the learning materials, construct new materials for others, and interact with other students about the materials by collaborating, investigating, analysing, sharing, and reflecting (Ekici, Kara & Ekici, 2012). Moodle does support this style best, because it has a flexible array of module activities and resources to create different types of static module materials (a text page, a web page, a link to anything on the web, a view into one of the module's directories and a label that displays any text or image), as well as diverse types of interactive module materials (assignments, choice, journal, lesson, quiz and survey) and different kinds of activities where students interact with each other (chat, forum, glossary, wiki and workshop) (Ekici, *et al.*, 2012).

The Moodle platform is widely used by universities, communities, schools, teachers, students and even business associates. Many academic institutions use it to deliver fully online modules, while some use it to supplement their traditional face-to-face modules. The Moodle e-learning platform offers the following unique characteristics that make its use practically applicable in the educational settings (Al-Ajlan, 2012; Shulamit & Yossi, 2011).

a) Moodle is the most user-friendly and flexible free and open-source courseware, easy to download and install on any computer without any cost.
b) Moodle allows teachers to provide and share documents, grade assignments, conduct quizzes, participate in discussion forums and chats with their students in an easy-to-learn manner and to create quality online modules.
c) Moodle provides the teachers with the possibility to monitor the learning process of an individual or group of students, at any given time. It also facilitates the option to reflect on the process of teaching and learning.

The important advantages and disadvantages of Moodle were highlighted by (Martinez & Jagannathan, 2008; Singh, 2015) as follows:

2.4.1.1 Advantages

a) Moodle's low cost provides an enormous benefit for institutions with limited financial resources to afford the product.
b) Ease of customization. Moodle code is open and can be easily accessed and modified to meet the needs of the institutions, teachers and the students.
c) Moodle is available in multiple languages, thereby making it possible for students and teachers across the world to view the Moodle site in a different languages by selecting the language of their choice.
d) Moodle has various features that are highly flexible in their use such as communication features.

2.4.1.2 Disadvantages

a) Moodle is a new technology and the market that it targets comprised majorly adult students. For adult students to get acquainted with the Moodle features and functionality may be a big problem for them.

b) Moodle lacks the ability to integrate with human resource systems.
c) Moodle may lack security because of its open source availability.

2.4.2 Sakai Platform

Sakai is a free and open source LMS developed by a worldwide consortium of several higher education institutions meant for sharing applications among higher education institutions. It was designed to develop a set of collaborative tools for teachers, students and researchers to support their teaching, research and general project collaboration (Hanover Research Council, 2009; Alves, Miranda, Morais & Alves, 2012). It is flexible, popular and can handle a large number of users, easy to use and has many features that support teaching, learning, research and other projects (Dube & Scott, 2014). Sakai has gained a great reputation within and among higher education research institutions because it was designed specifically for them so as to provide students with the environments that will allow them to make their learning results known through the creation of content in learning platforms (Abdulateef, Elias & Mohamed, 2016).

The main features provided by the Sakai collaborative environment are as follows: Notices, Reviews /Assignments, Calendar, Chat, Drop Box, Email, Discussion forums, Chats, Register, Messages, News, Reviews, Presentations, Resources, Programs, Online Tests and Quizzes, Web Content, Wikis and Blogs. Sakai can hold a variety of teaching strategies such as blended learning, online teaching strategy and collaborative learning by making use of its tools. As a newer platform, Sakai has not yet achieved the large penetration outside, the higher education marketplace that Blackboard and Moodle have gained. Its reputation for higher-end features, scalability, and security, however, is helping to make inroads into the government and public sector markets as well (Singh, 2015). It offers various advantages and disadvantages highlighted by Alves, *et al.*, (2012); Wei, Wu & Zheng, (2014); Singh, (2015) below.

2.4.2.1 Advantages

a) Sakai helps to integrate the services of the higher education institutions such as academic services (register, timetables and examinations) and human and financial resources that use Sakai.
b) It is an open source and, therefore, accommodates various universities and colleges that have low budgets for IT development.

c) It allows customization. Therefore, users can easily customize the entire site according to their desire and needs.
d) Sakai has an active learning community which can provide timely help to any user. The convenient communication and cooperation between teachers and teachers, teachers and students, students and students, can help the effective application and functional evaluation of the Sakai system.

2.4.2.2 Disadvantages

a) Sakai is Java-based, and therefore universities and colleges require developers for it.
b) With it being a free online educational interface, the demand for Sakai is high and many institutions use it as their primary IT structure. This may cause some users to experience inconsistencies in Sakai functionality
c) Security may lack due to its open source availability.

2.4.3 Blackboard Platform

Blackboard is one of the leading proprietary commercial e-learning systems developed by Blackboard Inc. It is often called the Microsoft of higher education technologies, representing virtually the sole provider of educational e-learning solutions (Hanover Research Council, 2009). Since its introduction in 1997, it has made significant progress and revolutionized the way that students and teachers experience the entire educational process by interacting with each other for various academic purposes (Singh, 2015). It is the most widely adopted LMS software package among higher education institutions dedicated to teaching and learning across the world (Martin, 2008). Its main purposes are to supplement traditional face-to-face modules and to deliver fully online modules (Zaki & El Zawaidy, 2014).

The blackboard learning system has established its platform by ensuring that its customers are provided with a healthy and engaging environment and takes measures to introduce innovative features continuously to stay ahead of its competitors. Blackboard interface offered twelve different languages to accommodate students and teachers across the world. Blackboard provides two ranges of products, namely Networked Transaction Environment (NTE) which allows students and teachers to access on and off campus transactions and Networked Learning Environment (NLE) which offers instructors the options to manage course work efficiently and maintain comfortable discussions with their students (Bradford, Porciello, Balkon & Backus, 2007).

Blackboard offers a wide range of features that make it a very suitable candidate for an optimum online learning environment including discussion boards, email, course content areas, a gradebook and digital drop box, an announcements section, online tests and surveys, among other options. Blackboard also provides two synchronous communication tools: Chat and Virtual Classroom. The Chat tool shows text posted by individual participants, while the Virtual Classroom displays text as well as a shared whiteboard, course map, and group browser window. It has various advantages and disadvantages highlighted below by Bradford, et *al.,* (2007); Alharbi, (2015) & Singh, (2015).

2.4.3.1 Advantages

a) Increased accessibility allows students to have full access to the module addresses, notes, connections, slides and visual guides via the internet at anytime and anywhere.
b) Improved feedback which gives students immediate access to their evaluations and scores they obtained in tests and assignments. Getting input and grades has profited both students and teachers by sparing time and making the whole educational process productive.
c) Improved communication between teachers and students with the use of its communication tools to give students feedback, and help them to collaborate with their peers and teachers to extend the learning opportunities beyond classroom periods.

2.4.3.2 Disadvantages

a) Complex to use: Many students find Blackboard complicated and difficult to operate.
b) Cost: Blackboard is very expensive and not all institutions can easily afford huge expenses to operate Blackboard, and therefore, many institutions have decided against using it and have gone for open source e-learning platforms like Moodle.
c) Security: Blackboard lacks adequate security in that it allows students to change their grades and download unpublished examinations. It also allows criminals to get personal information from the system.

2.4.4 Comparative Studies of E-Learning Platforms

Comparing different e-learning platforms is very crucial and interesting because they have diverse features and functionalities that seem to be more or less adequate for different learning settings and objectives. Many studies have been carried out in many universities across the world that compares commercial and open-source e-learning platforms based on the users' experiences with their features and functionalities, so that they will be able to choose the best platform suitable to their needs. Kennedy (2005a, 2005b) investigated the advantages that Moodle offered over Blackboard from the perspective of the preservice teachers at Hong Kong Institute of Education through evaluations about the use of Moodle. The result showed that preservice teachers preferred Moodle over Blackboard because Moodle has helped them to develop an experience about teaching in the future. Machado & Tao (2007) compared the students' experiences between Blackboard and Moodle at California State University and discovered that course material organization and communication were rated higher on Moodle than on Blackboard, and 75% of the students preferred Moodle as opposed to Blackboard.

Bri, Garcia, Coll & Lloret (2009) made a comparative study between Blackboard, Moodle, WebCT and Sakai based on four criteria, namely popularity on the World Wide Web, features, usability in the Spanish Universities and performance evaluation between Moodle and Sakai. The results indicated that Moodle was the most popular platform, the most used platform in Spanish universities and the platform that got better results in the performance evaluation. The results further showed that Moodle and Sakai had all the major features required to promote effective online learning compared to Blackboard and WebCT.

Carvalho, Areal & Silva (2011) surveyed 876 students' perceptions and experiences with Blackboard and Moodle at the University of Minho in Portugal. They used four factors, namely level of satisfaction, modes of engagement, global preference of the platforms and assessment of specific features and functionalities. The results indicated that 46.5% of the students with experience on both platforms stated a preference for Blackboard over Moodle, while 34.7% preferred Moodle and 18.9% had no preference.

Unal & Unal (2011) reported a comparative usability study of Blackboard and Moodle from the perspectives of 135 students at South-Eastern University. The students were divided into two groups to use the two LMSs at different time. An online survey was provided for all the students at the end of each semester to solicit their experiences with the two LMS systems. The results from the two groups showed that on almost every function that was compared, Moodle was preferred by all the students over Blackboard.

Peña, Tello & Cámara (2011) made a comparative study on eight free learning platforms (ATutor, Claroline, Docebo, dotLRN, Sakai, ILIAS, Moodle, OLAT) based on criteria such as communication tools, evaluation tools, administrative tools, roles, documentation, standards, operating systems. The results showed that Moodle was the best LMS considered by the users. Al-Ajlan (2012) compared Moodle and other ten e-learning platforms based on features, capabilities and technical aspects and came to the conclusion that Moodle and Sakai were the best platforms.

Cavus & Zabadi (2014) made a comparative study about the communication tools of six popular open learning platforms (ATutor, Claroline, Dokeos, Ilias, Moodle and Sakai). The comparison showed that Moodle had the best communication tools with user friendly interface. Moodle has the best skype and interactive whiteboard for students and teachers, has a very active discussion forum for teachers and students to exchange ideas. It also provides easy ways for teachers to upload files and present materials to their students.

Abdulatteef, Elias & Mohamed (2016) evaluated and compared three Open Source software (OSS) Learning Management System (LMS), namely dot LRN, Moodle and Sakai based on the software functionality criteria for each platform in order to determine their strengths and limitations. The data were collected from LMS's websites, and it was found that Moodle had better features (criteria) compared to the other educational platforms; Sakai came second; followed by dotLRN as the last platform. Overall, these studies suggest that users tend to prefer Moodle over other e-learning platforms.

2.4.5 Activities in E-Learning Platforms

Activities create communication between teacher and student, thereby making both sides to be involved in the learning process. The main goals of activities in e-learning platforms are to save teachers' time, ease workflow and promote cooperation between teachers and students (Tamnovceva, & Ivanovs 2013). The activities of e-learning platforms are classified into six classes as follows (Piotrowski, 2010).

a) Creation - refers to the production of learning and teaching materials by teachers.
b) Organization - refers to the arrangement of the materials for educational purposes (that is combining them into modules).
c) Delivery - refers to the publication and presentation of the materials, so that they can be accessed by students.

d) Communication - refers to the computer-mediated communication between students and teachers and among students.
e) Collaboration - refers to students jointly working on projects; it also includes collaboration between teachers.
f) Assessment - refers to the formative and summative evaluation of learning progress and outcomes, including feedback.

2.4.6 E-Learning Platform Features

Features are components created through e-learning platforms to provide interactions among students and between teachers and students. Features also help teachers and students to share information and collaborate among themselves. Examples of features are listed in table 2.2 (Costa, Alvelos & Teixeira 2012; Logan & Neumann, 2010; Singh, 2015; Choudhury & Khataniar, 2016).

Table 2. 2: The various activities and features available in e-learning platforms

Activity	Features	Functionalities
Creation	Database	Allows the teachers and students to build, display and search a bank of record entries about a topic. It allows teachers and students to share a collection of data. Use for storing past examination papers, activities for students to do, and collections of students' work.
	Bookmarks	Bookmark manage, create, save, share, display and update links of internet. It allows students to return to important sites within and outside their classes on the web.
Organization	Lessons	Represent a set of ordered topics summarizing the instructional materials. Lesson allows teacher to delivers content in an interesting and flexible way. It consists of a number of pages, each page normally ending with a question and a number of possible answers. If the students answer the question successfully, they may progress to the next page. Otherwise, they can be sent back to the previous page. It can be a helpful tool for practicing material, studying, and testing.
Delivery	Assignments	Enables a teacher to allow students to upload and submit their assignment online for teacher's evaluation, feedback including grades. Students can submit tasks in any file format such as (Word document, PowerPoint, Video clip etc)
	Workshops	Represent a peer assessment activity. It allows teachers and students to assess each other's projects in a number of ways. Allow students to submit their work via an online text tool and attachments.

Communication	Chats	Allow teachers and students to have a real-time synchronous discussion through the web. It helps the students to post questions to the teachers. It is a useful way to get a different understanding of each other and the topic being discussed.
	Internal Mail	It allows group of students and teacher to exchange information between each other. It is the simplest way of one-one communication between teacher and the students.
	Discussion Forums	Represent a communication and discussion tool between students and teachers at different times. Helps students to construct new knowledge. It is used for general announcement and allow teachers to add posts and send emails.
	Scheduler	Useful for posting required meetings between students and teachers, such as advising days, or simply for optional office hours. Has the students sign up for the time that best suits them.
	Document Sharing	The documents like HTML, PDF, JPG, DOC etc. can be shared among students and the teacher.
	Video Services	Enable video conferencing and enable teachers to run stream video from within the system.
	Interactive Whiteboard	A touch-sensitive screen which support many different style and are used by the teachers and students in synchronous methods.
Collaboration	Glossary	It is like database which allows teacher and student to create and maintain a list of terms and definitions, as in in a dictionary. Enables teachers to export entries from one glossary to another within the same module. Students can click on a difficult word in a text and they will automatically be taken to the explanation provide in the glossary. Typical uses are an A-Z of difficult words and collections of useful websites.
	Digital Library	It contains digital objects like magazine, news, journals, visual materials etc. It archived live lectures that are recorded and the students can access it at any convenient time.
	Calendar	Teachers can use this feature to post due dates for assignments and tests.
	Wikis	A wiki page allows teachers and students to edit each other's content and contribute their own material. Promotes collaboration and knowledge sharing, and increases participation, all of which are essential properties in an educational context. Enable group work to develop quickly without students needed to be in the same place at the same time.
Assessment	Choices	Allows teachers to ask questions and specify a choice multiple answers. It is a useful mechanism to stimulate thinking about a topic, to allow the class to vote on a direction for the module, or to gather research feedback.

	Quiz	Allows teachers to design and set quiz tests, with different types of answer, such as multiple choices, true/false and short answer questions. It allow multiple attempts. Each attempt is automatically marked, and the teacher can choose whether to give feedback or to show correct answers. Quiz module includes assessment and grading facilities. The teacher used it to track student's progress and the effectiveness of the curriculum.
	Journal	Used to encourage teachers and students to reflect on the module and content, and to stimulate deep thinking and learning. This is private between student and teacher and each journal can be directed by an open question.

2.4.7 Main Attributes of E-Learning Platforms

E-learning platform has many features to enhance teaching, learning and assessment processes among teachers and their students in higher and secondary education around the world. Studies have been conducted that itemise and outline the main functionalities, features, usability, technicalities and services of various e-learning platforms (Bri, Garcia, Coll & Lloret, 2009; Al-Ajlan, 2012; Choudhury & Khataniar, 2016; Abdullateef, Elias & Mohamed, 2016). The characteristic features of three most popular and active open source and proprietary e-learning platforms used in the academic environments for academic purposes are presented below, namely Blackboard, Moodle and Sakai. These include communication and collaboration features, productivity features, course delivery features. The e-learning platform features are divided into learner tools and support tools.

2.4.7.1 Learner Tools

The learner tools consist of communication and collaboration tools and productivity tools for students to access learning content. Each learner tool has different features, and each e-learning platform has some of them.

Table 2. 3: Learner Tools for selected e-learning platforms

Features	Platforms		
	Blackboard	Moodle	Sakai
1. Learner Tools			
1.1.Communication and Collaboration Features			
Blogs	Yes	Yes	Yes
Discussion Forums	Yes	Yes	Yes
File Exchange	Yes	Yes	Yes
Internal Email	Yes	Yes	Yes
Online Journal/Notes	Yes	Yes	Yes
Real-time Chat	Yes	Yes	Yes
Whiteboards	Yes	Yes	No

Video Services	No	Yes	No
Instant Messaging	Yes	Yes	Yes
Wikis	Yes	Yes	Yes
Database Activity	No	Yes	No
1.2. Productivity Features			
Bookmarks	Yes	No	Yes
Calendar/progress review	Yes	Yes	Yes
Orientation/Help	Yes	Yes	Yes
Searching Within Course	Yes	Yes	Yes
Glossary	Yes	Yes	Yes
Digital Library	Yes	Yes	No
Total Features	17	17	17
Total Available Features	15	16	13
Total Missing Features	2	1	4

Table 2.3 shows that all the e-learning platforms have all features, which means that they are strong on learner tools. Moodle e-learning platform is shown to be the best with the maximum number of 16 learner tool's features out of 17, followed by Blackboard with 15 and Sakai with 13 features.

2.4.7.2 Support Tools

Support tools are made up of course delivery tools and course development tools for teachers, and administration tools for managing student admissions, enrolment, resource planning and accounting. All these tools have various features, and each e-learning platform has some of them.

Table 2. 4: Support Tools for selected e-learning platforms

Features	Platforms		
	Blackboard	Moodle	Sakai
2. Support Tools			
2.1. Administrative Features			
Authentication	Yes	Yes	Yes
Course Authorization	Yes	Yes	Yes
Hosted Services	Yes	Yes	Yes
Registration Integration	Yes	Yes	Yes
Administrative Reporting	Yes	Yes	Yes
2.2. Course Delivery Features			
Test Types/Quizzes	Yes	Yes	Yes
Assignments	Yes	Yes	Yes
Workshops	No	Yes	Yes
Course Management	Yes	Yes	Yes
Online Grading Tools	Yes	Yes	Yes
Student Tracking	Yes	Yes	Yes
Lessons/ Course Document	Yes	Yes	Yes
2.2. Course Development Features			
Blended Learning	Yes	Yes	Yes

Accessibility Compliance	Yes	Yes	Yes
Content Sharing/Reuse	Yes	Yes	Yes
Course Templates	Yes	Yes	Yes
Customized Look and Feel	Yes	Yes	Yes
Instructional Design Tools	Yes	Yes	Yes
Instructional Standards Compliance	Yes	Yes	Yes
Total Features	18	18	18
Total Available Features	18	18	18
Total Missing Features	0	0	0

Table 2.4 shows that the administrative, course delivery and course development features of all these platforms are very similar, although they differ in terms of their use and the overall layout. All the three e-learning platforms have all the support tool features, which means that they are all strong on support tools.

Table 2. 5: Comparison of the three selected e-learning platforms

Features / Tools	Platforms		
	Blackboard	Moodle	Sakai
Student Tools	15	16	12
Support Tools	17	18	18
Total Features	35	35	35
Total Available Features	33	34	31
Total Missing Features	2	1	4

Table 2.5 shows that the three selected e-learning platforms shared most of the features, and that Moodle had the highest feature of 34 out of 35; Blackboard came second with 33 features; followed by Sakai with 31 features. Hence, Moodle had the highest number of features compared to the other two platforms, which suggested that it could be the best e-learning platform in the academic environments among these three e-learning platforms. Moodle supports all requirements, excluding bookmarks, in learners' productivity feature. Blackboard has some weaknesses in the communication features, as it does not provide video services and database activity. Sakai also has several weaknesses compared to the other e-learning platforms; it has no whiteboard and does not provide information on database activity and video services in the learners' communication feature. Furthermore, it has no digital library in the learners' productivity feature. Thus, Moodle needs to develop the bookmarks while Blackboard needs to develop the database activity and video service in communication feature; and Sakai needs to develop the whiteboard, video services, database activity and digital library.

2.5 RESEARCH ON E-LEARNING INTEGRATION

2.5.1 Perceptions of Educational Benefits of E-learning Technology Integration

Recent research supports the evidence that integrating e-learning technologies into classroom benefits teaching and learning in educational settings (Amandu, Muliira & Fronda, 2013; Costa, *et al.*, 2012; Abdelraheem, 2012; Martin-Blas, 2009). The potential benefits of integrating e-learning technologies into teaching and learning as outlined by researchers include: improving student-student and student-teacher interactions, student's satisfaction of a module, students' motivation, students' performance, sharing of content and information, effective collaboration and communication, as well as teaching, learning and assessment.

2.5.1.1 Improving Student-Student and Student-Teacher Interactions

Interaction is defined as the process that actively involves the learner physically and intellectually (Abdelraheem, 2012). A student's physical presence in a face-to-face module assumes that he or she has a sense of belonging in the class or within a smaller groups. He or she listens to the discussion and may choose to raise a hand to comment, to ask or answer a question. Furthermore, this same student may develop a relationship with her classmates and discuss topics during a break outside the classroom. However, this is an assumption and is not always true. For a variety of reasons, some students especially the introverted students, often feel left out as part of the group in a face-to-face classroom instruction (Abdelraheem, 2012).

The interactive capacity of e-learning tools supports interaction between students and teachers and among students. These interactive tools, such as instant messaging alerts, discussion forums and chats inform each student about the topic to be addressed in the next learning session. (Amandu, *et al.*, 2013). These tools make it possible for students to share their knowledge and difficulties, as they can ask questions from their teachers and other students in order to clarify specific aspects of the modules that are not clear to them, for instance, by sending personal messages to each other. The interactive tools such as discussion forums and chats make it possible for the teacher to prepare for upcoming classes and have a glimpse into students' progress. It also helps teachers to notice the concepts that are very difficult for students to understand. Furthermore, interactive tools help to facilitate student learning more effectively rather than relying solely on the traditional mid semester assessment criteria (Martín-Blas & Serrano-Fernández, 2009).

Scholars such as Arrington, Hill, Radfar, Whisnant & Bass (2008); McLaren, Rummel, Pinkwart, Tsovaltzi, Harrer & Scheuer (2008); Tosun (2014) affirm that student-student and student-teacher interactions in traditional laboratory are insufficient because students work independently. In an attempt to choose the right method in science education laboratory practice that will involve students' interactions, Tosun (2014) carried out a study to reveal the impact of e-learning in supporting cooperative learning processes among 46 undergraduate students taking General Chemistry Laboratory modules at a State university in Turkey. A questionnaire was administered to determine student opinions about e-learning in supporting group cooperation in chemistry laboratory. The findings of the study revealed that e-learning enabled almost half of the students to engage in supportive interaction in the laboratory, to follow the module notes and participate actively in the module.

Sallam & Alzouebi's (2014) case study explored the perceptions of 12 teachers about the use of e-learning in private high school at Al-Ain, United Arab Emirates. The results showed that the majority of the teachers were very optimistic about e-learning tools because they fostered interaction between students and their peers and students and their teachers compared to large lecture classes. Most of the teachers stated that interactions with their students were at their best as e-learning gave them new opportunities to discuss with their students and support them on important aspects of their module.

Abdelraheem (2012) conducted another study to ascertain students' perceptions of the quality of interaction in a module that was delivered through e-learning. A questionnaire was distributed to 57 undergraduate students in the Department of Instructional and Learning Technologies in the College of Education of Sultan Qaboos University. Results showed that students held the view that the quality of interaction in the module was excellent. The students explained that interactions with their peers came first within the e-learning platform because they helped them to participate and collaborate with each other in the learning process, followed by interactions with their teachers because the teachers guided the students during online discussions and final interactions with the content.

On the other hand, a study conducted by Seluakumaran, *et al.*, (2011) indicated that not all students participated fully in the interactive functions of e-learning. Some students' reluctance to participate actively in the interactive features could be due to lack of teachers' involvement in the discussion forum. Seluakumaran, *et al.*, (2011) emphasized that for students to participate effectively in the interactive functions, the teachers should play a facilitator's role by giving students immediate feedback to their questions.

2.5.1.2 Improving Student Satisfaction with a Module

Satisfaction is an influential factor in the successful integration of e-learning in the science education module. To get any educational value out of e-learning, the students must be satisfied with the e-learning interface and the module being offered using e-learning (Baturay, 2011). Previous studies on students' satisfaction with a module using e-learning have been carried out. Ekici, *et al.,* (2012) evaluated the views of 57 preservice primary school teachers about the potential contribution of using e-learning to complement face-to-face teaching in undergraduate Physics in the Faculty of Education, Pamukkale University, Turkey. Some pre- service teachers stated that they were happy that physics classes were done using e-learning because they could repeat lessons through the internet, share module notes, send questions and have instant access to their examination evaluations which had a powerful influence on student achievement.

Seluakumaran, *et al.,* (2011) assessed the usage pattern of e-learning in a blended learning environment and its impact on 178 physiology students learning outcomes such as examination performance and student feedback at the University of Malaya. The results showed that the students were generally satisfied with using e-learning tools because they allowed interaction among their peers and the teachers.

Bulic & Novoselic (2014) conducted another study to determine the efficiency of e-learning with the acquired knowledge of 48 preservice teachers compared to traditional teaching in four biology lessons at Pujanka Univerity in Split, Croatia. The results showed that many of the students were satisfied with using e-learning in a biology class because the various digital teaching materials and activities helped to develop their skills, and helped them to recognize and solve real life problems about the topics.

However, contrary to expectations, some preservice science teachers in studies conducted by Ekici, *et al.,* (2012); Ndlovu & Mostert (2014) stated that they were not happy that science classes were conducted using e-learning because they had very limited access to the internet, internet connectivity was expensive and very slow where such facilities were available.

2.5.1.3 Student Motivation

Motivation is a key element to achieve effective teaching and learning. Williams and Williams (2011) stated that "motivating students to continue to study and enjoy learning is probably the most important factor that teachers can target in order to improve learning".

Liao (2006) distinguishes between extrinsic motivation, which he refers to as engaging in an activity because of its foreseeable rewards such as pay increase or promotion to the next level and intrinsic motivation which refers to engaging in an activity without receiving any reward, but mainly for satisfaction and enjoyment. However, Liao (2006) asserts that student are intrinsically motivated to learn, they experience flow with their learning, they will be eager to learn more, and achieve better results.

Some empirical research evidence shows that the current generation of undergraduate students in higher education is unenthusiastic about the learning process and they disengage from the learning processes that follow only the traditional teacher-centred approaches; that such approaches do not help most students to grasp core concepts and skills, leaving a sizeable number of them behind in the course (Deslauriers & Weiman, 2011; Stowe, von Freymann, & Schwartz, 2011).

This lack of motivation on the part of students towards learning leaves teachers in undergraduate programmes disturbed with the task of keeping students interested in their classes and other learning activities. As a remedy, teachers need to integrate high-quality and highly effective e-learning tools which will evoke students' motivation, leading to the mastery of the subject matter (Amandu, *et al.*, 2013). E-learning is an affordable innovative strategies with tools such as chats, discussion forums and instant messaging which rely typically on intrinsic motivation, that teachers can use to promote student self-directed learning. These e-learning tools can stimulate students' interests and motivate them to remain focused on their studies and to be actively engaged in learning beyond the classroom (Amandu, *et al.*, 2013).

Several studies have been carried out on how e-learning motivates students intrinsically to learn. Amandu, *et al.*, (2013) in their study discussed how e-learning had been used to transform traditional clinical teaching into more active learning experiences among undergraduate nursing students learning at Sultan Qaboos University in Oman. The authors explained that e-learning was a user-friendly and affordable innovative teaching strategy that was used to motivate, promote and sustain student interest in self-directed learning. They concluded that e-learning enhanced students' pre-class preparations, post-class participation and overall motivation for self-directed learning.

Waheed, Kaur, Ul-Ain & Qazi (2013) carried out a study to examine how e-learning features like Communication module, Assignment module, Course Content module and Course delivery module could motivate 276 students to learn. The results of the study showed that these e-learning features proved to be significant predictors that motivated students to learn. In addition, the students were able to communicate with their classmates and teachers using the communication tools. The assignment module was easy for students to submit their assignments and check their grades without wasting money on printing costs. The content uploaded on the e-learning portal by the teachers was informative, recent and relevant. This helped the students to take advantage of the current and useful knowledge repository. The easy way to access these features with autonomy strongly motivated the students intrinsically to use e-learning to further their studies.

In a similar attempt, Fayed (2010) used Moodle as a supporting e-learning platform to motivate Grade 12 students who lack interest in English and ICT in English Second Language (ESL) schools in Dubai. The results of the study indicated that the discussion forums in Moodle motivated most students to learn.

Sallam & Alzouebi (2014) conducted another study to examine the perceptions of 12 teachers on the use of e-learning and its impact on student motivation to learn. The teachers agreed that e-learning features such as chats and blogs were useful to motivate students to learn. The more abled students were challenged to practise as many times as they wanted before an examination**,** and the less abled students had enough time to participate, learn and use the materials posted by their teachers to build their confidence. The teachers added that the interactive features in e-learning also motivated those students who were too shy to express their opinions in face-to-face discussions with their classmates to participate in group work, share their ideas, and demonstrate their abilities and talents to improve their learning performance.

2.5.1.4 Improving Student Performance

E-learning has many tools that can be used to complement the traditional teaching to improve student learning outcomes. Seluakumaran, *et al.,* (2011) claim that the interactive features in e-learning promote learning, help students to understand concepts and assist them to perform better in tests and examinations. For example, the online quizzes give instant feedback to allow students evaluate their performance in tests and assist them to prepare better for the examinations.

Scholars such as Martin-Blas & Serrano-Fernandez (2009); Ahmad & Al-Khanjari (2011); Seluakumaran, *et al.,* (2011); Pacemska, Pacemska & Zlatanovska (2012) affirm that the use of e-learning improves the performance of student learning. For example, Martin-Blas & Serrano-Fernandez (2009) investigated the responses of 52 students on the use of e-learning as an enhancement of the face-to-face instruction in undergraduate Physics module at the Universidad Politécnica de Madrid in Spain. The results showed that students who used e-learning regularly performed better in the module compared to other students who did not use e-learning.

Ahmad & Al-Khanjari (2011) explored the effect of e-learning on 510 students learning a module named “Basic Computing Skills” offered in the foundation programme at the Sultan Qaboos University, Sultanate of Oman. The results revealed that students had little experience of e-learning at the beginning of the module but valued the use of e-learning towards the end of the module as it was accessible from internet at any time. The students indicated that e-learning successively improved their understanding of the module and prepared them better for the examination.

Pacemska, *et al.,* (2012) compared the performance of 130 students in Mathematics who used e-learning as a learning tool with those who did not use e-learning at the University "GoceDelcev" the Republic of Macedonia. They compared the level of students’ performance in the examination when the teaching process was carried out with classical verbal text method and when the teaching process was supported by e-learning. The results showed that students had the best grade in mathematics examination during the academic period when more intensive use of e-learning was applied in the learning process than other students who rarely or never used e-learning.

In a similar vein, Seluakumaran, *et al.,* (2011) evaluated the usage pattern use of e-learning on 178 students’ learning outcomes at the University of Malaya. The results showed that students’ performance in their final physiology examination improved significantly compared with the previous year that students did not use e-learning.

However, results from other study report no significant differences in learning effectiveness between e-learning and traditional teaching methods. Bulic & Novoselic (2014) conducted a study to determine the efficiency of e-learning compared to traditional teaching on the acquired knowledge of 48 preservice teacher on four biology lessons at Pujanka Univerity in Split, Croatia. Twenty four (24) preservice teachers who made up the experimental group were taught using the digital materials on e-learning. At the same time, the biology teacher presented the same topic to another group of twenty four preservice teachers attending the same school (control group) using the traditional teaching methods with various knowledge sources. The results revealed that the text and visual descriptions in e-learning were highly helpful for the students during the learning process, but the experimental group's quiz results were not significantly better than the control group's quiz results.

2.5.1.5 Sharing Information and Content Knowledge

E-learning allows teachers and students to share information among themselves through the use of discussion forums and chats (Al-Ani, 2013). E-learning provides a lot of information about the students' usage of the system and also about their performance. The teacher can know all the activities carried out by each student on the platform such as number of visits, time spent doing each task, scores, and other related aspects of usage. The e-learning discussion forums, chats and instant messaging are supportive tools which provide comfort zones for students to share their ideas, information and difficulties among themselves and with their teachers. These tools also make it possible for the teacher to distribute useful information about the learning content to students before the class, as this can help students to read the contents beforehand and concentrate on understanding the contents in the classroom (Amandu, *et al.*, 2013).

The use of e-learning for sharing information among teachers and their students have been demonstrated by some studies. Martín-Blas & Serrano-Fernández (2009) created an undergraduate online Physics module as an enhancement of the face-face instructions. The results of their study showed that e-learning helped both teachers and students to have a virtual space where they could share knowledge and information through chats and forums.

Al-Ani (2013) conducted a study to investigate the effectiveness of using e-learning in a blended learning environment to activate the achievement of 283-students in all the colleges at Sultan Qaboos University. The results revealed that e-learning created an environment that allowed collaboration and communication among students. The students explained that using e-learning developed their skills to browse through websites searching for information, expanded their social context by sharing knowledge among themselves. In addition, they had more time for discussion and reflections.

Ndlovu & Mostert (2014) conducted another study to investigate the effect of e-learning to support 71 in-service mathematics teachers in a blended learning Advanced Certificate in Education (ACE) programme in South Africa. The views of the 71 teachers who participated in the module were solicited using a questionnaire. The results indicated that e-learning discussion forums gave the in-service teachers an opportunity to address their learning needs, share content knowledge, experiences and challenges with other in-service teachers; that through these discussion forums they received help in any topic they found difficult to understand.

However, Negash, *et al.*, (2008) explain that students may find it difficult to share information with their teachers and classmates due to system malfunctioning, system connectivity errors and other disruptions. Students felt frustrated when they experienced interruptions in the internet which prevented them from sharing information about the content with their teachers and colleagues. This led to lower rates of student's usage of e-learning for instructional purposes.

2.5.1.6 Enabling Communication and Collaboration

According to Kurebwa (2013) collaboration is the process of interaction and communication either person to person or person to group. Kurebwa (2013) views collaborative learning as a social activity involving students and teachers through which information is acquired and knowledge is shared. Students communicate with their peers and teachers through collaborative learning, thus allowing them to socialize and learn together. When students work together collaboratively they are not only learning, they are also contributing to the development of the group. In addition, communication among students can add value to the learning process by facilitating the development of higher order thinking skills, increase student involvement, interest, motivation and the achievement of higher learning outcomes.

E-learning has the potential to enhance communication and collaboration among students and teachers and between students and their peers by creating a new learning environment. In an e-learning environment the relationship between teachers and students is no longer a one-way relationship, but about creating interaction and collaboration between students to increase their participation in the classroom (Taha, 2014).

Ekici, *et al.*, (2012) & Waheed, *et al.*, (2013) explained that e-learning created a constructive learning environment that allows collaborative learning among students. E-learning enables students to participate in discussions among the whole class or within smaller groups with the use of communication tools such as chats and discussion forums to exchange knowledge about the content among their peers and teachers and to engage in active learning processes that lead to better understanding of the content. Additionally, Ekici, *et al*, & Waheed, *et al.*, explained that e-learning allowed teacher to act as collaborators by distributing information about the content material, assignments and tests to students, as well as engaging in discussions with students using communication tools such as chats and discussion forums to motivates and engage students in interactive learning activities. They also pointed out that teachers worked collaboratively with other teachers to create a variety of activities and to improve the instructional process through the use of communication hardware and software.

The communicative and collaborative approaches of e-learning to support student learning have been attested to by several studies. Sallam & Alzouebi (2014) conducted a case study to explore the perceptions of 12 teachers about the use of e-learning in private high school at Al-Ain, United Arab Emirates. The results indicated that the majority of the teachers were very optimistic that e-learning tools would foster communication between students and their peers and students and their teachers, more so than was possible in large class modules. Most of the teachers stated that e-learning provided new channels to post messages to the students, give them advice and support they needed on important aspects of their modules.

In a similar study, Paynter & Bruce (2012) conducted a case study to explore the views of 29 students about the effectiveness of e-learning in Integrated Human Studies (IHS) modules at the University of Western Australia. The results showed that the majority (75%) of the students strongly agreed that e-learning helped them to communicate and collaborate with other students in the module by working together in a group to construct knowledge among themselves.

Amandu, *et al.*, (2013) discusses how e-learning was used to successfully promote self-directed learning (SDL) among undergraduate nursing students at Sultan Qaboos University, College of Nursing, in Oman. The authors explained that the usage of e-learning communication tools such as discussion forums provided a comfort zone for the students to initiate and follow up discussions on topics, share experiences and collaborate with their classmates to promote better academic achievement. They inferred that students who engaged and collaborated effectively with their peers in e-learning environment performed better than those who disengaged from e-learning environment.

In their study on the usage of e-learning, Prenjasi & Ahmetaga (2015) explored the expectation of 33 students on the effective usage of e-learning in a module called Experimentation Physics at the Bachelor Level at the University of Shkoder in Albania. Open-ended questions were designed to get a wide range of responses from the students. In the results, the majority of the students (81.8%) affirmed that e-learning enhanced communication with their professor and other students; that that e-learning remained an innovation for teaching and learning process with the potential to help learners acquire new methods and techniques for innovative learning; that student-student communications represent a good opportunity for the students to exchange opinions about the module, and in essence, improve the effectiveness of the module and learning; that, in essence, e-learning supports learners in their studies because it offer them an opportunity to ask questions concerning the subject from their teachers who are always available to answer any questions at any time.

2.5.1.7 Improving Teaching, Learning and Assessment

Prenjasi & Ahmetaga (2015) assert that e-learning as part of new methods of teaching and learning improves teaching and learning processes, allows students to participate actively in the learning process and supports students' studies. Accordingly, e-learning makes teaching become dynamic, flexible and enables teachers to easily post module guides, assignments, announcements and module documents to the students. It also allows teachers to monitor each of the student's logins on a given lesson, discussion forum activity and quiz results (Bulic & Novoselic, 2014). The e-learning interactive features enhance the student's learning experience with its ability to provide prompt feedback for the student about their grades (Martinez & Jagannathan, 2008). For example, the Assignment tool (in which students can upload their work in any file format) allows the teacher to provide detailed comments in text as well as in audio formats. Furthermore, journal and many other tools help the teacher to send feedback to all students.

Sallam & Alzouebi (2014) investigated 12 teachers' perceptions about the use of e-learning to enhance teaching and learning. Open-ended questions were designed to get a wide range of responses from the teachers. The majority of teachers agreed that e-learning offered new approaches to conducting assessments by giving them immediate results and ensuring that students were promptly informed about their current attainment levels. E-learning gave the teachers time and space to cover all aspects of the subjects and to enhance the curriculum after-school activities. For example, the science teachers explained that e-learning allowed them to use as many examples and videos as the lesson required; go beyond the textbooks and direct students to relevant websites for useful information. Moreover, e-learning helped them to save time and effort in teaching, planning, marking and documenting students' work, instead of keeping piles of files.

In addition, some teachers in this same study explained that using e-learning gave them the opportunity to practise differentiated teaching by grouping students according to their individual learning styles and abilities in the following ways:

a) They design questions and activities that are suitable for each and every student's needs;
b) Upload materials that are appropriate to the students' different learning styles (for instance, visual students have more time to watch pictures and videos related to the topic);
c) Group students virtually according to their abilities and learning styles and give each group the activities and support according to the group members' levels;
d) Apply mixed abilities group strategies which help students to learn from each other virtually so that poor performing students can benefit from high achievers as they discuss their work in the 'discussion forum' or 'Wikis'. Similarly, students with high potential can learn from helping their peers to identify their areas of weaknesses;
e) Allowed teachers to evaluate students according to their abilities and gave them constructive feedback (Sallam & Alzouebi, 2014).

However, contrary to the positive investigation presented in the above paragraphs, Chen & Lu (2013) argue that assessments conducted with the use of e-learning was varied, focusing on classroom performance, practical work in traditional classrooms, and examinations, online learning, online discussions, online quizzes, and online assessment. This makes it difficult for teachers to assess students' learning effectiveness with the use of e-learning. As a result, electronic plagiarism problems and other issues related to low levels of control arise. Thus, there are some control measures which teachers need to put in place to avoid the negative effects of online assessment. Teachers should strengthen the education and awareness of intellectual property rights, and let students realize that plagiarism is an offence. Second, teachers should give students homework that will require them to design their own learning materials which they cannot get directly from the internet, so as to avoid plagiarism to some extent. Third, teachers should use technical means, such as anti-plagiarism detection software to prevent students from copying, as well control the proportion of assessment done online and balance it with other forms of assessment (Chen & Lu, 2013).

2.5.2 Predictors of E-Learning Technology Integration

There is a paucity of research investigating the factors that influence or predict preservice science teachers' integration of e-learning technologies into the teaching and learning of science subjects in South Africa. As a result, this section will review national and international literature on factors influencing or predicting integration of ICT and e-learning in general. Upon examining the relevant literature on ICT and e-learning integration, previous authors argued that one's attitude towards e-learning, skill, satisfaction with e-learning, flow experience and behaviour intentions are amongst the critical factors influencing one's propensity to integrate, or not to integrate e-learning into the instructions. Given their immediate relevance to this study, which is directly related to educational settings, this section systematically discusses these factors and the interactive effects, among them as a way of laying a solid foundation upon which the model being proposed in this study stands.

2.5.2.1 Attitude

An effective integration of e-learning into the teaching and learning processes will not be realized by teachers who hold negative attitudes or strong antagonism towards ICT, no matter how novel and useful the ICT may be (Huang & Liaw, 2005). Thus, the successful implementation and integration of e-learning largely depends on the attitudes of teachers who eventually determine how these tools will be used in the classrooms (Afshari, Bakar, Su Luan, Samah & Fooi, 2009).

A study was conducted by Drent & Meelissen (2008) to examine factors influencing the innovative use of ICT by a sample of 210 teacher educators in the Netherlands. The study revealed that positive attitudes of the teacher educators towards computers had a direct positive influence on their innovative use of ICT. Wong, Osman, Goh & Rahmat (2013) explained that the attitude of preservice teachers was an important predictor of successful ICT integration into teaching and learning. Yapici & Hevedanli (2012) conducted a study to determine the attitude of preservice teachers towards using ICT for biology teaching. The researchers administered questionnaires to 70 biology education preservice teachers, and found that the preservice teachers had positive attitudes towards the use of ICT for biology teaching.

In a very similar attempt, Govender (2010) investigated the attitudes of 45 preservice science teachers towards the use of an e-learning system in a blended learning environment at a South African University. The results showed that preservice teacher had positive attitudes towards the use of e-learning. Many of the respondents explained that the combination of the e-learning and the face-to-face mode of instruction enabled them to benefit from the module; that through their interactions with the lecturers, they were motivated to work and felt that the quality of education had improved.

Psycharis, *et al.,* (2013) explored the use of e-learning for changing 25 grade eight students' conceptions of fundamental issues in electricity. Results indicated that the students had strong attitudes towards the use e-learning for teaching and learning Natural Sciences. Similar results were reported by Al-Ani (2013) whose study revealed that integration of e-learning helped students to developed positive attitudes toward the module subjects and learning.

Scholars such as Sun, Tsai, Finger Chen & Yeh (2008) and Cheok & Wong (2015) argued that students' attitudes towards e-learning must be considered as an important factor in e-learning satisfaction. Students who have positive attitudes towards e-learning are more satisfied in using the system, and they are ready to overcome any difficulties that may arise from using the system. Sun, Tsai, Finger Chen & Yeh (2008) conducted a study among 295 students at two public universities in Taiwan to investigate the critical factors affecting students' satisfaction with e-learning. The results revealed that teachers' attitudes towards e-learning was one of the critical factors affecting student satisfaction with e-learning.

Prior research has demonstrated that attitude is a significant predictor of preservice teachers' intention to integrate e-learning (Teo & Lee, 2010; Teo & Tan, 2012). For example, Teo & Lee (2010) examined the key predictors underlying 157 preservice teachers' intention to use technology by employing the theory of planned behaviour (TPB) as a research model at the National Institute of Education (NIE) in Singapore. The results showed that attitude towards ICT usage was the strongest and significant predictor of intention to use technology than subjective norms, while perceived behavioural control was not. In a similar vein, Teo & Tan (2012) applied the theory of planned behaviour (TPB) to explain 293 preservice teachers' intention to use technology at a teacher training institute in Singapore through a questionnaire. The results showed that attitude, subjective norms and perceived behavioural control had significant influences on intention, with attitude having the largest influence

Based on the evidence reported above about the influence of attitude on e-learning usage, one may infer that if preservice science teachers have formed positive attitudes towards the use of e-learning, they are more likely to integrate it into their teaching and learning processes.

2.5.2.2 Skill

The ICT skills of teachers are another major predictor of ICT integration and lack of it has been reported as an inhibitor of ICT integration into classroom practice (Mofokeng & Mji, 2010; Howie, 2009; Agyei & Voogt, 2011; Allayar, 2011). Howie, (2009), Mofokeng & Mji, (2010) and Makgato, (2012) have revealed in their studies that most teachers in South African secondary schools are not competent in the pedagogical use of ICT for effective delivery of mathematics and science instruction. Bordbar (2010) discovered that the majority of teachers who showed negative or neutral attitudes towards the integration of ICT into teaching and learning processes lacked the knowledge and skills that would allow them to make informed decisions. Babic (2012) concurs that new knowledge and skills about e-learning technology encourages changes in teachers' attitudes, thereby influencing them to integrate e-learning technologies in their classrooms.

Peralta & Costa (2007) conducted a qualitative case study on teachers' skills and confidence level regarding the use of ICT teaching in five European countries. Their study revealed that technical skills influenced the Italian teachers' use of ICT in teaching. In Portugal, the experienced and new teachers stressed the need for technical skills; the innovative teachers emphasized curricula and didactic skills and the preservice teachers cited technical and pedagogical skills as significant factors for integrating ICT in teaching and learning processes (Peralta & Costa, 2007).

ICT competencies or skills are also seen as critical factors influencing preservice teachers' success in integrating ICT for teaching and learning purposes (Al-Ruz & Khasawneh, 2011). In a study, Allayar (2011) assessed 123 preservice science teachers' attitudes and competence towards ICT in science education curriculum at the Public Authority of Applied Education and Training (PAAET) in Kuwait. The study revealed that the majority of preservice science teachers had basic ICT skills such as looking for information from CD-ROMs and word-processing activities, but lacked advanced ICT skills and competencies such as videoconferencing, working with simulations and animations, and experimenting with virtual laboratories. The study also revealed that the preservice science teachers had positive attitudes towards ICT.

Agyei & Voogt (2011) conducted another study to predict ICT integration of 60 in-service mathematics teachers from 16 Senior High Schools and 120 preservice mathematics teachers at the University of Cape Coast. A questionnaire was used to collect data from both in-service and preservice teachers. The study reported lower levels of ICT integration by these teachers, resulting from their low ICT competencies and access levels of ICT.

Suffice it to mention that having basic ICT competencies is necessary, but it is not sufficient for preservice teachers to effectively integrate ICT in their teaching. In addition, they also need to be knowledgeable about the latest ICT innovations, like e-learning systems and how they can be used to enhance learning (Asiri, *et al.,* 2012). Moreover, if preservice teachers are to demonstrate ICT competencies, the university lecturers must, themselves, use ICT in the modules that they teach. Preservice teachers would be familiarised with the ICT through these modules, discover how it can be used to meet the learning objectives, motivate preservice teachers to integrate ICT into their teaching and may improve their technological skills (Al-Ruz & Khasawneh, 2011).

Asiri, *et al.,* (2012) strongly affirm the position that behavioural intentions of teachers towards integrating ICT are significantly influenced by their ICT competencies. Smarkola (2008) examined teachers' intentions to use e-learning for instruction by investigating how perceived skills influenced teachers' intention to use e-learning. The results showed that teachers' perceptions of their skills predicted their intention to utilise e-learning for instruction. Anderson, Groulx & Maninger (2011) conducted another study to investigate the factors that predicted 217 preservice teachers intention to integrate e-learning technologies in their classrooms at a private University in the United States. The findings of the study revealed that value beliefs and skills predicted preservice teachers' intention to integrate e-learning frequently in their classrooms. Consequently, if preservice science teachers have enough knowledge and skills to use e-learning technologies, they might integrate them for teaching and learning in their classrooms.

2.5.2.3 Satisfaction

The initial perceived satisfaction of users with e-learning will determine whether they will use the ICT continuously. A user who is more satisfied with the e-learning usage will have a higher level of future usage. In this regard, Ramayah, Lee & Mohamad (2010) and Baturay (2011) posit that user satisfaction is an important factor in measuring the effectiveness and usage of e-learning for research, teaching and learning purposes, because higher satisfaction is related to higher levels of e-learning usage.

Some studies have demonstrated the effects of satisfaction on intention to use e-learning. The relationship between satisfaction and intention has been validated in consumer behaviour research on a variety of product and service contexts (Bhattacherjee, 2001a, 2001b). The re-validation of this relationship with the e-learning context attests further to the strength of this relationship (Liaw, 2008; Lee, 2010; Chang, 2013). A study conducted by Ramayah & Lee (2012) examined the impact of student satisfaction with e-learning on intention to use e-learning among 250 undergraduate students from a public university in Penang, Malaysia. Their results showed that students' satisfaction was significant in determining students' intention to use the e-learning system.

A total of 424 university students in Taiwan was surveyed using a standard questionnaire, after using the Blackboard e-learning system for two months to determine their satisfaction, behavioural intentions and effectiveness of the Blackboard e-learning system (Liaw, 2008). The results of the study showed that perceived satisfaction and perceived usefulness were important predictors of students' behavioural intention to use the e-learning system. The extended expectation-confirmation model was used by Lee (2010) to explain and predict students' continuance intention in using e-learning. A total of 363 students in a web-based learning programme designed for Continuing Education at National Pingtung University in Taiwan were engaged. The study examined the effects of perceived usefulness, subjective norm, satisfaction, flow, attitude and perceived behavioural control on the continuance intentions to use e-learning. The results showed that satisfaction was the strongest predictor of students' continuance intention among all these factors.

Scholars such as Seluakumaran, *et al.,* (2011); Ekici, *et al.,* (2012); Bulic & Novoselic (2014) have carried out some studies on how satisfaction with e-learning technologies increase its usage by students, which invariably improved students' satisfaction with their module. These have been discussed in detail in *Section 2.5.1.2*, showing that the greater the satisfaction of preservice science teachers with e-learning technology experience, the stronger their intentions to integrate – and actually integrating e-learning technologies into the teaching and learning of science in their classrooms.

2.5.2.4 Flow Experience

People experience flow when they are completely engrossed in an activity to the point of losing sense of time and unable to recognize changes in their immediate environments. In particular, they can be very disconcerting to other people in the degree to which they can concentrate only on their ongoing activity. Flow experience is an intrinsic motivation which can stimulate users to do an activity with inner joy (Lee, 2010). Motivation can be divided into two types "extrinsic" and "intrinsic motivation." Extrinsic motivation refers to engaging in an activity because of its foreseeable valued outcomes, such pay increase or promotion to the next level. Intrinsic motivation on the other hand, refers to engaging in an activity without receiving any noticeable reinforcement, apart from simply for enjoyment (Liao, 2006).

Flow has two components - concentration and enjoyment in an activity. Concentration refers to the degree to which a student's attention focuses on an activity (Trevino & Webster, 1992). Enjoyment refers to the degree to which ICT usage being perceived to be pleasant, irrespective of the consequences that may arise (Davis, Bagozzi & Warshaw, 1992; Liao, 2006). When students use e-learning technologies, they may experience flow, as most e-learning tools provide interactive functions such as chat rooms and entertainment services, which may help students to enjoy and concentrate on their learning (Lee, 2010). Flow is sometimes similar to addiction and most researchers measure it with two variables - concentration and enjoyment. Kim & Jang (2015) explain that when students experience the enjoyment of using e-learning technologies, their intrinsic motivation regarding the use of e-learning technology increases.

Evidences from the literature supports the application of flow experience in explaining e-learning attitude, satisfaction, skills, intention and usage amongst students. Many researchers assert that when students are intrinsically motivated to learn, their level of learning increases and they develop a positive attitude and willingness to learn (Finneran & Zhang, 2005; Liao, 2006; Kim & Jang, 2015; Tuunanen & Govindji, 2016). For example, Liao (2006) applied flow theory to examine the cause and effect of the flow experience on students' attitude to using e-learning systems in a distance learning environment. Questionnaires were distributed to 253 undergraduate students who enrolled and engaged in studying a distance learning module at the National Chengchi University and the National Chiao-Tung University in Taiwan. The results indicated that flow theory worked well in a distance learning environment. The students experienced flow in using a distance learning system, and this developed many positive attitudes in them towards using e-learning systems.

Scholars such as Kim 2005; Shin, 2006; Park & Kim, 2006; Joo, Joung & Kim, 2013 have recognized flow experience as an effective factor for students' satisfaction in e-learning environments For example, Shin (2006) examined the relationships between flow and satisfaction among 525 undergraduate students who had completed e-learning courses. The findings showed that flow in e-learning was a significant variable affecting students' satisfaction in their studies. In a similar vein, Joo, Joung & Kim (2013) investigated the structural relationships among teaching presence, cognitive presence, usage, flow and satisfaction among 462 students registered for cyber-lectures in South Korea. The results showed that each of these variables and flow had significant effects on students' satisfaction in e-learning environments.

Schuler, Sheldon & Frohlich (2010) and Kim & Jang (2015) explain that enjoyment as an intrinsic motivator provides a perception of competence in using technology. Thus, motivating students to learn to acquire knowledge and gain the necessary skills in an e-learning environment is important as a goal of instruction. Kim & Jang (2015) argue based on the results of their study, which examined the predictors of preservice teachers usage of e-learning technology tools during teaching practice, that as the comfort level and enjoyment of preservice teachers increases by virtue of their usage of e-learning technologies during their teaching practice, their skills in integrating e-learning into their curriculum also increases. Thus, when preservice teachers are intrinsically motivated they feel autonomous and competent and would able to demonstrate their skill to effectively integrate technology into their teaching activities.

Teo & Noyes (2011) conducted a study to examine the influence of perceived enjoyment on preservice teachers' intention to use technology in Singapore. One hundred and fifty-three (153) PSST completed a questionnaire measuring five factors in the study. The results showed that perceived enjoyment was a significant predictor of PSSTs' intention to use technology.

Lee (2010) carried out another study to explain and predict students' continuance intention in using e-learning, using the flow theory among 363 students in a Web-based learning service designed for Continuing Education students at the National Pingtung University in Taiwan. The study examined the effects of satisfaction, flow experiences, perceived usefulness, attitude, subjective norms, and perceived behavioural control on the adoption and continuance intention to use e-learning. The results showed that the students obtained the flow experience by concentrating on the e-learning services that directly affected students' intention to use the e-learning service. In general, the results demonstrated that concentration had a significant influence on the students' intention to use the e-learning service.

Moreover, if teachers and students believe that e-learning is very interesting and enjoyable for teaching and learning, they will integrate it into their teaching and learning processes (Elkaseh, Wong & Fung, 2015; Kim & Jang, 2015). In another study, Kim & Jang (2015) examined the predictors of preservice teachers' usage of Web 2.0 tools during their teaching practice. This study was conducted with 102 preservice teachers after a technology module at a national university in South Korea. A total of 102 preservice teachers completed the online questionnaire, and the results revealed that 68% of the preservice teachers used Web 2.0 tools during their teaching internship as a result of their perceived enjoyment (a feature of flow experience) in using Web 2.0 tools in the communication technology module. In essence, the results indicated that perceive enjoyment was the strongest predictor of preservice teachers' use of Web 2.0 tools during their teaching practice.

In addition, the time that students invest in working with the ICT is another dimension that researchers should look at. After students experience flow in a learning activity, they tend to continue engaging in that activity and want to explore new functions of the activity, ignoring the sense of time until the time elapsed. According to Csikszentmihalyi (2007), a researcher can experience flow when doing research in a dark room through the microscope and see some beautiful glowing objects in different colours moving around or may be stationary. Thus, a researcher can sit in front of the microscope for three or four hours at a time, just looking at the material and analysing it, not knowing that time has passed really fast. Hence, when preservice science teachers use e-learning technologies, there is potential for them to experience flow and this could lead them to integrate e-learning technologies into their classroom instruction.

2.5.2.5 Intention

Several technology acceptance models, such as the theory of reasoned action (TRA; Fishbein & Ajzen, 1975**)**, theory of planned behaviour (TPB; Ajzen, 1991), and technology acceptance model (TAM; Davis, 1989) unite and emphasise the point that the most immediate and important predictor of a behaviour (usage) is behavioural intention. In regard of the relationship between intention and behaviour, researchers have used behavioural intention to predict in-service and preservice teachers' use of ICT and e-learning in the teaching and learning contexts (Teo & Lee, 2010; Teo & Tan, 2012; Lee, Cerreto & Lee, 2010; Zhou, Chan, & Teo, 2016). In a study by Teo and Lee (2010), the theory of planned behaviour (TPB) was applied to examine the intentions of 157 preservice teachers to use technology at the National Institute of Education (NIE) in Singapore thorough a questionnaire. Structural Equation Modelling (SEM) analytic technique was used to validate the data captured. The results of this study showed that attitude and subjective norms were significant predictors of behavioural intention to use technology while perceived behavioural control was not. The results explained about 40% of the variance in intention to use technology among preservice teachers in Singapore.

In a similar vein, Teo & Tan (2012) applied the theory of planned behaviour (TPB) to explain 293 preservice teachers' intention to use technology at a teacher training institute in Singapore through a questionnaire. SEM was also used to analyse the TPB model. The results showed that attitude, subjective norms and perceived behavioural control had significant influences on intention. Overall, the study explained 51% of the variance in intention of the preservice teachers' intention to use technology.

Lee, Cerreto & Lee (2010) used the theory of planned behaviour to investigate 34 high school teachers' intentions to utilise technology such as PowerPoint to create and deliver teachers' lessons in the Republic of Korea. The results revealed that attitude, subjective norms, and perceived behavioural control were statistically significant predictors of teachers' intentions to use computers to create and deliver lessons. The study accounted for 70% of the variance in teachers' intentions to use technology.

Zhou, Chan, & Teo (2016) applied the TPB to explain the intention of 190 secondary school mathematics teachers to use Dynamic Geometry Environments (DGEs) in Macau through a questionnaire. Using the SEM approach, the results revealed that subjective norms and perceived behavioural control were significant positive predictors of intention, while attitude was not. The study accounted for only 19.5% of the variance in intention of the teachers to use technology.

However, a limitation of these studies is that there are inconsistencies in the variance at which intention might lead to integration in all these studies. Based on this limitation, previous authors (Davis, Bagozzi & Warshaw, 1989; Sheeran, 2002; Taylor &Todd, 1995; Venkatesh, Morris, Davis & Davis, 2003; Amireault, Godin, Vohl & Pérusse, 2008; Bhattacherjee & Sanford, 2009) have suggested a need to moderate this inconsistency in the variance at which intention can predict integration with a moderator, which has been dealt with in *Section 2.5.3* of this study.

2.5.2.6 E-Learning Technology Integration

The ever-growing and emergent role of e-learning technologies in education have put great pressure on teachers and schools to create new technology-enhanced teaching methods to improve the quality of teaching and learning (Sadaf, 2013). The integration of e-learning technologies has become a policy choice in educational development and reform across the world. This evolving trajectory strengthens the conviction that traditional approaches to teaching cannot cope with the high demand for education (Evoh, 2009). The integration of e-learning technologies in education should change the nature of teaching rather than just using technology to disseminate traditional teaching and learning methods. It requires that teachers should alter their classroom practices from traditional teacher-centred application to student-centred mode of teaching.

To show that that there is a major concern about integrating e-learning technologies into the education system, many governments across the nations of the world have invested and made considerable capital investments through several initiatives to provide a variety of interventions to help teachers integrate e-learning technologies into teacher education programmes and schools, with the goal to influence the education system, the performance of teachers and enhance student learning outcomes (Isaacs, 2007; Ndlovu, 2009; Teo & Wong, 2011; Sadaf, 2013). Despite these initiatives, many studies have revealed that the integration of e-learning technologies in many schools are insufficient and has not reached the levels of effective technology usage promoted by educational reform programme effort (Howie, 2009; Mofokeng & Mji 2010; Makgato, 2012; Sadaf, 2013).

However, Evoh (2009) expresses concern about teachers' unwillingness to integrate e-learning technologies to innovate teaching and learning, arguing that one solution to this dilemma is to shift our mindsets away from the notion of training in-service teachers for integrating e-learning technologies alone and focus on embracing and preparing preservice teachers, who are expected to be part of the innovation change process for technology integration as a way to improve teaching and e-learning in the classrooms. Several researchers have stated that the role of preservice teachers in the integration of e-learning technology in the classrooms has been crucial (Chen, 2010; Teo & Schaik, 2009; Wong, Osman, Goh & Rahmat, 2013).

In light of this, educational institutions have been helping and providing their preservice teachers with many varied technology-related experiences and preparing them to utilise technology to enhance teaching and learning to overcome the challenges they will most probably face in classroom practice. Today's preservice teachers are expected to be leaders of technology application in the curriculum upon their graduation from the universities and to demonstrate to seasoned contemporaries the new trends in technology in order for them to gain expertise (Krueger, Hansen & Smaldino, 2000; Ward & Overall, 2013). By doing so, newly qualified teachers may not be re-trained in the basic technology skills and integration of e-learning technologies into the curriculum and instruction. The literature revealed that many national and international studies have been conducted highlighting the innovative use of e-learning technologies in high schools, primary schools and many of the reputed universities of the world *(see table 2.3).*

2.5.2.6.1 Integration of E-Learning Technology in Science Education

The use of e-learning technologies in schools, particularly in teaching science has been a subject of much discussion in educational forums. The place of e-learning technologies in teaching science education in schools cannot be over emphasized considering its promises for effective teaching and learning. More importantly, when e-learning technologies are used to supplement traditional teaching, they have the potential to play an important role in making school science more relevant, interesting and motivating to students to learn (Mork, 2005).

The use of ICT in science instruction began in the seventies (Martin-Blas, 2009). Since then, many studies have analysed the effectiveness of new technologies in teaching and learning of science subjects (Martin-Blas, 2009; Seluakumaran, *et al.*, 2011). These authors consider that teaching science as a scientific problem-solving paradigm is more effective and efficient than using only traditional approach. Although, there is a view regarding the learning of science that students' learning efficiency of science is not as good as expected. Students usually find it difficult to apply the concepts they have been taught in the science classroom, as they may be frightened by the challenge of abstract thinking (Martin-Blas, 2009; Kalanda, 2012). In this technological age, proficiency in science is highly desirable for all students as e-learning technologies offer teachers and students many interesting tools to use in science activities which can improve both the practical and theoretical aspects of science teaching and learning processes (Osborne & Hennessey, 2003; Martin-Blas , 2009).

Science education researchers such as Kabapinar (2004) and Rankumise (2012) have found that interactive teaching strategies such as enquiry and problem-based science approaches result in higher gains in knowledge and understanding of scientific concepts. This active, constructivism-based approach to science teaching and learning supports students' creativity, participation, social learning development, and encourages the acquisition of new skills such as: high-order thinking and learning skills, learning to develop hypotheses, setting up experiments, drawing conclusions, working in groups and interact with peers, and reporting findings (Sporea & Sporea, 2011). For example, e-learning as an interactive teaching strategy has many features which can be used to explain many scientific concepts that are very difficult for students to understand (Martin-Blas, 2009; Cavus & Alhih, 2014).

Inan (2010) grouped the use of e-learning technologies in school into three categories: for instructional preparation (which includes preparing for various classroom activities; such as preparing instructional materials, communicating or collaborating with peers, and students, and preparing lessons plans); for instructional delivery, to present instruction by using a projector; and to facilitate learning with the use of software applications, such as word processing, presentations spreadsheets and Web 2.0 tools.

Many previous studies have highlighted the good practice of using e-learning technologies for imparting sciences across the world. Table 2.6 summarises those relevant studies that have explored the use of e-learning technologies for science teaching and learning.

Table 2. 6: Summary of previous studies on the use of e-learning technologies for science

Author	Country	Method	Result
Cahill (2008).	Wimberley Independent School District, United States.	Assessed the usage patterns of e-learning by biology teachers and students in the ninth grade biology classroom.	1. Results indicated that teachers and students acquired new skills to use e-learning, and helped students to engage in self-centred learning.
Ahmad and Al-Khanjari (2011).	Sultan Qaboos University, Sultanate of Oman.	Explored the effect of e-learning on 510 students learning a module named “Basic Computing Skills” offered in the foundation program through questionnaires.	1. Students specified that e-learning improved their understanding and learning of the module materials and examination preparation. 2. Availability and usage of e-learning led to more positive attitudes towards the module by the students.
Pacemska, Pacemska and Zlatanovska (2012).	University "GoceDelcev" the Republic of Macedonia.	Compare the achievements of 130 students in Mathematics who used Moodle as a teaching tool with those who did not use Moodle.	1. Students achieved the best results in the mathematics examination during the academic period when more intensive use of Moodle was applied in the learning process. 2. Students that used Moodle platform regularly throughout the school year got better grades in the examination than those who rarely or never use it.
Seluakumara, Jusof, Ismail and Husain (2011).	University of Malaya.	Evaluate the usage pattern of Moodle and its impact in a blended learning environment for 178 students learning outcomes in physiology using student exam performance, and student feedback.	1. Student performance in their final physiology examination marks was improved compared with the previous class that did not use Moodle, suggesting that the implementation of Moodle had a positive effect on student

			learning outcomes. 2. Students were generally satisfied with Moodle e-learning tool because it allowed interactions with their peers and tutors.
Ekici, Kara and Ekici (2012).	Faculty of Education, Pamukkale University, Turkey.	Evaluate the views of 57 preservice primary school teachers about the potential contribution of using e-learning to complement face-to-face teaching in undergraduate Physics.	1. Such blended learning approach helped the teacher candidate to participate actively in the lesson. 2. It makes them contented with using e-learning and most of them tried to use this method in their professional life, especially in the instructional process.
Çelik (2010).	Afyon Kocatepe University, Faculty of Education.	Evaluate the views of 196 preservice teachers of Physics, Chemistry and Biology department on the use of e-learning in a blended environment to teach Instructional Technologies and Material Design.	1. The result indicated that the use of e-learning provided meaningful learning for the preservice teachers and helped them to embody the abstract topics in their module and save time to study out of the classroom.
Florio (2014).	Simon Fraser University, Canada.	Use e-learning in a blended learning environment to reduce student misconceptions in projectile motion, a topic in Physics.	1. E-learning did help students to understand the concept of projectile motion and confidently challenged their misconceptions about projectile motion.
Bulic and Novoselic (2014).	Pujanka Univeristy in Split, Croatia.	Determine the efficiency of e-learning with the acquired knowledge of 48 preservice teacher compared to traditional teaching on four biology lessons.	1. Preservice teachers pointed out that the text and visual descriptions were highly helpful during the learning process, but the experimental group's quiz results were not significantly better than the control group's results. 2. The majority of the preservice teachers was satisfied with using e-learning in a biology class and develop positive feelings towards e-learning.
Psycharis, Chalatzoglidis and kalogiannakis (2013).	Secondary education in Greece.	Explored the role of e-learning as a tool for changing 25 grade eight students' initial conceptions of fundamental issues in electricity in Physics.	1. Results showed a slight improvement in students' performance in Physics and the difference was associated with a significant change in the students' conceptual understanding because the students expressed their views that e-learning helped them to have a better conception about Physics.
Pardamean, Suparyanto and Kurniawan	Private University in Jarkarta.	Assessed the usage of e-learning in graph theory with 97 undergraduate students divided	1. Results indicated students in the experimental group performed significantly better

(2013)		into two groups. The experimental group consisted of 48 students taught through the use of blended learning while the control group consisted of 49 students taught through the use of conventional methods.	than those in the control group.
Ndlovu and Mosert (2014)	Advanced Certificate in Education (ACE) programme in South Africa	Investigated the effect of e-learning to support 71 in-service mathematics teachers in a blended learning. Advanced Certificate in Education (ACE) programme in South Africa.	The results indicated that e-learning helped the in-service teachers to address their learning needs about the mathematical content, sharing of ideas and experiences with each other. They also managed to interact with their lecturers to gain clarity on topics and concepts they found difficult to understand.

2.5.2.7. Limitation on Factors Predicting e-Learning Technology Integration

This literature review of factors predicting e-learning technology integration revealed two limitations. First, these studies that have been examining factors influencing or predicting integration of e-learning technologies have failed to review the relationships among these factors, which would have given us a better understanding of how these factors predict the integration of e-learning technologies. Second, most of these studies have failed to use a mixed methods research paradigm (a combination of quantitative and qualitative data) thereby providing a narrow way of understanding integration of e-learning technologies. Some of the studies used quantitative methods which provide only one perspective about this phenomenon. Few studies (Tuunanen & Govindji, 2016; Ekici, *et al.,* 2012; Peralta & Costa, 2007) used only qualitative methods. Using both quantitative and qualitative methods in this type of studies is appropriate to combine the strength of both approaches, validate the results and examine factors predicting e-learning technology integration from diverse perspectives so as to provide a more useful and broader understanding of the complexity of the integration in schools. Hence, the relationship among factors that influence preservice teachers to integrate e-learning technologies are depicted in Table 2.7.

Table 2. 7: Relationship among the factors predicting e-learning technology integration

Factors	Relationship	Authors & Years
Attitude	Attitude → Satisfaction	Piccoli, Ahmad & Ives, 2001; Sun, *et al.,* 2008; Cheok & Wong, 2015.
	Attitude →Intention	Teo, 2008; Teo & Lee, 2010; Lee, Cerreto & Lee, 2010.
	Attitude →Integration	Drent & Meelissen, 2008; Govender, 2010; Yacipi & Hevedanli, 2012; Al-Ani, 2013; Psycharis, *et al.,* 2013; Wong, *et al.*, 2013.
Skill	Skill →Attitude	Bordbar, 2010; Babic, 2012.
	Skill →Intention	Smarkola, 2008; Anderson, Groulx & Maninger, 2011.
	Skill →Integration	Peralta & Costa, 2007; Howei, 2009; Mofekeng & Mji, 2010; Al-Ruz & Khasawneh, 2011; Allayar, 2011; Agyei & Voogt, 2011.
Satisfaction	Satisfaction →Intention	Liaw, 2008; Lee, 2010; Ramayah & Lee, 2012; Chang, 2013; Aziz & Kamaludin, 2014.
	Satisfaction→Integration	Ramayah, *et al.*, 2010; Baturay, 2011; Seluakumaran, *et al.*, 2011; Ekici, *et al.*, 2012; Bulic & Novoselic, 2014.
Flow Experience	Flow →Attitude	Finneran & Zhang, 2005; Liao, 2006; Kim & Jang, 2015; Tuunanen & Govindji, 2016.
	Flow →Skill	Schuler, Sheldon & Frohlich, 2010; Kim & Jang, 2015.
	Flow →Satisfaction	Kim, 2005; Shin, 2006; Park & Kim, 2006; Joo, Joung & Kim, 2013.
	Flow →Intention	Lee, 2010; Teo & Noyes, 2011.
	Flow →Integration	Elkaseh, Wong & Fung, 2015; Kim & Jang, 2015.
Intention	Intention →Integration	Teo & Lee, 2010; Teo & Tan, 2012; Lee, Cerreto & Lee, 2010; Zhou, Chan & Teo, 2016

2.5.2.8 The Need for a Unifying Framework for e-Learning Technology Integration

This study combined factors influencing technology integration in the literature, namely attitude, skill, satisfaction, flow experience and intention to postulate a new model to predict preservice science teachers' integration of e-learning technologies. These five factors were combined for the following three reasons. First, previous researchers have found attitude to be the greatest predictor of technology integration at the highest level of teachers' technology integration in the classroom (Christensen & Knezek, 1999; Knezek, Christensen & Fluke, 2003).

Morales (2007) argues that teachers' attitudes to use technology are pointless if it is not supported by the necessary skills to use the technology, that is, the attitude must be blended with skills for technology integration to be effective, hence the use of skills in this model which some researchers (Morales, 2007; Agyei &Voogt, 2011) agreed to be a significant predictor of technology integration. However, preservice teachers' technology integration can be influenced by other factors, such as their intention (Teo & Lee, 2010; Teo, & Tan, 2012; Lee, Cerreto & Lee, 2010; Zhou, Chan, & Teo, 2016). Furthermore, even if preservice teachers have a strong intention to integrate technology, they may feel that they are not satisfied with the performance and functions of e-learning and the e-learning environment. The use of satisfaction addresses this gap.

Second, the addition of the flow experience in this study gives room to capture the elements of intrinsic motivation through quizzes and other creative methods that create fun and interest in the learning process (Lee, 2010). Flow experience has been used to describe a state in which people are totally involved in an activity to the point of losing sense of time and being unable to recognize changes in their immediate surroundings (Csikszentmihalyi, 1997). When preservice science teachers use e-learning technologies, there is potential for them to experience flow, because most e-learning products provide chat rooms, discussion boards, all of which may create fun, provide enjoyment and lead to concentration and engage them to integrate e-learning technologies in classrooms.

Third, since each of these factors has been studied separately by researchers to influence technology integration, the combination of these factors is seldom examined under a single framework to sort out their relative importance and to identify the relationships among them. Thus, studying the factors separately may provide an incomplete understanding of preservice teachers' integration of technology. Hence, it is possible that, when these factors are combined, they collectively provide an improved and a broader understanding of the factors that best predict the integration of e-learning technologies than when each factor is examined alone.

2.5.3 The Intention-Behaviour Gap

As discussed in chapter one of this study, there is increasing empirical evidence in the literature that contradict the claim by extant theories of technology usage that intention is a primary predictor of the user's actual IT usage (Sheeran, 2002; Taylor & Todd 1995; Venkatesh *et al.,* 2003). These authors point out that intention may not always influence usage of technology or may do so in an inconsistent manner because of the predictive power of intention which constitutes a low-to-medium effect size of intention on usage. This degree of inconsistency between users' intention and usage is called 'the intention-behaviour gap'.

In the context of educational system, it is not always the case that teachers or students who express intention to integrate a particular technology will translate their intention into the actual integration of technology in the real classroom configuration. There are third factors that may inhibit or enhance the direction and the strength of the relationship between intention and the actual integration of technology known as a moderator.

2.5.3.1. Emphasis on Moderating Factors

A moderating factor is an interesting term used when the relationship between independent and dependent factors is surprisingly weak, inconsistent or does not exist (Touray, Salminen & Mursu, 2013). Based on the inconsistency or contradictory findings reported in the literature about the relationship between intention and usage behaviour, it is apparent that a moderating factor can be introduced to improve the strength of the relationship. However, the literature review of ICT usage reveals that relatively few studies have examined the factors that may moderate the relationship between intention and usage behaviour. For example, Bhattacherjee & Sanford (2009) tested the moderating roles of two dimensions of attitude strength (personal relevance and related expertise) on the intention-behaviour relationship of document management system usage amongst governmental employees in Ukraine. The result showed that the moderating roles of the two attitude strengths were positive and stronger on the relationship between intention and behaviour. That is, the intention-behaviour relationship was larger for users with stronger attitudes and smaller for users with weaker attitudes.

Moghavvemi, Mohd Salleh & Abessi (2013) also used the precipitating events such as incentive, loan and resource availability, as moderators between entrepreneurs' intention and the actual use of ICT in their daily business activities in Malaysia. The results showed that the moderating factors mitigated the link between intention and usage behaviour. However, the limitations of these studies are that the results are restricted to ICT usage among governmental employees and business activities. With specific regard to the field of e-learning technology integration, these moderators do not address the specific transformation that e-learning intends to bring into the education system. There is the necessity, therefore, to find more appropriate moderators that could reflect the important roles that ICTs are targeted to achieve in the education system.

2.5.3.2 Moderating Effects Innovation and Quality Consciousness

The unique moderators being proposed in this study for moderating intention-integration relationships are *innovation consciousness* and *quality consciousness.* These consciousness-based moderators are relevant because they have been emphasised in the literature as the major benefit that usage of e-learning technologies brought into the educational process (Asiri, *et al.*, 2012; Buabeng-Andoh, 2012). In addition, the overarching goal of the modern education system, is to seek innovative ways of achieving quality or excellence in teaching and learning with the use of e-learning technologies (Biggs, 2003). The concept of consciousness implies a subjective or a phenomenal sense of feelings, choice, control of voluntary behaviour, memory, thought, language and internally generated patterns in the brain (Hameroff & Penrose, 2014). This study, thus, assessed consciousness in terms of the conceptual measures of sense of self, knowledge awareness, control of voluntary behaviour to integrate e-learning and feelings of intrinsic quality or excellence that e-learning brings to the vanguard of an education system.

2.5.3.2.1 The Concept of Innovation

Innovation is an idea, practice or object that is perceived as new by an individual or a group of people while innovativeness refers to the degree to which an individual or group of people is relatively earlier in accepting new ideas than other member of a social system (Rogers, 2003, 2005). A person is called innovative if s/he is an active seeker of new ideas. An innovative person has relatively high willingness to accept and adapt new technologies, s/he tends to expect an outstanding performance through the new system. Innovative students are very enthusiastic to learn new technologies quickly, accept them and use them in their learning. This automatically increases their technology usage rate (Turan, Tunc & Zehir, 2008).

Numerous higher educational institutions across the world, such as universities, are being extremely reshaped by technological innovations. The implementation of e-learning programmes in these institutions has emerged as an innovative strategy to transform them to a digital scholarly environment which promotes the culture of student-centred methods in the way they conduct their teaching and learning (Masizana, Mpoeleng & Nkgau, 2009).

The innovation theory, for instance, the diffusion of innovations theory (Rogers, 1995) postulates innovation decision as a mental process through which an individual diffuses from the first knowledge of an innovation to forming an attitude towards the innovation. This attitude might be a decision to integrate or reject an innovation, which may be influenced by characteristics such as benefit, compatibility, complexity, trialability and observability of the innovation. Relative advantage denotes any likely benefits that the new system can offer students over the previous and alternative technology while compatibility refers to the extent to which an innovation satisfactorily meets the existing values, beliefs and needs of students. Complexity refers to the degree to which the system is perceived by students as relatively easy or difficult to understand or use. Trialability indicates the degree to which an innovation can be used by students on a trial basis before making a major commitment to its use. Observability refers to the degree to which the reality of the results of using an innovation can be clearly seen by others.

However, the integration of e-learning technologies into curriculum delivery develops innovative spirits in students. It encourages constructive and dynamic learning such that the critical thinking capability of students can be developed in a more efficient way as opposed to the traditional teaching practices (Chigona, Chigona & Davids, 2014). Many studies have been carried out in the literature to affirm that e-learning is an innovation to support the teaching and learning process. Rogers & Wallace (2011) examined the relationships between the level of computer innovativeness and the level of technology integration among 200 preservice education major teachers at a South West private University in the United States. The results showed that a significant relationship was found between technology integration and computer innovativeness. In other words, this study showed that the degree of e-learning innovativeness of preservice teachers greatly influenced them to integrate e-learning into their teaching and learning.

Liao & Lu (2008) used diffusion of innovation characteristics of e-learning to understand factors that may impact the intention to use online e-learning among 137 students who enrolled in a project management (PM) module at a comprehensive university in Taiwan. Students received a one hour, hands-on demonstration on using e-learning before the module actually began. At the end of the module, the students were asked to complete a questionnaire. The results indicated a significant relationship between students' perceptions of innovation attributes of the learning website and their intention to use e-learning. Notably, this study also indicated that the students' intentions were related to their actual use of a web learning system.

Ali, Haolader & Muhammad (2013) identified the innovations that e-learning had brought into teaching-learning process in higher institutions of learning in Uganda. A questionnaire was administered to 90 teachers and 75 administrators from five selected higher education institutions in Uganda. The findings of the study revealed that the teaching staff and the administrators classified the innovations that e-learning had brought into the teaching-learning processes to include: e-communication, online student registration, quick access to information, reducing the burden of keeping hardcopies, online advertisement and networking with resourceful persons. The findings of the study concluded that the presence of all these innovations provided an opportunity for the staff to integrate e-learning into the teaching and learning processes.

Prenjasi and Ahmetaga (2015) conducted another study to investigate the expectations of 33 students about the usage of e-learning for the module Experimentation of Physics at the Bachelor level and Micro Computer-based laboratory at Master's level at the University of Shkoder in Albania. Open-ended questions were designed to get a wide range of responses from the students. The results showed that the majority of the students affirmed the view that e-learning remained an innovation for teaching and learning processes which helped them to acquire new methods and techniques for innovative learning.

2.5.3.2.2 The Concept of Quality

The quality of the educational process is one of the factors responsible for student's achievement and success in their learning (Babic, 2012). The concept of quality can be explained within the total quality management framework as the philosophy that is aimed at achieving quality or excellence in education through the use and application of e-learning technology tools and techniques as well as the management of soft aspects such as human motivation (Zadry & Yusof, 2006).

E-learning is undoubtedly playing an important role in the field of education, in schools and universities, by directly contributing significantly to the improvement of the quality of teaching and learning practices - and by providing teachers with improved educational content and more effective teaching methods. E-learning also contributes to better preparation of students for the information age, improved learning outcomes and competencies of students, and by equipping students with the required survival skills for the information society and knowledge economy (Ziphorah, 2014). Thus, Ageel (2011) asserts that the integration of e-learning in education is one of the interventions through which students are provided with quality education. Students gain access to wider academic resources through the use of e-learning technologies which engage them in interactive learning and promote individualized learning among them. The necessary skills and knowledge of e-learning possessed by the students facilitate the provision of quality education and improvement in their academic performance.

Some studies have been carried out to support the evidence that e-learning improves the quality of teaching and learning processes. Govender (2010) assessed the attitudes of 45 computer science education preservice teachers towards the use of e-learning system in a blended learning environment at a South African University. The results showed that the majority of the preservice teachers contended that the use of e-learning in their instruction increased the quality and efficiency of education.

Yanuschik, Pakhomova & Batbold (2015) utilise e-learning to improve the quality of education for 65 international students having difficulties learning mathematics in their first year at Tomsk Polytechnic University in Russia. The students were divided into two groups, one group was taught the module on linear algebra and analytic geometry via the traditional method and the other group was taught the same module using e-learning assisted instruction (for both lectures and practical training) to supplement the educational process. The performance of the students was compared in theoretical tests and practical skills acquired during classes. The result showed that the students belonging to the group that received their instruction supported by e-learning performed better than the students following traditional instruction. The use of e-learning improved the efficiency of the classroom work, enabled students to navigate through the learning materials, helped them to respond faster to teachers' questions and enhanced their problem solving skills. The study concluded that the use of e-learning in the educational process improved the quality of practical sessions of the module and provided a better understanding of the module content.

Based on the above evidence from the literature on innovation and quality, this study strongly posits that if preservice science teachers are conscious that integration of e-learning technologies would improve the quality of teaching and learning science, develop an innovative spirit in students to promote deep learning and help student to dynamically construct their own knowledge, then quality consciousness and innovation consciousness will strengthen the intentions of preservice teachers to integrate e-learning technologies into their teaching and learning of science subjects

Figure 2.1 shows the SEM of the moderated relationship between intention and integration. This structural model provides the mechanism to realize the third objective of this study.

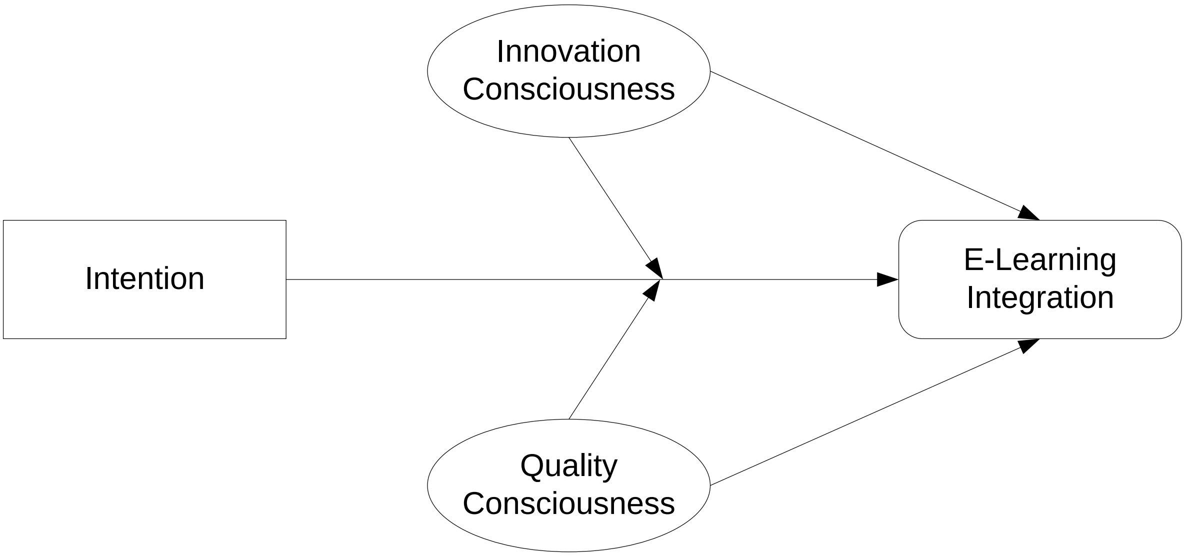

Figure 2.1: SEM of moderated relationship between intention and integration

2.5.4 Preservice Teachers' Experiences about E-Learning Technology Integration

Despite the continuing debates on the advantages and disadvantages of e-learning technology integration in classroom learning, researchers tend to agree that it is important to prepare teachers who are capable and comfortable to apply advanced technologies to promote students' critical thinking abilities, collaboration, and problem-solving skills (Choy, Wong & Gao, 2009). The preparation of teachers for effective integration of e-learning technologies into instructions appears to be a key component in almost every improvement plan for education and educational reform programmes (International Society for Technology in Education, 2007; Bos, 2011; Incikabi & Tokmak, 2013). This is also on the programme of South Africa's educational reform initiatives on e-learning and ICT (Department of Education, 2004). South Africa's ICT policy in Education emphasizes that integrating technology into Primary and Secondary education (grades 1–12) as one of the main educational priorities of the educational system of the nation (Department of Education, 2004:19). However, preparing preservice teachers to integrate new and emerging ICTs in their curriculum remains a challenging task (Groove, 2008). In this regard, teacher education programmes have made extensive efforts in addressing these concerns by providing preservice teachers with the necessary skills and knowledge for integrating e-learning technologies through teacher education modules. In addition, preservice teachers are given the opportunity to experiment with technology during their teaching practice so as to prepare them to use e-learning technologies effectively in classrooms (Kay, 2006; Wright & Wilson, 2006; Choy, *et al.*, 2009; Liu, 2012). Technology modules have successfully shown advantages in developing the preservice teachers' basic knowledge and skills in a manageable way (Persichitte, Caffarella, & Tharp, 1999; Ertmer, 2005; Coutinho, 2008).

However, Evoh (2009) expresses concern about the unwillingness of teachers to integrate ICT to innovate teaching and learning, arguing that one solution to this dilemma is to shift the mindsets away from the notion of training in-service teachers for technology integration alone and focus on embracing and preparing preservice teachers, who are expected to be part of the innovation change process, for technology integration. This can be achieved by including ICT integration as a core part of the teacher education curriculum to give them more innovative skills and pedagogy, as a way to improve technology integration in the classrooms. A number of scholars have indicated that the role of preservice teachers in the integration of e-learning technology in the classrooms has been very important (Chen, 2010; Teo & van Schaik, 2009; Wong, Osman, Goh & Rahmat, 2013). In light of this, educational institutions has been helping and providing their preservice teachers with many varied technology-related experiences and preparing them to utilize technology to enhance teaching and learning to overcome the challenges they will most probably face in the classroom practice. Today's preservice teachers are expected to be leaders of technology application to the curriculum upon their graduation from the universities and to demonstrate to seasoned contemporaries the new trends in technology in order for them to gain expertise (Krueger, Hansen & Smaldino, 2000; Ward & Overall, 2013). By doing so, newly qualified teachers may not be re-trained in basic technology skills and the integration of technology into the curriculum and the instructions.

Teaching practice experiences are critical periods in preparing preservice teachers to effectively teach with technology (Bullock, 2004; Groove, 2008). The actual practice of teaching with technology itself can be a powerful influence on preservice teachers' learning and could have an enormous impact on their abilities to transfer the technology-related knowledge and skills they gain through their universities modules to other educational situations (Bullock, 2004; Choy, *et al.,* 2009). It is an opportunity to see whether or not they can apply what they have learned in the university classroom to real life situations in the lessons for their students, which is an essential part of their preparation for teaching.

Choy, *et al.,* (2009) suggest that when preparing preservice teachers to teach with technology, they should be contextually and socially situated in the school-based learning environment for better transfer of knowledge and skills. For example, in South Africa, the initial experience of technology integration by preservice science teachers occurs during the mandatory teaching practice period. During this period, the preservice science teachers teach science subjects (mathematics, physical science, natural science, life sciences, and technology) as per their areas of study at the university. This is carried out at designated primary and secondary schools for six weeks under the supervision of host teachers in the schools and supervisors from their universities. The preservice science teachers are required to complete their teaching practice before their graduation, in order to fulfil the graduation requirements of teacher certification. Thus, teaching practice is a critical component of every university's teacher certification programme, during which preservice teachers are given an opportunity to teach students in a formal classroom environment and to integrate technologies in their teaching activities.

If preservice teachers are able to adopt the pedagogical use of e-learning technologies learned in their teacher education programme, during the teaching practice experience in their beginning years of teaching, it is likely that they will bring new ideas and practices into their classrooms and the schools. Ultimately, they may become the change agents in their schools, helping to alter the school culture by modelling for the veteran teachers how to effectively integrate e-learning technologies into the instructional processes (Choy, *et al.,* 2009). This pattern will be an indication that new graduates from a teacher education programmes have more knowledge of e-learning technology integration and are better prepared to integrate e-learning technologies into classroom instruction compared to more experienced teachers (Inan & Lowther, 2010).

Scholars such as Bullock (2004); Groove (2008); Choy, *et al.*, (2009); Sadaf (2013) suggest that the integration of e-learning technologies during teaching practice should be taken seriously in the preparation of preservice teachers as a means of establishing ICT practices which they will use in their classrooms after graduation (Bullock, 2004; Groove, 2008; Choy, *et al.*, 2009; Sadaf, 2013). There are some studies that have investigated the preservice teachers' practices with the integration of e-learning technologies till the end of the teaching practice experience. Brown & Warschauer (2006) investigated preservice teachers' perceptions of technology during module work and teaching practice, and reported that the preservice teachers lacked exposure to technology integration during their teaching practice experience. However, they did not examine if the preservice teachers had used technology during teaching practice.

In their study to explore changes in the intentions of 118 preservice teachers' and their actions to integrate technology in the classrooms during their teaching practice in Singapore, Choy, *et al.*, (2009) reported that both quantitative and qualitative approaches showed that preservice teachers had positive intentions to integrate technology to facilitate student-centred learning in their teaching. However, many of the preservice teachers were unable to integrate technology into their lessons during their teaching practice because technology such as hardware and software were not readily available in the classrooms, plug-ins were not updated and internet speed was slow. In addition, few preservice teachers who used technology used it as instructional tools to deliver information, capture student attention by showing images or videos from the internet and to promote student-centred learning in their lessons.

Chen (2010) used the SEM technique to investigate 206 preservice teachers' integration of technological resources specifically to support student-centred learning in the United States. Online surveys during preservice teachers' teaching practice experience and paper-based surveys during method classes were used to collect data from the preservice teachers. This study is limited on two grounds. First, a single methodological approach was used to carry out both surveys, and failed to provide a qualitative report to validate the quantitative results reported in the study. Second, the study failed to explain whether the preservice teachers, examined during method classes actually integrated technology during their teaching practice experiences.

Kim & Jang (2015) conducted another study in South Korea to examine 102 preservice teachers' actual integration of Web 2.0 tools into their teaching during their teaching practice. Results revealed that 68% of the pre- service teachers integrated Web 2.0 tools during their teaching practice as a result of their perceived enjoyment (a factor to measure flow experience) in using Web 2.0 tools. They concluded that as the comfort level and enjoyment (a construct to measure flow experience) of preservice teacher increased by virtue of the usage of Web 2.0 tools, their competence in integrating technology into their curriculum also increased.

Sadaf (2013) investigated preservice teachers' abilities to carry out their intentions to integrate (or not to integrate) Web 2.0 technologies into actual classrooms during their student teaching experiences. Results revealed that preservice teachers intended to use Web 2.0 technologies to facilitate student-centred learning. The result further revealed that the preservice teachers who used Web 2.0 technologies during the student teaching experience used them as instructional delivery tools (to facilitate comprehension of content and to motivate students) and to facilitate student-centred learning (for developing technology skills, problem solving skills, engagement with content, interaction with students and teachers, and sharing of information). On the other hand, a few were unable to use it due to limited access to technology resources (e.g., the internet, computer labs, blocked websites, etc.) and unsupportive cooperating teachers who were not accepting new technologies.

Liu (2016) examined how and why 31 preservice teachers integrated technology to enhance instruction in elementary classrooms during their teaching practice in California. Results revealed that the preservice teachers used technology for student engagement and motivation, interaction and to meet the need of individual students. The study further revealed that the influence of mentor teachers, technology access, skills, and their attitudes were the factors that influenced them to integrate technology in the classroom.

2.6 THEORETICAL CONSIDERATIONS

In response to the need of addressing the success of integrating e-learning technologies to improve teaching and learning in educational sectors, many researchers have developed various theories to integrate e-learning. Therefore, this study proposes a model to predict integration of e-learning technologies in the teaching and learning of science subjects by preservice science teachers. The factors that constituted this model were justified by the extant and robust theories of the Will, Skill, Tool (WST) model of ICT integration, the Theory of Planned Behaviour (TPB), the Expectation-Confirmation Theory (ECT), and the Flow Theory (FT). The objective of the next section is to discuss these theories of ICT and e-learning usage that justify the theoretical framework of this study. In addition, this section elaborates on each theory and reviews pertinent literature.

2.6.1 The Will, Skill, Tool Model

The Will, Skill, Tool (WST) model of ICT integration (Knezek, Christensen, Hancock, & Shobo, 2000) developed in the instructional ICT research field, focuses on the teachers' influence on ICT integration and its influence on academic performance. The WST model postulates that enhance will, skill, and access of a teacher to ICT tools leads to higher stages of classroom ICT integration, which in turn leads to greater student achievement. The key elements of the model are Will (computer attitude) of the teacher, Skill (ICT competence), and Tools (access to ICT tools) and they are all essential ingredients for a teacher to effectively integrate ICT into classroom practice. The WST model predicts the level of ICT integration as a function of attitude, competence and access to ICT. It also allows testing the importance of each of its elements separately and in combination through multivariate data analysis techniques. Figure 2.2 shows the Will, Skill, Tool model of technology integration.

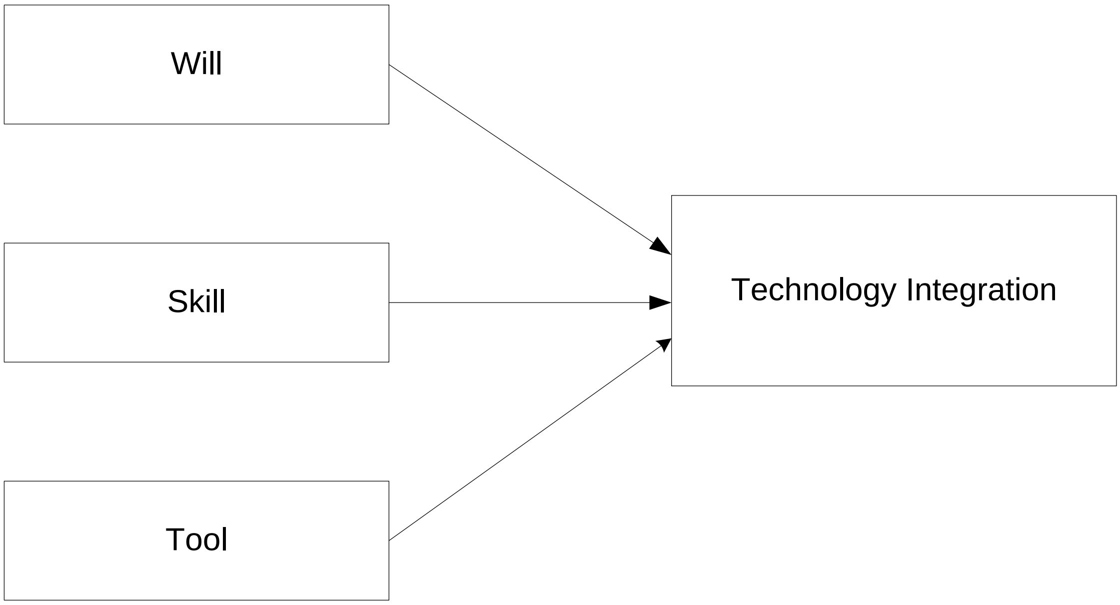

Figure 2.2: The WST Model of Technology Integration

The main constructs of the WST are described as follows.

Will refers to attitudes and dispositions towards using technology in the classroom. Attitudes towards technologies influence the teachers' acceptance and integration of technology into their classroom (Agyei & Voogt, 2011). Thus, teachers' willingness to integrate technology plays a vital role of technology integration. If teachers have a positive attitude towards technology, they are more likely to integrate technology in the classrooms (Petko, 2012).

Skill refers to the ability of an individual to perform a specific task (Agyei & Voogt, 2011). Technology skill is also a critical factor influencing teachers' success in integrating technology for teaching and learning purposes (Al-Ruz & Khasawneh, 2011). Technology skill is the ability of a teacher to integrate technology in the classrooms to foster effective teaching and learning. How proficient the teachers are with technology tools determine their levels of competence with technology integration in the classroom.

Tool refers to access to infrastructures for technology and the extent of using technology in educational settings and at home. The incorporation of hardware, software, networking and connectivity in educational settings is a basic condition of technology access

(Morale, 2006). Therefore, a teacher's personal accessibility level of technology at school and home and the availability of the tools to the students could be an important factor in determining the integration of technology in the classroom.

The WST model has been used to comprehensively explain and predict teachers' levels of ICT integration into classroom practice. Morales (2007) used the WST model to predict integration of ICT into the classroom among 978 elementary and middle school teachers in Mexico and 932 elementary and middle school teachers in Texas. The results indicated that the best predictor of ICT integration was Skill for Texas teachers and Tool for Mexican teachers. Agyei & Voogt (2011) applied the WST model to predict integration of ICT into the classroom by 60 in-service mathematics teachers from 16 Senior High Schools and 120 preservice mathematics teachers at the University of Cape Coast in Ghana. The study showed that Skill (competencies) was the strongest predictor of classroom integration of ICT by these teachers.

Morales (2007); Knezek & Christensen (2015) argue that at the highest stage of teachers' technology integration, attitude to push forward was the best predictor. Knezek, Christensen & Fluke (2003) tested the WST model in 1999 with 39 high school teachers in Texas to predict their stages of technology integration. Using regression analysis, the study showed that attitude was the strongest predictor of classroom integration of technology for these teachers.

2.6.2 Theory of Planned Behaviour (TPB)

The theory of planned behaviour (TPB) (Ajzen, 1991) is an extension of the theory of reasoned action which came as a result of some limitations found in the original model (Fishbein & Ajzen, 1975). This dealt with behaviours over which people had incomplete powers of using their will, or situations where they had incomplete control of their behaviour (Ajzen, 1991). The TPB is a theory which predicts deliberate behaviour, because behaviour can be deliberate and planned. TPB postulates that intentions of individuals are the proximal determinants of their behaviours, with intention as a concept to capture the motivation of an individual to perform a given behaviour (Ajzen, 1991). The TPB asserts that behavioural intention is jointly determined by the attitude towards the behaviour, subjective norm and perceived behavioural control. The stronger the intention of an individual to engage in a behaviour, the more likely the individual would perform that behaviour. Thus, in TPB, perceived behavioural control, together with behavioural intention, can be used directly to predict behavioural achievement, or actual behaviour (Ajzen, 1991). TPB is a well-grounded framework for conceptualizing, measuring and empirically identifying factors that determine behavioural intention (Ajzen, 2008). Figure 2.3 shows the Theory of Planned Behaviour.

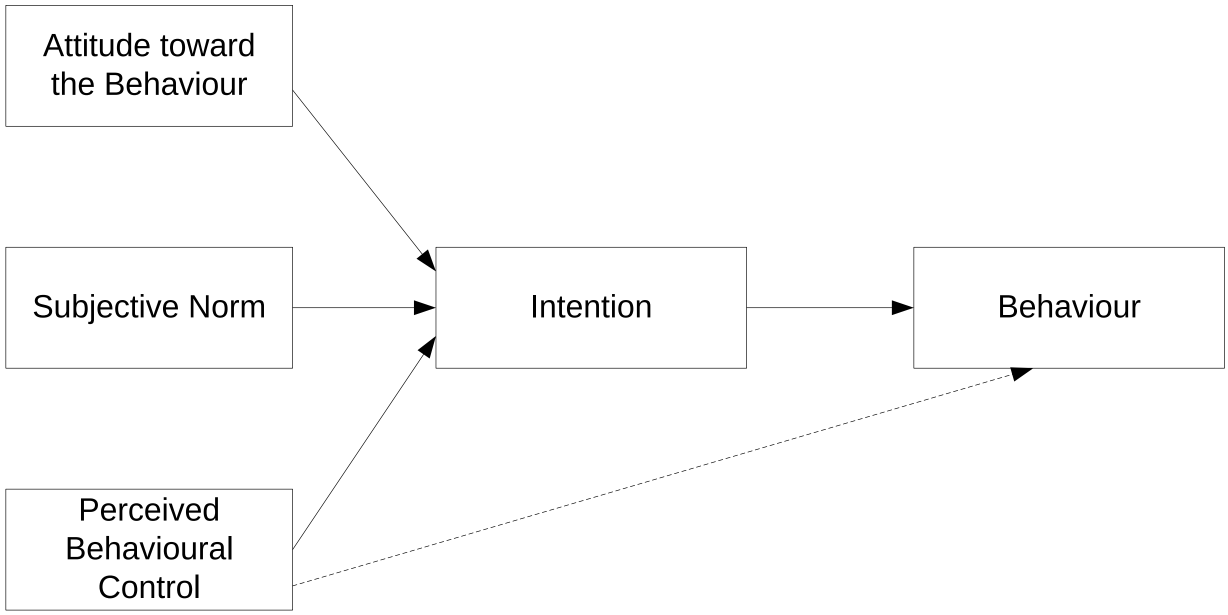

Figure 2.3: The Theory of Planned Behaviour

The main constructs of the TPB are described as follows.

Attitude towards behaviour refers to the degree to which a person has a favourable or unfavourable evaluation about the final behaviour. The more favourable the attitude toward the behaviour, the stronger will be an individual's intention to perform the target behaviour (Ajzen, 1991). Teacher attitude towards technology is central to any successful use of technology in schools (Teo & Tan, 2012). For example, teachers' poor attitude towards technology use for teaching and learning can affect students' view about the importance of technology in schools.

Subjective norms refers to the perceived social pressure to perform or not to perform the behaviour of an individual. In the subjective norm, the opinion of other people plays a vital role in the decision that the individual makes. In the technology acceptance context, peer influence and the influence of superiors are two important features of subjective norm. For example, a teacher may need to use technology because the school management has given the order to do so.

Perceived behavioural control refers to the perceived ease or difficulty of performing the behaviour and are assumed to reflect past experience as well as anticipated impediments or obstacles. PBC posits that the more resources and opportunities individuals believe they possess, the greater their control over the behaviour. Hence, if an individual have a favourable attitude and/or subjective norms to perform their intention, but believes that they lack the necessary resources and opportunities to perform the behaviour, the actual behaviour may be lower than expected.

Intention refers to the motivational factors that influence a behaviour; they are indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behaviour“ (Ajzen, 1991:181). An individual’s intention to perform a given behaviour is the central factor in the theory of planned behaviour. Intention also serves as a mediator in the relationship between behaviour and other factors, such as attitude, subjective norms, and perceived behavioural control.

As a prevailing theory for behavioural prediction, TPB was applied in an educational setting to examine the intentions of teachers to utilize computer to create and deliver lessons (Lee, Cerreto, & Lee, 2010), use Dynamic geometry environments (DGEs) in mathematics (Zhou, Chan, & Teo, 2016), and to examine preservice teachers’ intention to use technology (Teo & Lee, 2010; Teo, & Tan, 2012).

2.6.3 Expectation-Confirmation Theory (ECT)

The logic of the Expectation-Confirmation Theory (ECT) (Oliver, 1980; Bhattacherjee, 2001) posits that the intention of an individual to continue using an ICT is dependent on three important variables - the user’s level of satisfaction with the IT, the extent of the user’s confirmation of expectations, and perceived usefulness. First, users’ satisfaction is the primary determinant of individual’s continuance intention to use ICT (Bhattacherjee, 2001). In turn, a user’s satisfaction is influenced by his/her confirmation of expectation from prior ICT usage and perceived usefulness. The confirmation of expectations implies that users have gained the expected benefits through their experience with ICT usage, and thus relates positively to their satisfaction. On the other hand, based on the expectation-confirmation paradigm, users’ perceived usefulness of ICT have a positive effect on their satisfaction with ICT usage (Lee, 2010). Second, the ICT acceptance literature has consistently found that perceived usefulness is the most important determinant of users’ intentions (Davis, Bagozzi & Warshaw, 1989). Consequently, the ECT posits users’ perceived usefulness of ICT has a positive influence on their continuance intention to use ICT. Finally, the ECT posits that users’ confirmation of expectations is positively associated with their perceived usefulness of ICT usage. Figure 2.4 shows the Expectation Confirmation Theory.

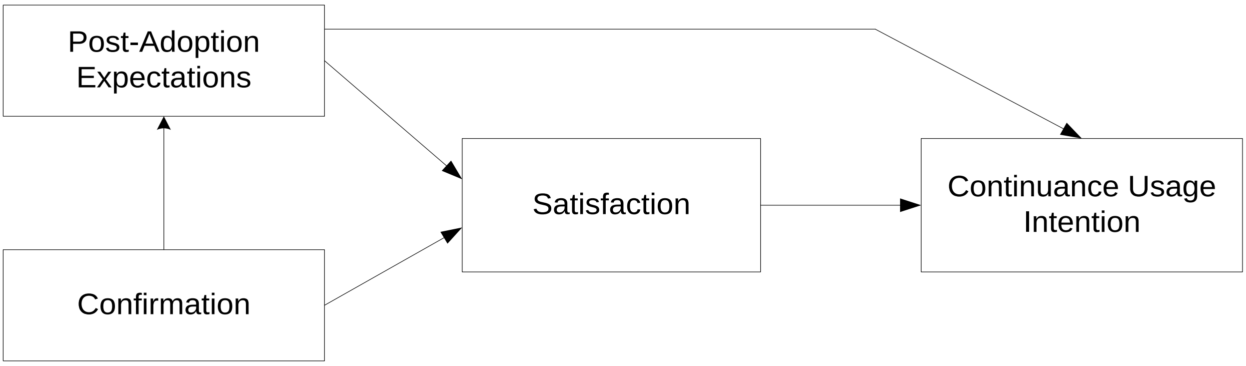

Figure 2. 4: The Expectation Confirmation Theory

The main constructs of the ECT are described as follows.

Perceived usefulness is a user's perception of the degree to which using a particular technology would enhance their job performance. This means that a user will tend to use technology if he/she perceives technology to be a useful and meaningful way to work more effectively. Users' perceived usefulness provides the baseline level, against which confirmation is assessed by users to determine their satisfaction **(**Bhattacherjee, 2001). A high baseline level enhance user's satisfaction, while low baseline reduces their satisfaction with the technology.

Confirmation determines the extent to which users' expectation about using a technology is confirmed. Confirmation is positively related to satisfaction with technology usage because it implies the users' realisation of the expected benefits of using a technology (Bhattacherjee, 2001).

Satisfaction refers to the degree to which users felt satisfied with their e-learning experience and environment as a whole (Joo, Joung & Kim, 2013). Users' satisfaction with technology is the primary determinant on their intention to continue using the technology. A user who is more satisfied with the usage experience of technology will have a higher level of technology continued usage, while dissatisfied user will discontinue its subsequent use. For example, students who experience a higher level of satisfaction with technology are more inclined to continue using technology.

The ECT has been established as a reliable model in an educational sector for explaining teachers' and students' usage of e-learning (Lee, 2010; Lin, 2011; Sorgenfrei, Borschbach & Smolnik, 2013).

2.6.4 Flow Theory

Flow is an intrinsic motivation factor. Csikszentmihalyi (1975) proposed that flow theory is a better way to understand intrinsic motivation. When people are in the flow state, they become totally immersed in their activities to the point of losing an awareness of time and critical matter, unable to recognize changes in their environments that nothing else seems to matter besides what they are doing (Lee, 2010). From the motivation perspective, people make an effort to use e-learning technologies because of both extrinsic and intrinsic reasons (Liao, 2006).

Most researchers often measure flow using two variables - concentration and enjoyment in an activity (Ghani & Deshpande, 1994; Lee, 2010). In the context of this study, concentration refers to the degree to which the attention of preservice science teachers focuses on using e-learning (Trevino & Webster, 1992). For preservice teachers to be in a flow state, they must focus their attention on learning activities as a result of the interactive features of e-learning technology, and this may influence their attitude towards utilization of e-learning (Liao, 2006).

Enjoyment on the other hand, refers to the extent to which ICT usage being perceived as pleasant, regardless of the consequences that may come out of the usage (Davis, *et al.*, 1992). When preservice science teachers use e-learning technologies, they may experience flow, as most e-learning products have many interactive functions which can help them enjoy their learning activities by using such systems. Flow theory is a valuable framework for studying individual's experience of learning through the use of ICT, including e-learning. Many researchers have extensively applied flow theory to explain teachers' and students' intentions and usage of e-learning (Ghani & Deshpande, 1994; Liao, 2006; Lee, 2010; Teo & Noyes, 2011; Joo, Joung, & Kim, 2013; Kim & Jang, 2015) as discussed in *section 2.5.2.4.*

2.7 THE PROPOSED CONCEPTUAL RESEARCH FRAMEWORK

The purpose of this section is to provide a foundation for this study in terms of the selected factors that form the proposed conceptual framework. The building of this conceptual framework was based on reviewing related literature and was guided by this research’s aim. As discussed in the preceding section, many studies on ICT integration have previously examined diverse predominant factors predicting teachers’ propensity to integrate ICT into their classrooms. These factors include attitudes toward technology (Teo, 2008; Yapici & Hevedanli, 2012), skills (Agyei & Voogt, 2011; Allayar, 2011), satisfaction with e-learning (Lee, 2010; Ramayah & Lee, 2012), flow experience (Liao, 2006; Lee, 2010), and intention (Teo & Lee, 2010; Teo, & Tan, 2012; Lee, Cerreto & Lee, 2010; Zhou, Chan, & Teo, 2016). One of these studies (Lee, 2010) developed a model to explain the relationships among some of these factors (attitude, satisfaction, flow experience) and how they predict students’ continuance intention toward e-learning and not integration of e-learning. In addition, all these factors have hitherto not been coherently integrated into a unified structural model subject to examination for validation, as well as determining the relationships between them in predicting or explaining the integration of e-learning technologies. Thus, this study combines all these factors and systematically unifies them under a single framework to uncover a set of salient factors that would best predict preservice science teachers’ integration of e-learning technology in the science classroom.

The preceding section 2.6 has laid the basis for this section by discussing the multiple theories that guide and justify the factors used for the development of the proposed conceptual framework. Accordingly, the proposed conceptual model is built on multiple theories, including the Will, Skill, Tool (WST) model (Knezek, Christensen, Hancock & Shobo, 2000), Theory of Planned Behaviour (TPB) (Ajzen, 1991), Expectation-Confirmatory Theory (ECT) (Bhattacherjee, 2001), and Flow Theory (FT) (Csikszentmihalyi, 1997). Theoretically, to justify the use of all the predictor factors in this study, the WST model justifies two predictor factors which are the individual’s skill towards e-learning which has been found to be the strongest predictor of classroom integration of ICT by teachers (Morales, 2007; Agyei & Voogt, 2011) and attitude which also has been found to be the best predictor of technology integration by teachers (Knezek, Christensen & Fluke, 2003).

In addition, TPB justifies the predictor factor (intention) which has been presented to be the most influential predictor of technology usage within the framework of the TPB (Ajzen, 1991; Teo, 2011). Similarly, ECT justifies the predictor factor (satisfaction) which also has been found to be a significant factor influencing continuous intention to use e-learning (Roca, *et al.*, 2006; Liaw, 2008; Ramayah & Lee, 2012), and equally an important factor in measuring the effectiveness and integration of e-learning (Sørebø & Sørebø, 2008; Baturay, 2011). Lastly, the flow theory justifies the predictor factor (flow experience) to capture the elements of intrinsic motivation. Ghani, Supnick & Rooney (1991) and Lee, (2010) measured flow using two variables, namely, enjoyment and concentration which are adopted in this study. Enjoyment has been found as a significant predictor of preservice teachers' use of technology (Teo & Noyes, 2011) and strongest predictor of preservice teachers' usage of technology during teaching practice (Kim & Jang, 2015). Concentration has also been discovered to have significant influence on students' intention and usage of e-learning (Liao, 2006; Lee, 2010), and also a significant variable influencing student satisfaction of e-learning (Joo, Joung, & Kim, 2013). The interrelationships and interactions of all these predictor variables are reflected in Figure 2.5, which forms the Conceptual Framework of this study.

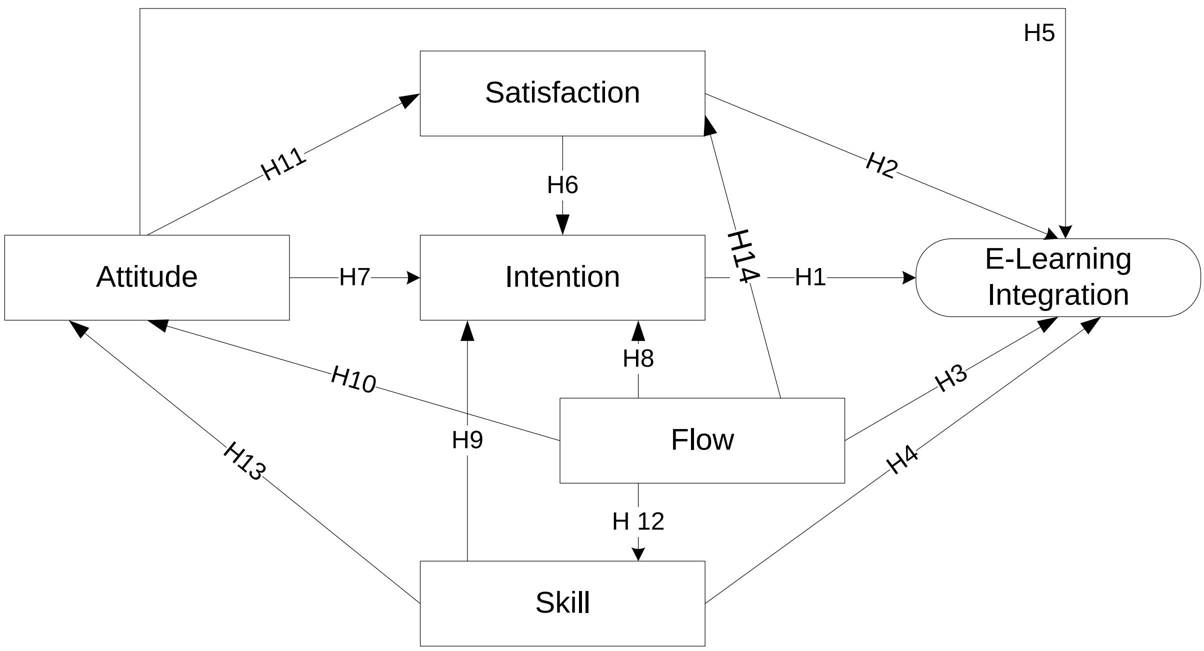

Figure 2. 5: The Proposed Conceptual Framework

Hence, the factors of the conceptual framework developed in this study and the theories from where they originated are presented in the table 2.8.

Table 2. 8: Theories, factors and relationships between factors

Factors	Operational definition	WST	TPB	ECT	FT
Attitude (ATT)	The extent to which a preservice teacher possesses the positive feelings about integrating e-learning technologies for teaching and learning (Fishbein & Ajzen, 1995).	A→ EI	A → I		
Skills (SKL)	The ability or skill of a preservice teacher to handle a wide range of aspects of e-learning technologies for diverse teaching and learning (Tondeur *et al.*, 2008).	SK→ EI			SK→ F
Satisfaction (SAT)	The degree to which pre-service teachers felt satisfied with the experience of e-learning technologies and the e-learning environment as a whole (Joo, *et al.*, 2013).			S → EI	
Flow (FLW)	The degree to which pre-service teachers become intensively involved and focused on learning activities with e-learning technologies to the point that nothing else seems to matter to them (Csikszentmihalyi, 1997).				F→I
Intention (INT)	The degree of pre-service teacher to be willing to integrate e-learning technologies for teaching and learning (Davis, 1989).		I →EI		
Integration (INTE)	The means of using e-learning technologies to assist teaching and learning (Williams, 2003).	√	√	√	√

2.8. SUMMARY AND CONCLUSION

This chapter has provided an overview of the theoretical context and types of e-learning. The chapter has also discussed e-learning platforms and the most popular and active e-learning platforms used in the academic environments and their salient features. Thereafter, attention focussed on the perceived educational benefits of e-learning technologies. This review has shown that e-learning technologies have great potential to improve teaching and learning because of their distinct ability to facilitate effective collaboration and communication, improving student-student and student-teacher interactions, improving students' satisfaction with their module, motivating students, improving students' performance, sharing of content and information, as well as improving assessment.

Moreover, in this chapter, a review of existing literature has been presented to identify the factors that could predict the integration of e-learning technologies. The factors that have been discussed are attitude, skills, satisfaction, flow experience and intention. However, the review showed that no previous studies have attempted to combine these five factors in one research to predict the integration of e-learning technologies by preservice science teachers in the classroom. The chapter also looked in depth at innovation and quality consciousness as moderators to strengthening the relationship between intention and integration so as to add value to the small number of studies examining moderators of the intention-integration gap relationship.

Furthermore, this chapter has developed a conceptual framework for this research. The framework is built on eminent and robust theories that have been validated and found useful in explaining technology usage. The proposed conceptual framework is novel because it combines the factors that were examined separately in previous studies to explain technology integration (TI). However, to the best of the researcher's knowledge, the combination of these factors has seldom been used to frame research studies to predict preservice science teachers' integration of e-learning technologies in the classroom within the context of South Africa. The proposed conceptual framework could be used as a frame of reference by educational institutions, governments, policy makers and e-learning facilitators to design, implement and develop better e-learning strategies and projects in schools. In addition, it could hopefully provide a test-bed to help government and educational institutions formulate policies governing e-learning implementation and development. Finally, this conceptual framework can also be used by researchers and scholars in the field of e-learning to understand the implementation and development of e-learning projects.

CHAPTER THREE

RESEARCH METHODOLOGY AND DESIGN

3.1 INTRODUCTION

This chapter presents the research methodology used to answer the research questions, achieve the aim and objectives and test the hypotheses formulated in chapter one of this study. The chapter discusses the research paradigm, research design, target population and research sample used in this study. Next, it discusses the data collection instrument and data collection procedures. The chapter also explains the data analysis and ethical issues connected to the study. Finally, a conclusion is drawn to summarise the chapter.

3.2 RESEARCH PARADIGM

As outlined in chapter one, the research questions sought to be answered in this study are re-stated below.

3.2.1 What are preservice science teacher' perceptions of the educational benefits of integrating e-learning technologies in the teaching and learning of science subjects?

3.2.2 What factors best predict or explain preservice science teachers' integration of e-learning technologies in the teaching and learning of science subjects?

3.2.3 How can quality and innovation consciousness moderate the relationship between intention to integrate and the actual integration of e-learning technologies in the teaching and learning of science subjects by preservice science teachers?

3.2.4 What are the preservice science teachers' experiences with regard to integrating e-learning technologies in the teaching and learning of science subjects during teaching practice?

The philosophical orientation followed in this study was mainly influenced by a world view that is discussed below:

The term 'paradigm' refers to the philosophy that governs the research method which need to be considered in an attempt to achieve the research objectives and addresses the research questions (Saunders, Lewis & Thornhill, 2007). Kuhn (1970) opines that a paradigm is a set of values and techniques which acts as a guide, dictating the kinds of problems that researchers should address in a study and the types of explanations and solutions that are acceptable to solve the problems (Kuhn, 1970-175). Mack (2010) envisages a research paradigm as a "loose collection of logically related assumptions, concepts or propositions that orientate research and researcher's thinking." Creswell (2014) defines paradigm as a set of belief system or world view that guides the study. That is, the types of belief held by individual researchers will often lead to their choice of accepting a quantitative, qualitative, or mixed methods approach in their research. Kumar (2011) explains that the purpose of a research paradigm is to determine the mode of inquiry that is employed in carrying out the study. Further, Kumar (2011) asserts that to apply one approach extensively to all the research problems can be misleading and inappropriate. Johnson, Onwuegbuzie & Turner (2007) posit that the synthesis of two paradigms has been established as a third research paradigm which is the mixture of qualitative and quantitative research methods in a single study. They opined that the importance of mixed methods in a research is that it provide the most informative, complete, and balanced presentation of research results.

According to Kumar (2011), there are two main research paradigms, positivism and interpretivism. These paradigms can also be referred to as quantitative and qualitative respectively. Positivism represents the traditional form of research, and mostly applies to quantitative research than qualitative research. Positivism is otherwise called positivist or post-positivist research, empirical science, and post- positivism because it represents the thinking after positivism which challenge the traditional notion of the absolute truth of knowledge (Creswell, 2014:36). Positivism also implies that one's claim about an imaginary knowledge cannot be absolutely positive when examining human actions and behaviour. Moreover, Positivists hold the view that causes determine the effects or outcomes. Thus, positivists study problems in order to identify and assess the causes that influence the outcomes as found in experiments, and also to reduce the ideas into small testable variables, such as, hypotheses and research questions. Positivist researchers develop knowledge based on careful observation and the measurement of what they consider to be an objective reality (Creswell, 2014:36), which de-emphasises individual perceptions. For the positivists, only the phenomena that can be observed and measured are considered valid knowledge which is objectively measurable through numeric measures. Positivists posit that the world is governed by law or theories that need to be tested and refined through observation and measurement, in order to predict the forces that surround us (Al-harbi, 2010). Finally, positivist researchers start their inquiry by a theory or hypothesis, collect data that either supports or rejects the hypothesis.

On the other hand, interpretivism is largely qualitative in nature. Interpretivist holds the view that reality is subjective and multiple (Creswell, 2014:37), and that individuals seek understanding of the world in which they live and work. Every individual perceives the world differently and views it in different contexts, and their behaviours and actions are unpredictable (Khan, 2014). Thus, varied and manifold meanings are built as the researcher interacts with the world, which subsequently leads the researcher to look for the complexity of the situation being studied rather than narrowing it down to a few ideas or experiences of the participants. Interpretive researchers, thus, use various methods to study how individuals perceive the world and attempt to understand people's behaviours and actions by using qualitative research method (such as observations, open-ended questions and interviews) so that individuals can share their views of the problem being investigated. (Creswell, 2014:38).

The philosophy that support interpretive research is hermeneutics and phenomenology (Imenda & Muyangwa, 2006:23; Thomas, 2010). The authors further explain that hermeneutic is a major branch of interpretive philosophy which can be treated as both an underlying philosophy and a research methodology with a specific mode of analysis. This study combine hermeneutic and qualitative content analysis as mixed methods of analysis to describe data and to understand the meaning of textual data which may not be clear in one way or another. The application of the mixed methods in this study was based on the use of a questionnaire with both closed-ended and open-ended questions. The positivism paradigm approach adopted in this study used closed-ended questions to examine e-learning integration model (ELIM) factors that predict the preservice science teachers' (PSSTs) integration of e-learning technologies in their classrooms. This was justified by creating some hypotheses that would be tested through the data collected with closed-ended questions. Also, ELIM factors would be measured statistically using a non-experimental statistical method knows as the Warp PLS 4.0 (SEM) to see whether the data collected would support or refute the research hypotheses. On the other hand, the interpretivism (hermeneutic) paradigm approach adopted in this study used open-ended questions to explore the PSSTs perceptions of the benefits of e-learning technologies in the educational sectors and PSSTs experiences with the actual integration of e-learning technologies during their teaching practice in schools. These open-ended questions were analysed using hermeneutic content analysis. It is in line with this background that this study was located within the mixed-methods research paradigm.

3.3 RESEARCH DESIGN

A research design is a comprehensive plan for data collection in an empirical research project aimed at answering specific research questions (Bhattacherjee, 2012:35). In order to investigate the preservice science teacher's integration of e-learning technologies in their classroom and during their teaching practice, a descriptive and confirmatory cross sectional survey design was chosen for this study. In essence, this study contained the elements of descriptive and cross-sectional research. The design was adopted as it helps to describe the true and broader picture of the phenomenon and population under study without exposing the variables to any manipulation or control by the researcher (Kothari, 2004; Baha, 2016). Moreover, it helps to solicit for information and honest views from the preservice science teachers regarding their perceptions of the educational benefits of e-learning technologies in a science classroom and about integration of e-learning technologies during teaching practice. The cross sectional research design was appropriate as the study investigated factors that predicted integration of e-learning technologies at a specific point in time by testing hypotheses. Cross sectional study was also suitable for this study as it sorted out the existence and magnitude of the effect of the relationships of one or more independent factors upon dependent factors in the ELIM at a given point in time (William, 2006).

The steps of the design were as follows:

(i) The administration of a questionnaire to indicate the general demographic information of the preservice science teachers (gender, year of study, age, program of study) and to verify the amount of time that the preservice science teachers spent on using e-learning technologies for studying sciences, which was used to represent preservice science teachers experience of using e-learning technologies.

(ii) The PSSTs completed some open-ended questions to solicit for information and honest views of preservice science teachers regarding their perceptions of the educational benefits of e-learning technologies in a science classroom. This section aimed at addressing the Research Question number one.

(iii) The administration of some closed-ended questions to (1) identify the factors that best predict or explain preservice science teachers' integration of e-learning technologies in the teaching and learning of science subjects. This was designed to address Research Question number two. The following fourteen hypotheses were tested.

a) Intention will be a significant predictor for integrating e-learning technologies by pre-science teachers.

b) Satisfaction will be a significant predictor for integrating e-learning technologies by preservice science teachers.
c) Flow experience will be a significant predictor for integrating e-learning technologies by preservice science teachers.
d) Skill will be a significant predictor for integrating e-learning technologies by preservice science teachers.
e) Attitude will be a significant predictor for integrating e-learning technologies by preservice science teachers.
f) Satisfaction will be a significant predictor for preservice teachers' intention to integrate e-learning technologies.
g) Attitude will be a significant predictor for preservice teachers' intention to integrate e-learning technologies.
h) Flow experience will be a significant predictor for preservice teachers' intention to integrate e-learning technologies.
i) Skill will be a significant predictor for preservice teachers' intention to integrate e-learning technologies.
j) Flow experience will be a significant predictor for preservice teachers' attitude to integrate e-learning technologies.
k) Attitude will be a significant predictor for preservice teachers' satisfaction to integrate e-learning technologies.
l) Flow experience will be a significant predictor for preservice teachers' skill to integrate e-learning technologies.
m) Skill will be a significant predictor for preservice teachers' attitude to integrate e-learning technologies.
n) Flow experience will be a significant predictor for preservice teachers' satisfaction to integrate e-learning technologies.

(2) To investigate the moderating roles that quality consciousness and innovation consciousness played on the relationship between intention to integrate and the actual integration of e-learning technologies in the teaching and learning of science subjects by preservice science teachers. This was to address Research Question number three. The following hypotheses were tested.

a) Preservice science teachers' teaching and learning quality improvement consciousness will positively moderate the relationship between their intention and integration of e-learning technologies.

b) Preservice science teachers' innovation consciousness will positively moderate the relationship between their intention and integration of e-learning technologies.

(iv) The administration of open-ended questions soliciting preservice science teachers' experiences about integrating e-learning technologies during their teaching practice. This was design to address the Research Question number four. This section would allow the PSSTs to reflect on their experience with the integration of e-learning technologies into the teaching of science subjects during their teaching practice.

Table 3.1 depicts the design with the outline of data sources and analysis techniques in connection to the research questions.

Table 3.1: Research Questions, Data Sources and Analysis Techniques

Research Questions	Data Sources	Analysis Techniques
Q1. PSSTs perceptions of integrating e-learning technologies.	Open-ended survey	QUAL: Hermeneutic content analysis Percentages and frequencies
Q2. Factors best predict PSSTs integration of e-learning technologies.	Closed-ended survey ELIM scale	QUANT: WarpPLS 4.0
Q3. Moderating factors of quality and innovation consciousness.	Closed-ended survey MOD scale	QUANT: WarpPLS 4.0
Q4. PSSTs actual integration of e-learning technologies during teaching practice.	Open-ended survey	QUAL: Hermeneutic content analysis Percentages and frequencies

3.4 DATA COLLECTION INSTRUMENTS

Data collection in this study was triangulated to provide diverse perspectives, and in order to enhance the reliability and validity. A questionnaire was the main tool used for collecting both quantitative and qualitative data in order to answer the research questions of this study. A questionnaire was chosen because it was the most suitable method to generate data appropriate for testing the hypotheses and the model in this study (Fife-Schaw, 2006). The questionnaire consisted of four essential sections (a) biographical information and the amount of time preservice science teachers spent on using e-learning technologies (b) preservice science teachers' perceptions of the educational benefits of integrating e-learning technologies (c) E-learning integration model (ELIM) scale and moderator (MOD) scale (d) preservice science teachers' reflections and feedback from their teaching practice experience.

The amount of time preservice science teachers spent on using e-learning technologies and the moderator scale were constructed by the researcher based on the literature review. Preservice science teachers' perceptions about e-learning technologies, ELIM scale and PSSTs reflections and feedback from their teaching practice experience were developed based on the literature review and previous research (Sadaf, Newby & Ertmer, 2012; Sadaf, 2013; Lee, 2010; Liao, 2006) with modifications to make the instruments fit the context of the integration of e-learning technologies. Permission to modify the instruments were obtained from the authors through email (*see Appendix D*).

Section One: Biographical Information

This section included age, gender, department, programme of study, and how often the PSSTs used e-learning technologies, along with two open-ended questions to verify the amount of time that PSSTs had used e-learning technologies and the activities they performed on the e-learning site (*see Appendix E, Section A*).

Section Two: Perceptions about E-Learning Technologies

This section consisted of four open-ended questions about PSSTs perceptions about the educational benefits of e-learning technologies in order to address Research Question number one. An open-ended approach is effective when the researcher is trying to gain deep information by digging into a rich description of participants' perceptions (Creswell, 2014). (*See Appendix E, Section B*).

Section Three: E Learning Technology Integration (ELIM) and Moderator (MOD) Scale

The ELIM scale consisted of 30 closed-ended items on a 5-point Likert-scale (strongly agree to strongly disagree) to examine factors that predict preservice science teachers' integration of e-learning technologies. This addressed Research Question number two. This instrument measured six factors which are attitude, intention, satisfaction, skills, flow experience and integration. The MOD scale consisted of 6 closed-ended items on a 3-point Likert scale (yes, somewhat, no) to examine the moderating roles of consciousness between intention to integrate and the actual integration of e-learning technologies. This was to address Research Question number three. This instrument measured two factors which are quality consciousness and innovation consciousness (*see Appendix E, Section C*).

Section Four: Preservice Science Teachers' Reflections and Feedback from Teaching Practice

This section consisted of two closed-ended questions on a 2-point Likert scale (yes, no) asking the PSSTs whether they had e-learning technologies in the school where they did their teaching practice and whether they had used e-learning technologies during that time. This section was followed by six open-ended questions to obtain in-depth information from the PSSTs about their actual integration of e-learning technologies into the teaching of science subjects during their teaching practice. The questions probed further to reveal reasons for using or not using e-learning technologies during their teaching practice, the techniques they employed, the goal and evidence of using e-learning technologies during their teaching practice. This addressed the fourth research question. This section allowed the PSSTs to reflect on their experiences with the integration of e-learning technologies into the teaching of science subjects during their teaching practice (*see Appendix E, Section D*).

3.5 DATA COLLECTION PROCEDURES

3.5.1 Pilot Study

A pilot study was conducted as a prelude to the main study in March during the first semester of 2016 academic session, to assess the reliability and validity of the research instrument, identify the flaws as well as to determine whether the research procedures was viable. The pilot study consisted of purposively selected thirty (30) fourth year preservice science education teachers at the participating South African University. The pilot study used a mixed methods approach to collect data to understand preservice science teachers' integration of e-learning technologies during their teacher science education modules and their experience with integration of e-learning technologies into the teaching of science subjects during their teaching practice. The entire procedures planned for the main study were carried out in the pilot study.

The WarpPLS 4.0 (SEM) statistical software package was used to analyse and validate the data. After the pilot study, the questionnaire was purified by eliminating those questions that did not appear to be relevant to the research questions as a result of poor wording, and others were either modified or substituted. Furthermore, a few changes were made by re-wording some items in the ELIM scale because of their low loading on their related factors as a result of poor wording. For example, the item related to Attitude saying: "Once I start working with e-learning, I find it hard to stop" was rephrased to read: "I believe it is a good practice to use e-learning technologies for teaching and learning." Also, a statement related to Flow Experience stating: "I am deeply absorbed in learning when I use e-learning tools" was rephrased as follows: "I find it interesting when I use e-learning for teaching and learning."

3.5.2 Main Study

Upon receiving an approval from the Research Committee of the participating South African University to commence the study, the main study was conducted several months after the pilot study. The data collection procedures entailed the following steps. The first step was to collect the names of lecturers offering modules in fourth year science education classes from the head of the department in the university selected for the study. Second, the researcher sought the consent of the lecturers to collect data in their classes. Third, the lecturers gave their permission, arranged the dates and times that were convenient for the researcher to collect data in their classes. Fourth, the researcher met the lecturers and the PSSTs during their face-to-face lectures, addressed the PSSTs about the purpose of the research and sought their consent by presenting the consent form. The PSSTs who agreed to participate in the study were required to sign an Informed Consent form. Fifth, the questionnaire was administered by the researcher. The researcher and the research assistants monitored the completion of the questionnaire and collected the completed questionnaire from the PSSTs. The questionnaire took 30-40 minutes to complete. The main study sample consisted of a hundred (100) fourth-year preservice science education teachers who completed the questionnaire at the participating South African University. All the PSSTs who had been requested to participate in the study completed the questionnaire, giving a response rate of 100%.

3.6 POPULATION AND RESEARCH SAMPLE

This study focused mainly on the integration of e-learning technologies by preservice science teachers during their teacher education modules and during their teaching practice in high schools. Therefore, the entire preservice science teachers who enrolled in a Bachelor of Science Education programme in the Faculty of Education, KwaZulu-Natal Province

Universities constituted the target population of this study. According to Imenda and Muyangwa (2006:97), a target population is a group of subjects to whom the findings of a given study will be generalized. The research sample allows the researcher to collect the information required to answer or address the research objectives, questions or hypotheses. A convenience purposive sampling method was used to drawn 100 samples from the fourth year preservice science education teachers at the participating South African University. Cohen (2007) and Creswell (2014) explain that convenience sampling involves choosing the nearest respondents that are readily available and accessible at the time of the study. In this regard, not all preservice science education teachers enrolled in the department of Mathematics, Science and Technology Education (MSTE) were sampled. Moreover, Kumar (2011) posits that the primary consideration in purposive sampling is based on the researcher's judgement as to who can provide the best information to accomplish the objectives of the study. The researcher selected a set number of respondents that are best positioned to provide the required information for this study. Fourth year preservice science education teachers were conveniently and purposively chosen for this study because they were involved in formal e-learning classes in their different modules and they had recently completed their teaching practice in the high schools, thus, they were expected to provide in-depth information about the study being investigated. Although, the first, second and third year preservice science education teachers were also involved in formal e-learning classes in their different modules, they have not been in the teaching practice during the data collection process for this study. Therefore, the fourth year preservice science education teachers fulfilled the purpose of this study.

The WarpPLS 4.0, a component-based structural equation modelling (SEM) was employed to analyse data in this study. According to Chin (1998b) Partial Least Squares (PLS) can be a powerful method of analysis for a number of reasons including its minimal demands on sample size of 30-100. While the covariance-based SEM, requires a sample size of 100-150 participants (Kline, 2005), a rule of thumb for partial least squares (PLS) path modelling suggested by (Henseler, *et al.*, 2009:292) requires the sample size be equal to the larger of either:

a) Ten times the number of indicators of the scale with the largest number of indicators, which equates to ten times the six indicators of flow experience in the ELIM scale and gives a minimum of sixty (60) preservice science education teachers; or
b) Ten times the largest number of independent variables used to determine a dependent variable in the inner path model, which equates to ten times the number of five

independent variables (attitude, satisfaction, skill, flow experience, and intention) used to predict the e-learning integration and gives a minimum of fifty (50) preservice science education teachers. Taking this suggestion into consideration, the 100 sample size used in this study was well above the recommended sample for PLS and appropriate minimum for covariance-based structural equation modelling (SEM). Thus, the sample size of 100 preservice science teachers used in this study meets these requirements.

3.7 RELIABILITY AND VALIDITY OF THE STUDY

To raise the quality of this study, four procedures were used to enhance the reliability and validity: (1) content validity of the questionnaire, (2) internal reliability of the ELIM and MOD instruments. (3) construct validity of the ELIM and MOD instruments.

3.7.1 Content Validity of the Questionnaire

Content validity, according to Kumar (2011), is the establishment of a logical link between the items on the questionnaire instrument and the objectives of the study. It is also judged on the basis of the extent to which statements or questions represent the issue they are supposed to measure, as judged by a researcher and experts in the field. Since some of the items were developed and modified to suit the purpose of this study, there was a need to ensure that these items had content validity. Content validity in this study was established through an interactive process with the supervisor of this study and experts in the Department of Information Technology at another South African institution different from the participating South African University, to ensure that the instrument was in line with the objectives of the study. Based on their suggestion, some statements were rephrased to improve the validity of the instruments.

3.7.2 Internal Reliability of the ELIM and MOD Scales

After data quality had been evaluated, the WarpPLS 4.0 regression algorithm was run to generate the e-learning integration model (ELIM) and moderators (MOD) parameter estimates. According to Urbach & Ahlemann (2010) and Hair, Ringle & Sarstedt (2011) model validation is a process of systematically evaluating whether the hypotheses expressed by the structural model are supported by the data or not. It is also an attempt to determine whether the measurement and structural models fulfil the quality criteria for empirical work. The statistical output in this study was analysed based on the recommendations of Urbach & Ahlemann (2010) and Hair, *et al.,* (2011) for model validation. The procedures used for analysing the internal reliability of the measurement models (ELIM and MOD) are as discussed below.

3.7.2.1 Assessment of the Measurement Model

A reflective measurement model was used in this study. In a reflective measurement model, all the measures are expected to be highly correlated with one another, and with the latent variable (LV) (Kock, 2015). The reliability of the measurement items was assessed by examining the internal consistency reliability and the indicator reliability (Urbach & Ahlemann, 2010; Hair *et al.,* 2014; Navimipour & Zareie, 2015). Reliability implies "repeatability" or "consistency". The reliability of data is the extent to which a given instrument consistently gives the same results upon repeated applications (Imenda & Muyangwa, 2006:113).

Internal consistency based reliability have been assessed using the traditional standard such as Cronbach's Alpha (CA), whereas a high alpha value assumes that the scores of all items with one construct have the same range and meaning (Cronbach 1951). The alternative and more appropriate measure to Cronbach's Alpha is the Dillon-Goldstein's rho composite reliability (CR) (Werts, Linn & Jöreskog 1974), which Chin (1998b) recommends as a better measure of reliability in PLS because CR overcomes some of CA's deficiencies of severely underestimating the internal consistency reliability of LVs in PLS structural equation models. Additionally, CR takes into account that all indicators have different loadings (Henseler, *et al.,* 2009). Regardless of which reliability coefficient is chosen for assessing internal consistency, values above 0.700 are desirable, whereas values below 0.600 indicate a lack of reliability. On the other hand, levels above 0.950 are more suspect than those in the middle ranges, implying potential common method bias (Chin, 1998b; Henseler, *et al.,* 2009; Urbach & Ahlemann, 2010). The composite reliabilities for the factors in the model ranged from 0.757 to 0.879, which exceeded the recommended threshold value of 0.70 (Chin, 1998b), with the lowest value being 0.757 for the integration factor. Hence, all factors have acceptable reliability (*see Table 4.6).*

Indicator reliability describes the extent to which a variable or set of variables is consistent regarding what it intends to measure (Urbach & Ahlemann, 2010). The reliability of one construct is independent of and calculated separately from that of other constructs. The researcher can monitor reflective indicators' loadings to assess indicator reliability. Generally, it is suggested that an LV should explain at least 50 percent of each indicator's variance. Thus, indicator loadings should be significant, at least at the 0.050 level and greater than 0.707 (Chin 1998b). Urbach & Ahlemann (2010) state that there may be different reasons why these requirements are not fulfilled, including:

a) The item is simply unreliable;
b) The item may be influenced by additional factors, such as a method effect;
c) The construct itself is multidimensional in character and thus items are capturing different issues.

If any of these cases occur, the measurement model needs to be adjusted by removing the offending indicators and rerun the PLS algorithm in order to obtain revised results (Urbach & Ahlemann, 2010). To assess individual indicator reliability the researcher looked at their loadings to their respective factors**.** Seven unreliable indicators were removed because their loadings were below the acceptable standardized loading value of 0.70 and were considered unreliable for ELIM. The level of significance of all the remaining indicator loadings, also proved significant at $p<0.001$, which indicated that the indicators were reliable.

3.7.3 Construct Validity of the ELIM and MOD Instruments

Construct validity refers to the extent to which a measured variable actually measures what it was constructed to measure in the context in which it is applied (Raykov, 2011). Convergent validity and discriminant validity are two forms of construct validity. Model validity can be measured by the estimate of convergent validity and discriminate validity of model factors.

Convergent validity (CV) shows the extent to which multiple items of a specific factor converge to represent the same factor (Suki, 2011). Average Variance Extracted (AVE) suggested by Fornell & Larcker (1981) is the criterion usually applied to confirm convergent validity and an AVE value which equals or exceed the minimum level of 0.5 indicates that an LV is on average able to explain more than half of the variance of its indicators and, thus, demonstrates sufficient convergent validity (Urbach & Ahlemann, 2010). The convergent validity for factors in the model ranged from 0.511 to 0.720, which demonstrated sufficient convergent validity (Fornell & Larcker, 1981) as shown in table 4.6.

Discriminant validity (DV) indicates the extent to which a given factor and its items differ from another factor and its items (Suki, 2011). Two important criterion for measuring discriminant validity are commonly used in SEM using PLS:

(a) Fornell-Larcker criterion: The benchmark suggested by Fornell and Larcker (1981) which requires a latent variable to share more variance with its assigned indicators than with any other latent variable. Accordingly, the square root of the AVE for each factor should be greater than the correlation shared between one factor and other factors in the model (Bhattacherjee & Sanford, 2009; Navimipour & Soltani, 2016). That is, the values on the diagonal of the table (containing correlations among the factors), which are the square roots of the average variances extracted for each factor, should be higher than any of the values in the corresponding rows and columns (that is off-diagonal). As shown in table 4.8, the bolded elements in the matrix diagonals representing the square roots of the AVEs, are greater in all cases than the off-diagonal elements in their corresponding rows and columns. Hence, discriminant validity was achieved at both the *item* and *factor* levels – thereby deeming the constructs in the proposed research model to be adequate.

(b) Cross-loading: Cross-loadings are obtained by correlating each LV's component scores with that of all other items (Chin, 1998b). If each indicator's loading is higher for its designated construct than for any of the other constructs, it can be inferred that the different constructs' indicators are not interchangeable (Urbach & Ahlemann, 2010). That is, the loadings of each item is expected to be higher than all of its cross loadings or any other constructs (Henseler, *et al.*, 2009). As shown in table 4.7, all indicators loaded more highly on their respective factor (that is the bolded factor loadings) than on any other factor (that is the non-bolded factor loadings in any row and column), indicating discriminate validity.

3.8 METHOD OF DATA ANALYSIS

Both quantitative and qualitative data analysis methods were employed for the analysis of this study. The quantitative data were initially entered into Microsoft Excel spreadsheet Version 5 and then converted to WarpPLS 4.0 software for further statistical analysis to test the relationships between the exogenous (independent) and the endogenous (dependent) variables in the ELIM. The qualitative data (open-ended survey) were analysed using content analysis, wherein individual responses were coded, rearranged into different categories and recurring themes were identified. The themes that provided explanations related to the e-learning integration model (ELIM) factors, PSSTs perceptions about e-learning and preservice science teachers' experiences with e-learning technologies during teaching practice in the literatures were identified.

3.8.1 Quantitative Analysis

The data collected from the biographical information, usage, hours spend on using e-learning each week and activities performed on the e-learning site was analysed with descriptive statistics such as tables, frequencies and percentages. The frequencies of responses from one hundred preservice science teachers and percentages were tabulated.

3.8.1.1 The ELIM and MOD Factors

The data collected for ELIM and MOD scales were coded in Microsoft Excel and analysed using the WarpPLS 4.0 - Structural Equation Modelling (PLS-SEM) software package to empirically establish and analyse relationships between constructs of the ELIM, and analyse the moderating effect of the MOD factors between intention and integration (Kock, 2015). SEM is a statistical technique for simultaneously testing and estimating causal relationships among multiple independent and dependent constructs based on statistical data and qualitative underlying assumptions (Urbach & Ahlemann, 2010). In this study, the focus was on how the constructs such as attitude, skills, satisfaction, flow experience and intention can predict pre- service science education teachers' integration of e-learning technologies into the teaching and learning of science subjects. The study also sought to confirm the validity of a set of hypotheses on the basis of the empirical data collected.

There are different methods, statistical models and software programmes available in the literature for explaining and analysing relationships between multiple variables based on a dataset, such as Factor Analysis (FA), Multiple Factor Analysis (MFA), Multiple Regression Analysis (MRA), Principal Component Analysis (PCA), Path Analysis (PA) and Structural Equation Modelling (SEM) (Hair *et al.,* 2010:627). Each of these methods has its own requirements, merits and demerits. SEM techniques such as LISREL and PLS are second generation multivariate analysis techniques (Fornell, 1987) and differ from first-generation techniques, such as multiple regressions, factor analysis, or discriminant analysis, in that SEM allows the researcher to simultaneously consider relationships among multiple independent (exogenous) and dependent (endogenous) variables (Urbach & Ahlemann, 2010). Thus, SEM answers a set of interconnected research questions in a single, methodical, and complete analysis. An additional benefit of SEM is that it supports Latent Variables

(LVs), or “hypothetical constructs developed by a scientist for the purpose of understanding a research area” (Urbach & Ahlemann, 2010). Since LVs are unobservable and cannot be directly measured, researchers use observable and measurable indicator variables - also referred to as manifest variables - to approximate LVs in theoretical models. Hence, in this study, the relationships theoretical constructs, such as attitude, skills, satisfaction, flow experiences, intention and e-learning integration among could be analysed. Presently, there are two universal approaches to SEM: one, Covariance-Based Structural Equation Modelling (CBSEM), as implemented for example, in Linear Structural Relationship (LISREL), and two, the Component-Based Partial Least Square (PLS) approach as implemented for example in WARP. Although the structural model of CBSEM and PLS might look identical, there are fundamental differences in terms of developing, estimating and interpreting a proposed model that is using any of them (Hair *et al.,* 2010:775).

3.8.1.2 The Partial Least Squares Method

Partial least squares is a component-based approach for testing structural equation models. PLS algorithm originated in the social sciences by economics Wold’s (1966) early work on the principal component analysis (PCA). It was first completely formalized in 1979 (Wold, 1979), with his main reference to PLS in 1985 (Wold, 1985). Since then, several researchers have built on the Wold’s work, developing it further and refining the algorithm (Chin & Todd, 1995; Chin, 1998b; Chin & Newsted, 1999; Kock, 2015). PLS generalizes and combines features from PCA and MRA to predict a set of dependent variables from a large set of independent variables. Urbach and Ahlemann (2010) state that PLS has become increasingly popular as an alternative to SEM during the last few years and has been applied in various disciplines including marketing (Henseler, *et al.,* 2009), education (Christmas, 2005; Angnakoon & Boonsong, 2012), computer science ((Navimipour & Soltani, 2016) and consumer and service research (Ringle, Sarstedt & Mooi, 2010). Urbach and Ahlemann (2010:9) summarise the distinctive characteristic of PLS which makes it attractive to researchers as the statistical means for testing SEM, compared to other analytical models, as follows:

a) PLS makes fewer demands regarding sample size range from 30 to 100 cases than other methods.
b) PLS does not require normal-distributed input data.
c) PLS can be applied to complex structural equation models with a large number of constructs and links.

d) PLS is able to handle both reflective and formative constructs.
e) PLS is better suited for theory development than for theory testing.
f) PLS is especially useful and best suited for prediction.

Thus, PLS was chosen in this study for two reasons. First, the proposed research model is still at an early stage of development and has not been tested extensively both in the literature and in practice. Second, the interest in this study was to assess the predictive power of the independent variables on the dependent variables. The PLS-SEM interface is described by two models.

a) A measurement model, also called outer model, which describes the relationships between the latent variables (LVs) that make up the model and their associated observed or manifest variables (MVs). In this sense, the path coefficient for measurement models are determined by loadings as this study is a reflective measurement model, the loading are outer model parameter estimates.
b) A structural model, also called inner model, which encompasses the relationships between the latent variables that make up the model. The independent latent variables are referred to as exogenous variables and the dependent LVs as endogenous variables. In this sense, the path coefficients are inner model parameter estimates. The combination of measurement and structural models leads to a complete SEM. The steps taken to analyse the measurement model in this study have been outlined in *Section 3.7.3.1* above.

3.8.1.3 Assessment of the Structural Model

The structural model comprises the relationship between constructs or latent variables that were hypothesized in the research model. The goodness of a theoretical model is established by the strength of each structural path and the combined predictiveness. The structural model can be analysed after the reflective measurement models have been successfully validated (Urbach & Ahlemann, 2010). The following indexes were employed in this study to evaluate the structural model, that is, the fit of the model. Firstly, evaluating each endogenous LV's coefficient of determination (R^2), secondly, measuring the significance and relevance of the path coefficients (β), thirdly, calculating the effect sizes (f^2), fourthly, assessing the predictive relevance (Q^2) and lastly evaluating the Goodness of Fit (*GoF*) index in both outer and inner models (Urbach & Ahlemann, 2010; Navimipour & Soltani, 2016).

3.8.1.3.1 Coefficient of Determination *(R^2)*

The coefficient of determination *(R^2)* of an endogenous variable was used to measures the quality and predictive power of the inner model. R^2 is the amount of variance in the dependent variables according to the latent variables which explains it in the model (i.e. a latent variable that is hypothesized to be affected by one or more other latent variables), and reflects the percentage of the variance in the latent variable that is explained by the latent variables that are hypothesized to affect it. The value should be high enough for the model to have a minimum level of explanatory power (Urbach & Ahlemann, 2010). The higher the R-squared coefficient, the better is the explanatory power of the predictors of the latent variable in the model, especially if the number of predictors is small. Chin (1998b) considers values of approximately 0.67 as large, values around 0.33 as medium, and values of 0.19 as small, weak.

3.8.1.3.2 Path Coefficient (*β*)

The path coefficient (*β*) is also known as "Beta coefficient". A path coefficient's magnitude indicates the strength of the relationship between two LVs (Urbach & Ahlemann, 2010). The path coefficients between latent variables in the model show the algebraic sign, magnitude and significance. The path coefficients should be significant at least at the .050 level.

3.8.1.3.3 Effect Size *(f^2)*

The effect size *(f^2)* measures if an independent LV has a large effect on a dependent LV in the model. It is calculated by WarpPLS 4.0 as the absolute values of the individual contributions of the corresponding predictor LVs to the R-squared coefficients of the criterion LV in each LV block (Kock, 2015). The effect sizes provided by WarpPLS 4.0 are similar to Cohen's *f* -squared coefficients (Cohen, 1988), however, they are calculated using a different procedure. The reason for this is that the stepwise regression procedure proposed by Cohen (1988) for the calculation of *f*-squared coefficients is generally not compatible with PLS-based SEM algorithms. The removal of predictor LVs in LV blocks, used in the stepwise regression procedure proposed by Cohen (1988), tends to cause changes in the weights linking LV scores and indicators, thus biasing the effect size measures. With the effect sizes researcher can ascertain whether the effects indicated by path coefficients are small, medium, or large. The recommended values for f^2 are between 0.02 and 0.15, between 0.15 and 0.35, indicating that an exogenous variable has small, medium, or large effect on an endogenous variable, respectively (Cohen, 1988; Chin, 1998b).

3.8.1.3.4 Predictive Relevance (Q^2)

Predictive Relevance Q-squared coefficient is a nonparametric test also known as Stone-Geisser Q^2 coefficient. It is used to assess the predictive validity associated with each endogenous variable in the model, that is, it measures the extent to which the prediction is successful (Urbach & Ahlemann, 2010). The recommended threshold value is Q -squared coefficient greater than zero, which suggest that the model have predictive relevance for a certain endogenous variable (Henseler, *et al.*, 2009).

3.8.1.3.5 Goodness of Fit (GoF)

The Goodness of Fit (GoF) index**,** referred to as "Tenenhaus GoF" is a measure of a model's explanatory power (Tenenhaus, Vinzi, Chatelin & Lauro, 2005). The overall predictive power of the model should be assessed if the research model has more than one endogenous construct. The purpose of GoF index is to account for the performance of the PLS model at both measurement and structural models with a focus on providing a single measure for the overall predictive performance of the model (Navimipour & Soltani, 2016). The recommended values for GoF is *small* if equal to or greater than 0.1, *medium* if equal to or greater than 0.25, and *large* if equal to or greater than 0.36 (Wetzels, Odekerken-Schroder & Van Oppen , 2009; Kock, 2015). A value lower than 0.1 for the GoF suggests that the explanatory power of a model may be too low to be considered acceptable.

3.8.2 Qualitative Analysis

The qualitative data collected from open-ended survey were analysed using tables, frequencies, percentages and hermeneutic content analysis (HCA). Hermeneutic Content Analysis is an innovative analysis method. Vieira and de Queiroz (2017) define HCA as a mixed methods which consist of Hermeneutic Analysis and Qualitative Content Analysis. HCA brings together Hermeneutic and Qualitative Content Analysis by combining the principles of content analysis as coding, categorization, systematization and interpretation with understanding and reflection. The authors further explain that using HCA as analysis method is essential by taking into account interpretation and understanding as important elements in analysis and reflection of content and textual elements. Vieira and de Queiroz

(2017) further made a distinction between hermeneutic and qualitative content analysis. Hermeneutic is art of interpretation of understanding a text in a circular movement involving both subjective and objective sides, while qualitative content analysis is a method for systematically describing the meaning of qualitative data through coding and categorization, and description of material. In essence, qualitative content analysis describes the data, while hermeneutic interprets and reflects the data. Hsieh & Shannon (2005) and Delvin (2006:199) listed the steps to take in qualitative content analysis as follows:

- Read through all the written responses
- Create a condensed list of the respondents
- Create a list of categories (not more than six to seven).
- Develop an operational definition for each category

Moreover, Vieira and de Queiroz (2017) listed the hermeneutic rules in order to help in interpretation of text.

- Read through all text
- Study the text sentence-by-sentence, impression after impression; so, to perform the explanation of contradictions at least
- Read the text again as a whole
- Bring some reflections from general text
- Make a draft for each part of text, as private formulation of explanation

In this study, the researcher combined qualitative content analysis and hermeneutic rules and follow the steps set out below for easy interpretation of the data and for comparison purposes. Firstly, all the preservice science education teachers' written responses were read word by word to derive codes. Secondly, the data were coded by segmenting and assigning labels to the text passages. Thirdly, codes were rearranged into categories based on their similarities and their frequencies and percentages were noted. Fourthly, these emerging categories were used to group codes into clusters and recurring themes were identified. Fifthly, the themes that provided explanations related to the ELIM factors and perceptions of preservice science teachers about the educational benefit of e-learning related to the literature were identified. Moreover, similar responses based on the reflections of preservice science teachers' experiences with e-learning technologies during teaching practice were grouped into categories for each question and their frequencies and percentages were noted. The purpose of using frequency and percentage was to identify categories that had the greatest explanatory potential. The phrases describing the purpose, techniques, outcomes and evidence for using e-learning technologies were sorted together to explain, describe and interpret preservice science teachers’ experiences with e-learning technologies during their teaching practice. Finally, for the purpose of substantiating the categories, preservice science teachers’ views and responses were interpreted and quoted verbatim, where applicable.

3.9 ETHICAL CONSIDERATIONS

Permission to conduct research was sought from the University selected for this study. The institution’s Research Committee required the researcher to submit the following documents before the Ethical Clearance Certificate (*see Appendix C*) could be granted: a copy of questionnaire to be administered (*see Appendix E*), permission letter from the dean of the researcher’s faculty (*see Appendix A)* and participant informed consent form (*see Appendix B*).

When it was time to collect the data, the researcher addressed the participants and explained to them the purpose and objectives of the study, and why they were selected to provide information that was desired for the study. A letter of consent was given to the participants to obtain permission from them to participate in the study (*see Appendix B*). The participants were assured in the consent form that their participation was voluntary, and that any information they provided would be treated with utmost confidentiality and strictly used for the purposes of the study only. Thereafter, the participants completed the consent form and voluntarily responded to the questionnaires.

3.10 CONCLUSION

This chapter has described the methods used in this research and provided justification for the use of the chosen design for investigating factors predicting the integration of e-learning technologies in the teaching and learning of science subjects by preservice science teachers.

Both quantitative and qualitative approaches to data collection were used because of the nature of the data that needed to be collected in order to validate the findings. The research paradigm, research design, data collection instruments and procedures, population and research sample, procedures for checking the reliability and validity of the research instruments have all been described and explained. The chapter also described the method of data analysis and ethical considerations. In the next chapter, data analysis, presentation and interpretation of results are presented.

CHAPTER FOUR

DATA PRESENTATION AND RESULTS

4.1 INTRODUCTION

This chapter presents the results of the analyses obtained from both the quantitative and qualitative data in line with the research questions and hypotheses of this study. This research focused on the study of the integration of e-learning technologies by preservice science teachers while at university and during their teaching practice in schools.

Four research questions were posed to fulfil the aim of this study.

4.1.1 What are preservice science teachers' perceptions of the educational benefits of integrating e-learning technologies in the teaching and learning of science subjects?

4.1.2 What factors best predict or explain pre-service science teachers' integration of e-learning technologies in teaching and learning of science subjects?

4.1.3 How can quality and innovation consciousness moderate the relationship between intention to integrate and the actual integration of e-learning technologies in the teaching and learning of science subjects by pre-service science teachers?

4.1.4 What are the preservice science teachers' experiences with regard to integrating e-learning technologies in the teaching and learning of science subjects during teaching practice?

This chapter begins by describing the results of the descriptive statistics of the biographical profile of the respondents. Subsequently, the findings according to the research questions are presented. Finally, this chapter concludes with a summary.

4.2 BIOGRAPHICAL INFORMATION OF THE RESPONDENTS

Among the 100 PSSTs who participated in this study, 54 were females (54%) and 46 males (46%). The majority of the PSSTs (72%) were 21-25 years of age, which fits the general age profile of undergraduate students at the institution, and South Africa, generally, while few (8%) were 31-35 years of age. About 39% indicated that they used e-learning in their science modules several times each week, 26% used it several times a day, 20% at least once in a week and 15% once in a day. In addition, 30% of the PSSTs indicated that they spent 1-2 hours on using e-learning each week, 28% spent 3-4 hours using e-learning each week, 13% spent 7-8 hours using e-learning each week, 12% spent 5-6 hours using e-learning each week, 11% spent 11-12 hours each week using e-learning and 6% spent 9-10 hours each week using e-learning. The results thus indicated that the majority of the PSSTs were technology savvy. Thinyane (2010) reported similar findings about usage of e-learning in teaching and learning in Higher Education Institutions in South Africa. The PSSTs represented 15 major study areas in their programme of study with mathematics and life science having the greatest number of PSSTs. In addition, the participants came from the various subjects combinations offered in the Department of Mathematics, Science and Technology Education. Table 4.1 presents the biographical information of PSSTs who participated in this study.

Table 4.1: Biographical information of participants in the study

	No of PSSTs	Percentage (%)
Gender		
Female	54	54%
Male	46	46%
Age		
21-25 years	72	72%
26-30 years	20	20%
31-35 years	8	8%
Department (MSTE)	100	100%
Year of Study		
Fourth	100	100%
E-learning frequency of use to supplement class learning		
Use several times a week	39	39%
Use several times a day	26	26%
Use at least once a week	20	20%
Use about once a day	15	15%
Hours spend on using e-learning each week		
1-2 hours	30	30%
3-4 hours	28	28%
7-8 hours	13	13%
5-6 hours	12	12%
11-12 hours	11	11%
9-10 hours	6	6%
Programme of Study		
Mathematics and Life Science	27	27%
Technology	12	12%
Mathematics, Chemistry and Technology	9	9%
Mathematics and Physics	7	7%
Mathematics	6	6%
Mathematics and Chemistry	6	6%

Mathematics, Life Science and Technology	6	6%
Mathematics, Physics and Technology	5	5%
Life Science and Technology	5	5%
Mathematics, Chemistry and Life Science	4	4%
Mathematics, Chemistry and Physics	4	4%
Chemistry and Technology	3	3%
Mathematic and Technology	2	2%
Chemistry, Physics and Technology	2	2%
Mathematics, Physics and Life Science	2	2%

4.2.1 Preservice Science Teacher's Use of E-Learning Technologies

The activities that PSSTs performed on the e-learning site determined their level of usage of e-learning technologies. The various activities are presented in table 4.2.

Table 4.2: PSSTs use of E-Learning Technologies

E-Learning Activities	**No of PSSTs (%)**
Download module materials (notes, question papers, assignments)	100 (100%)
Write quiz tests and assignments	90 (90%)
Checking updates on module assessments and grades	85 (85%)
Searching for additional information about the module	54 (54%)
Send emails to colleagues	46 (46%)

Note. Participants performed more than one activity on the e-learning site

Table 4.2 shows the distribution of various activities that PSSTs performed when using e-learning technologies. The vast majority of the PSSTs used e-learning technologies to download module material (100%), write quiz tests and submit assignments (90%) and checked updates of their assessments and grades (85%). More than half of them (54%) used e-learning technologies to search for additional information about the module and (46%) of them used e-learning technologies to send emails to their colleagues.

4.3 PRESERVICE SCIENCE TEACHERS' PERCEPTIONS ABOUT E-LEARNING TECHNOLOGIES

This section presents the information collected from the PSSTs about their perceptions of the educational benefits of integrating e-learning technologies within the science classroom environment. This section addresses and answers the first research question of the study though hermeneutic content analysis. Other variables presented in this section include the disadvantages of integrating e-learning technologies in the teaching and learning of science subjects as viewed by the PSSTs. The coding process used to analysed the qualitative data is outlined in *section 3.8.2*.

Research Question 1: *What are preservice science teachers' perceptions of the educational benefits of integrating e-learning technologies in the teaching and learning of science subjects?*

4.3.1 PSSTs Perceptions of Integrating E-Learning Technologies in the Teaching and Learning of Science Subjects

The perceptions of the PSSTs about the benefits of integrating e-learning technologies in the teaching and learning of science subjects are presented in table 4.3.

Table 4.3: PSSTs perceptions of integrating e-learning technologies in the teaching and learning of science subjects

Emerging Themes/Categories	**No of PSSTs (%)**
Search and share information about the content	22 (22%)
Improve teaching and learning	21 (21%)
Improve technology skill of student	20 (20%)
Increase motivation to learn	11 (11%)
Improve learners understanding of the content	10 (10%)
Enable communication between teachers and students	09 (09%)
Save time	07 (07%)
Total Responses	**100**

According to Table 4.3, of the 100 PSSTs, (22%) of them perceived that e-learning technologies were useful for searching and sharing information about the content. The following were some of the quotes from the PSSTs to explain and support their perceptions.

a) *"Help to download extra information about the topic without buying books and also past examination papers."*
b) *"Important for posting and sharing information about the topic to learners."*
c) *"Good because lecturers upload content and previous question paper for students to learn."*

d) *"I downloaded materials about the content from the internet to improve my learning."*

Some (21%) of the PSSTs explained that e-learning improved teaching and learning, as reflected in following statements:

a) *"Help teachers to be updated and to improve student learning."*
b) *"I go beyond textbooks to get more useful information on the internet to improve my content."*
c) *"Teachers gave many examples in science lesson using video for clarification of the topic."*
d) *"Using e-learning technologies to present a lesson will improve teaching and learning."*
e) *"Teaching and learning with e-learning technologies improve teachers work and make them to be innovative."*

Furthermore, (20%) of the PSSTs indicated that e-learning technologies improved the technology skill of student and helped them to think critically. This is indicated in the following statements:

a) *"It develops my technology skills to browse through the internet for materials about topic."*
b) *"Increase my thinking about the topic when I study using internet."*
c) *"Help me to be technology savvy, being technologically oriented, instead of writing notes in face-to-face lectures."*

Some (11%) of the PSSTs explained that e-learning motivated learners to learn. This is substantiated by the following statements:

a) *"Help stimulate my interest in learning because I enjoy using technology."*
b) *"E-learning embraces the interest of students more and motivate them to go above working on their assignment."*
c) *"E-learning stimulates and raises students' motivation towards learning."*
d) *"Help to motivate students' to engage in a meaningful learning."*

Next were the 10% who explained that e-learning technologies improved learners' understanding of the content, as presented below:

a) "*...whenever our teachers used pictures to present the lesson, I tend to respond to questions."*
b) *"Help students to see things practically and to understand the lesson better rather than using textbooks."*

c) *"Learners understand concepts by showing them video to visually explain to them instead of telling them."*

d) *"When teachers use e-learning technologies in science lessons, I understand better than when he taught us using the textbooks ... Many of us participated actively."*

e) *E-learning technologies are very good to help students to have a clear understanding of concepts."*

A comparatively smaller number (09%) of the PSSTs explained that e-learning technologies enabled communication between teachers and students. They made this point as follows:

a) *"I chat with my classmates to discuss about the topic for clear understanding."*

b) *"Teachers communicate with us through discussion forums in the Moodle platform to remind us about assignments."*

c) *I have more time to interact and communicate with my colleagues for clear understanding of concepts."*

Lastly, 7% of the PSSTs indicated that using e-learning technologies helped them to save a lot of time in their studies. This is substantiated by the following quotes:

a) *"Save time for my study outside the classroom."*

b) *"Help to save time to mark learner's test."*

4.3.2 PSSTs Views about Disadvantages of Integrating E-Learning Technologies in the Teaching and Learning of Science Subjects

The various disadvantages of integrating e-learning technologies in the teaching and learning of science subjects as viewed by the PSSTs are presented in table 4.4.

Table 4.4: Disadvantages of integrating e-learning technologies in the teaching and learning of science subjects

Emerging Themes/Categories	**No of PSSTs (%)**
Lack of e-learning facilities	31 (31%)
Make learners to be lazy	30 (30%)
Bring distraction into the classroom	29 (29%)
Promote plagiarism	08 (08%)
Very expensive	02 (02%)
Total Responses	**100**

Table 4.4 shows that among the 100 PSSTs, 31% indicated that the lack of e-learning facilities can hinder e-learning integration. This is indicated in the following statements:

a) *"Disadvantages occur when the teacher plan to present some slides only to find out there is no power supply."*
b) *"It will be difficult for schools that still lack access to the internet to use e-learning."*
c) *"Lack of access to the internet denied some learners to study or get information about the topic easily."*

Next, 30 % of the PSSTs pointed out that integration of e-learning technologies made learners to become lazy:

a) "*Learners do not think if the teacher asks them questions, but they simply search through google and yahoo, to get the answer easily."*
b) *"Many learners rely more on e-learning and become lazy to attend classes."*
c) *"Some teachers may be so lazy that they uploaded videos of lessons and let learners view them and don't teach them anything about the topic."*
d) *"Make learners to be lazy and lack the skill of writing."*

Furthermore, 29% of the PSSTs explained that integrating e-learning technologies brought distraction into the classroom and made learner not to focus in the classroom:

a) *"Some learners focus on other activities which are not related to classwork when using e-learning."*
b) *"Learners may lose focus and start entertaining other interesting thing from the internet and forget studying."*
c) *"It can shift the main focus of study and it can create a lot of debates that are unnecessary and unhelpful."*
d) *"Learners may be excited about the internet and end up visiting sites that has nothing to do with education."*
e) *"Power cut can affect computer to stop working to distract learners."*
f) *"Some learners will be playing games in the classroom to distract other learners."*
g) *"It will distract students from focusing on the real issues addressed by the content.*

A comparatively smaller number (08%) of the PSSTs pointed out that integrating e-learning technologies promoted plagiarism. This was stated as follows:

a) *"It will increase the level of cheating of the learners in class and the use of textbooks will decrease."*
b) *"Encourage plagiarism, students cannot think critically because they copy information from the internet."*

c) *"If learners are given an assignment, they end up committing plagiarism."*

Lastly, 02% of the PSSTs indicated that integrating e-learning technologies would be very expensive and not affordable:

a) *"Very expensive and not economical for some students to connect to the internet at home.*

b) *"The e-learning technologies are very expensive to afford."*

4.4. FACTORS THAT BEST PREDICT PRESERVICE SCIENCE TEACHERS' INTEGRATION OF E-LEARNING TECHNOLOGIES IN TEACHING AND LEARNING OF SCIENCE SUBJECTS

This section presents the results of the analysis related to the factor (s) that best predict PSSTs integration of e-learning technologies in teaching and learning of science subjects. This section addresses and answers the second research question of this study. To identify factors that best predict PSSTs the integration of e-learning technologies, a path analysis based on the proposed ELIM factors was conducted (*see Figure 2.5*). This section starts by presenting the results of the descriptive statistics of the research instruments. Next, it describes the assessment of the measurement and structural models in order to answer the *apriori* hypotheses formulated in Chapter One, as a way of cross-validating the results of the proposed model in this study.

Research Question 2: *What factors best predict or explain preservice science teachers' integration of e-learning technologies in teaching and learning of science subjects?*

4.4.1 Descriptive Statistics

The descriptive statistics for each factor indicator are shown in table 4.5. For ELIM factor indicators, all mean scores fell above the midpoint of 3.0 ranging from 3.540 to 4.630. This indicates an overall positive response to the factors that were measured in the model. The standard deviations ranged from 0.500 to 1.004 indicating that the item scores reflected a fairly narrow spread around the mean. The data in this study were regarded as normal for the purposes of structural equation.

Table 4.5: Means and Standard Deviations of the Factors

Factors	Indicators	Means	Standard deviation
Attitude	ATT 1	4.630	0.506
	ATT 2	4.350	0.770
Intention	INT 1	3.750	0.914
	INT 2	4.110	0.680
	INT 3	4.050	0.657
Skill	SKL 1	3.980	0.864
	SKL 2	4.020	0.853
	SKL 3	3.750	0.903
	SKL 4	3.730	0.952
Flow	FLW 1	4.170	0.779
	FLW 2	4.150	0.783
	FLW 3	3.930	0.844
	FLW4	3.860	0.853
Integration	INTE 1	4.150	0.500
	INTE 2	3.610	1.004
	INTE 3	3.540	0.915

4.4.2 The Modified Research Model

Following the results of the path coefficient and significance level of each factor during the data analysis of the structural model, the researcher reflected upon the proposed model and made necessary revisions. Thus, the proposed model presented in Chapter 2 of this study was modified. The path coefficient and level of significance results revealed that the effect of satisfaction (one of the proposed factors) on integration was found to be insignificant, and was consequently removed from the model which, in turn, automatically removed the two links that led to satisfaction that were found to be significant. Although the link between satisfaction and intention was found to be significant, which supported the earlier prediction by ECT, it was however not the main purpose of this study. The study sought to investigate the factors that would predict the integration of e-learning technologies by preservice science teachers, and not to predict intention. Another most convincing reason to support the removal of satisfaction from the proposed model was that the predictive power (R^2) of the proposed model with satisfaction included was 44%. After removing satisfaction from the model, the researcher re-run the PLS algorithm to obtain the revised results. The predictive power (R^2) of the revised model remained as 44%, which showed that satisfaction did not have any significant contribution to the model. The modified ELIM is shown in figure 4.1.

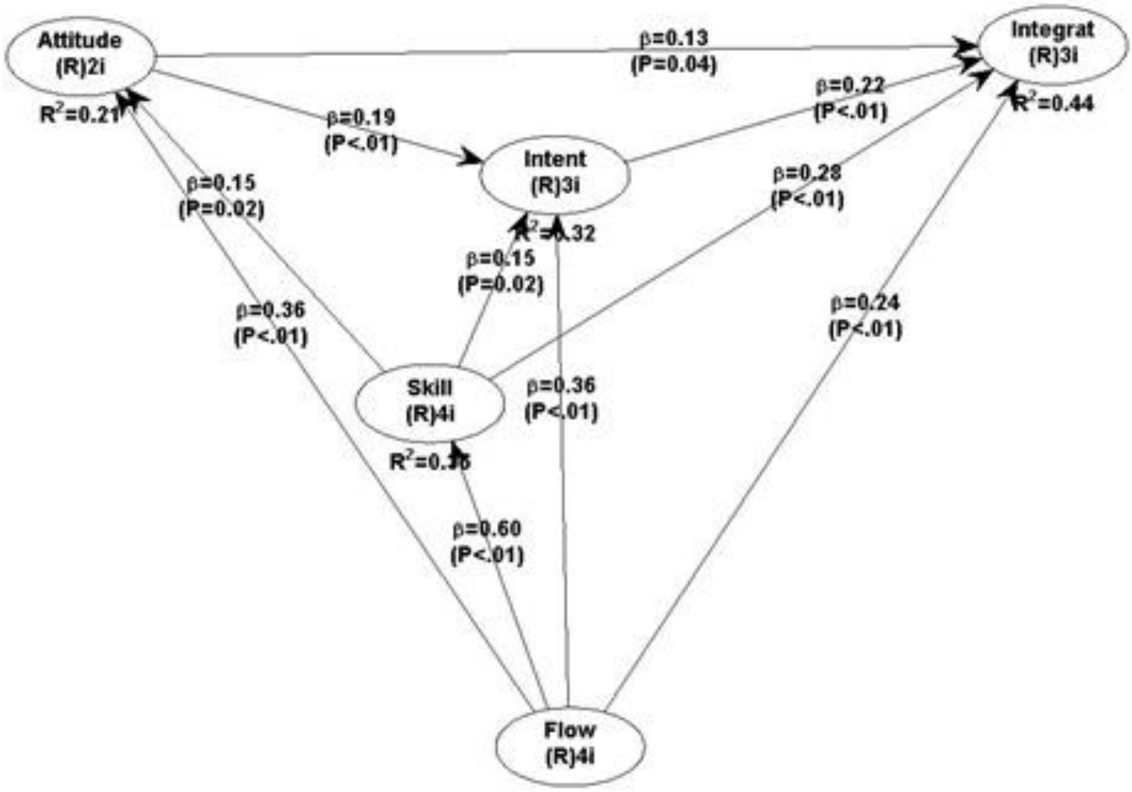

Figure 4. 1: The Hypothesized Research Model

4.4.3 Assessing the Measurement Model

In testing the measurement model, a confirmatory factor analysis was performed via the WarpPLS 4.0 (SEM) software (Kock, 2013). The Warp Partial Least Squares (PLS) 4.0 (SEM) tool was used to assess the psychometric properties of the measurement model (i.e. the reliability and validity of the scales used to measure each variable). The measurement model was assessed using item loadings, internal consistency reliability, indicator reliability, convergent validity, and discriminant validity as suggested by Henseler, *et al.,* (2009), Urbach and Ahlemann (2010) and Kock, (2015). Each factor was measured using reflective indicators. To assess each item reliability, its loadings to their respective factors was examined. According to Chin (1998b) standardized loadings should be greater than 0.707 and significant at least at the 0.050 level. Seven unreliable items were removed because their loadings were below the acceptable standardized loading value of 0.70 and were considered unreliable for ELIM. The level of significance of all the remaining reliable item loadings, also proved significant at p<0.001, which indicated that the indicators were reliable. Table 4.6 presents the remaining item loadings, their levels of significance, internal consistency (composite reliability values above 0.7), and convergent validity (average variance extracted with values equal or above 0.50) which all fell above 0.50. Examining the loadings for each of the five factors, all the 16 item loadings **(λ)** were above 0.70 and ranged from 0.712 to 0.879. Moreover, all item loading were significant at *p* <0.001 level, indicating that the selected items were measuring the factors at a statistically significant level.

Table 4.6: Results of the Measurement Model for ELIM

Factors	**Items**	**Loading**	**P Value**	**Composite Reliability (CR)**	**Convergent Reliability (AVE)**
Attitude	ATT1	0.848	<0.001	0.837	0.720
	ATT2	0.849	<0.001		
Intention	INT1	0.746	<0.001	0.838	0.635
	INT2	0.875	<0.001		
	INT3	0.763	<0.001		
Skill	SKL1	0.745	<0.001	0.879	0.645
	SKL2	0.852	<0.001		
	SKL3	0.739	<0.001		
	SKL4	0.866	<0.001		
Flow	FLW1	0.879	<0.001	0.878	0.645
	FLW2	0.848	<0.001		
	FLW3	0.763	<0.001		
	FLW4	0.712	<0.001		
Integration	INTE1	0.744	<0.001	0.757	0.511
	INTE2	0.735	<0.001		
	INTE3	0.743	<0.001		

Furthermore, to ensure that all the items loaded more highly on their respective factor than on any other factor, cross-loadings were computed, and these are shown in Table 4.7. This was achieved (i.e. the bolded factor loadings were higher than the non-bolded factor loadings in any one row and column), and all the items loaded more highly on their respective factor and no significant loadings on any other factor.

Table 4.7: Combined loadings and cross-loadings for ELIM

Items	DV	ATT	INT	SKL	FLW	INTE
ATT1	Yes	**0.848**	0.040	0.230	-0.093	-0.136
ATT2	Yes	**0.849**	-0.040	-0.229	0.093	0.135
INT1	Yes	-0.026	**0.746**	0.103	-0.220	0.079
INT2	Yes	-0.021	**0.875**	-0.028	0.097	-0.002
INT3	Yes	0.056	**0.763**	-0.039	0.022	-0.068
SKL1	Yes	-0.062	0.019	**0.748**	-0.042	-0.091
SKL2	Yes	0.004	0.131	**0.852**	0.023	-0.211
SKL3	Yes	-0.084	0.067	**0.739**	0.034	-0.230
SKL4	Yes	-0.007	-0.118	**0.866**	-0.014	0.183
FLW1	Yes	0.050	-0.199	0.077	**0.879**	0.129
FLW2	Yes	0.054	0.082	-0.008	**0.848**	-0.105
FLW3	Yes	-0.017	0.212	-0.037	**0.763**	-0.182
FLW4	Yes	-0.251	-0.009	-0.141	**0.712**	0.218
INTE1	Yes	0.030	0.293	-0.027	-0.219	**0.744**
1NTE2	Yes	0.099	-0.269	0.053	0.089	**0.735**
INTE3	Yes	-0.116	-0.085	-0.016	0.158	**0.743**

4.4.3.1 Internal Consistency

The internal consistency reliability of each factor was assessed using composite reliability (CR) instead of Cronbach's alpha due to the propensity of Cronbach's alpha to understate reliability. Chin (1998b) and Henseler, *et al.*, (2009) recommend composite reliability to be a better measure of reliability in PLS because CR overcomes some of CA's deficiencies of severely underestimating the internal consistency reliability of factors in PLS structural equation models. The composite reliabilities of all the factors in the model ranged from **0.757 to 0.879,** which exceeded the recommended threshold value of 0.70 (Chin, 1998b), with the lowest value being 0.757 for the integration factor. Hence, all factors have acceptable reliability (*see Table 4.6*).

4.4.3.2 Convergent Validity

The convergent validity is considered adequate when average variance extracted (AVE) equal or exceeds 0.50 (≥.50). In addition, the AVE for all five factors had an acceptable level of convergent validity ranged from **0.511** to **0.720,** which demonstrated sufficient convergent validity (Fornell &Larcker, 1981) as shown in table 4.6. Overall, the factor loadings, composite reliability coefficient and AVEs met the recommended guidelines, indicating that the convergent validity of the proposed factors of the measurement model was adequate for SEM.

4.4.3.3 Discriminant Validity

The discriminant validity was assessed using Fornell & Larcker's (1981) criterion that the square root of AVE for each factor should exceed the correlations between that factor and all other factors. As shown in table 4.8, the bolded elements in the matrix diagonals representing the square roots of the AVEs, are greater in all cases than the off-diagonal elements in their corresponding rows and columns. For example, the highest correlation between any pair of factors was 0.582 (between skill and flow). This number was lower than the lowest square root of AVE among all factors, which was 0.715 for integration. This indicates that each factor shared more variance with its assigned items than with any other factors. Hence, discriminant validity was achieved at both the *item* and *factor* levels – thereby deeming the constructs in the proposed research model to be adequate.

Another test for discriminant validity is cross-loadings, obtained through correlating each latent variable's component scores with that of all other items (Chin, 1998b). If each indicator's loading is higher for its designated construct than for any of the other constructs, it can be inferred that the different constructs' indicators is not interchangeable (Urbach & Ahlemann, 2010). That is, the loading of each item is expected to be higher than all of its cross loadings or any other construct (Henseler, *et al.*, 2009). As shown in table 4.7, all indicators loaded more highly on their respective factor (i.e. the bolded factor loadings) than on any other factor (i.e. the non-bolded factor loadings in any row and column), indicating discriminate validity.

Table 4.8: Discriminant Validity for the Measurement Model

Factors	AVE	ATT	INT	SKL	FLW	INTE
ATT	0.720	**0.848**				
INT	0.635	0.349	**0.797**			
SKL	0.645	0.317	0.383	**0.803**		
FLW	0.645	0.431	0.518	0.582	**0.803**	
INTE	0.511	0.342	0.447	0.505	0.478	**0.715**

Note: Square roots of the average variance extracted (AVEs) shown on the diagonal and off-diagonal represent the correlations.

4.4.4 Assessing the Structural Model

The structural model was assessed with the aim of determining the explanatory power of the model and to test the proposed research hypotheses in this study. The following indexes were employed in this study to evaluate the structural model. Firstly, each endogenous LV's coefficient of determination (*R2*) was evaluated; secondly, the significance and relevance of the path coefficients were measured; thirdly, the effect sizes (*f2*) was calculated; fourthly, the predictive relevance (Q^2) was assessed; and lastly the Goodness of Fit (GoF) indexes in both outer and inner models were evaluated (Urbach & Ahlemann, 2010; Navimipour & Soltani, 2016).

4.4.4.1 Assessment of Coefficient of determination (R^2)

The coefficient of determination (R^2) of the endogenous factors was used to measures the quality and predictive power of the inner model. The values indicate the percentage of variance explained by the model and give information about the predictive explanatory power of the structural model. According to the thresholds values denoted by Chin (1998b), the overall R^2 of integration (the ultimate factor) in this study was 0.44. This means that four factors (intention, attitude, skill, and flow) combined to explain 44 % (R^2 = 0.44) of integration which was moderate (*see Figure 4.1*). In addition, there are some interactive effects among intention, attitude, skills and flow experience on integration. Therefore, attitude, skill and flow explained 32 % (R^2 = .32) of intention which was moderate. Further, flow and skill explained 21 % (R^2 = .21) of attitude which was small, and finally flow explained 36 % (R^2 = 0.36) of skill which was moderate. In all cases, the explained variance (R^2) was above 10%, so the complete model was well defined (Navimipour, *et al.,* 2016). The R^2 values of the endogenous variables and the significance of the modelled paths are all depicted in Figure 4.1.

4.4.4.2 Assessment of the Path Coefficient (β)

According to the significance of path coefficients, all the ten structural paths (hypothesized associations) were strongly significant at $p<0.05$. The results of path coefficients indicated that PSSTs' integration of e-learning technologies was jointly predicted by intention (β=0.22, $p<0.01$), attitude (β=0.13, $p<0.05$), skill (β=0.28, $p<0.01$), and flow (β=0.24, $p<0.01$), with PSSTs' skill as the strongest predictor. Intention, in turn, was predicted by attitude (β=0.19, $p<0.01$), skill (β=0.15, $p<0.05$), and flow (β=0.36, $p<0.01$). The results suggest that PSSTs flow experience had the greatest effect as compared to the attitude and skill. Further, the attitude was predicted by skill (β=0.15, p<0.05) and flow (β=0.36, p<0.01), with flow experience having the greatest effect. Finally, skill was mainly predicted by flow (β=0.60, p<0.01).

4.4.4.3 Assessment of Effect Sizes (f^2)

The effect size of path links between exogenous and endogenous variables in the structural model were calculated by Warp PLS 4.0, which is similar to Cohen's Effect Size (f^2) Coefficients (Kock, 2015). The effect size of the structural model can be considered a small (f^2 = 0.02), medium (f^2 = 0.15), or large (f^2 = 0.35), respectively (Cohen, 1988; Chin, 1998b). *Integration* factor, attitude (f^2 =0.05) yielded a small effect size, intention (f^2 =0.11) and flow (f^2 =0.13) yielded a small to medium effect sizes, while skill (f^2 =0.15) yielded a medium effect size. *Intention* factor, skill (f^2 =0.06) gave a small effect size, attitude (f^2 =0.07) gave a small to medium effect size and flow (f^2 =0.19) yielded a medium to large effect size. Regarding, the *attitude* factor, skill (f^2 =0.05) gave a small effect size and flow (f^2 =0.16) a medium to large effect size. Finally, flow (f^2 =0.36) has a large effect size on *skill* factor. Table 4.9 presents the effect sizes of path links between independent and dependent variables in the structural model.

Table 4.9: Effect Size of Paths (f^2)

Path	**Effect size**	**Inference**
Intention → Integration	0.11	Small to medium
Attitude → Integration	0.05	Small effect size
Skill → Integration	0.15	Medium effect size
Flow → Integration	0.13	Small to medium
Attitude → Intention	0.07	Small to medium
Skill→ Intention	0.06	Small effect size
Flow → Intention	0.19	Medium to large
Skill → Attitude	0.05	Small effect size
Flow → Attitude	0.16	Medium to large
Flow → Skill	0.36	Large effect size

4.4.4.4 Predictive Relevance (*Q^2*)

The Stone-Geisser Q^2 predictive relevance (validity) of the model was assessed in association with each endogenous variable. The recommended threshold value is Q^2 coefficient greater than zero, otherwise the model lacks predictive relevance (Henseler, *et al.*, 2009; Kock, 2015). Each endogenous variable Q^2 value in the model was greater than zero (attitude (Q^2 =0.23), intention (Q^2 =0.33), skill (Q^2 = 0.37) and integration (Q^2 =0.45). Therefore, the model has predictive relevance. Table 4.10 shows the predictive relevance of each of the endogenous variables in the model.

Table 4.10: Predictive relevance result of the Model

Factors	**Q Square**
Attitude	23
Intention	33
Skill	37
Integration	45

Finally, the overall predictive power of the model was assessed through the Goodness of Fit (GoF) index. The threshold (GoF) values for validating the PLS model globally is GoF_{small}=0.1, GoF_{medium}=0.25, and GoF_{large}=0.36 (Wetzels, *et al.*, 2009; Kock, 2015). The overall predictive power of ELIM was 0.46, which exceeds the cutoff value of 0.36 for large GoF. Thus, the ELIM in this study has "large" explanatory power. Therefore, the structure of the model has a good fit with the data.

4.4.5 Reiteration of Research Question Two

What factors best predict or explain preservice science teachers' integration of e-learning technologies in teaching and learning of science subjects?

In order to explain factors that best predict preservice science teachers' integration of e-learning technologies in the teaching and learning of science subjects, a path coefficient analysis based on the ELIM factors was used (*see Figure 4.1*). The following ten hypotheses were tested using Warp Partial Least Squares (PLS) 4.0 SEM:

a) Intention will be a significant predictor for integrating e-learning technologies by pre-science teachers.
b) Attitude will be a significant predictor for integrating e-learning technologies by preservice science teachers.

c) Skill will be a significant predictor for integrating e-learning technologies by preservice science teachers.
d) Flow experience will be a significant predictor for integrating e-learning technologies by preservice science teachers.
e) Attitude will be a significant predictor for preservice teachers' intention to integrate e-learning technologies.
f) Skill will be a significant predictor for preservice teachers' intention to integrate e-learning technologies.
g) Flow experience will be a significant predictor for preservice teachers' intention to integrate e-learning technologies.
h) Skill will be a significant predictor for preservice teachers' attitude to integrate e-learning technologies.
i) Flow experience will be a significant predictor for preservice teachers' attitude to integrate e-learning technologies.
j) Flow experience will be a significant predictor for preservice teachers' skill to integrate e-learning technologies.

4.4.5.1 E-Learning Integration

The model (ELIM) proposes that intention, attitude, skill and flow combined to predict the integration of e- learning technologies. The WarpPLS results confirmed that these four factors together significant explained 44% of the variance of E-learning integration (R^2 = 0.44, coefficient of determination). The results of path coefficient indicated that PSSTs' integration of e-learning technologies were jointly predicted by intention (β=0.22, p<0.01), attitude (β=0.13, p<0.05), skill (β=0.28, p<0.01), and flow (β=0.24, p<0.01), with PSSTs' skill having the strongest significant effect, followed by flow, intention and attitude. Hence, hypotheses H_1, H_2, H_3 and H_4 were supported.

4.4.5.2 Intention

The WarpPLS results confirmed that three factors, attitude, skill and flow interact together to explain a significant variance of 32% (R^2 = 0.32) in intention. Further, the path coefficient results showed that flow experience had the strongest significant effect on intention (β=0.36, p<0.01), followed by attitude (β=0.19, p<0.01) and skill (β=0.15, p<0.05). Thus, hypotheses H_5, H_6 and H_7 were supported.

4.4.5.3 Attitude

The WarpPLS results confirmed that two factors, skill and flow combined together to explain a significant variance of 21% (R^2 = 0.21) in attitude. The path coefficient results indicated that flow experience have the greatest significant effect on attitude (β=0.36, p<0.01) and followed by skill (β=0.15, p<0.05). Hence, hypotheses H_8 and H_9 were supported.

4.4.5.4 Skill

The WarpPLS results confirmed that skill was mainly determined by flow and explained a significant variance of 36% (R^2 = 0.36) of skill. The path coefficient results indicated that flow experience had a strong significant effect on skill (β=0.60, p<0.01). Thus, hypothesis H_{10} was supported.

Finally, Table 4.11 shows the summary of the hypotheses and its results, and they are all supported in this study.

Table 4.11: Summary of results of hypotheses

Hypotheses	**Path**	**Path coefficient (β)**	**Significance (p-Value)**	**Validation**
H_1	Intention → Integration	0.22	0.002^{**}	Yes
H_2	Attitude → Integration	0.13	0.04^{*}	Yes
H_3	Skill → Integration	0.28	0.001^{***}	Yes
H_4	Flow → Integration	0.24	0.001^{***}	Yes
H_5	Attitude → Intention	0.19	0.007^{**}	Yes
H_6	Skill → Intention	0.15	0.024^{*}	Yes
H_7	Flow → Intention	0.36	0.001^{***}	Yes
H_8	Skill → Attitude	0.15	0.024*	Yes
H_9	Flow → Attitude	0.36	0.001^{***}	Yes
H_{10}	Flow → Skill	0.60	0.001^{***}	Yes

Path significance: * $p<0.05$, ** $p<0.01$, *** $p<0.001$

4.4.6 Preservice Science Teachers Description of Factors that Predict Integration of E-Learning Technologies in the Science Classroom

This sub-section presents the results of the analysis of preservice science teacher's views about the factors which they considered to be important in predicting integration of e-learning technologies in teaching and learning of science subjects. The hermeneutic content analysis of the open-ended question resulted in descriptions of the factors which the respondents advanced to support their answers on predicting integration of e-learning technologies in teaching and learning of science subjects. The responses given by the PSSTs were categorised according to the proposed factors in the e-learning integration model (ELIM). The coding process used to analysed the qualitative data is outlined in *section 3.8.2*.

How do you describe the factors that predict integration of e-learning technologies in the teaching and learning of science subjects?

Table 4.12 presents the descriptions given by the PSSTs about the factors that they considered to be predictors of e-learning technology integration in their science lesson classrooms.

Table 4.12: Predictors of e-learning technologies in science lesson

Factors	**Emerging Themes/Categories**	**No of PSSTs (%)**
Skill	Technological skills	32 (32%)
Attitude	Engagement with content and students	15 (15%)
	Enhance learning	14 (14%)
	Facilitates learners' understanding of concepts	11 (11%)
Flow experience	Increase concentration level in classroom	16 (16%)
	Make learning to be more interesting and enjoyable	12 (12%)
	Total Responses	**100**

Using the ELIM framework as a guide, six themes emerged from the open-ended survey, three themes were allied with ***attitude***, one with ***skill,*** and two with ***flow experience***.

For **attitude,** 40% of the 100 PSSTs stated that attitude was the most important factor that predicted or determined integration of e-learning in their science lessons. The three themes showed that the most noted explanation to integrating e-learning was the potential of e-learning technologies to increase students' engagement with content and other students

(15%). Fourteen (14%) of PSSTs explained that e-learning technologies have the potential to enhance learning and eleven (11%) of PSSTs believed that e-learning technologies enhanced and facilitated learners' understanding of concepts. Examples of the statements advanced by the respondents were:

a) *"I would use e-learning technologies because it provides many way for me to learn, then I participate and engage more in the class whenever my lecturer uses technology."*
b) *"Help students to be more involved and engage with the concepts and lesson because of its attractive tools"*
c) *"E-learning helps me to communicate and interact with my classmates in the classroom and also with my teachers outside the classroom."*
d) *"Using e-learning technologies help teachers to have enough time to interact with the student."*
e) *Using e-learning technologies in my module provides various opportunities for me to learn.*
f) *"I would use e-learning technologies in my science lesson because it improves students learning positively."*
g) *"E-learning has visual tools that will help science teachers to teach topic that are difficult for them than when using textbook in a traditional classroom,….and allow teachers to interact with their learners than traditional classroom where teachers spend more time writing on the board."*
h) *"E-learning has visual tools that can be used to explain abstract concepts to learners to improve the understanding of concepts because learners can see things for themselves."*
i) *"When my teachers use e-learning technologies in science class, I have a clearer understanding of the concepts than when the lesson was taught using only books."*

For ***skill,*** 32% of the PSSTs explained that technological skill was the most important factor that predicted integration of e-learning in their science lessons. PSSTs' technological skills enhanced integration of e-learning technologies in their science lessons. The following statements illustrate this point:

a) *"I know how to use e-learning to research things about my module by downloading useful materials from the internet that will help me to understand my module."*
b) *"I have the knowledge and skill to use e-learning technologies because I can deliver my lesson using power point."*

c) *"I have the skill to use and play video as an alternative way to explain my lesson to learners so that they can view things for themselves in the class."*
d) *"I have the knowledge and skill to use e-learning technologies to chat with my classmates and discuss about the topic we taught in the class."*
e) *"I do have skill to download pictures of the topic I want to teach and use it as example for the learners to understand better."*
f) *"I am able to download useful materials about my module from the internet."*
g) *"I have the knowledge and skill to write quiz test in the Moodle platform."*
h) *"I have the knowledge and skill to search some notes from internet in addition to textbook so that I can explain the topic very well to the learners."*
i) *"I have the knowledge and skill to download notes, assignment and test from the Moodle platform and upload assignment and test and send it to my lecturer."*

For ***flow experience,*** 28% of the PSSTs explained that flow experience was the most important factor that predicted integration of e-learning in their science lessons; 16% of the 28 PSSTs explained that e-learning technologies enabled them to concentrate and pay attention in the classroom because of the interactive and innovative tools of e-learning, and 12% of the 28 PSSTs mentioned that e-learning technologies made lesson enjoyable for them. The following statement substantiates this point:

a) *"I concentrated and paid more attention in the class whenever my lecturer was using the Moodle platform because the whole activities was interesting."*
b) *"I concentrated on chatting with my colleagues using a discussion forum about the topic that was taught in the class."*
c) *"I focused my attention on learning activities when I used the internet to download more information about my module."*
d) *"I find it interesting and enjoy learning activities when I write my module quizzes on Moodle platform."*
e) *"The visual tools in Moodle capture my interest in my module and I enjoy the topic that my lecturer is teaching in the class."*
f) *"Anytime I write quizzes on Moodle platform, I remember what to do quickly to answer the question the way I saw it in the images that my lecturer showed us in the class."*
g) *"Moodle visual tools capture my attention in class and make my module interesting to learn."*

4.5 MODERATING EEFECTS OF INNOVATION CONSCIOUSNESS AND QUALITY CONSCIOUSNESS

This section presents empirical data to evaluate the moderating effects of *innovation consciousness and quality consciousness* on the relationship between intention to integrate e-learning technologies and the actual integration of e-learning technologies for teaching and learning of science subjects. This addresses Research Question Three of this study. The section presents the results of the descriptive statistics of the moderator's instruments. Next, it describes the assessment of the measurement model and the moderated structural model in order to validate the results of the proposed hypotheses in this study.

Research Question 3: How *can quality and innovation consciousness moderate the relationship between intention to integrate and the actual integration of e-learning technologies in the teaching and learning of science subjects by preservice science teachers?*

4.5.1 Descriptive Statistics

The descriptive statistics for each factor indicators are shown in Table 4.13. All means are above the midpoint of 2.0 ranging from 2.73 to 2.86. This indicates an overall positive response to the factors that are measured in this study. The standard deviations for the two factors were less than one and this indicates that the item scores were close to the mean scores.

Table 4.13: Means and standard deviations of the Factors

Factors	Indicators	Means	Standard deviation
Innovation Consciousness	INC 1	2.790	0.518
	INC 2	2.730	0.489
Quality Consciousness	QUC1	2.860	0.403
	QUC2	2.850	0.411

4.5.2 Assessing the Measurement Model

The Warp Partial Least Squares (PLS) 4.0 Structural Equation Modelling (SEM) tool was used to assess the psychometric properties of the measurement model (i.e. the reliability and validity of the scales used to measure each variable). The measurement model was assessed using item loadings, internal consistency reliability, reliability, indicator reliability, convergent validity, and discriminant validity as suggested by Henseler, *et al.*, (2009), Urbach and Ahlemann (2010) and Kock, (2015). Each factor was measured using reflective indicators. Examining the loadings for each of the two factors, all the four items loadings **(λ)** were above 0.70 and ranged from **0.767 to 0.779**. Moreover, all items loading were significant at *p* <.001 level, indicating that the selected items were measuring the factors at a statistically significant level. Table 4.14 below presents the item loadings, their level of significance, internal consistency (composite reliability values above 0.70), and convergent validity (average variance extracted with values equal or above 0.50).

Table 4.14: Results for the Measurement Model for MODERATOR

Factors	**Items**	**Loading**	**P Value**	**Composite Reliability (CR)**	**Convergent Reliability (AVE)**
Innovation	INC1	0.779	<0.001	0.755	0.606
	INC2	0.779	<0.001		
Quality	QUC1	0.767	<0.001	0.741	0.588
	QUC2	0.767	<0.001		

To ensure that all the items loaded more highly on their respective factor than on any other factor, cross-loadings were computed in Table 4.15 below. This was achieved (i.e. the bolded factor loadings were higher than the non-bolded factor loadings in any one row and column), and all the items loaded more highly on their respective factor and no significant loadings on any other factor.

Table 4.15: Combined loadings and cross-loadings for MODERATOR

Items	DV	INC	QUC
INC1	Yes	**0.779**	0.239
INC2	Yes	**0.779**	-0.239
QUC1	Yes	-0.128	**0.767**
QUC2	Yes	0.128	**0.767**

4.5.2.1 Internal Consistency

The internal consistency reliability of each factor was assessed using composite reliability (CR) instead of Cronbach's alpha due to the propensity of Cronbach's alpha to understate reliability (Chin, 1998b; Henseler, *et al.,* 2009). The composite reliabilities of the moderating factors ranged from **0.741 to 0.755,** which exceeded the recommended threshold value of 0.70 (Chin, 1998b). Hence, all factors had acceptable reliability.

4.5.2.2 Convergent Validity

The convergent validity is considered adequate when the average variance extracted (AVE) equals or exceeds 0.50 (≥.50). In addition, the AVE for the moderating factors had an acceptable level of convergent validity ranged from **0.588** to **0.606,** which demonstrate sufficient convergent validity (Fornell and Larcker, 1981) as shown in table 4.14. Overall, the factor loadings, composited reliability coefficient and AVEs met the recommended guidelines, indicating that the convergent validity for the proposed moderating factors of the measurement model was adequate for structural equation modelling.

4.5.2.3 Discriminant Validity

The discriminant validity was assessed using the Fornell and Larcker's (1981) criterion that the square root of AVE for each factor should exceed the correlations between that factor and all other factors. As shown in Table 4.16, the bolded elements in the matrix diagonals representing the square roots of the AVEs, are greater in all cases than the off-diagonal elements in their corresponding rows and columns. Hence, discriminant validity was achieved at both the item and factor levels – and therefore, the moderating factors in the proposed research model are deemed to be adequate.

Another test for discriminant validity involves determining *cross-loadings*, obtained through correlating each latent variable's component score with those of all other items (Chin, 1998b). If each indicator's loading is higher for its designated construct than for any of the other constructs, it can be inferred that the different constructs' indicators are not interchangeable (Urbach & Ahlemann, 2010). That is, the loading of each item is expected to be higher than all of its cross loadings or any other constructs (Henseler, *et al.*, 2009). As shown in Table 4.15, all items load more highly on their respective factors (i.e. the bolded factor loadings) than on any other factor (i.e. the non-bolded factor loadings in any row and column).

Table 4.16: Discriminant Validity for the Moderator

Factors	AVE	INC	QUC
INC	0.606	**0.779**	
QUC	0.588	0.185	**0.767**

Note: Square roots of the average variance extracted (AVEs) shown on diagonal.

4.5.2.4 Assessing the Structural Model

The hypothesized structural moderating effect of quality consciousness and innovation consciousness on the relationship between intention and integration is shown in figure 4.2.

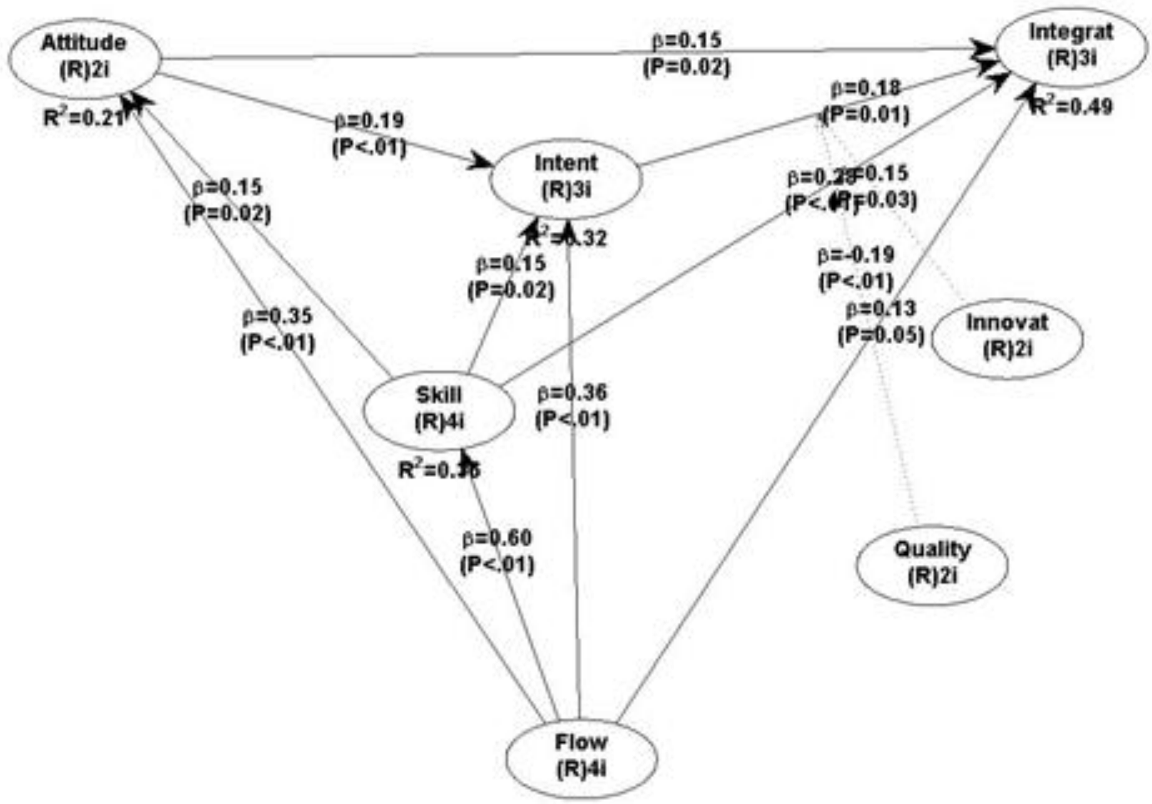

Figure 4. 2: The Hypothesized Structural Moderating Effect

Figure 4.2 presents the result of the moderating role of *innovation consciousness and quality consciousness* between intention and integration. The estimate of the overall explanatory power, path coefficient and associated p-value of the path, have already been presented. First, the explanatory power of the moderated research (which included innovation and quality) model was compared with that of a baseline model (which excluded innovation and quality). The baseline research model (*see Figure 4.1*) explained 44% (R^2=44) of the variance in e-learning integration, with intention having a standardized path coefficient of β = 0.22 on the dependent variable (e-learning integration). However, the moderated research model explained 49% (R^2=49) of the e-learning integration variance (*see Figure 4.2*), representing an 11% increase in the explanatory power over the baseline research model. Hence, innovation and quality consciousness do have a salient effect in moderating the relationship between intention and e-learning technology integration.

Second, the individual path significances and standardized path coefficients for each hypothesized path in the moderated research model was examined. The effect of intention on e-learning integration was significant in the baseline research model ($\beta = 0.22$, $p<0.01$), this effect still remained significant in the moderated research model ($\beta=0.18$, $p<0.05$), but the path coefficient reduced from 22 to 18, once the moderating effects of innovation and quality were added to the model (*see Figure 4.2*). The reduction of the path coefficient does not have any negative effect on this result, since the path was significant, and the major concern in this study was the estimate of the overall explanatory power of the moderated research model.

Moreover, the moderating effect of innovation consciousness on the intention-integration relationship was positive and strongly significant at $p<0.05$ ($\beta=0.15$, $p<0.05$), thereby supporting hypothesis H_{11} of this study. Furthermore, quality consciousness had a strong positive moderating effect on the intention-integration relationship and significant at $p<0.01$ ($\beta=0.19$, $p<0.01$), thereby supporting hypothesis H_{12} of this study.

It is notable that although both innovation and quality consciousness positively and significantly moderated the relationship between intention and integration, the moderating effect was stronger for quality (($\beta=0.19$) than innovation ($\beta=0.15$). This result demonstrates that the quality of education consciousness influences the integration of e-learning technologies in a moderating manner more than innovation consciousness. The summary of the validation of the hypothesised moderating effect is presented below.

a) Intention will be a significant predictor for integrating e-learning technologies by pre-science teachers.
b) Attitude will be a significant predictor for integrating e-learning technologies by preservice science teachers.
c) Skills will be a significant predictor for integrating e-learning technologies by preservice science teachers.
d) Flow experience will be a significant predictor for integrating e-learning technologies by preservice science teachers.
e) Attitude will be a significant predictor for preservice teachers' intention to integrate e-learning technologies.

f) Skill will be a significant predictor for preservice teachers' intention to integrate e-learning technologies.
g) Flow experience will be a significant predictor for preservice teachers' attitude to integrate e-learning technologies.
h) Skill will be a significant predictor for preservice teachers' attitude to integrate e-learning technologies.
i) Flow experience will be a significant predictor for preservice teachers' attitude to integrate e-learning technologies.
j) Flow experience will be a significant predictor for preservice teachers' skill to integrate e-learning technologies.
k) Preservice science teachers' innovation consciousness will positively moderate the relationship between their intention and integration of e-learning technologies.
l) Preservice science teachers' teaching and learning quality improvement consciousness will positively moderate the relationship between their intention and integration of e-learning technologies.

Finally, Table 4.17 shows the summary of the moderated model hypotheses and its results, and they are all supported in this study.

Table 4.17: Summary of hypotheses result of moderated model

Hypotheses	**Path**	**Path coefficient (β)**	***p*-Value**	**Validation**
H_1	Intention → Integration	0.18	0.011*	Yes
H_2	Attitude → Integration	0.15	0.023*	Yes
H_3	Skill → Integration	0.28	0.001***	Yes
H_4	Flow → Integration	0.13	0.051*	Yes
H_5	Attitude → Intention	0.19	0.007**	Yes
H_6	Skill → Intention	0.15	0.025*	Yes
H_7	Flow → Intention	0.36	0.001***	Yes
H_8	Skill → Attitude	0.15	0.023*	Yes
H_9	Flow → Attitude	0.36	0.001***	Yes
H_{10}	Flow → Skill	0.60	0.001***	Yes
H_{11}	Innovation (moderating effect)	0.15	0.026*	Yes
H_{12}	Quality (moderating effect)	0.19	0.008**	Yes

Path significance: $p<0.05$, ** $p<0.01$, *** $p<0.001$*

Table 4.17 shows the detailed results of the various path coefficients and path significance of the moderating factors. All the twelve structural paths in this study were strongly significant at $p<0.05$. Thus, all the twelve hypotheses in this study were supported. Overall, the effects of innovation consciousness and quality consciousness resulted in a salient effect of 49% on the predictive power of the structural model.

4.5.2.5 Assessment of Moderated Model Effect Size (*f^2*)

The effect size of path links among exogenous and endogenous variables in the structural model were calculated using Warp PLS 4.0, which is similar to Cohen's Effect Size (*f^2*) Coefficients (Kock, 2015). The effect size of the structural model can be considered a small (f^2 = .02), medium (f^2 = .15), or large (f^2 = .35) effects respectively (Cohen, 1988; Chin, 1998b). I*ntegration* factor, attitude (f^2 =0.06) yielded a small effect size, intention (f^2 =0.09) and flow (f^2 =0.07) yielded a small to medium effect sizes, while skill (f^2 =0.15) yielded a medium effect size. For *intention* factor, skill (f^2 =0.06) gave a small effect size, attitude (f^2 =0.07) gave a small to medium effect size and flow (f^2 =0.19) yielded a medium to large effect size. Regarding, the *attitude* factor, skill (f^2 =0.05) gave a small effect size and flow (f^2 =0.16) a medium to large effect size. For *skill* factor, flow *(*f^2 =0.36) has a large effect size on skill. Finally, *innovation* had a small effect size as a moderator and *quality* had a small to medium effect size as a moderator in the model. Table 4.18 presents the effect sizes of path links among independent and dependent variables in the structural model.

Table 4.18: Effect Size of Paths (f^2) for moderated model

Path	**Effect size**	**Inference**
Intention → Integration	0.09	Small to medium
Attitude → Integration	0.06	Small effect size
Skill → Integration	0.15	Medium effect size
Flow → Integration	0.07	Small to medium
Attitude → Intention	0.07	Small to medium
Skill→ Intention	0.06	Small effect size
Flow → Intention	0.19	Medium to large
Skill → Attitude	0.05	Small effect size
Flow → Attitude	0.16	Medium to large
Flow → Skill	0.36	Large effect size
Innovation (moderator)	0.06	Small effect size
Quality (moderator)	0.08	Small to medium

4.6 PRESERVICE SCIENCE TEACHERS REFLECTIONS AND FEEDBACK FROM TEACHING PRACTICE

This section presents the information obtained from the PSSTs reflections and feedback on their experience with integration of e-learning technologies into the teaching and learning of science subjects during their teaching practice. In doing so, the section addresses the fourth and final research question of this study. As stated in chapter three, data analysis was undertaken using hermeneutic content analysis. This section is divided into three parts. The first part deals with PSST's biographical information, the second part with the PSSTs usage of e-learning technologies during their teaching practice, and the third part deals with constraints faced by the PSSTs with regard to the utilisation of e-learning technologies during their teaching practice. The coding process used to analysed the qualitative data is outlined in *section 3.8.2*.

Research Question 4: *What are the preservice science teachers' experiences with regard to integrating e-learning technologies in the teaching and learning of science subjects during teaching practice?*

4.6.1 Biographical Information of the Respondents

As already reported, the research sample comprised 100 fourth year preservice science teachers, who completed their six weeks student teaching practice during the first semester of 2016 academic session. Of the 100 PSSTs, 13% taught grades 4-5, 11% taught grades 5-6, 37% taught grades 6-7, 37% taught grades 8-9 and 2% taught grade 11. The most content areas taught by the majority of preservice science teachers were mathematics, natural science and technology; and a few PSSTs taught physical science. More than half 67% of the PSSTs reported that there were no technologies in their designated schools of teaching practice and 33% reported that there were technologies in their designated schools of teaching practice. Almost half 47% of the PSSTs reported that they used e-learning technologies during teaching practice, while 53% reported that they never used e-learning technologies of any kind. Among the 47 (47%) PSSTs who used e-learning technologies during teaching practice, almost half 23 (49%) of them explained that they used internet technologies during the teaching practice, 9 (19%) used video on smartphones, 8 (17%) used laptops connected with internet, and 7 (15%) used desktops and overhead projectors (*see*

Table 4.19). Table 4.19 presents the biographical information of PSSTs during teaching practice.

Table 4.19: Biographical Information of PSSTs

	No of PSSTs	Percentage (%)
Weeks spent on teaching practice		
6 weeks	100	100%
Grade levels taught during teaching practice		
Grade 4-5	13	13%
Grade 5-6	11	11%
Grade 6-7	37	37%
Grade 8-9	37	37%
Grade 11	2	02%
Subject taught during teaching practice		
Physical Science	3	03%
Maths, Natural Science & Technology	37	37%
Maths & Natural Science	46	46%
Natural Science	3	03%
Natural Science & Technology	8	08%
Maths & Technology	3	03%
Technologies in the school during teaching practice		
Yes	33	33%
No	67	67%
E-learning technology usage during teaching practice		
Yes	47	47%
No	53	53%
Type of e-learning technologies used during teaching practice		
Internet	23	49%
Smartphone Video	9	19%
Laptop	8	17%
Desktop and overhead projector	7	15%

4.6.2 Preservice Science Teachers' Usage of E-learning Technologies During Teaching Practice

The sub-section presents results on the PSSTs' usage of e-learning technologies during their teaching practice. The results are presented according to each question in Appendix A, section D, Part 2 of PSSTs' reflections and feedback from teaching practice under questions 1-3 below. The variables presented in this sub-section include PSSTs' reasons for integrating e-learning technologies during their teaching practice, the techniques they employed and evidence of using e-learning technologies during their teaching practice. The PSSTs' responses to each question are presented in tables, followed by one or more quotations from the PSSTs' motivations to further substantiate the point concerned.

Moreover, the number of PSSTs from a total of 47 PSSTs who contributed to the particular statement under each question is also indicated.

Question 1: *Explain, why did you use e-learning technologies in your science lessons during teaching practice?*

Table 4.20 shows the distribution of explanations given by the PSSTs with regard to reasons for integrating e-learning technologies in science lessons during their teaching practice.

Table 4.20: PSSTs reasons for integrating e-learning technologies

Emerging Themes/Categories	**No PSSTs (n=47)**
Mastery of the content and lesson preparation	23 (49%)
To enhance teaching in a visual way	9 (21%)
To clarify concepts for the learners	8 (17%)
Enhance learners' concentration	7 (15%)
Save time	3 (6%)
Total Responses	**50**

Note. Some PSSTs responses might fit into more than one theme.

According to table 4.20, half of the PSSTs (23 out of 47, 49%) reported that using e-learning technologies helped them to gain mastery of the content to be taught in the class and helped them to prepare lesson notes. Some of their statements were as follows:

a) *"I used internet to search for more information to supplement the information that I had in order to clarify some concepts and give more examples."*
b) *"Helped me to download materials from the internet to prepare for my lesson."*
c) *"I used internet to google some science concepts to improve my teaching and to add more to the information written in the textbook."*
d) *"My purpose of using internet was to get more information about the concepts to be taught in the class."*
e) *"I used my smartphone and internet to search for more information about the topic when I was preparing for my lesson since the school did not have different teaching books to give reliable information."*
f) *"I downloaded materials from the internet to prepare my lesson notes and the activities to give my learners."*

g) *"I wanted to be knowledgeable about the topic that I was to teach the leaners so that I could make them understand better."*

Nine PSSTs (21%) reported that they used e-learning technologies as visual tools to enhance teaching, assist learners visualise and understand content better. This is indicated in the following statements:

a) *"To present the lesson so that learners could visualise the images of complex concepts to enable them have clear understanding of the topic because resources to conduct experiment were not provided."*
b) *"Wanted learners to have visual knowledge of the content, visual learners understand by showing them pictures of the content."*
c) *"Visual tools such as video enable learners to see abstract and complex concepts which are difficult to see by other means."*
d) *"When learners observe thing themselves, they keep in mind the concepts and remember what has been taught in the class easily."*
e) *"Used to show pictures and images of the topics which are difficult for learners to understand to help them understand better."*
f) *"The students can easily observe things themselves to make complex concepts clearer for them to them understand."*
g) *"To present the lesson so that learners can visualise the complex concepts to enable them understand concepts better."*

Eight PSSTs (17%) indicated that e-learning technologies helped them to clarify concepts so as to make learners understand. This is indicated in the following statements:

a) *"I used e-learning technologies because I wanted to demonstrate concepts to learners in pictures."*
b) *"To clarify the concept of parallel series connection of resistors for learners to understand."*
c) *"I enjoy using e-learning technologies to demonstrate topics to learners as in real life situations to help them understand better.*
d) *"To clarify topic in natural science which have more pictures and images than writing notes.*
e) *"I wanted to demonstrate some images of the lesson using videos for learners to understand."*

Seven (15%) explained that e-learning technologies helps them to enhance learners' concentration in the class. The following statements substantiate this point:

a) *"To gain learners attention and participation in class so as to help them have a deep understanding of the content."*
b) *"To help attract learners' attention, enable them to enjoy the lesson and focus on learning their subjects."*
c) *"I used e-learning technology since the content of the subjects was difficult for the learners I had to find a way for them to concentrate and make them understand."*
d) *"I used some pictures in my lesson to hold learners' attention and for them to concentrate in class so that they can remember information and respond to questions."*

Three PSSTs (6%) believed that e-learning technologies helped them to save time during teaching:

a) *"To save time for teaching to take place."*
b) *"I spend less time writing on the board because the lesson was on the slides that I prepared."*
c) *"I had more time to interact with learners."*

Question 2: *Explain, how did you use e-learning technologies in your science lessons during teaching practice?*

Table 4.21 presents a summary of the responses given by the preservice science teachers on how they used e-learning technologies in science lessons during teaching practice.

Table 4.21: PSSTs description of how they used e-learning technologies

Emerging Themes/Categories	**No of PSSTs**
Searching for additional information about the content	23 (49%)
Show video on the topic to reinforce teaching and for learners to understand concepts better	9 (19%)
Group learners into small group to visualise the picture of the concepts on the laptop	8 (17%)
Deliver lesson using PowerPoint	7 (15%)
Total Responses	**47**

According to table 4.21, half of the PSSTs (23 out of 47, 49%) reported using e-learning technologies for instructional preparation. This is substantiated by the following quotes:

a) *"I browsed the internet to get additional information to improve the quality of my lesson."*
b) *"I used my smartphone to search materials for practical sessions and also used it to take photos."*
c) *"I used the internet to google information about the topic and write it down on notes."*
d) *"I download pictures and images of the content from the internet and showed it to learners."*
e) *"I used internet google to get more information about electric circuits and then took some tutorial questions to give to my learners."*
f) *"I used the internet to search for some information relevant to the lessons to be taught."*
g) *"I used the internet to search for some pictures and for more example on certain topics to illustrate them during my teaching session."*

Seventeen PSSTs (32%) reported using e-learning technologies to facilitate student-centred learning by showing them videos and grouping them into smaller groups. This point is indicated in the following statements:

a) *"I grouped leaners groups of four to allow them to watch the lesson on the laptop by giving each group a chance to watch."*
b) *"I showed videos and pictures to learners on every topic I dealt with.*
c) *"I grouped learners into two groups, to watch different videos of safety with electricity and then discussed what was important for them to stay safe with electricity. I showed them some of the electrical safety tips from videos."*
d) *"I showed learners a video on "illegal connection of electricity" which illustrated the dangers of doing so; I wanted learners to have a visual knowledge of what we are talking about."*
e) *"In natural science and technology they were learning about musical instruments so I showed learners different types of musical instruments and told them that if they are combined together they will bring a nice sound. I showed them a music video where different types of instruments were used. Learners had a clear understanding of musical instruments from that experience, and it won't be easy for them to forget what they saw."*

f) *"The lesson was based on the animals called Big Five in South Africa, and I realised that many of the learners could not recognise and differentiate them from other animals therefore, I projected a video showing them the Big Five."*

Seven of the PSSTs 7 (15%) explained that they used e-learning technologies as instructional delivery to enhance their teaching. This is indicated in the following statements:

a) *"I did PowerPoint presentations with some pictures to create a good picture of what an experiment should look like, including videos."*
b) *"I used desktop and an overhead projector and I was explaining the slides to hold the learners' attention and for them to take down notes."*
c) *"I used desktop accompanied by small speakers, so that every learner in the classroom could hear very clearly."*
d) *"I used desktop and a projector to present the lesson so that every learners could see. After the lesson I told them to go and make their own musical instruments."*
e) *"I connected my laptop to the school projector to teach the concept of parallel series connection of resistors. I asked learners a question, like what will the ammeter read when equal resistors are connected in parallel and then test their response."*
f) *"I use PowerPoint to present my lesson because it allowed me to interact well with my learners and helped me to teach very fast."*
g) *"I used PowerPoint for my lesson and the learners participated actively and interacted with themselves in the class than using only traditional one way of writing on the board only."*

Question 3: *What evidence do you have to show that you used e-learning technologies in your science lessons during teaching practice?*

Table 4.22 shows the distribution of explanations given by the PSSTs based on the evidence that they used e-learning technologies for science lessons during their teaching practice.

Table 4.22: Evidence that PSSTs used e-learning technologies

Emerging Themes/Categories	**No of PSSTs**
Lesson plans and notes prepared through the internet	20 (43%)
Learners concentration watching video of the lesson	9 (19%)
Learner participation in group discussion in class with laptop	8 (17%)
Mentor teacher supervision when using a projector in the class	7 (15%)
No evidence	3 (6%)
Total Responses	**47**

Almost half (20 out of 47, 43%) of the PSSTs explained that the lesson plan and notes they prepared using the internet technologies was evidence that they used e-learning technologies during their teaching practice. This is indicated in the following statements:

a) "*The lesson plan that I prepared for getting additional information through internet.*"

b) *"My lesson plans, the e-learning were mentioned under the teaching materials used."*

c) *"I copied all the information inside my memory stick and CD, and I left the CD for the school for educator to use it."*

d) *"My lesson plan showed that under teaching aids and even the lecturer that evaluated my teaching can tell you that I used e-learning."*

e) *"Lesson plan which I wrote as a preparation for my lessons."*

f) *"The lesson plans that I wrote do have books that I used and internet sites where I gathered additional information."*

g) *"References of internet sites that I used as teaching and learning support materials inside my lesson plan."*

h) *"I indicated it in my lesson plan that I used internet to improve my teaching and lesson as teaching and learning support materials."*

Nine out of 47 (19%) of the PSSTs reported that their learners were focused when watching the video of the lesson. This is indicated in the following statements:

a) *"Learners paid attention and concentrated watching the pictures of the content in the videos throughout the lesson."*

b) *"Leaners did not feel strange in the class, they focused their attention watching the videos that I showed them."*

c) *"Learners concentrated on watching information about musical instrument and how to use them rather than read them on the book, although they didn't know how to use them."*

Eight PSSTs (17%) explained that their learners participated actively in small group discussions in class as indicated in the following quotes:

a) *"Interaction between learners occurred in their small groups."*
b) *"Learners actively participated in small group discussions and asked questions."*

Seven (15%) reported that their mentor teachers were assessing them during the presentation of the lesson in class. This is substantiated by the following quotes:

a) *"Mentor teacher supervised the lesson."*
b) *"I was evaluated by my mentor teacher during my teaching practice using e-learning technologies."*
c) *"Mentor teacher supervision when using a projector in the class."*

A relatively small number of the PSSTs respondents 3 (6%) failed to cite any evidence of how they used e-learning technologies in their science classes during their teaching practice.

4.6.3 Preservice Teachers Inability to Use E-Learning Technologies During Teaching Practice

In this section, the researcher presents the difficulties experienced by the PSSTs in ways that militated against their use of e-learning technologies during their teaching practice. These are presented according to each question in Appendix A, section D, Part 3, questions 1-6 below. The variables presented in this sub-section include PSSTs' reasons for not integrating e-learning technologies during their teaching practice, action taken for not using/integrating e-learning technologies, evidence to support their actions, benefits for schools to introduce e-learning technologies into their curriculum and benefits for the PSSTs to use e-learning technologies in their teaching after their graduation from the university. The PSSTs responses to each question are presented in tables, followed by one or more quotations from the PSSTs' motivations in substantiating their responses. Moreover, the number of PSSTs from a total of 53 PSSTs who made each statement under each question is also indicated. The 53 PSSTs were those who reported that they did not use e-learning technologies during teaching practice.

Question 1: *Explain why you did not use e-learning technologies in your science lessons during teaching practice?*

Table 4.23 presents the reasons given by the PSSTs as a result of their inability to integrate e-learning technologies into their science lessons during teaching practice.

Table 4.23: PSSTs reasons for not using e-learning technologies

Emerging Themes/Categories	**No of PSSTs**
Lack of e-learning facilities in the schools	53 (100%)
Total Responses	**53**

Table 4.23 shows that all 53 (100%) PSSTs were unable to integrate e-learning in their science lessons during teaching practice because of lack of e-learning facilities in the schools. This is supported by the following quotes:

a) *"There is no internet in the school."*
b) "No computer in the school."
c) "No computer and projector in the school."

Question 2: *What actions did you take for not using e-learning technologies for your science lessons during teaching practice?*

Table 4.24 presents the explanations of the action taken by the PSSTs as a result of their inability to integrate e-learning technologies into their science lessons during teaching practice.

Table 4.24: Action taken by PSSTs for not using e-learning technologies

Emerging Themes/Categories	**No of PSSTs (n=53)**
Used traditional method of teaching	53 (100%)
No action	6 (11%)
Inform my subject mentor	5 (9%)
Inform the principal to get a computer	4 (8%)
Total Responses	**68**

Note. Some PSSTs responses might fit into more than one theme.

The table shows that the majority of the PSSTs (38 out of 53, 72%) used traditional methods of teaching.

a) "I used different textbooks that were prescribed for learners."

b) *"I followed the procedure that other educators used, by using textbook, chalk and board, pictures and charts for learners where possible to explain concepts to them."*

c) "*I used textbooks as other teachers were doing."*

d) *"I used textbooks for teaching and learning."*

e) *"I used the prescribed textbooks."*

f) *"I only taught using textbook and other materials available in the school."*

g) *"I used textbooks in order to find information based on what I am going to teach."*

h) *"I used hard copies like textbooks to teach my learners."*

i) *"I used to draw pictures on the charts and demonstrate them on the board."*

j) *"For science, mathematics and technology classes, I used pictures and models to demonstrate to the learners what I was talking about."*

k) *"I used worksheet and handouts if ever I needed to show learners different or other knowledge besides the one in their textbooks."*

l) *"Asking learners to reflect on their textbook, making sketches of them in demonstrating to them what was being taught."*

Five PSSTs (9%) explained that they informed their subject mentor about this constraint, as indicated in the following quotes:

a) *"I asked for any e-learning support from my science teacher mentor they couldn't get one."*

b) *"I ask them from my lesson mentor, he was always promising that he will get them until I finished my teaching practice."*

c) *"I informed my subject mentor to get a computer for me."*

Four PSSTs (8%) explained that they informed the principal of the school as indicated in the following quotes:

a) *"I asked the principal for computer and projector. The response I got made me adapt with the situation at that time."*

b) *"I requested the principal of the school to get a computer and projector."*

Lastly, 6 (11%) explained that they did not take any action for their inability to integrate e-learning technologies during their teaching practice.

Question 3: *What evidence do you have to support the action you took for not using e-learning technologies for your science lessons during teaching practice?*

Table 4.25 presents the explanations of the PSSTs as evidence to support the actions they took for not using/integrating e-learning technologies in their science lessons during teaching practice.

Table 4.25: Evidence to support PSSTs action taken for not using e-learning technologies

Emerging Themes/Categories	**No of PSSTs**
Used teaching aids for the science lesson	38 (72%)
Letter written to the principal and science subjects coordinator	9 (17%)
No evidence	6 (11%)
Total Responses	**53**

The majority of the PSSTs (38 out of 53, 72%) explained that they used teaching aids to present concepts to learners for them to understand. This is substantiated by the following quotes:

a) *"Using chart and pictures to clarify concepts."*
b) *"I get more images that I used in the science lessons."*
c) *"Practically, I helped the learners to see what I am talking about by doing practical like making electrical circuits during the practical sessions."*
d) *"The lesson plan and charts in the form of teaching aid that I used."*
e) *"Pictures and also lesson plans as evidence."*
f) *"Lesson plans of the lessons taught showing teaching resources used."*
g) *"Posters that I made for learners as a demonstration."*
h) *"Lesson plans that I prepared for the class."*

Nine (17%) PSSTs explained that they wrote a letter to the principal of the school.

a) *"I went to the principal asking if they had a portable projector, unfortunately they did not."*
b) *"I sent a letter to the principal of the school."*

Question 4: *What did they need to have in the school for you to have used e-learning technologies for your science lessons?*

Table 4.26 shows a breakdown of e-learning technologies needed in the school, as given by the PSSTs.

Table 4.26: E-learning technologies needed in the schools

Emerging Themes/Categories	**No of PSSTs**
Computer, projector and computer laboratory	36 (68%)
Internet Access	17 (32%)
Total Responses	**53**

From the information in Table 4.26 more than half of the PSSTs (36 out of 53, 68%) indicated that computers, data projectors and computer laboratories were the tools most needed in the schools for effective teaching and learning to take place:

a) *"They should have projectors and computers or laptops."*
b) *"Computers, projectors, computer laboratory."*
c) *"Firstly, they need computer laboratory and computers."*
d) *"Projectors, computers, plugs in the classroom."*
e) *"Electricity, projector and computer."*
f) *"They need computers and projectors as well as the board for the projectors."*
g) *"They need projectors to connect to computers."*

Seventeen PSSTs (32%) explained that the school needed internet and WiFi as indicated in the following quotes:

a) *"Access to internet or WiFi so that it can be possible to use internet."*
b) *"Internet access and simple tablets."*
c) *"Available internet/WiFi."*
d) *"WiFi or internet access because they have a computer lab."*
e) *"Computer and WiFi for the learners to be able to access the content."*

Question 5: *What did you see as the benefits for the high school where you did your teaching practice to introduce e-learning as an innovation of their curriculum implementation?*
Table 4.27 shows what the PSSTs saw as the benefits for the school to introduce e-learning as an innovation of their curriculum implementation.

Table 4.26: Benefits for schools to introduce e-learning technologies into the curriculum

Emerging Themes/Categories	**No of PSSTs**
Increase the pass rate of science subjects in the school	9 (31%)
E-learning training workshop for the teachers in the school	7 (24%)
Improve the quality of science teaching in the school	5 (17%)
Report to department of education to supply e-learning facilities	2 (7%)
Nothing	6 (21%)
Total Responses	**29**

Nine PSSTs (9 out of 29, 31%) explained that the introduction of e-learning technologies into the school curriculum will increase the pass rate of science subjects in the school. This is indicated in the following statements:

a) *"If they introduce e-learning may be the school pass rate will increase since learners will learn by observing and seek information from different senses and able to interact with their own world."*
b) *"I think learners pay more attention when using visual and audio media in the class, so introducing e-learning will help more learners to gain focus and help increase their pass rate in science subjects."*

Seven PSSTs (24%) explained that training of the educators in the schools on how to use e-learning is of utmost importance for e-learning to take root in the school. This view is illustrated by the following statements:

a) *"Their teachers need to go for the training to know how to use e-learning technologies."*
b) *"Workshop for the educators to train them how to use e-learning."*
c) *"I think if they can open workshops for educators to be able to operate e-learning technologies."*
d) *"Training of educators on how to use e-learning."*
e) *"Have a formal workshop to educate teachers more about educational media."*

Five PSSTs (17%) explained that the introduction of e-learning technologies into the school curriculum will improve the quality of science teaching in the school. This is indicated in the following statements:

a) *"I see e-learning improving the quality of education in the schools."*
b) *"E-learning could make teaching and learning easier in the school and learners would be interested and it would make their life easy."*
c) *"It will make the teacher's job at the school easier and also learners learning will be much better."*

Two PSSTs (7%) indicated that the school should report to the Department of Basic Education to supply them with e-learning facilities as indicated in the following statements:

a) *"To report to the department of education that they are in need of e-learning equipment."*
b) *"They should communicate with department of education to assist the school about e-learning."*

Question 6: *What did you see as the benefits for you to use e-learning in your teaching after your graduation from the University?*

Table 4.28 presents the benefits of the PSSTs using e-learning in their teaching after graduating from the university.

Table 4.27: Benefits for PSSTs to use e-learning technologies

Emerging Themes/Categories	**No of PSSTs**
Improve the quality and standard of my science lesson	18 (50%)
Increase my technology skill	10 (28%)
Save time	8 (22%)
Total Responses	**36**

Eighteen PSSTs (18 out of 36, 50%) explained that the use of e-learning technologies will improve the quality and standard of their science lesson. This is indicated in the following statements:

a) *"Improve the quality of my teaching and learning and to communicate effectively."*
b) *"It will help me to understand what I will be teaching using different strategies."*

c) *"Since using Moodle make things easier for me in school, I will proceed using e-learning in school after my graduation from the University to improve the quality of my teaching."*

Ten PSSTs (28%) explained they foresaw that the use of e-learning will increase their technology skill. This is substantiated by the following statements:

a) *"I want my learners to be exposed to the innovations around us and the importance of technology."*

b) *"Is to keep on becoming more knowledgeable and have more or develop more skills about e-learning."*

c) *"Because I have been taught via e-learning so it will increase my technology skill."*

d) *"I must be certain to acquire all the necessary skills needed to be able to use e-learning effectively."*

Lastly, eight PSSTs (22%) explained that e-learning technologies would help them save time.

a) *"It will save me time during the lesson delivery."*

b) *"It saves my time so that I can give learners suitable and recent information during my teaching."*

c) *"To reduce time for writing some notes."*

d) *"It saves a lot of my time during teaching and make my work faster".*

4.7 SUMMMARY AND CONCLUSION

In this chapter, the results of the study were presented. This study investigated preservice science teachers' integration of e-learning technologies in the teaching and learning of science subjects during their science education module and during their teaching practice experience in schools. The main aim of this chapter was to present answers to the four research questions, as well as the results of hypothesis-testing. The first research question revealed that PSSTs perceived e-learning technologies to be useful in terms of perceptions pertaining to them as (a) e-learning technologies beneficiaries: for searching and sharing information about the content, improving learning, and helping save a lot of time in their studies outside classroom, (b) them as teachers: improving teaching, helping save a lot of time to mark learners' tests quicker, improving technology skill of learners and helping them think critically, motivating learners to learn and improving learners' understanding of the content. The second research question was concerned about the factors that predicted preservice science teachers' integration of e-learning technologies based on the proposed research model, the e-Learning Integration Model (ELIM). The results of the path coefficient showed that PSSTs' integration of e-learning technologies were jointly predicted by intention, attitude, skill and flow, with preservice science teachers' skill as the strongest predictor, followed by intention, flow experience and attitude. All the *apriori* hypotheses tested and the interrelationships between them were all supported in this study. The content analysis of open ended questions revealed that the most important factors that predicted the PSSTs' integration of e-learning technologies was attitude, followed by skill and flow experience. The third research question was on the moderating effect of innovation consciousness and quality consciousness on the links between intention and integration. This revealed that innovation consciousness and quality consciousness had a significant effect in moderating the relationship between intention and integration, with quality consciousness having the strongest moderating effect. The fourth research question was concerned about the PSSTs' reflections and feedback from their teaching practice experience. This revealed that most PSSTs who used e-learning technologies during their teaching practice used them for instructional preparation, some used them to facilitate student-centred learning and a few used them as instructional delivery tools. Those who did not use e-learning technologies during their teaching practice explained that this was due to a lack of e-learning facilities in their designated school of teaching practice. The next chapter will discuss the results of this study.

CHAPTER FIVE

DISCUSSION OF FINDINGS

5.1 INTRODUCTION

The focus of this study was to investigate preservice science teachers' integration of e-learning technology into the teaching and learning of science subjects while at university and during their teaching practice in schools. This chapter discusses the results of this study which have been analysed and presented in chapter. This is done in accordance with the fourth research questions, against the backdrop of the literature reviewed in chapter two. For quick reference, the four research questions are hereby re-stated:

5.1.1 What are preservice science teachers' perceptions of the educational benefits of integrating e-learning technologies in the teaching and learning of science subjects?

5.1.2 What factors best predict or explain preservice science teachers' integration of e-learning technologies in the teaching and learning of science subjects?

5.1.3 How can quality and innovation consciousness moderate the relationship between intention to integrate and the actual integration of e-learning technologies in the teaching and learning of science subjects by preservice science teachers?

5.1.4 What are the preservice science teachers' experiences with regard to integrating e-learning technologies in the teaching and learning of science subjects during teaching practice?

Consequently, in line with the above research questions, this chapter is organized as follows: (a) Preservice science teachers' perceptions about e-learning technology integration; (b) Factors that best predict preservice science teachers' integration of e-learning technology in teaching and learning of science subjects; (c) The moderating effects of innovation consciousness and quality consciousness; (d) Preservice science teachers' reflections and feedback from teaching practice; and (e) Conclusion of the chapter.

5.2 PRESERVICE SCIENCE TEACHERS' PERCEPTIONS OF E-LEARNING TECHNOLOGY INTEGRATION

This section discusses the findings on preservice science teachers' perceptions of the educational benefits of integrating e-learning technology in the science classroom environment. This answers the first research question of the study. Other variables discussed in this section include the disadvantages of integrating e-learning technology in the teaching and learning of science subjects as viewed by the preservice science teachers.

Research Question 1: *What are preservice science teachers' perceptions of the educational benefits of integrating e-learning technology in the teaching and learning of science subjects?*

The study finding was that preservice science teachers perceived that searching and sharing information about the content was the biggest benefit that e-learning technology brought to the teaching and learning of science subjects. The literature study has revealed that e-learning technology supportive tools such as internet, chats and instant messaging provided a comfort zone for students to share their knowledge, ideas, information and difficulties among themselves and with their teachers. These tools also make it possible for the teacher to distribute useful information about the learning content to students before class time, as this helps students to prepare beforehand and concentrate on understanding the content in the classroom (Al-Ani, 2013; Amandu, *et al.,* 2013). This finding corroborates the findings earlier reported by (Martín-Blas & Serrano-Fernández, 2009 and Ndlovu & Mostert, 2014) that e-learning helps students to address their learning needs, share information and knowledge about the content, experiences and challenges with their colleagues to render help in any topic they find difficult to understand, and for sharing information about the content among teachers and their students.

Moreover, the finding revealed that preservice science teachers perceived that e-learning technologies have great potential to improve teaching, learning and assessment in the classroom. The literature reviewed indicated that e-learning as new methods of teaching and learning improve teaching and learning process, allow students to participate actively in the learning process and support students' by providing prompt feedback to them about their progress (Martinez & Jagannathan, 2008; Prenjasi & Ahmetaga, 2015). This findings of this study support those reported by Sallam & Alzouebi (2014) that e-learning enhances the teaching and learning process and offered new approaches to conduct assessments by giving teachers immediate results, and ensure that students are promptly informed about their attainment levels on an ongoing basis. In addition, e-learning gives the teachers time and space to cover all aspects of the subjects, enhances the curriculum after-school activities and may be used to direct students to relevant websites for useful information. This finding also supports the findings of Prenjasi & Ahmetaga (2015) who showed that e-learning technologies remained an innovation for the teaching and learning process by helping students acquire new methods and techniques for innovative learning. E-learning supports students in their studies by offering them an opportunity to ask questions concerning the subject from their teachers who are always available to answer any questions at any time.

In addition, the finding also revealed that preservice science teachers perceived that e-learning technology improves technology skill of learners and help them think critically. The literature study presented earlier in chapter two revealed that the use of e-learning technology helped preservice teachers to develop their technology skills by navigating through online module materials, thereby enhancing their communication skills (Al-Ruz, & Khasawneh 2011; Department of Education and Early Childhood Development, 2012). This finding corroborates the findings of previous studies (Al-Ani, 2013; Bulic & Novoselic, 2014) who showed that the usage of e-learning technology learning developed the preservice teachers' technological skills to browse through websites to search for information and to solve real life problems about the topics. This finding is also supported by Seluakumaran, *et al.,* (2011) and Chigona, *et al.,* (2014) who indicated that integration of e-learning into the curriculum delivery process develops innovative spirits in students, and developed critical thinking capabilities of students in a more efficient way as opposed to the traditional teaching practices.

Furthermore, the finding revealed that preservice science teachers perceived that e-learning technology helped to maintain learners' interests in their learning through the use of innovate and interactive tools, and motivated them to learn. E-learning technologies are affordable innovative teaching strategies with interactive tools such as chats, discussion forums, instant messaging and entertainment functions, which rely typically on intrinsic motivation, which teachers can use to promote student self-directed learning (Amandu, *et al.,* 2013). A lot of literature indicated that e-learning technology interactive tools can stimulate students' interest to experience flow, enjoyment, and motivated them to focus attention on their studies and to be actively engaged in learning beyond the classroom (Lee, 2010; Amandu, *et al.,* 2013; Kim & Jang, 2015). This finding supports previous findings (Fayed, 2010; Amandu, *et al.,* 2013; Lee, 2010; Sallam & Alzouebi, 2014; Waheed, *et al.,* 2013) that e-learning technology motivates, promotes and sustained student interest in self-directed learning. They concluded that e-learning motivated those students who are too shy to express their opinions in face-to-face discussions with their classmates to participate in group work, share their ideas, and demonstrate their abilities and talents to improve their learning performance**.**

Additionally, the results to the first research question further revealed that preservice science teachers perceived that e-learning technology improved learners' understanding of the content. The literature revealed that the interactive features in e-learning technologies promoted active learning to assist students to better grasp concepts being taught, resulting in better tests and performance in examinations (Serrano-Fernandez, 2009; Seluakumaran, *et al.,* 2011; Pacemska, *et al.,* 2012). This result supports previous findings that integration of e-learning technology improved student understanding of the content and better prepare them for examinations (Ahmad & Al-Khanjari, 2011). This is also supported by other research findings which have reported that usage of e-learning significantly improved student performance in their examinations compared to other students who rarely or never use e-learning, thereby, suggesting that the usage of e-learning had a positive effect on student learning outcomes (Martin-Blas & Serrano-Fernandez, 2009; Seluakumaran, *et al.,* 2011; Pacemska, *et al.,* 2012).

Last but not least, the results also revealed that preservice science teachers perceived that e-learning technology enabled seamless communication between teachers and learners. This is in line with the literature which revealed that e-learning technology has the potential to enhance communication and collaboration among students and teachers as well as between students and their peers by creating a new learning environment (Kurebwa, 2013; Taha, 2014). Moreover, Ekici, *et al.,* 2012; Waheed, *et al.,* 2013) stressed further that e-learning creates a constructive learning environment that allows communication among students to participate in discussions in the whole class or within smaller groups through the use of communication tools such as chats and discussion forums to exchange knowledge about the content. Additionally, Ekici, *et al.,* (2012) and Waheed, *et al.,* (2013) explained that e-learning allowed teachers to act as collaborators by distributing information about the content materials, assignments and tests to students, engage in discussions with students using communication tools such as chats and discussion forums to motivate and engage students in interactive learning activities. The results of this study support previous research findings (Paynter & Bruce , 2012; Amandu, *et al.,* 2013; Prenjasi & Ahmetaga, 2015; Sallam & Alzouebi, 2014) which reported that e-learning technology tools fostered communication between students and their peers as well as students and their teachers than in a large classroom environment, assist them to initiate and follow up discussions on topics, share experiences and collaborate with their classmates in a group to construct knowledge and promote better academic achievement

Lastly, the results also revealed that preservice science teachers perceived that e-learning technologies help save a lot of time in their studies outside classroom and to mark learners' assignment and tests. The results of this study support previous findings (Çelik, 2010; Sallam & Alzouebi, 2014) which indicated that the use of e-learning helped preservice teachers to save time to study outside the classroom, as well as help teachers save time and effort in teaching, planning and marking students' work.

On the other hand, the preservice science teachers' perceived the following as obstacles to integrating e-learning technology into the teaching and learning of science subjects: lack of e-learning facilities; distractions and lack of focus in the classroom by learners; make learners to become lazy; that e-learning technologies promote plagiarism; and that they are very expensive to afford. These findings are consistent with the findings of previous research (Choy *et al.,* 2009; Ekici, *et al.,* 2012; Ndlovu & Mostert, 2014). For example, Choy *et al.,* (2009) indicated that preservice teachers were unable to integrate technology in their lessons during their teaching practice because technology such as hardware and software were not readily available in the classrooms, plug-ins were not updated and internet speed was slow. Kalanda (2012) explained in his study that lack of ICT infrastructure such as limited ICT facilities and insufficient computer laboratories and poor maintenance were among the hindrances affecting some teachers in the preparation of lessons, examination questions, and to integrate ICT into their science lessons. Similarly, Ekici, *et al.,* (2012) and Ndlovu & Mosert (2014) reported in their studies that preservice science teachers were unable to use e-learning technology in their science classes because they had very limited access to the internet, and that internet connectivity were very slow and expensive to afford where such facilities were available.

Moreover, the literature reviewed showed other obstacles of integrating e-learning technology in the classrooms as promoting plagiarism and distract student attention to focus on the learning content. Several scholars indicated that e-learning technology such as internet provided students with a varieties of learning information and resources where students get answer directly to their learning content. They argue that this does not allow students to think critically to provide answers to their learning content, and thus can lead to plagiarism through copying and pasting (Chen & Lu, 2013; Arkorful & Albaidoo, 2014; Ocholla & Ocholla, 2013). Similarly, Negash, *et al.,* (2008) points out that e-learning can distract students' attention in the classroom because of interruption caused by malfunctioning equipment and internet; system connectivity errors such as video frames freezing, and audio breaking up during an actual lesson. This may frustrate student wishing to access information about the learning content which can cause unnecessary delays, thereby affecting students' understanding of module materials and lower their rates of using e-learning for instructional purposes. In addition, Kalanda (2012) and Nkula & Krauss (2014) assert that e-learning technologies can also distract student's attention learning the content and instead use the technology for other activities not related to subject matter such as entertainment especially when the students are not closely supervised by the teachers.

However, despite all of these obstacles and disadvantages, findings from the review of literature in this study show that it is certain that e-learning technologies bring positive and innovative changes to teaching and learning as there are some control measures which teachers need to explicitly put in place to solve the problem themselves and those that they should present as grievances to the school principals, school boards and the government to address the issues in order to improve the quality of education.

To sum up, in answering the first research question, the results of this research showed that the educational benefits of integrating e-learning technologies outweighed the barriers and the preservice science teachers acknowledged and appreciated that the integration of e-learning technologies carried great potential and major advantages for teaching and learning of science subjects.

5.3 FACTOR THAT BEST PREDICT PRESERVICE SCIENCE TEACHERS' INTEGRATION OF E-LEARNING TECHNOLOGIES IN THE TEACHING AND LEARNING OF SCIENCE SUBJECTS

This section discusses the results of the analysis related to the factors that best predict preservice science teachers' integration of e-learning technologies in the teaching and learning of science subjects. This section answers the second research question of this study.

Research Question 2: *What factors best predict or explain preservice science teachers' integration of e-learning technologies in the teaching and learning of science subjects?*

The aim of this study was to develop and test a model to explain the integration of e-learning technologies among preservice science teachers in the teaching and learning of science subjects. This study has examined the extent to which the proposed ELIM is a valid model to explain PSSTs' integration of e-learning technologies. The proposed model posited that four factors predicted the integration of e-learning technologies among preservice science teachers. These factors are intention, attitude, skill and flow experience.

5.3.1 E-Learning Integration

The results of this study revealed that the four factors (intention, attitude, skill, and flow experience) explained 44% of the variance in the dependent variable (e-learning technology integration). The explanatory power of the model to explain the integration of e-learning technologies was moderate. The results also suggested that the proposed model has a good fit and thus provided a strong evidence that ELIM is a valid model in explaining the integration of e-learning technologies among preservice science teachers. All the four factors significantly predicted the integration of e-learning technologies, with skill as the strongest predictor (β=0.28), p<0.01), followed by flow experience (β=0.24), p<0.01), intention (β=0.22), p<0.01), and attitude (β=0.13), p<0.05). This study makes a significant contribution by validating the developed ELIM for the preservice science teachers in South Africa, a sample that was not examined by previous research in the field of e-learning.

5.3.2 Skill

The results of this study revealed that among the four factors proposed to predict the integration of e-learning technologies among preservice science teachers in the teaching and learning of science subjects, skill was the strongest predictor. This finding is consistent with previous studies on technology integration (Morales, 2007; Agyei & Voogt, 2011; Allayar, 2011) who reported that skill was the strongest predictor of classroom integration of ICT by teachers. This led to the inference to confirm hypothesis H_3 that skill will be a significant predictor for integrating e-learning technologies by preservice science teachers.

The results of open ended survey data in this study also revealed that preservice science teachers acknowledged that technological skill was an important predictor of the integration of e-learning technologies for science lessons. For example, a respondent stated that:

> *"I know how to use e-learning to research things about my module by downloading useful materials from the internet that will help me to understand my module."*

Another respondent said:

"I have the knowledge and skill to download notes, assignment and test from the Moodle platform and upload assignment and test and send it to my lecturer."

Again, another respondent commented:

"I have the skill to use and play video as an alternative way to explain my lesson to learners so that they can view things for themselves in the class."

Likewise, another respondent said:

"I have the knowledge and skill to use e-learning technologies because I can deliver my lesson using power point."

This implies that preservice science teachers have positive experience with e-learning technologies during their science education modules in the classroom and this could have helped increase their knowledge and skills to use e-learning technologies for various teaching and learning activities such as downloading learning materials from the internet, delivering lessons using PowerPoint and writing quiz tests on the Moodle e-learning platform. This finding is consistent with the findings of other studies (Coutinho, 2008; Kay, 2006; Wright & Wilson, 2006; Choy, *et al.*, 2009; Liu, 2012) that by providing preservice teachers with the necessary skills and knowledge for integrating e-learning technologies through their science education modules, this will give them the opportunity to experiment using various technologies in their learning content and in the classroom during their teaching practice. However, this finding contradicts some previous studies (Al-Ruz & Kahsawneh, 2011; Ziphorah, 2014) which reported that preservice teachers lacked the skill to integrate e-learning in the classroom during their practical field training.

5.3.3 Flow Experience

The results showed that *flow experience* was the second predictor of the integration of e-learning technologies among preservice science teachers. This suggests that preservice science teachers have been engrossed with their learning content whenever they log into an e-learning technology platform. In addition, this occurs when they use the interactive functions such as chats and message boards which helped them enjoying and concentrate on their learning content. This supports an earlier finding by Kim & Jang (2015) who found that preservice teachers integrated Web 2.0 tools during their teaching internship as a result of enjoyment they had when using Web 2.0 tools in their communication technology module in the classroom. The literature also revealed that if teachers and students believe that e-learning is very interesting and enjoyable for teaching and learning, they will integrate it into their teaching and learning process (Elkaseh, Wong & Fung, 2015; Kim & Jang, 2015). This led to the acceptance of H_4 that flow experience will be a significant predictor for integrating e-learning technologies by preservice science teachers.

The results of open ended survey also revealed that flow experience was an important predictor of the integration of e-learning technologies in science lessons. The preservice science teachers explained that e-learning technology enabled them to concentrate and pay attention in the classroom because of the interactive and innovative tools of e-learning, and that e-learning technologies made lesson enjoyable for them. For example, a respondent stated that:

"I concentrated and paid more attention in the class whenever my lecturer was using the Moodle platform because the whole activities was interesting."

Similarly, another respondent commented that:

"I concentrated on chatting with my colleagues using a discussion forum about the topic that was taught in the class."

Again, another respondent said:

"The visual tools in Moodle capture my interest in my module and I enjoy the topic that my lecturer is teaching in the class."

This notion is supported by Kim & Jang (2015) who point out that when students experience enjoyment using e-learning technologies, their intrinsic motivation (flow experience) increases.

5.3.4 Intention

The results to the second research question revealed that intention was the third highest predictor of the integration of e-learning technologies among preservice science teachers. The finding of this study is inconsistent with the assumption of technology acceptance model (TAM; Davis, 1989), theory of planned behaviour (TPB; Ajzen, 1991) and the findings of several technology usage studies (Teo & Lee, 2010; Teo, & Tan, 2012; Lee, Cerreto & Lee, 2010; Zhou, Chan, & Teo, 2016) that intention is the most immediate predictor of technology usage. It is worth noting that the possible reason for this inconsistency could be that prior to this study, the preservice science teachers had been using e-learning technologies to perform various learning activities in their different science education modules. Another possible reason might be that the earlier researchers did not examine skill which is the strongest predictor in this study to compete with intention. Nevertheless, intention was a significant predictor of e-learning technology integration in this study. This led to the inference made in respect of hypothesis H_1 that intention will be a significant predictor for integrating e-learning technologies by preservice science teachers.

The open-ended survey does not provide any result on intention to integrate e-learning technology among preservice science teachers, of which the reason might be that prior to this study, the preservice science teachers had been using e-learning technologies to perform various learning activities in their different science education modules.

5.3.5 Attitude

The results revealed that attitude was the fourth and last predictor of the integration of e-learning technologies among preservice science teachers. This finding contradicts the findings of some authors (Morales, 2007; Knezek, Christensen &Fluke, 2003; Knezek & Christensen, 2015) to the effect that at the highest stage of teachers' technology integration, attitude to push forward was the strongest predictor of classroom integration of technology for these teachers. One possible reason for this contradiction could be due to the fact that preservice science teachers' attitude to predict e-learning integration might not be strong enough to be the strongest predictor in this study. Although the coefficient of determination value (R^2 = 21%) for attitude compare to other factors in the model was small, it was nonetheless strongly significant at $p<0.05$ *(see Section 4.4.4.1 and 4.4.4.2).* Thus, this finding showed that preservice science teachers had positive attitude towards the integration of e-learning technologies. This results agrees with some previous findings (Govender, 2010; Yapici & Hevedanli, 2012; Wong, Osman, Goh & Rahmat, 2013) which indicated that the attitude of preservice teachers was an important predictor of successful ICT integration into teaching and learning, and that preservice teachers had positive and strong attitudes towards the use of e-learning technologies for teaching and learning. This led to the inference with respect to hypothesis H_2 that attitude will be a significant predictor for integrating e-learning technologies by preservice science teachers.

From open ended responses, the results also showed that preservice science teachers have strong and positive attitude towards integrating e-learning technologies in their classroom. They believed that integrating e-learning technologies in the classroom had the potential to increase students' engagement with teachers, academic contents and with other students; enhance learning; and facilitate learners' understanding of difficult concepts. For example, one respondent stated:

> "*I would use e-learning technologies because it provides many ways for me to learn, then I participate and engage more in the class whenever my lecturer uses technology.*"

Another respondent said:

> *"Using e-learning technologies in my module provides various opportunities for me to learn.*

Again, another respondent commented:

> *"E-learning has visual tools that can be used to explain abstract concepts to learners to improve the understanding of concepts because learners can see things for themselves."*

This finding is supported by Asiri, *et al.,* (2012) who noted that teachers' positive attitudes toward technology could only be enhanced if they are aware that technology system would fulfil their own or their students' needs, they will integrate it into their teaching. This finding implies that the preservice science teachers had a strong and positive attitude towards e-learning technologies which influenced them to integrate e-learning technologies into the teaching and learning of science subjects.

5.3.6 Antecedents to Intention

The ELIM model proposed that intention towards the integration of e-learning technologies could be determined by three factors: attitude, skill and flow experience. The path coefficient results indicated that the preservice science teachers' flow experience was the highest determinant of their intention to integrate e-learning technology in the teaching and learning of science subjects. This finding supports the findings reported by Lee (2010) who explained that students obtained flow experience by concentrating on the e-learning services which directly affected their intention to use the e-learning service, and thus, concentration (a construct to measure flow experience) had a significant influence on the students' intention to use the e-learning services. In addition, this finding is in harmony with the findings reported by Teo & Noyes (2011) to the effect that perceived enjoyment (a construct to measure flow experience) was a significant predictor of preservice teachers' intention to use technology. This finding implies that if preservice science teachers' flow experience with e-learning technology is good, their intention to integrate it into the teaching and learning of science subjects will be enhanced. This finding led to the acceptance of hypothesis H_7, stating that flow experience will be a significant predictor of preservice teachers' intention to integrate e-learning technologies in their teaching.

The results to the second research question also revealed that preservice science teachers' attitude was a significant antecedent to their intention to integrate e-learning technologies in the teaching and learning of science subjects. This finding corroborates previous findings (Lee, Cerreto & Lee, 2010; Teo & Lee, 2010; Teo & Tan, 2012) who reported that preservice teachers' positive attitude was a significant predictor of their intention to integrate the e-learning system. This suggests that preservice science teachers' intention to integrate e-learning technologies is influenced by their positive attitudes towards e-learning technologies. Accordingly, hypothesis H_5 that attitude will be a significant predictor of preservice teachers' intention to integrate e-learning technologies was accepted.

Moreover, the results also revealed that the preservice science teachers' skill was a significant antecedent to the intention to integrate e-learning technologies in the teaching and learning of science subjects. This finding agrees with Smarkola (2008) who reported that teachers' technological skills predicted their intention to use computers for instruction. Similarly, this supports an earlier finding by Anderson, Groulx & Maninger (2011) who reported that skill predicted preservice teacher's intention to integrate e-learning frequently with students in their classroom. This implies that preservice science teachers' skill with respect to a particular e-learning technologies is a good predictor of their intention to integrate e-learning technologies. Accordingly, hypothesis H_6, stating that skill will be a significant predictor for preservice teachers' intention to integrate e-learning technologies was accepted.

5.3.7 Antecedents to Attitude

The ELIM model proposed that attitude towards the integration of e-learning technologies could be determined by two factors: skill and flow experience. The path coefficient results showed that preservice science teachers' flow experience was the strongest determinant of their attitude towards integrating e-learning technologies in the teaching and learning of science subjects. This finding is in line with the notion held by many researchers (Finneran & Zhang, 2005; Liao, 2006; Kim & Jang, 2015; Tuunanen & Govindji, 2016) that when students are intrinsically motivated to use e-learning technologies, their level of learning will increase and will have a positive attitude towards integrating e-learning technologies into teaching and learning. This finding is also supported by Liao (2006) who found that undergraduate students' flow experience in using e-learning technologies developed their positive attitudes towards using the e-learning technologies in their distance learning module. Consequently, hypothesis H_9 was accepted, that is, that flow experience is a significant predictor for preservice teachers' attitude to integrate e-learning technologies in their teaching and learning.

The findings also revealed that the preservice science teachers' skills was a significant antecedent to their attitude to integrate e-learning technologies in the teaching and learning of science subjects. This finding concurs with Bordbar (2010) who revealed that the majority of teachers who showed negative or neutral attitude towards the integration of ICT into teaching and learning processes lacked knowledge and skills to integrate ICT into teaching and learning in the classroom. Similarly, this finding is also supported by Babic (2012) who stated that new knowledge and skills about e-learning technologies encouraged changes in teachers' attitudes to integrate e-learning technologies in the classroom. Thus, hypothesis H_8 was accepted, that is, that skill is a significant predictor of preservice teachers' attitude to integrate e-learning technologies in their teaching and learning.

5.3.8 Antecedents to Skill

This study also proposed that the preservice science teachers' skill to integrate e-learning technologies could mainly be determined by flow experience, an intrinsic motivation factor. The path coefficient results revealed that the preservice science teachers' flow experience was the main determinant of their skills to integrate e-learning technology in the teaching and learning of science subjects. The literature has revealed that the most important goal of teaching in e-learning environment is to intrinsically motivate student to acquire knowledge and gain the necessary skills that would help them integrate e-learning technology into teaching and learning (Schuler, Sheldon & Frohlich, 2010; Kim & Jang, 2015). For example, Kim & Jang (2015) stressed that when preservice teachers are intrinsically motivated they feel autonomous and skilled to effectively integrate technology into their teaching activities. This finding concurs with the outcomes of a study by Kim & Jang (2015), who concluded that preservice teachers integrated Web 2.0 tools during their teaching practice as a result of their perceived enjoyment (a construct to measures flow experience) in using Web 2.0 tools. Thus, hypothesis H_{10} was accepted, that is, that flow experience is a significant predictor of preservice teachers' skill to integrate e-learning technologies in their teaching and learning.

5.3.9 Final Model

Overall, in answering the second research question, the final model in this study was a major achievement and demonstrated a good fit. The linear combination of the predictors accounted for 44% of the variance in e-learning technology integration. The explained variance of intention, attitude, skill, and integration accounted for 32%, 21%, 36%, and 44% respectively. This implies that the explained variance (R^2) of all predicted factors is above 10%, which fulfilled the recommended value (Navimipour, *et al.,* 2016). In addition, all the ten hypotheses are supported as summarized in *Table 4.11* of chapter four. This indicated that the research model provided good explanatory power to meet the research purpose. Moreover, this study has demonstrated that flow experience is the strongest determinant of preservice science teachers' intention, skill and attitude to integrate e-learning technologies into teaching and learning of science subjects. Furthermore, these findings has demonstrated that skill is the strongest predictor of the integration of e-learning technologies by preservice science teachers.

It is worth noting that the qualitative, open-ended, question (What is the most important factor that would influence you to integrate e-learning in your science lesson as a teacher?) was asked to support the hypotheses of this study. However, the qualitative results indirectly support the model, which posits that skill is the strongest predictor of the integration of e-learning technologies by preservice science teachers. The qualitative data revealed that attitude was the strongest predictor of the integration of e-learning technologies. However, there appears to be a strong link between skills in e-learning technologies and attitude towards the application of such technologies to teaching and learning. Bordbar (2010), for instance, reported that the majority of teachers who showed negative or neutral attitude towards the integration of ICT into teaching and learning processes lacked knowledge and skills to integrate ICT into teaching and learning in the classroom. Similarly, Babic (2012) also reported that new knowledge and skills about e-learning technology encouraged changes in teachers' attitudes to integrate e-learning technology in the classroom. Since hypothesis H_8 (skill will be a significant predictor of preservice science teachers' attitude to integrate e-learning technology) was accepted, it is likely that the skill of the preservice science teachers to integrate e-learning technology would have influenced their attitude towards the integration of e-learning technologies. It can then be inferred that hypothesis H_8 was implicitly validated in this study using qualitative data. Finally, this study has demonstrated that ELIM is capable of predicting preservice science teachers' integration of e-learning technologies in the teaching and learning of science subjects.

5.4 MODERATING EFFECTS OF INNOVATION AND QUALITY CONSCIOUSNESS

This section discusses the results related to the moderating effects of innovation and quality consciousness on the relationship between intention to integrate e-learning technologies and the actual integration of e-learning technologies for teaching and learning of science subjects by preservice science teachers, in order to answer the third research question of this study. To the best of researcher's knowledge, this study was the first to introduce the notions of innovation and quality consciousness to strengthen the relationship between intention and integration in the context of the integration of e-learning technologies.

Research Question 3: *How can quality and innovation consciousness moderate the relationship between intention to integrate and the actual integration of e-learning technologies in the teaching and learning of science subjects by preservice science teachers?*

5.4.1 Innovation Consciousness

The results revealed that innovation consciousness moderates the relationship between intention to integrate e-learning technologies and the actual integration of e-learning technologies for teaching and learning of science subjects by preservice science teachers. Moreover, the innovation consciousness moderator had a positive and stronger effect on the relationship between intention and integration (β=0.15, p<0.05). The literature revealed that the primary goal of the modern education system is to seek innovative ways of achieving quality or excellence in teaching and learning with the use of e-learning technologies (Biggs, 2003; Asiri, *et al.*, 2012; Buabeng-Andoh, 2012). Additionally, Chigona, *et al.*, (2014) assert that the integration of e-learning into curriculum delivery develops innovative spirits in students, and encourages constructive and dynamic learning such that the critical thinking capability of students can be developed in a more efficient way.

The results of this study support previous studies (Liao & Lu, 2008; Rogers & Wallace, 2011; Ali, Haolader & Muhammad, 2013; Prenjasi & Ahmetaga, 2015). For example, Liao & Lu (2008) indicated that a significant relationship existed between students' perceptions of innovation attributes of the learning website and their actual use of a web learning system. Rogers & Wallace (2011) showed that the degree of e-learning innovativeness of preservice teachers had much influenced on how they integrated e-learning into their teaching and learning. Similarly, Ali, *et al.,* (2013) concluded that the innovations that e-learning brought into the teaching-learning process provided an opportunity for the preservice teachers to integrate e-learning into the teaching and learning process. Prenjasi & Ahmetaga (2015) affirmed the notion that e-learning remains an innovation for the teaching and learning process which can help students to acquire new methods and techniques for innovative learning. This finding implies that the preservice teachers in this study were very innovative and enthusiastic to learn new technologies quickly, accept them and use them in their teaching and learning.

5.4.2 Quality Consciousness

The results revealed that quality consciousness moderates the relationship between intention to integrate e-learning technologies and the actual integration of e-learning technologies in teaching and learning of science subjects by preservice science teachers. Moreover, the quality consciousness moderator had a strong and positive effect on the relationship between intention and integration. It is noteworthy that the moderating effect of quality consciousness was positive and stronger (β=0.19, p<0.01) than for innovation consciousness (β=0.15, p<0.05). In other words, this finding demonstrates that the intention-integration relationship is larger for preservice science teachers who believed that quality of education consciousness can strengthen their intention to integrate e-learning technologies than for preservice science teachers who believed that innovation consciousness could strengthen their intention to integrate e-learning technologies.

The literature has revealed that quality of education process is one of the factors responsible for students' achievement and success in their learning (Babic, 2012). However, Ageel (2011) asserts that the integration of e-learning into educational processes is one of the interventions through which students are provided with quality education, and that the necessary skills and knowledge of e-learning possessed by students facilitate the provision of quality education and improvement in their academic performance.

The results of this study support previous findings (Govender, 2010; Yanuschik, Pakhomova & Batbold, 2015). For example, Govender (2010) indicated that preservice teachers contend that the use of e-learning increases the quality and efficiency of science education. Yanuschik, Pakhomova & Batbold (2015) showed that the use of e-learning improved the efficiency of the classroom work, enabled students to navigate through the learning materials, and helped them to respond faster to teachers' questions and problem solving. Yanuschik, *et al.,* (2015) concluded that the use of e-learning in the educational process improves the quality of practical session of the module and provides a better understanding of the module.

In this study, it is notable that although both innovation and quality consciousness positively and significantly moderated the relationship between intention and integration, the moderating effect was stronger for quality (β=0.19, p<0.01) than innovation (β=0.15, p<0.05). This finding demonstrates that the quality of education consciousness influences PSSTs intention to integrate e-learning technologies more than innovation consciousness.

To sum up, in answering the third research question, and based on the evidence from the results of this study, it is worth mentioning that preservice science teachers are conscious that the quality of teaching and learning of science would improve with the use of e-learning technologies. Thus, it can be concluded that quality consciousness and innovation consciousness provide salient effects to strengthen the relationship between intention to integrate e-learning technologies and the actual integration of e-learning technologies in teaching and learning of science subjects by preservice science teachers.

5.5 PRESERVICE SCIENCE TEACHERS REFLECTIONS AND FEEDBACK FROM TEACHING PRACTICE

This section discusses the results related to preservice science teachers' reflections and feedback on their experiences with integration of e-learning technologies into the teaching and learning of science subjects during their teaching practice in order to answer the fourth research question of this study. The section is divided into two parts. The first part discusses preservice science teachers' utilisation of e-learning technologies during their teaching practice (that is, preservice science teachers who indicated that they used e-learning technologies during their teaching practice). The second part discusses preservice science teachers' inability to use e-learning technologies during their teaching practice. This related to preservice science teachers who indicated that they never used e-learning technologies during their school-based teaching practice. Overall, therefore, this section looks at the preservice science teachers' reasons for integrating or not integrating e-learning technology during teaching practice.

Research Question 4: *What are the preservice science teachers' experiences with regard to integrating e-learning technologies in the teaching and learning of science subjects during teaching practice?*

5.5.1 Preservice Science Teachers' Utilisation of E-Learning Technologies during Teaching Practice

The results revealed that the most frequently used e-learning technology by the preservice science teachers was internet. This was followed by videos, laptops, desktops and overhead projectors. The results further revealed that the preservice science teachers used e-learning technologies for various educational purposes such as instructional preparation, instructional delivery, and facilitating learner-centred learning. The literature study revealed that technology is used in schools in three ways: for instructional preparation, for instructional delivery, and to facilitate learning (Inan, 2010). Thus, the results of this study are consistent with previous research (Choy, *et al.,* 2009; Chen, 2010; Sadaf, 2013). For example, Choy, *et al.,* (2009) reported in their study that preservice teachers used technology as instructional delivery tools to support their lessons and to facilitate student-centred learning. Chen (2010) focused on preservice teacher usage of technology to support student-centred learning. Moreover, Sadaf (2013) explained that preservice teachers used Web 2.0 technology as instructional delivery tools and to facilitate student-centred learning.

For instructional preparation, the study revealed that the most frequently cited reason by preservice science teachers to integrate e-learning technology was to use internet to search for additional information about science contents in order to gain mastery of the content, and to prepare their lesson plans. The results further revealed that they downloaded pictures and images to clarify difficult concepts to the learners in order to improve the quality of the lesson. The preservice science teacher might have chosen to use internet more than other e-learning technologies because of their skills in browsing the internet and the greater access they have to internet more than any other technology. This observation is consistent with Phua, Wong & Abu (2012) who found that teachers in their study used internet as a teaching and learning tool to acquire more information concerning Home Economics and to prepare their lesson plans.

For instructional delivery, the study revealed that preservice science teachers used PowerPoint to deliver their lessons, to capture learners' attention and participation in class, make difficult concepts clearer to the learners, to enhance interaction between teachers and learners, to motivate learners to concentrate in class, and to save time. This finding suggests that preservice science teachers have developed skills and confidence in the use of PowerPoint, which they use in teaching their science lessons. This finding concurs with previous findings (Choy, *et al.*, 2009; Kalanda, 2012). For example, Choy, *et al.*, (2009) reported in their study that preservice teachers used PowerPoint to support their teaching, convey information, and to gain students' attention in class. In similar vein, Kalanda, (2012) reported in his study that science teachers used slides and graphics in PowerPoint presentation software regularly to capture students' attention at the start of lessons, to interact well with their students, and to save time by spending less time talking and writing on the board in the traditional way of teaching.

To facilitate student-centred learning, the study revealed that preservice science teachers grouped their learners into small groups and played videos of the topic as visual tools for them in their small groups to reinforce teaching, and visually explain concepts better to learners so that they can understand the targeted concepts. These results support previous findings (Choy, *et al.*, 2009; Sadaf, 2013; Liu, 2016). For example, Choy, *et al.*, (2009) reported in their study that preservice teachers used videos to support their lessons and facilitate student-centred learning. Sadaf (2013) explained that videos were the most used Web 2.0 technologies by preservice teachers during their teaching practice due to their proficiency in using these tools to facilitate student-centred learning. Moreover, Liu (2016) explained that preservice teachers used videos to support student-centred learning by grouping students into two groups in class and playing the videos directly on the laptops which helped them to hold their students' attention and to understand the students' thinking process in problem solving.

Overall, this finding implies that preservice science teachers have positive experiences with e-learning technologies in the classroom and this helps them to integrate e-learning in their science lessons. In addition, the finding implies that preservice teachers were able to demonstrate their technology skills learned during the teacher education modules and actually integrate technology in their classroom. This findings supports the ELIM factor that predicted preservice science teachers' integration of e-learning technologies as well as concur with previous researchers who have indicated that by providing preservice teachers with the necessary skills and knowledge for integrating e-learning technology through their science education modules, this would give them the opportunity to experiment with using technology in their learning of content and in their classroom during their teaching practice (Coutinho, 2008; Kay, 2006; Wright & Wilson, 2006; Choy, *et al.*, 2009; Liu, 2012). However, this finding contradicts some other previous studies (Al-Ruz & Kahsawneh, 2011; Ziphorah, 2014) which found that preservice teachers lacked the skill to integrate e-learning in their classroom during their practical field training. In sum, based on the evidence presented above, it is safe to say that the ELIM is capable of predicting preservice science teachers' prediction of e-learning technologies.

5.5.2 Preservice Teachers' Inability to use E-Learning Technology during Teaching Practice

The study revealed that 53% of the preservice science teachers were unable to integrate e-learning technologies in their science lessons during teaching practice because of a lack of e-learning facilities in the school. This finding concurs with some previous findings that preservice teachers were unable to integrate technology in their classrooms because facilities such as hardware, software, and plug-ins were not readily available (Choy *et al.*, 2009; Sadaf, 2013). Moreover, preservice science teachers explained that they took a step by using the traditional method of teaching like other teachers in the schools, such as, using the prescribed textbook, chalk and board. They also used pictures and charts as teaching aids where possible to explain difficult concepts to learners for them to understand. In addition, some of the preservice science teachers explained that they informed their subject mentors and the principals of the schools whether they could render any assistance about providing e-learning facilities for them to use. This suggests that the preservice science teachers were ready and prepared to integrate e-learning technologies in their classrooms, but the facilities were not available. It is, therefore, possible that these students had the knowledge and the necessary skills to integrate e-learning technology into their teaching, but were let down by the non-availability of a supportive school environment. However, some studies reported findings which were opposed to this view, and reported that preservice teachers lacked the skills to integrate e-learning technologies into their classrooms during their practical field training (Al-Ruz & Kahsawneh, 2011; Ziphorah, 2014).

In addition, the preservice science teachers explained that in this 21st century, the provision of e-learning facilities such as computer laboratories, computers, LCD projector, TV monitors, electricity, internet, and WiFi are essential in the schools for effective teaching and learning of science so that abstract and difficult concepts would be made simpler for learners to comprehend. Similarly, if the schools are provided with all these facilities, the preservice science teachers stated that they are ready to help their science teachers and other interested teachers in the schools who do not have adequate technology skills on the use of technology to improve the teaching of science subjects. This finding lends support to Choy, *et al.,* (2009) who contend that preservice teachers are able to adopt the pedagogical use of e-learning technologies learned in their teacher education programmes during the teaching practice experiences. It is more likely that they may become the change agents in their schools, helping to alter the school culture and the veteran teachers in the effective integration of e-learning technology in the classroom.

Furthermore, the preservice science teachers realised that the introduction of e-learning into the school curriculum was an innovation that improved the quality of science teaching and education, enhanced the performance of learners in science subjects and increased the pass rates of science subjects. This insight by the preservice science teachers could be because of their exposure and experience to e-learning technology during their teachers' science education modules that helped them to appreciate the significance of using e-learning technologies in the classroom. This notion is supported by previous studies (Govender, 2010; Seluakumaran, *et al.,* 2011; Pacemska, *et al.,* 2012). For example, Govender (2010) indicated that preservice teachers affirmed the view that the use of e-learning technologies in the classroom increased the quality and efficiency of science education. Moreover, Seluakumaran, *et al.*, (2011) and Pacemska, *et al.,* (2012) explained that the utilisation of e-learning significantly improved student performance in their examination compared to other students who rarely or never used e-learning.

Lastly, the preservice science teachers saw the use of e-learning technologies in their science lesson after graduation from the University as a means of improving the quality of their teaching because they would be able to make use of different e-learning technology tools in the science classrooms. Likewise, the preservice science teachers reckoned that the use of e-learning technology would increase their technological skills and help them save time in their teaching. This finding corroborates the findings of previous studies (Al-Ruz & Khasawneh 2011; Al-Ani, 2013; Bulic & Novoselic, 2014) which showed that the use of e-learning technologies for learning improved preservice teachers' technological skills to browse through websites searching for information and to solve real life problems about the content in the classroom.

To sum up, in answering the fourth research question, the findings of this study were that preservice science teachers were able to integrate e-learning technologies during their teaching practice for instructional preparation, instructional delivery, and to facilitate learning among learners. In addition, it was interesting to note that although some preservice science teachers were anxious to integrate e-learning technologies in their science lessons because of their proficiency in their use, as well as the educational benefits they perceived derived therefrom, they were unable to integrate e-learning technologies during their teaching practice because of a lack of e-learning technologies at their designated schools. It is reasonable to infer that the skill of the preservice science teachers was the main factor that predicted the integration of e-learning technologies in this study.

5.6 CONCLUSION

This chapter discussed the results obtained from this study. The chapter revisited the research questions and from the research findings, it was evident that all the questions were adequately answered. The findings showed that the research model explained 44% of the variance in the integration of e-learning technologies. It has also revealed that skill was the best predictor of the integration of e-learning technologies by preservice science teachers. Additionally, flow experience was the second predictor, intention was the third predictor and attitude was the fourth and last predictor of the integration of e-learning technologies by preservice science teachers. The open-ended result lent support to the findings that skill, attitude and flow experience were important predictors of the integration of e-learning technologies in science lessons. The research findings also provided further evidence that innovation consciousness and quality consciousness positively and significantly moderated the link between intention and integration, but the moderating effect was stronger for quality consciousness.

The qualitative findings highlighted that integrating e-learning technologies into science lessons offered numerous benefits to preservice science teachers as (a) e-learning technologies beneficiaries: for searching and sharing information about the content, improving learning, and helping save a lot of time in their studies outside classroom, (b) them as teachers: improving teaching, helping save a lot of time to mark learners' tests quicker, improving technology skill of learners and helping them think critically, motivating learners to learn and improving learners' understanding of the content. In addition, the findings further revealed that the preservice science teachers were able to integrate e-learning technologies during their teaching practice for instructional preparation, instructional delivery, and to facilitate learning among learners. However, some preservice science teachers were unable to integrate e-learning technologies during their teaching practice because of a lack of e-learning technologies at their designated schools. The next chapter gives a summary of the whole study together with conclusions and recommendations for future study and classroom practice.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 INTRODUCTION

This chapter gives a summary of the study, highlights the implications and draws conclusions from the findings of this study. The chapter also highlights the contributions and limitations of this study. The chapter concludes with recommendations for future relevant research.

6.2 SUMMARY

6.2.1 The Problem

This study sprung from the premise that in the context of South Africa, there has been substantial research on the adoption and integration of ICT by secondary school teacher, integration of e-learning by lecturers in higher education institutions and comparisons of traditional methods of teaching with the use of e-learning. However, what remained uncovered was whether or not preservice teachers would integrate e-learning technologies into their science education modules while at university and during their teaching practice in schools. Hence, there has been a paucity of research investigating preservice science teachers' integration of e-learning technologies into the teaching and learning of science subjects in South Africa. The literature revealed that despite several available benefits of e-learning technologies, preservice teachers are not integrating e-learning technologies in the classroom during their teaching practice in schools. Although most of the preservice teachers may be sufficiently familiar with ICT in general, they may, or may not, be able to integrate newer e-learning technologies. The reason behind their inability to do so could depend on their perceptions about integrating e-learning technologies, and more importantly, may be related to factors that predict preservice teachers to integrate, or not to integrate, e-learning technologies. Therefore, the understanding of these factors can provide a useful guide to successful integration of e-learning technologies into the curriculum (Teo, *et al.,* 2008; Chigona & Dagada, 2011). The literature generally revealed the existence of three important gaps, namely, lack of ICT skill (Howie, 2009; Mofokeng & Mji, 2010), lack of models that combine all the prominent factors that predict or explain the integration of e-learning technologies in the literature (Alharbi, 2010; Teo, 2011), and the intention-behaviour gap (Venkatesh *et al.,* 2003; Bhattacherjee & Sanford, 2009) in the integration of e-learning technologies.

6.2.2 The Purpose of the Study

The main purpose of this study was to investigate the integration of e-learning technologies among preservice science teachers during their teacher education module programme in the university and during their teaching practice. Specifically, the study sought to:

a) To explore the perceptions of preservice science teachers about the educational benefits of integrating e-learning technologies in the teaching and learning of science subjects.
b) To identify the factors that could best predict or explain preservice science teachers' integration of e-learning technologies in the teaching and learning of science subjects.
c) To investigate the moderating effects of quality and innovation consciousness on the relationship between intention to integrate and the actual integration of e-learning technologies in the teaching and learning of science subjects by preservice science teachers.
d) To determine the extent to which preservice science teachers are able to integrate e-learning technologies in the teaching and learning of science subjects during teaching practice.

More specifically, the study attempted to find answers to the following research questions:

a) What are preservice science teachers' perceptions of the educational benefits of integrating e-learning technologies in the teaching and learning of science subjects?
b) What factors best predict or explain preservice science teachers' integration of e-learning technologies in teaching and learning of science subjects?
c) How can quality and innovation consciousness moderate the relationship between intention to integrate and the actual integration of e-learning technologies in the teaching and learning of science subjects by preservice science teachers?
d) What are the preservice science teachers' experiences with regard to integrating e-learning technologies in the teaching and learning of science subjects during teaching practice?

In answering these questions, the first and fourth questions were addressed through content analysis, the second and third questions were addressed by testing a number of hypotheses that were formulated using the Warp Partial Least Square (WarpPLS) 4.0 structural equation modelling (SEM) statistical software package.

6.2.3 The Conceptual Framework

The research questions of this study led to the review of relevant theory and literatures on e-learning technology integration, involving an overview of classification of e-learning, discussed e-learning in South Africa and e-learning platforms. In the process, various aspects of research on e-learning integration were unravelled - such as research on perceived educational benefits of e-learning technologies, predictors of the integration of e-learning technologies, intention behaviour gap and preservice science teachers' experiences about the integration of e-learning technologies. Moreover, a conceptual framework based on existing factors thought to predict and /or explain e-learning integration from previous studies was developed. These factors were combined to constitute a model to predict the integration of e-learning technologies among preservice science teachers. The model was justified by four extant and robust theories, namely the Will, Skill, Tool (WST) model of ICT integration, the Theory of Planned Behaviour (TPB), the Expectation-Confirmation Theory (ECT), and the Flow Theory (FT). In this study, the ELIM model postulated that preservice science teachers' integration of e-learning technologies can be predicted by four factors, namely, intention, attitude, skill and flow experience. The model also proposed that the relationship between intention and integration can be moderated by innovation and quality consciousness. To the best of the researcher's knowledge, no previous studies have attempted to combine these four factors in one research to predict the integration of e-learning technologies by preservice science teachers in the classroom. Furthermore, this study is likely the first to introduce the notion of innovation and quality consciousness as possible moderators in the relationship between intention and integration in the context of predicting e-learning technologies by preservice teachers.

6.2.4 Methodology

This study used a blend of mixed-methods research paradigm to provide diverse perspectives about preservice science teachers' integration of e-learning technologies into their science classrooms. The research design was descriptive, confirmatory and cross sectional. The preservice science education teachers in the Faculty of Education, at the participating South African University constituted the accessible population of this study. A convenience purposive sampling method was used to select 100 samples from the fourth year preservice science teachers. A pilot study was conducted before the main study to assess the reliability and validity of the research instrument, identify the flaws as well as to determine whether the research procedures was viable. The reliability and validity of the instruments was assessed with WarpPLS 4.0 a component-based structural equation modelling (SEM) strategy. Furthermore, the instruments was examined by experts in the department of Information Technology at another South African University and the promoter of this study. The measurement instrument and all indicators met the widely accepted criteria for reliability and validity as described in Chapter three *(see Section 3.7.3 1).* Open and closed-ended questionnaire was used for data collection in order to answer the research questions. The questionnaire consisted of (1) preservice science teachers' perceptions of the educational benefits of e-learning technologies (2) e-learning integration model (ELIM) and moderator (MOD) scales (3) preservice science teachers' reflections and feedback from the teaching practice. Ethical issues were adequately addressed during the whole data collection process. The data collected were quantitatively analysed using WarpPLS 4.0 SEM and qualitatively analysed using hermeneutic content analysis.

6.2.5 Major Findings

The major findings of this study related primarily to the preservice science teachers' perceptions about e-learning technology integration; factors that best predict preservice science teachers' integration of e-learning technologies into the teaching and learning of science subjects; moderating effects of innovation consciousness and quality consciousness; and preservice science teachers' reflections and feedback from teaching practice. This was in line with the research questions of this study.

6.2.5.1 Preservice Science Teachers' Perceptions about Educational Benefits of E-Learning Technology Integration

The findings were that integrating e-learning technology into science lessons offered numerous benefits for the preservice science teachers such as searching and sharing information about the content and with their colleagues and teachers to render help in any topic they found difficult to understand; improving teaching, learning and assessment by giving the teachers time and space to cover all aspects of the subjects, by directing students to relevant websites for useful information and providing prompt feedback for the student about their current attainment levels in their studies; that technology integration improves technology skill of preservice science teachers and helps them think critically by browsing through websites to search for information and to solve real life problems about the topics. Moreover, the integration of e-learning technologies motivates learners to learn through the use of interactive tools which stimulate learners' interest to experience flow, enjoy the lesson, encourage them to focus attention on their studies and to be engage actively in learning beyond the classroom; improves learners' understanding of the content by using e-learning technology interactive features which promote active learning and assist learners to better grasp concepts being taught, thereby resulting in better academic performance. Furthermore, the integration of e-learning technologies enables seamless communication between teachers and learners by allowing teachers to distribute information about learning materials, assignments and tests to learners, engage in discussions with learners using communication tools such as chats and discussion forums to motivate and engage them in interactive learning activities; and finally helps learners save a lot of time in their studies outside the classroom, as well as help teachers save time in respect of marking. Lastly, the findings are related to the flow theory that integration of e-learning technologies into teaching and learning motivates learners to learn through the use of interactive tools which stimulate learners' interest to experience flow; enjoy the lesson, encourage them to focus attention on their studies and to be engage actively in learning beyond the classroom.

The above notwithstanding, preservice science teachers perceived the following as obstacles militating against the integration of e-learning technologies into the teaching and learning of science subjects: lack of e-learning facilities; distractions and lack of focus in the classroom by learners; the notion that e-learning technology integration would make learners to become lazy; that e-learning technology integration would promote plagiarism; and that it was very expensive and therefore unaffordable.

Overall, however, the findings of this research showed that the educational benefits of integrating e-learning technology outweighed the barriers, as there are some control measures which teachers, themselves, need to explicitly put in place to overcome the barriers and those that they should present as grievances to the school principals, school governing bodies (SGBs) and the government to address the issues in order to improve the quality of education. The preservice science teachers acknowledged and appreciated that the integration of e-learning technologies had positive advantages for teaching and learning of science subjects.

6.2.5.2 Factors that best Predict Preservice Science Teachers' Integration of e-Learning Technologies into the Teaching and Learning of Science Subjects

This study proposed a model to predict preservice science teachers' integration of e-learning technologies into the teaching and learning of science subjects. The model (ELIM) postulated that intention, attitude, skill and flow experience could combine to predict e-learning technology integration. These four factors together were found to significantly predict e-learning integration in respect of the preservice science teachers. The preservice science teacher's propensity to integrate e-learning technologies was jointly predicted by intention (β=0.22, p<0.01), attitude (β=0.13, p<0.05), skill (β=0.28, p<0.01) and flow experience (β=0.24, p<0.01), with preservice science teachers' skill as the strongest predictor, followed by intention, flow experience and attitude. The linear combination of these predictors significantly predicted 44% of the variance in e-learning technology integration. The model had a moderate explanatory power to predict e-learning technology.

Moreover, there were some interactive effects among intention, attitude, skill and flow experience on integration. Specifically, intention was predicted by attitude (β=0.19, p<0.01), skill (β=0.15, p<0.05), and flow experience (β=0.36, p<0.01) with flow experience having the greatest effect as compared to attitude and skill. Further, attitude was predicted by skill (β=0.15, p<0.05) and flow experience (β=0.36, p<0.01), with flow experience having the greatest effect. Finally, skill was mainly predicted by flow experience (β=0.60, p<0.01). Thus, the findings of this study revealed that flow experience was the strongest determinant of preservice science teachers' intention, skill and attitude to integrate e-learning technologies into their teaching and learning of science subjects. The findings implied that preservice science teachers were intrinsically motivated to use e-learning technologies which explicitly influenced their intention, skill and attitude to integrate e-learning technologies into teaching and learning of science subjects.

Furthermore, these findings indicated that skill was the strongest predictor of e-learning technology integration by preservice science teachers. In addition, all the ten hypotheses proposed in the study were supported. This indicated that the research model had good explanatory power and fit to meet the research purpose. The results from the open-ended section of the questionnaire validated the ELIM model findings that skill, attitude and flow experience were important predictors of e-learning technology integration in science lessons. Lastly, the findings are related to the Will, Skill, Tool Model of ICT integration that the skill of a teacher to integrate technology in the classrooms leads to higher stages of classroom ICT integration, which in turn leads to greater student achievement.

6.2.5.3 Moderating Effects of Innovation Consciousness and Quality Consciousness

To investigate the moderating effects of quality and innovation consciousness on the relationship between intention to integrate and the actual integration of e-learning technologies in the teaching and learning of science subjects by preservice science teachers, the WarpPLS 4.0 SEM was used. The results were that the overall explanatory power of the baseline research model (which excluded innovation and quality) explained 44% (R^2 = 44) of the variance in e-learning integration (*see Figure 4.1*), with intention having a standardized path coefficient of (β = 0.22) on the dependent variable (e-learning integration). However, the moderated research model (which included innovation and quality) explained 49% (R^2 = 49) of the e-learning integration variance *(see Figure 4.2*), representing an 11% increase in the explanatory power over the baseline research model. Moreover, the result was that both innovation and quality consciousness positively and significantly moderated the relationship between intention and integration of e-learning technologies for teaching and learning of science subjects by preservice science teachers, and the moderating effect was stronger for quality (β=0.19, p<0.01) than for innovation (β=0.15, p<0.05). Thus, the two hypotheses were supported, and that the intention-integration relationship was larger for preservice science teachers who believed that quality of education consciousness strengthened their intention to integrate e-learning technologies than for preservice science teachers who believed that innovation consciousness strengthened their intention to integrate e-learning technologies. Thus, the result indicated that the preservice teachers were conscious of the innovations that e-learning brought into teaching-learning of science subjects, and in the same vein, were conscious that integration of e-learning technologies into science lessons would improve the quality of teaching and learning of science subjects.

6.2.5.4 Preservice Science Teachers' Reflections and Feedback from Teaching Practice

The fourth research question sought to determine the extent to which preservice science teachers were able to integrate e-learning technologies in the teaching and learning of science subjects during teaching practice. The results revealed that the most frequently used e-learning technology by the preservice science teachers was internet, followed by videos, laptops, desktops and overhead projectors. This showed that preservice science teachers were able to integrate different e-learning technologies for various educational purposes such as instructional preparation, instructional delivery, and facilitating student centred learning. The findings further revealed that most preservice science teachers used internet technologies during their teaching practice for instructional preparation, some used videos to facilitate student-centred learning and a few used PowerPoint as instructional delivery tools. More specifically, the results showed that the preservice science teachers had skills in browsing the internet as a teaching and learning tool to acquire more information about the content and to prepare their lesson plans. They also had the skills and confidence in the use of PowerPoint to deliver their science lessons, to capture learners' attention and enhance their participation in class, make difficult concepts clearer to the learners, to enhance interaction between teachers and learners, to motivate learners to concentrate in class, and to save time. Further, the preservice science teachers were proficient in using videos as visual tools to reinforce their teaching, to visually explain concepts better to learners, and to sustain their learners' attention in the classrooms.

Nonetheless, although some preservice science teachers were positively disposed towards integrating e-learning technologies in their science lessons in respect of their proficiency in their application, as well as their awareness of the educational benefits, they were unable to integrate e-learning technologies during their teaching practice because of the non-availability of e-learning technologies at their designated schools.

Overall, this finding to the fourth research question is that preservice science teachers were positively disposed to the integration of e-learning technologies in their classrooms, and many were able to demonstrate their technology skills in their education modules and in their classrooms during teaching practice. This findings are related to the Will, Skill, Tool Model of ICT integration that the skill of a teacher to integrate technology in the classrooms leads to higher stages of classroom ICT integration, which in turn leads to greater student achievement. This outcome concurs with the quantitative finding that skill was the best factor that predicted preservice science teachers' integration of e-learning technologies. In addition, the finding showed that the model (ELIM) developed in the study was a good predictor of preservice science teachers' integration of e-learning technologies.

6.3 IMPLICATIONS

This section outlines the implications of the research findings.

6.3.1 Implications for Teacher Education

The results of this study provide evidence that pre-service teachers' skills were the strongest predictor of e-learning technologies integration. Accordingly, teacher education institutions should take note of this variable and restructure their programmes in ways that will promote technology integration by student teachers by strengthening their skills base. Thus, the focus of teacher education programmes in preparing pre-service teachers to effectively integrate e-learning technologies in their classrooms should be on improving preservice teachers' e-learning technology skills to integrate e-learning technologies that support student learning. In this regard, teacher education programmes can provide opportunities for preservice teachers to practise using supportive tools for e-learning technologies in developing actual lesson plans that integrate e-learning technologies, micro-teach those lessons in teacher education modules, and reflect on their experiences. This might help improve and consolidate their skills towards the integration of e-learning technologies in the classrooms.

Overall, the researcher believes that the findings of this study will assist teacher educators to have proper understanding of factors that predict preservice teachers to use or integrate e-learning technologies before investing in the development of e-learning technologies. Certainly, the insights from this study could help teacher educators to develop more appropriate e-learning strategies to help improve the quality of e-learning in the education system.

6.3.2 Implications for Practice

The findings of this study will also assist teachers and learners to realise that the use of e-learning technologies, such as internet and videos, could improve the overall teaching-learning process of science subjects. In particular, internet is immensely useful to teachers, particularly in gaining mastery of the content to be taught and in helping them to prepare lesson plans. The use of videos will assist teachers to clarify abstract scientific concepts to the learners through visualization – and this improves the instructional process. This way, the use of videos to support classroom learning can enhance learners' academic performance. Videos can help learners gain better conceptual understanding of the highly abstract and complex concepts of science subjects. Learning through videos may also facilitate learner-centred learning as it encourages students to learn by themselves, motivate them to learn, increase their learning skills by combining all senses. Learner-centredness also gives learners the opportunity to interact, argue and engage with teachers, academic content and with other learners.

This study also showed that some preservice teachers were unable to use e-learning technologies during teaching practice due to limited access to technology resources in their designated schools. To help preservice teachers successfully integrate e-learning technologies in their classrooms, school authorities should create an appropriate environment by equipping their schools with e-learning facilities such as computers, networks, educational software, e-learning technologies tools and e-libraries to improve the quality of e-learning and education. There is a need to establish support systems between schools and the government to alleviate the challenges faced by pre-service teachers in using e-learning technology tools during teaching practice. More collaboration and better communication between schools and the government is thus needed so the latter is made aware of the current status of e-learning facilities in each school.

Finally, pre-service science teachers should understand the application of integration of e-learning technology supportive tools from two perspectives – as students in their university studies, and as teachers when they assume the teaching role. They should, as much as possible, attempt to visualize the use of e-learning technology in the classroom as teachers, and build on their experiences using e-learning technology tools. Furthermore, they should reflect upon the learning benefits they gained that can be carried over to their students when they become in-service teachers, such as technology confidence and technology skills. Overall, as they strive for efficient and effective use of e-learning technology supportive tools, they will concurrently benefit as learners. Their technology skills and understanding of the constructivist learning practices that can be used when they become in-service teachers will be enhanced.

6.4 CONCLUSION

The successful integration of e-learning to innovate the standard of teaching and learning is becoming increasingly prominent in the educational sector across the world. Preservice science teachers are expected to drive e-learning innovations as change agents based on their experience from teacher education programmes by, inter alia, integrating e-learning technologies into teaching and learning to transform the education system. The first step towards addressing the inability of preservice science teachers to integrate technology during their science education module in the university and during their teaching practice experience in schools is to understand the factors that can predict integration of e-learning technologies into teaching and learning of science subjects among the preservice science teachers. This was the main thrust of this study, and the findings have revealed encouraging patterns towards full integration of e-learning technologies.

This study has brought fresh ideas to the ongoing discourse about the inability of preservice teacher to integrate e-learning technologies in the classroom during their teaching practices in schools. The educational benefits of integrating e-learning technologies into the teaching and learning of science subjects appeared to be obvious to the preservice science teachers. It is important to capitalise on these positive perceptions when preservice take their university modules and when they go out to schools for teaching practice. Accordingly, it is hoped that the PSSTs will become the change agents in their first years of teaching in schools, transform the school culture and help the in-service science teachers in the effective integration of e-learning technologies in the classroom. However, it is clear that some preservice science teachers were positively disposed towards integrating e-learning technologies in their science lessons in respect of their proficiency in their application and their awareness of the educational benefits. They were unable to integrate e-learning technologies during their teaching practices because of the non-availability of e-learning technologies in their designated schools. This outcome bemoans the lack of e-learning facilities in many South Africa rural schools, in spite of the effort of the South African government to equip schools with e-learning facilities such as computers, networks and educational software. Nonetheless, this study has shown that there is still a lot to be done in South Africa for e-learning in education programme to be fully implemented, and to be able to compete technologically with the developed world. Overall, this study has succeeded in achieving its objectives, thereby making a significant contribution to both theory and practice.

6.5 CONTRIBUTION OF THE STUDY

This study uniquely contributes to the general literature and practice in relation to the integration of e-learning technologies within the context of the education system. The unique contributions of this study are enunciated as follows.

Firstly, there has hitherto not been any comprehensive study about the integration of e-learning technologies which consisted of both quantitative and qualitative dimensions to the study among preservice science teachers in South Africa. This study developed and validated E-Learning technology Integration Model (ELIM) among the preservice science teachers in South Africa. This model is novel and a sample that was not examined by previous research in the field of e-learning to date has been considered. This study also provided a strong evidence that ELIM is a valid model with moderate explanatory power for predicting the integration of e-learning technologies in the teaching and learning of science subjects.

Secondly, this study was the first to introduce innovation and quality consciousness as new moderators to strengthen the gap between intention to integrate and the actual integration of e-learning technologies. Thus, the study added value to the small number of studies which have so far examined moderators in the intention-integration gap relationship in the context of e-learning technology integration.

Thirdly, from a practical perspective, this study has contributed to a better understanding of the factors that predict the integration of e-learning technologies into the teaching and learning of science subjects by preservice science teachers. The study has revealed the order of strength among a number of predictor variables in the integration of e-learning technologies into the teaching and learning of science subjects in secondary and higher education. This finding could provide insight for the university e-learning management, information and educational technology practitioners before investing in the development of e-learning. This would also be used as a guideline to devise more appropriate e-learning strategies and policies which could help to improve the quality of education and inject innovation into the education system. In addition, the general findings of this study may help governments, non-government organisations (NGOs), e-learning advocates and policy makers to design and implement better e-learning strategies and policies in schools towards promoting e-learning integration.

6.6 LIMITATIONS

There are four limitations that may be cited in respect of this study:

First, the sampling procedure and the nature of the sample were restrictive. A convenience purposive sampling method (*see Chapter 3*) was employed. The scope of the study was confined to the preservice science teachers in one public university out of many universities in South Africa. Therefore, the findings of this study may only be cautiously generalised to the whole population of preservice science teachers in South Africa Universities. Additionally, a total number of 100 preservice science teachers was selected for the study which constituted a small sample size. Although, small sample sizes is sufficient for the WarpPLS technique, a bigger research sample could have yielded better results and findings. Therefore, caution should be exercised in the interpretation and generalising of the findings of this study.

Secondly, a cross-sectional research design was used for data collection at a specific point in time, thus, it is possible that the relationships among factors could change over time. Thus, the results may be validated by further studies over time.

Thirdly, the coefficient of determination *(R^2)* which represents the predictive power of the model was 44% for integration of e-learning technologies for teaching and learning of science subjects by preservice science teachers. According to the thresholds values denoted by Chin (1998b), an R^2 of 44% explains a moderate amount of variance in e-learning technology integration. These results suggest that four factors (intention, attitude, skill, and flow) explained a moderate share of the variation in the preservice science teachers' integration of e-learning technology, leaving 56% unexplained**.** Moreover, the findings further suggest that the additional variance may be explained by other important factors that were either not fully explored or not explored at all that could have predicted integration of e-learning technologies among preservice science teachers. In fact, the research did not attempt to search for the factors that preservice science teachers would see as predicting their integration of e-learning technologies in science classrooms. Thus, although factors used in this study were sourced from a thorough and extensive survey of the literature, an exploratory study that taps on the thoughts and views of both preservice and servicing teachers could have revealed other factors which could have strengthened the explanatory power of the model developed in this study.

Fourthly, both quantitative and qualitative data were collected through self-report measures which may lead to *common method variance*, a situation where the relationships between factors are inflated, and *social desirability*, a situation whereby respondents provide favourable responses, rather than truly providing responses on what they really believe, think or do (Alharbi, 2012). Additionally, the researcher could have included classroom observations as part qualitative data collection, to observe how preservice science teachers were integrating e-learning technology in their science lessons, rather than simply relying self-reporting by the respondents. Due to time constraints, the researcher was unable to schedule observations of the preservice science teachers in an authentic classroom setting.

6.7 RECOMMENDATIONS FOR FUTURE RESEARCH

Based on the findings of this study, the following emerged as possible recommendations for future research. Firstly, the qualitative data pertaining to the preservice science teachers' experiences with the integration of e-learning technologies during their teaching practice was based on their self-reported data. Future studies should endeavour to use authentic classroom observations of how preservice science teachers actually integrate e-learning technologies in their science lessons in addition to the use of questionnaires so as to get better results.

Secondly, although the literature in this study was extensive and comprehensive, future studies could include exploratory interviews with both serving and preservice science teachers to get additional factors not considered in this study in order to strengthen the predictive and explanatory power of the ELIM model. Certainly, this could also benefit research in the integration of e-learning technologies in schools.

Thirdly, longitudinal studies may be conducted to examine how the relationships among the factors identified in this study vis-à-vis preservice science teachers integration of e-learning technologies into their science lessons changes over time. Moreover, this could allow tracking preservice science teachers into their first year of teaching in schools in order to provide a clearer assessment of how they integrate e-learning technologies during their beginning year of teaching in schools, and beyond.

Fourthly, the model developed in this study (ELIM) may be extended to include other relevant independent variables of e-learning technologies based on new findings from latest literature that might not have been explored in this research. Another extension would be to repeat the study by increasing the sample to include preservice science teachers from other universities in South Africa so that the results can be generalised to a broader target population of preservice science teachers in the country.

Finally, a comparative study can be conducted to test the model (ELIM) developed in this study between preservice and in-service science teachers to examine the degree to which differences may occur in explaining the integration of e-learning technologies into their science lessons. The findings of such research would inform policy makers, e-learning facilitators, teacher educators, and other education officials in their planning, designing and developing better e-learning curricula in schools.

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APPENDICES

APPENDIX A

Department of Maths, Science and Technology Education
Faculty of Education
University of Zululand
KwaDlangezwa, 3886
23 July 2015.

The Executive Dean
Faculty of Education
University of Zululand
KwaDlangezwa, 3886

Dear Madam

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

My name is Cecilia Temilola Olugbara. I am a DEd student in the Faculty of Education, Mathematics, Science and Technology Education Department, University of Zululand. I am conducting a research study titled: "A Study of E-learning Technologies Integration by Pre-Service Science Teachers" under the supervision and guidance of Prof. SN Imenda and Dr. HB Khuzwayo.

I am now approaching the data collection stage of my research which is intended to take place between September and October 2015. I hereby seek your permission to administer a questionnaire to fourth year Bachelor of Education (B.Ed) students in the department of MSTE. My instrument and other related documents are soon to be discussed by the University's Ethics Committee.

The information to be obtained will be strictly treated in confidence and will be used for the purpose of the study only. You are also assured that the study will not in any way obstruct the academic programme of the proposed participating students, and their consent will be individually sought.

Your favourable response to this request will be highly appreciated.

Yours faithfully,

CT Olugbara (Mrs)

APPENDIX B

Department of Maths, Science and Technology Education
Faculty of Education
University of Zululand
KwaDlangezwa, 3886
23 July 2015.

Dear Respondent

My name is Cecilia Temilola Olugbara. I am a Doctoral student in the Department of Mathematics, Science and Technology Education at the University of Zululand. I am conducting a research study on “**A Study of E-Learning Technologies Integration by Pre-Service Science Teachers.”**

You are invited to participate in this study because you are a preservice teacher studying science education at University and who is using e-learning technologies as a learning tool. The typical questions will be about your perception and experience with using e-learning technologies in your science class.

It is hoped that this study will help us to understand preservice science teachers’ experiences with e-learning technologies, and improve its usage to transform the standard of teaching and learning science in schools.

Your participation in this study is voluntary. All the information you provide will remain strictly confidential between you and researchers in this study. You are free to withdraw from the study at any time without any negative consequence. You may not benefit financially by taking part in this study. If you have any questions or concerns about participating in this study, please contact me or my supervisors at the numbers listed below. It should take you about 40 minutes to complete the questionnaire. I hope you will kindly take the time to complete the questionnaire.

Yours sincerely

CT Olugbara

…………………………………….

Researcher's   Signature and Date

………………………………………

Prof. SN Imenda (Promoter)

…………………………………

Dr. HB Khuzwayo

CONSENT

I have read the information provided in the information letter above about this study. I have been given the opportunity to ask all the questions I have at this time related to this study, all my questions have been answered to my satisfaction. I am aware that my participation in this study is voluntary and that I may withdraw from the study at any time without being penalized for doing so. I also understand that all personal information will be treated as confidential by the researcher. I voluntarily agree to participate in this study.

……………………………. ……	………………………..	…………………….
Participant's Name (print)	Signature of Participant	Date

APPENDIX C

UNIVERSITY OF ZULULAND
RESEARCH ETHICS COMMITTEE
(Reg No: UZREC 171110-030)

RESEARCH & INNOVATION
Website: http://www.unizulu.ac.za
Private Bag X1001
KwaDlangezwa 3886
Tel: 035 902 6887
Fax: 035 902 6222
Email: ManqeleS@unizulu.ac.za

ETHICAL CLEARANCE CERTIFICATE

Certificate Number	**UZREC 171110-030 PGD 2015/105**							
Project Title	**A study of the Moodle e-learning platform integration by pre-service science teachers**							
Principal Researcher/ Investigator	CT Olugrara							
Supervisor and Co-supervisor	Prof SN Imenda				Dr. HB Khuzwayo			
Department	Mathematics, Science & Technology Education							
Nature of Project	Honours/4th Year		Master's		Doctoral	x	Departmental	

The University of Zululand's Research Ethics Committee (UZREC) hereby gives ethical approval in respect of the undertakings contained in the above-mentioned project proposal and the documents listed on page 2 of this Certificate.

Special conditions: (1) The Principal Researcher must report to the UZREC in the prescribed format, where applicable, annually and at the end of the project, in respect of ethical compliance.
(2) Documents marked "To be submitted" (see page 2) must be presented for ethical clearance before any data collection can commence.

The Researcher may therefore commence with the research as from the date of this Certificate, using the reference number indicated above, but may not conduct any data collection using research instruments that are yet to be approved.

Please note that the UZREC must be informed immediately of

- Any material change in the conditions or undertakings mentioned in the documents that were presented to the UZREC
- Any material breaches of ethical undertakings or events that impact upon the ethical conduct of the research

Classification:

Data collection	Animals	Human Health	Children	Vulnerable pp.	Other
X					

Low Risk	Medium Risk	High Risk
	X	

The table below indicates which documents the UZREC considered in granting this Certificate and which documents, if any, still require ethical clearance. (Please note that this is not a closed list and should new instruments be developed, these would require approval.)

Documents	Considered	To be submitted	Not required
Faculty Research Ethics Committee recommendation	X		
Animal Research Ethics Committee recommendation			X
Health Research Ethics Committee recommendation			X
Ethical clearance application form	X		
Project registration proposal	X		
Informed consent from participants	X		
Informed consent from parent/guardian			X
Permission for access to sites/information/participants	X		
Permission to use documents/copyright clearance			X
Data collection/survey instrument/questionnaire	X		
Data collection instrument in appropriate language		Only if necessary	
Other data collection instruments		Only if used	

The UZREC retains the right to

- Withdraw or amend this Certificate if
  - Any unethical principles or practices are revealed or suspected
  - Relevant information has been withheld or misrepresented
  - Regulatory changes of whatsoever nature so require
  - The conditions contained in this Certificate have not been adhered to

- Request access to any information or data at any time during the course or after completion of the project

The UZREC wishes the researcher well in conducting the research.

Professor Nokuthula Kunene
Chairperson: University Research Ethics Committee
12 November 2015

CHAIRPERSON
UNIVERSITY OF ZULULAND RESEARCH ETHICS COMMITTEE (UZREC)
REG NO: UZREC 171110-30
12 -11- 2015
RESEARCH & INNOVATION OFFICE

POSTGRADUATE CHANGE OF TITLE HDC02/2015

RESEARCH PROPOSAL

<table>
<tr><td>S Number</td><td colspan="3"></td><td>Student Number</td><td colspan="2">200712074</td></tr>
<tr><td>Name of Student</td><td colspan="6">OLUGBARA CECILIA TEMILOLA</td></tr>
<tr><td>e-mail</td><td colspan="3"></td><td>Mobile</td><td colspan="2"></td></tr>
<tr><td>Degree</td><td colspan="3">DOCTOR OF EDUCATION</td><td>Course Code</td><td colspan="2">EDU 800</td></tr>
<tr><td>Year of first registration</td><td></td><td colspan="3">Expected year of completion</td><td colspan="2"></td></tr>
<tr><td colspan="2">Full-time X</td><td></td><td colspan="3">Part-time</td><td></td></tr>
<tr><td>Old Thesis/Dissertation Title</td><td colspan="6">A STUDY OF THE MOODLE E-LEARNING PLATFORM INTEGRATION BY PRE-SERVICE SCIENCE TEACHERS</td></tr>
<tr><td>New Thesis/Dissertation Title</td><td colspan="6">A STUDY OF E-LEARNING TECHNOLOGY INTEGRATION BY PRESERVICE SCIENCE TEACHERS</td></tr>
<tr><td>Department</td><td colspan="6">MATHEMATICS, SCIENCE AND TECHNOLOGY EDUCATION</td></tr>
<tr><td>Supervisor</td><td colspan="6">PROF SN IMENDA</td></tr>
<tr><td colspan="5" rowspan="2">Is the candidate registered for the current year?</td><td>Yes</td><td>X</td></tr>
<tr><td>No</td><td></td></tr>
<tr><td colspan="7"><u>Note</u>: The HDC will not consider the change of title unless the above question is answered in the affirmative</td></tr>
</table>

<table>
<tr><td>General Comments</td><td colspan="2">The title of the thesis was changed so as to explore the qualitative part of the research work in high schools. The new topic widens the scope to include other e-learning platforms apart from Moodle.</td></tr>
<tr><td>Candidate’s Signature</td><td></td><td>Date: 07/03/2017</td></tr>
<tr><td>Signature Supervisor</td><td></td><td>Date: 07/03/2017</td></tr>
<tr><td>Signature HOD</td><td></td><td>Date:</td></tr>
<tr><td>Signature Dean/Deputy Dean</td><td></td><td>Date:</td></tr>
</table>

APPENDIX D

Gmail **Kemi Olugbara <kemiolugbara@gmail.com>**

PERMISSION TO ADAPT AND MODIFY INSTRUMENT

2 messages

Kemi Olugbara <kemiolugbara@gmail.com> Thu, Sep 15, 2016 at 5:13 AM
To: sadaf@bsu.edu

Good day to you Sadaf. My name is CT Olugbara, I am a doctoral candidate at University of Zululand, South Africa. My research topic centered on "E-Learning Integration by Pre-Service Science Teachers."
I requested for your thesis "An investigation of the factors that influence preservice teachers' intentions and actual integration of web 2.0 technologies" as a guide in this study that you sent to me.
I am now seeking permission letter to adapt and modify some of the items of your instrument to fit the context of my study.
I thank you for your significant contribution to the field of technology.
Kind regards
CT Olugbara

Sadaf, Ayesha <sadaf@bsu.edu> Thu, Sep 15, 2016 at 5:21 AM
To: Kemi Olugbara <kemiolugbara@gmail.com>

Dear CT Olugbara - You have my permission to modify the instruments.

All the best with your research!

Best,
~Ayesha

....
Ayesha Sadaf, Ph.D.
Assistant Professor and Program Manager, Educational Technology
Program Director, MA Curriculum & Educational Technology
Department of Educational Studies, TC 816
Ball State University
Muncie, IN 47306
sadaf@bsu.edu
[Quoted text hidden]

APPENDIX E

SURVEY OF E-LEARNING TECHNOLOGY INTEGRATION BY PRESERVICE SCIENCE TEACHERS

Faculty of Education
Department of Mathematics, Science and Technology Education
University of Zululand

INTRODUCTION

Dear Pre-Service Teachers,

This questionnaire is designed to collect data on e-learning integration. In particular, it focuses on factors influencing pre-service teachers' integration of e-learning in the teaching and learning of science, and to ascertain the prospects of pre-service science teachers integrating e-learning into their science education instruction in high schools. In this study, e-learning integration means the use of e-learning technologies to support teaching and learning of science subjects. You have been introduced to e-learning at the University of Zululand (i.e. Moodle) which normally occurs within a blended learning environment to supplement the traditional face-to-face teaching and learning. E-learning technologies can include World Wide Web (www), internet, e-mail, intranet and wireless network services, library's e-technologies, using computer labs, smart phones, and the Moodle e-learning platform.

This questionnaire consists of four sections, and all instructions have been written in italics to help you distinguish them from the questions. Your details and honest responses will be highly-appreciated. Your responses will be kept strictly confidential, and will only be used for the purpose of this study. Participation is voluntary and you are therefore free to withdraw at any time should you feel being inconvenienced in any way. However, it will be in the interest of the researcher if you could participate in the study up to the end.

Thank you for your cooperation in advance!

SECTION A: BIOGRAPHICAL INFORMATION

Please, answer the following questions by writing your answer in the spaces provided, or by crossing the appropriate box.

1. Your Age …………………………

2. What is your gender? Female……………………. Male………………………………

3. Department………………………………………………………………………..

4. Program of study: □ Physics □ Life Science □ Chemistry □ Mathematics □ Technology

5. Year of study………………………………………………..

6. Email/Phone number ……………………………………….

7. How often do you use e-learning to supplement your in-class learning?

   □ Don't use at all.

   □ Use about once each day.

   □ Use several times a day.

   □ Use at least once a week.

   □ Use several times each week.

   □ Use once a month.

8. Please specify how many hours each week you normally spend using e-learning ………… ………………… hours.

9. Which activities do you perform on the e-learning site? ……………………………………
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SECTION B: PRE-SERVICE SCIENCE TEACHERS' PERCEPTIONS ABOUT E-LEARNING TECHNOLOGIES

Kindly answer each question carefully and honestly to the best of your knowledge.

1. What do you think of using e-learning technologies in the teaching and learning of science subjects? ....
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2. What do you view as the disadvantages of using e-learning technologies in the teaching and learning of science subjects?...
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3. How do you describe the factor (s) that predict utilisation of e-learning technologies in teaching and learning of science subjects? ……………………………………………………….
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SECTION C: E-LEARNING TECHNOLOGY INTEGRATION SCALE

(i) The purpose of this scale is to determine the factors influencing pre-service science teachers' integration of e-learning technologies into science lessons.

Please read each of the following statements very carefully and tick the answer which best describes your degree of agreement or disagreement.

The following abbreviations are used: **SA -** Strongly Agree
A - Agree
N - Neutral
D - Disagree
SD - Strongly Disagree

E-LEARNING INTEGRATION ITEMS	**SA**	**A**	**N**	**D**	**SD**
1. I believe it is a good practice to use e-learning for teaching and learning					
2. I like the idea of using e-learning to prepare teaching and learning materials.					
3. I intend to use e-learning for teaching and learning.					
4. I plan to use e-learning for teaching and learning.					
5. I hope to frequently use e-learning for teaching and learning.					
6. I am knowledgeable about e-learning.					
7. I know how to use e-learning for teaching and learning.					
8. I know how to operate e-learning functions.					
9. I have the necessary skills to use e-learning for teaching and learning.					
10. I enjoy using e-learning as a teaching and learning assisted tools.					
11. I find it interesting when I use e-learning for teaching and learning.					
12. I find the use of e-learning pleasurable.					
13. I focus attention on learning when I use e-learning.					
14. I use e-learning frequently for learning.					
15. I use e-learning frequently for assessment.					
16. I use e-learning frequently to collaborate.					

(ii) The purpose of this scale is to determine the level of your consciousness about using e-learning to support teaching and learning science in high schools. *Please tick one choice in each row.*

MODERATORS ITEMS	YES	SOMEWHAT	NO
1. I understand that e-learning usage brings innovation to teaching and learning.			
2. I realise that e-learning usage brings innovation to teaching and learning.			
3. I am aware that e-learning is a valuable tool that can help improve the quality of teaching and learning.			
4. I understand that e-learning is a valuable tool that can improve the quality of teaching and learning.			

SECTION D: PRE-SERVICE TEACHERS' REFLECTIONS AND FEEDBACK FROM TEACHING PRACTICE

Reflecting on your experience with e-learning technologies during teaching practice, please answer the following questions:

1. How many weeks did you spend in the classroom teaching science during your teaching practice? ....

2. What was/were the grade level (s) you taught during teaching practice? …………………..

3. What was the subject area you taught during teaching practice? ....

4. Were there any e-learning technologies in the school where you did your teaching practice?

□Yes

□No

5. Did you use any type of e-learning technologies to supplement your science lessons during teaching practice?

□Yes

□No

6. Which e-learning technologies did you use to supplement your science lessons during teaching practice?

□Yes

□No

7. If you used any type of e-learning technologies in your science lessons during teaching practice, answer the following questions 7a-7c.

7a. Explain, why did you use e-learning technologies in your science lessons during teaching practice? ……………………………………………………………………………….

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7b. Explain, how did you use e-learning technologies in your science lessons during teaching practice? ……………………………………………………………………………….

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7c. What evidence do you have to show that you used e-learning technologies in your science lessons during teaching practice? ………………………………………………………………

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8. If you did not use any type of e-learning technologies in your science lessons during teaching practice, answer the following questions 8a-8f.

8a. Explain why you did not use e-learning technologies in your science lessons during teaching practice? ……………………………………………………………………………...

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8b. What actions did you take for not using e-learning technologies for your science lessons during teaching practice?...

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8c. What evidence do you have to support the action you took for not using e-learning technologies for your science lessons during teaching practice?..

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8d. What did they need to have in the school for you to have used e-learning technologies for your science lessons? …………………………………………………………………
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8e. What did you see as the benefits for the high school where you did your teaching practice to introduce e-learning as an innovation of their curriculum implementation?..........................
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8f. What did you see as the benefits for you to use e-learning in your teaching after your graduation from the University? ....
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Many thanks for your cooperation