ASSESSING TECHNOLOGY-BASED LEARNING AMONG PRE-SERVICE BIOLOGY TEACHERS IN COLLEGES OF EDUCATION IN NIGER STATE, NIGERIA

BY

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AUGUST, 2023

DECLARATION

I hereby declare that this thesis, "**Assessing Technology-Based Learning among Pre-Service Biology Teachers in Colleges of Education in Niger State, Nigeria**", is my work and to the best of my knowledge it has not previously been submitted by me or any other person for any course or qualification at this or any other tertiary institution. I also declare that as far as I am aware, all cited works have been acknowledged and duly referenced.

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Signature & Date

CERTIFICATION

This thesis titled "**Assessing Technology-Based Learning among Pre-Service Biology Teachers in Colleges of Education in Niger State, Nigeria"** by BABA, Ahmed (MTech/SSTE/FT//2018/8466) meets the regulation of the award of Masters of Technology (MTech) degree of the Federal University of Technology, Minna and is approved for it contribution to Science and Technology Education (STE) and literary presentation.

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This piece of research work is dedicated to my colleague late AHMED, Sani Rambo of blessed memory.

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Abstract

The purpose of this study is assessing technology-based learning among pre-service Biology teachers in colleges of education in Niger State, Nigeria. A cross-sectional survey design was adopted for this study. 2452 pre-service Biology teachers in colleges of education in Niger State form the population of the study. 277 pre-service teachers (127 of which are male and 150 female) were selected as the sample size using Taro Yamene's formula for sample size determination, purposive sampling was employed to select College of Education Minna and Federal College of Education Kontagora and simple random sampling was used to select NCE II pre-service teachers. Six research questions with corresponding three hypotheses guided the study. The data were collected using structured questionnaires on pre-service teachers' perceived usefulness, ease of use and behavioural intention to adopt technology-based learning for instructions. The instrument was

pilot tested using Cronbach Alpha, and it yielded reliability coefficients of 0.83, 0.79 and 0.83 for perceived usefulness, ease of use and behavioural intention respectively. The data were analysed using Mean, Standard Deviation and independent sample t-test. The findings of the study showed that pre-service biology teachers perceived technology-based learning useful and easy to use for instruction and their behavioural intention was also positive with grand mean of 3.30, 3.74 and 4.05 respectively. It also shows that female had higher mean rating ($\overline{X}$= 37.21, SD = 2.30 & $\overline{X}$ = 33.11, SD = 2.54**)** than their male ($\overline{X}$= 37.55, SD = 1.91 & $\overline{X}$ = 32.83, SD = 2.55) counterparts on the perceived usefulness and ease of use of technology-based learning. It also revealed that male had higher mean ($\overline{X}$ = 40.88 & SD = 1.64) rating than their female ($\overline{X}$ = 40.24 & SD = 1.56) counterparts on the behavioural intention towards of technology-based learning. The result also indicated that there are no significant differences in the perceived usefulness (t = -1.315; df = 275, P > 0.05) and ease of use (t = -.937; df = 275; P > 0.05) of male and female pre-service biology teachers' technology-based learning., but there is significant difference between male and female pre-service Biology teachers' behavioral intention (t = 3.330; df = 275; P <0.05) towards technology-based learning. It was concluded that technology is perceived useful and user friendly among the population. It was recommended among others that, since technology-based learning is seen as useful and easy to use by the pre-service teachers lecturers should be ready to use it as one of the technique to be employed in classroom teaching and learning; National Commission for Colleges of Education (NCCE) and the Colleges of Education stakeholders should provide enabling environment for the pre-service teachers to effectively utilise technology-based learning platforms for learning. Periodic orientations, symposia, conferences, seminars and workshops should be organised for the pre-service teachers so as to keep them up-to-date with the emerging technological trends that is the best fit for this present society of technological advancement; Government, nongovernmental

organisations (NGOs), National Educational Research and Development Agency (NERDA) and other research institutes should fund and encourage more researches in the field of technology integration in education as more gaps are yet to be filled.

CHAPTER ONE

1.0 INTRODUCTION 1.1 Background to the Study

The world is rapidly advancing technologically, transitioning from the industrial age to the information age. This era is crucial as it brings positive changes to society, businesses, and human life in general. The education sector must keep up with the emerging technological changes in the national, regional, and global environments by continuously upgrading its resources through modernizing the various elements of the system (Danjuma, 2015). Teaching and learning are influenced by various factors, including the imperative use of modern technologies to create an enabling learning environment. Modern technologies and Information and Communication Technology (ICT) provide exceptional infrastructure to deliver knowledge in numerous ways, in different regions, and with different learners (Mellati & Khademi, 2018).

The focus of 21st-century education must be on the integration of Information and Communication Technology (ICT) into teaching and learning. The application of computer technology in the classroom environment is vital in enhancing teaching and enriching learning (Falode, 2018). Technology integration includes educational software, computers, simulations, and other resources that enhance learning. One significant benefit of modern technology is the advent of technology-based learning (TBL). The importance of technology-based learning (TBL) cannot be overstated, including accessibility for all students, learning that matches learners‘ needs, timely updates, immediate feedback, and captivating learners‘ attention during learning, and encouraging critical thinking and creativity, among others.

Technology-based learning involves the use of electronic technology, either partially or entirely. This can include online and web-based education, intranet sites, audio and video conferencing, internet chat rooms, simulations, electronic gaming, CD-ROMs, and various mobile options.

Ghavifekr and Rosdy (2015) have concluded that technology-based learning (TBL) involves the use of electronic technology such as the internet, intranet, audio and video conferencing, and webcasts, among others. Planning and policy-making are necessary for implementing technology-based teaching and learning in schools. Researchers and policymakers must work together to achieve this. The education system has changed rapidly with the development of learning technologies in the late 20th century, offering a proactive, easy access, and comprehensive teaching and learning environment. Ejoh (2020) stated that in developing countries like Nigeria, evaluating teaching and learning initiatives is essential to identify a model that will best suit schools and skill development for students.

Several models have been developed to address users' responses to new technologies for learning, such as the technology acceptance model (TAM). According to Bumin *et al.* (2019), the widespread usage of every new technology requires acceptance and adoption. TAM is one of the most commonly used behavioral models, predicting individual acceptance and use of new information technology (Davis et al., 1989). TAM uses the theory of reasoned action (TRA) as a theoretical basis but replaces attitude measures with two technology acceptance measures: ease of use (EOU) and perceived usefulness (PU). TAM posited that EOU and PU, not attitude, ultimately determine a person's behavioral intention to use information technology (IT) (Davis *et al.*, 1989). PU refers to the belief that using a specific IT will enhance job performance, while EOU refers to the expectation that using a specific IT will be relatively easy (Davis, 1989). TAM suggests that an application that is perceived to be easier to use than another is more likely to be accepted by the user because effort is a finite resource that a person may allocate to various activities for which he or she is responsible. In TAM, PU is directly impacted by EOU, with intention to use mediating actual system use (Davis, 1989). Attitude to use concerns the user's evaluation of the desirability

of using a particular information system application (Davis, 1989). Attitude toward technology is defined as an "individual's positive or negative feelings (evaluative effect) about using a specific technology" (Venkatesh *et al.*, 2012). It determines the learner's willingness and psychological readiness to pay adequate attention to the concept learned. Positive attitude towards technology use will produce quality education.

However, the inadequate resourcing of technology and instructional materials to engage learners is a concern in Nigeria (Suleiman *et al.*, 2020; Zakariya, 2017). The education system faces challenges, including limited available funding to meet the changing technology demands in subSaharan Africa and Nigeria (Awofala & Lawani, 2020; Solomon & Fidelis, 2018). With the United Nations Educational, Scientific, and Cultural Organization (UNESCO) recommending a 26% budgetary allocation and Nigeria allocating less than 10% on education, funding challenges need to be highlighted (Ukaigwe & Nwosu, 2019). The National Teacher Education Policy (2014) enforced the need for quality teachers and instruction with its objective ―to produce highly knowledgeable, skilled, and creative teachers who are capable of producing students who can compete globally‖.

Furthermore, in 2009, Nigeria introduced the vision 2020; a vision intended to put the country on the path of economic growth and success (Sanubi & Akpotu, 2015). Public and private schools need to implement instructional changes and integrate technology to achieve their progressive goal. The need for Nigeria to meet its economic vision for 2030 is dependent on skills development, which is one of the central goals of the education sector (Sanubi & Akpotu, 2015). These policies' impact on engaging learners is necessary to enhance teaching and enrich learning (Bishop *et al.*, 2017). Due to the COVID-19 pandemic, thousands of educational institutions have been closed to promote social distancing measures and thus limit the virus's spread. This critical situation

highlights several concerns, such as the decline in the quality of education and students‘ learning outcome. It is a matter of paramount concern to implement innovative pedagogical methods and curriculum practices to strengthen the teaching-learning process in colleges of education, universities, and other institution of learning (Naciri *et al.,* 2020; Toquero, 2020). With concerted efforts still in place to combat the spread of COVID-19 in Nigeria, lecturers and students are now required to adopt technology-based learning platforms such as; virtual and e-learning management systems as alternatives to traditional face-to-face classroom interaction. However, for success, Nigeria needs to invest in an education system that places technology at the forefront of science learning and Biology inclusive.

Biology provides an ideal preparation for a list of careers ranging from basic science to engineering (Peters, 2015). The provision of a future workforce that possesses the skills and competence necessary to meet society's needs is a key deliverable of the educational system
(Lawler, 2016). To some however, high school students don‘t necessarily find the learning of Biology like other subjects more interesting with the use of technology tools except for the particular technology tools which they find acceptable (Cheung *et al.,* 2011). The acceptance or rejection of technology is influenced by two (2) constructs of belief; perceived usefulness and ease of use, which may either be positive or negative. Biology is as important as any other science subject and is given great cognizance in the country‘s educational system. Nigerian schools may consider adapting the technology acceptance model (TAM) framework to produce Biology students who can compete globally.

Globally, every nation strives towards the provision of quality education for its citizens through quality teaching and learning because of the realisation that education is necessary to engineer and consolidate any nation‘s developmental process. However, achieving quality education would be

a mirage if teacher training programmes are not in good shape. Teacher training programme refers to a programme that is geared towards the development of teachers‘ proficiency and competence that would enable and empower the teachers to meet the requirements of the profession and face the challenges therein (Oancea, 2014). The professionals who engage in this training are called teacher educators (Allen, 2011). Those primarily enrolled in teacher training programmes are often referred to as pre-service teachers. Pre-service teachers are those who will work in the educational sector of the economy to contribute their quotas towards making Nigeria a developed nation. Pre-service teachers are students who are studying educational courses or learning the art of teaching profession in various higher institutions of learning (Tukura & Falode, 2020). Gender is a general term which refers to the sexual categories of male and female.

Gender is the socio-cultural constructed characteristics and roles which are ascribed to males and females in any society (Nannim, 2018). Cislaghi and Heise (2019) defined it as the social meaning of being male or female, including the construction of identities, expectations, behaviours, and power relationships that derive from social interaction. There are a lot of arguments about the character of males and females in education concerning adopting or rejecting a new technology. For instance, the results from the work of Gambari *et al.* (2013) and Yaki *et al.* (2020) indicated that there is no significant difference in the perceived usefulness between male and female teachers and students. But the results of Egbo *et al.* (2011) and Ramírez-Correa *et al.* (2015) indicated a few statistically significant differences between males and females when adopting ICT and e-learning platforms, according to the tested models.

However, unless the hypotheses have been tested, the researcher cannot conclude yet that there exist (or not) some significant differences between male and female pre-service teachers‘ perceptions of technology-based learning.

Despite the widely advocated benefits of implementing technology-based teaching/learning activities, there are obstacles preventing teachers and students from using technology in their classrooms (Ndudi & Chinedu, 2016). Even though there are many new technology tools currently available for teachers to use in their classrooms, training must be provided and continuously encouraged for implementation to be successful. Teachers should realize that if they spend the initial time learning to use technology tools, such as an interactive whiteboard, email, or the internet, the tools could benefit their students in the long run. With practice and a little extra planning time, teachers should be able to integrate technology into their classrooms and soon witness the benefits, such as willingness to accept the new technology, positive behavioural intention, and improved students test scores. There are multitudes of technology tools available for classroom use that can benefit students Abanikannda (2018). These tools, ranging from computer-assisted instruction to collaborative and social learning platforms, are user-friendly and easily accessible. Therefore, it is imperative to assess how Pre-service Biology Teachers in Colleges of Education in Niger State are utilizing technology-based learning platforms.

1.2 Statement of the Research Problem

Biology can be a difficult subject for many students, especially those who only learn through textbooks in traditional classrooms. The abstract nature of Biology often makes it seem boring and hard to understand. Educators must find ways to make Biology more enjoyable for students.

Experimental and inquiry-based learning are two approaches that teachers can use to make Biology lessons more engaging. However, these methods face challenges in many learning contexts, from post-primary schools to tertiary levels. The main issues include the cost and availability of resources such as reagents, chemicals, specimens, and apparatus, as well as overcrowded laboratory spaces, time limitations, and ethical considerations. Other challenges include incomprehensible processes, self-doubt, visual disturbances, difficulty using apparatus, and limited instructional guidance.

To address these challenges, the researcher suggests using technology-based learning (TBL) to stimulate students' interest and help them develop a positive attitude towards Biology. This is particularly important for students pursuing courses in Medicine, Pharmacy, Nursing, Microbiology, Zoology, Botany, Anatomy, Physiology, Veterinary medicine, and physiotherapy. The study aims to determine if pre-service teachers in Niger State are ready to adopt TBL as an instructional delivery strategy and if they perceive it as useful and easy to use. With the increasing digitalization of schools and tertiary institutions, the adoption of TBL may provide a suitable strategy for effective teaching and learning of Biology. The study on Technology-Based Learning among Pre-service Biology Teachers in Colleges of Education in Niger State aimed to fill the gap in research on this topic in the Nigerian context.

1.3 Aim and Objectives of the study

The study aimed at ―assessing technology-based learning among pre-service Biology teachers in Colleges of Education in Niger State. The objectives of the study are to;

i. determine the pre-service Biology teachers‘ perceived usefulness of technology-based learning in Colleges of Education in Niger State.

ii. determine the pre-service Biology teachers‘ to perceived ease of use of technologybased learning.

iii. determine the behavioural intention of pre-service Biology teachers towards technology-based learning. iv. examine the male and female pre-service Biology teachers‘ perceived usefulness of technology-based learning.

v. examine the male and female pre-service Biology teachers' perceived ease of use of technology-based learning.

vi. examine the behavioural intention of male and female pre-service Biology teachers towards technology-based learning.

1.4 Research Questions

The following research questions guided the study;

i. What is the pre-service Biology teachers‘ perceived usefulness of technology-based learning in Colleges of Education in Niger State?

ii. What is the pre-service Biology teachers‘ to perceived ease of use of technology-based learning in Colleges of Education? iii. What is the behavioural intention of pre-service Biology teachers towards technologybased learning in Colleges of Education?

iv. What is the male and female pre-service Biology teachers‘ perceived usefulness of technology-based learning in Colleges of Education?

v. What is the male and female pre-service Biology teachers' perceived ease of use of technology-based learning in Colleges of Education?

vi. What is the behavioural intention of male and female pre-service Biology teachers towards technology-based learning in Colleges of Education?

1.5 Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance;

HO_1: There is no significant difference in the mean response of male and female pre-service Biology teachers' perceived usefulness of technology-based learning**.**

HO_2: There is no significant difference in the mean response of male and female pre-service Biology teachers' perceived ease of use of technology-based learning**.**

HO_3: There is no significant difference in the mean response of male and female pre-service Biology teachers' behavioural intention towards technology-based learning.

1.6 Significance of the Study

The results of this research will benefit various stakeholders, including pre-service teachers, lecturers, policymakers, curriculum planners, parents, and society at large.

The study has shown that incorporating technology tools in learning can enhance the academic performance of pre-service teachers and give them the autonomy to decide whether to adopt or reject such tools. This validates the Technology Acceptance Model (TAM) from a Nigerian perspective and encourages pre-service teachers to embrace technology in their academic work.

Lecturers can evolve from being knowledge providers to facilitators, which would reduce their workload but require technical proficiency. This shift in role will lead to more meaningful learning and better academic achievement. Lecturers can use online platforms to post courseware, assignments, and feedback for students, and adopt technology for research, evaluation, and teaching.

Policy makers can use the study's findings to select the right educational technology tools that promote 21st-century skills such as critical thinking, problem-solving, and digital competence

among students. They should also implement policies that provide basic educational gadgets and tools to promote quality education and high achievement rates.

Curriculum planners can use the study's results to design assignments and examinations that are online-based, challenging students and lecturers to become more proficient technically to facilitate information sharing and retrieval among students and lecturers.

Parents should emphasize the need for teachers to adopt technology-based learning and provide their children with technological devices such as personal computers and smartphones. This will help them in choosing the right schools for their children and prioritizing their needs.

Society as a whole will benefit from this work as it can assist in identifying individuals who are technically fit for jobs that require computer literacy, which is a major requirement for whitekola jobs in the current century.

1.7 Scope of the Study

This study focuses on assessing technology-based learning among pre-service Biology teachers in Colleges of Education in Niger State. These institutions are; Federal College of Education, Kontagora and College of Education, Minna. The participants of this study are pre- service Biology teachers. The variable scope include; Technology-Based Learning, Perceived useful, Perceived ease of use, Behavioural Intention and Gender.

1.8 Operational definition of terms

Attitude: the degree to which the pre service Biology teachers believe that performing the behavior is positive or negative.

Behavioral intention (BI): strength of pre service Biology teachers‘ readiness and willingness to utilize technology-based learning for learning Biology in colleges of education in Niger State.

Biology: is the science or study of life (both living and non-living).

Gender: pre-service Biology teachers‘ characteristics pertaining to femininity and masculinity.

ICT: is the study, design, development, application, implementation, support or the management of computer-based information systems.

Perceived ease of use (PEU): is the extent to which pre service Biology teachers believe that technology based learning would be less of mental and physical effort for learning Biology.

Perceived usefulness (PU): is the way in which pre service Biology teachers view the potent benefit that come along with adopting technology based learning for learning Biology.

Technology Acceptance Model (TAM): is the model used to understand the pre-service Biology teachers‘ perception, acceptance, use and adoption of technology based learning for learning Biology.

Technology Based Learning (TBL): encompasses interventions that rely on advanced electronic technologies to supplement pre-service Biology teachers‘ classroom-based instruction.
It is the learning that takes place partially or entirely via electronic technology.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Conceptual Framework

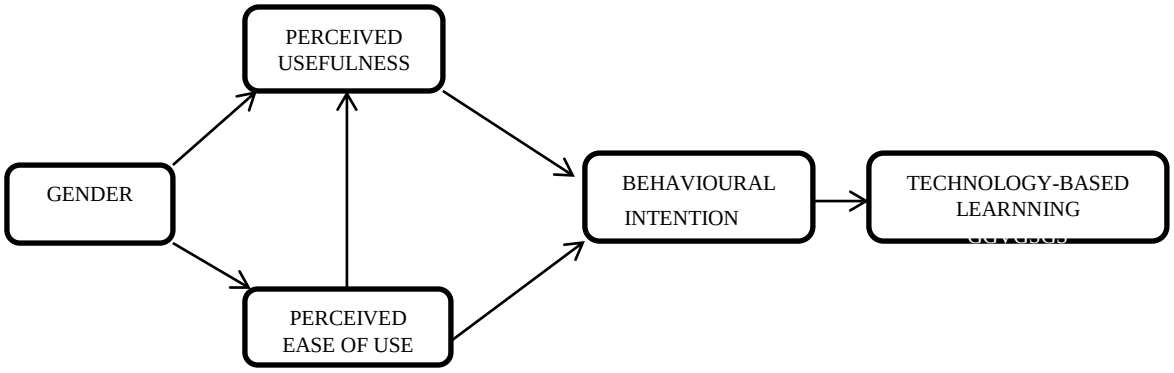

Figure 1: Schema of the Conceptual Framework

Source: the researcher, (2023).

2.1.1 Information and communication technology (ICT) in the contemporary world In today‘s world information communication technology (ICT) is rapidly spreading into almost all spheres of human activities at an unprecedented rate. Alongside this development, is an intense debate on the contribution of this technology towards productivity on one hand, and human welfare on the other hand in both developed and developing countries. Internationally, the spread appropriation of ICT has been a key dimension of globalisation, urging societies to build communication systems, manage them well, develop infrastructure and capacity to use it, and implement good policy and regulation (Kuyoro *et al.,* 2017). The role of Information and Communication Technologies (ICTs) in the 21st century has been described as vital to keeping abreast with rapidly changing technologies. Information and communication technology (ICT) has numerous definitions. To some it is a term that entails a lot of actions involving the acquisition, storage, processing and information dissemination through the use of suitable hardware and software designed for such purpose (Abubakar, 2010). ICT is the digital

processing and utilisation of information by the use of electronic computers. It comprises the storage, retrieval, conversion and transmission of information (Ifueko, 2011). The ICT covers all

forms of computer and communication equipment and software used to create, design, store, transmit, interpret and manipulate information in its various formats. Personal computers, laptops, tablets, mobile phones, transport systems, televisions, and network technologies are just some examples of the diverse array of ICT tools. All definitions of ICT share a similar notion that, information has to be generated and shared.

Information and communication technology refers to a range of technologies that are applied in the process of collecting, storing, editing, retrieving and transferring information in various forms. In recent years, there has been an exponential growth in the use of ICT tools and this has made great impact on both societies and peoples‘ daily lives. It is therefore, not surprising to see the increasing interest, attention and investment being put into the use of ICT in education all over the globe (Saddam *et al.*, 2012). ICT has taken a vital role in all areas of human life and their educational development has been seen to be pervasive. This clearly depict that ICT now serve as a backbone for the development of any society in all ramifications (Abubakar 2010). This simply implies that for a nation that desire to grow, ICT is the answer because it will go a long way in development of a nation generally.

Information and communication technology is denoted as a computer instrument used by people to work with the Information and using technology to process the needs of an organization. It includes both hardware and software computer components and several other devices such as audio, audio-visuals, visuals, photography, camera etc that convert information into common digital form. Agbetuyi and Oluwatayo (2012) lay their emphasis on the effective utilization of information technology to produce a new way for learning that is self-directed as one of the efforts to improve performance of the students. According to Khan *et al.* (2015), Information and communication technology refer to technologies that provide access to information through

communication. Also, ICT is an umbrella term that includes any communication device, encompassing radio, television, cell phones, computer and network hardware, satellite system to mention but a few, as well as various services and appliances with them such as distance learning (DL), video conferencing, e-learning, learning management system (LMS) and so on. A more pertinent role of Information and communication technology (ICT) is the transmitting, transferring, inculcating desired goals and values through education that cannot be overemphasised in any society (Akarowhe, 2017). Recognising the importance of ICT in teaching and learning, majority of the countries in the world have provided ICT teacher training in a variety of forms. Several efforts have been made by many countries to train teachers for effective use of computer as a tool for enhancing teaching and learning (Uko & Ebute, 2013). While Ibrahim (2012) further disclosed that computer is important in educational setting. The major importance include motivation, transformation of abstract idea to reality, facilitate understanding and comprehension of the subject matter and facts, address the needs of the users, thereby, making learners to learn at their own rate.

2.1.1.1 *Benefits of using ICT in education*

ICT according to Anikweze and Kanu (2018), affects teaching and learning in the following specific ways:

It provides a more scientific basis for designing instruction in a sequential manner and utilising adequate instructional materials and other reinforcement strategies;

It makes instruction richer and more powerful in influencing learning through the application of new forms of communication and technology by which distant and remote events can be brought close into the learning situation, e.g. use of films (motion pictures), slides, photographs and filmstrips;

ICT supports the delivery of educational resources, particularly course materials ranging from printed books and charts through radio and television to multimedia computers and internet;

ICT makes education to become more productive by speeding up learning and enabling students to invest more time in the application of acquired knowledge and creativity which can lead to breakthroughs;

It simplifies the task of the teacher in communicating abstract concepts to learners by helping to bridge the gap between theory and practice. Learners can study reality through computer simulation and the use of various media that are capable of bringing the world into the classroom;

Today, the emphasis on technology has led to broadening of the academic curricula to include legitimate courses in vocational areas such as home economics, journalism, accountancy, photography, environmental design, animal husbandry, television and broadcasting, engineering, electronics and puppetry;

ICT has further led to individualised instruction thereby enabling learners to proceed at their own rates through the use of programmed instruction, learning packages and computer terminals;

Beside improved access and equity in education by influencing open and distance learning, ICT has made it possible for instruction to be brought to individual homes through radio and T.V. broadcasts and through the internet. Even the handicapped and children with special learning problems could be provided with diversified learning environment employing appropriate technological devices that enable them to develop their potentials.

For instance, Braille for the visually impaired learner is an outcome of innovation in technology (Anikweze & Kanu, 2018).

2.1.1.2 *Constrains to the use of ICT materials in teaching and learning of biology*

Limitations of infrastructure and finances effectively bar some countries from participating in this electronic revolution. In other countries, education and government leaders have legitimate concerns about the cost, the efficacy, and the feasibility of using communication technologies in their education systems. More specifically, developing countries according to Nwachukwu (2014) face the following problems:

Desktop and Lap-top are still very expensive in Nigeria such that more than 85% of students are unable to acquire one for their academic utilisation. There are still large percentages of students who are still unable to purchase computers for use. Currently new computers are as from N150, 000.00 upwards.

Lack of knowledge on the part of teachers on the usage of electronic media to teach students poses a serious problem to the teaching and learning using electronic media in Nigerian colleges of education. Hence he stated that teachers might find it difficult to deliver the appropriate education and training to their students. This is because the more a teacher is able to utilize the available electronic media to teach his students, the more he will impact on these students.

It is not also certain that management of Nigerian Colleges of Education do organise regular inservice trainings for these lecturers who initially did not possess ICT literacy on employment to develop the skills and competencies needed for teaching with ICT. The so called capacity building workshops occasionally organised for teacher educators most often lack proper planning and adequate follow up activities to make the learned materials practicable and useful to both the

teacher educator and the teacher education institution. Most of these programmes apparently are mere jamborees aimed at certificating teacher educators already in the system. This is perceived so because ICT literacy has been made a prerequisite for their continued stay in service by Nigeria Commission for Colleges of Education (NCCE), the teacher education regulating body (Owolabi *et al.,* 2013). Onwuagboke *et al.* (2015) also added that, a visit to the classrooms in almost all the colleges of education in the country may reveal that ICT is not yet a common feature of the classroom environment despite the claim that all teacher educators are now ICT literate by virtue of the fact that they attended these workshops. Even when the workshops are well organised, the working environment in these colleges with its attendant lack of adequate infrastructure drastically reduces the gains of the programmes.

Nigeria being a developing nation cannot boast of twenty-four hours electricity supply to its citizens. The institutions are directly connected to national power lines, yet no electricity or power is supplied to the institutions. It is on a sad note that some of the schools and departments of the institutions cannot afford a generating set such that can power the entire computers and other electronic media for teaching and learning. Consequently, both the teachers and students are handicapped and may not be able to offer lesson using electronic media.

Some of the Nigerian Colleges of education are not able to connect to the world wide web (WWW), even if the colleges are connected, departments where students are to be taught information and communication technology are not connected due to the high costs involved in the connection.

Electronic media are still very expensive in Nigeria. This makes them a target for thieves who steal them and always have ready buyers at a second hand cheap rate. This automatically increases the

expenditure of the colleges by way of fortifying security measure and by providing extra burglary proof to protect the media room. These expenses including the large room the computers are to be kept made some colleges stay away from purchasing electronic media.

Lack of finance and distributive capacity are some of the major dilemma utilisation of electronic media is faced with. Nigeria has not been able to provide resources to keep up with this demand. This brings about compromised quality of education. Many Nigerian colleges are faced with predicament of educational expansion that corresponds with economic development. Other problems include technical know-how and lack of expert technicians (repairers).

2.1.2 Concept and nature of technology based learning

Technology is such a big part of the world today. Many jobs that did not need technology before now require it use. Most people have access to computers and know how to use them as well. Technology is being used by children and adults on a daily basis by way of web surfing, texting, social networking, interactive games, and in more ways. We are an evolving technological society and in many ways have become dependent on it use. Thus, the use of technology and teaching students with it has become a top priority in our schools (Costley, 2014).

Technology-based learning in the early 21st century is transforming the way people learn at a time when two powerful trends converge. The first trend is the rapid acceleration of technological change and the demand that this change places on education and workforce training during their professional live (Gudanescu, 2010). TBL is learning that takes place partially or entirely via electronic technology. This includes online and Web-based education, Intranet sites, audio- and video-conferencing, Internet chat rooms, simulations, electronic gaming, CD-ROMs, and a variety of mobile options (Carruth & Carruth 2013; Gan *et al.*, 2014).

According to Gudanescu (2010), Technology based learning is the way of learning using the electronic technology such as internet, intranet, audio and video conferencing, webcast and so on. The word technology comes from the Greek "Techne" which means craft or art. Technology based learning is transforming training and education by providing new technological opportunities to address new learning needs. TBL programs come in different delivery modes and forms. They can include online tools, such as discussion boards and e-mail, and real time events, through videoconferencing and web conferencing. They can be self-paced, and have a varying focus of instruction. Technology-based learning uses a series of delivery methods and hardware and software tools to manage and deliver learning content and manage and track learner progress, as well as learner-to-learner and learner-to-instructor communication. The methods used for teaching and learning in the informational environment are: web conferences are synchronous meetings in a virtual environment; online Forums (also called bulletin boards, discussion groups, or news groups); electronic mailing lists allow members to send messages to other members of the same mailing list; virtual collaborative workspaces; simulations; goalbased scenarios; learning management systems; integrated learning systems; and synchronous and asynchronous delivery modes technology-based among others.

TBL, as stated by Gan *et al.* (2014), broadly encompasses interventions that rely on advanced electronic or communication technologies to supplement or replace traditional (classroom-based) instruction. The rapid evolution and increasing adoption of TBL has dramatically altered the landscape for workforce training and education. One notable turning point was the introduction of personal computing and the internet, which allowed for standardization and increasingly widespread access to training and education. As noted above, a new ―generation‖ of TBL is dramatically altering it reach, adaptability, and the user experience. Due to both the diversity of

technologies and breadth of applications, TBL does not have a single definitive characterisation or definition. Rather, it is a continuum of interventions shaped primarily by how integral the technology is to the learning process. TBL models may rely entirely on technology for learning; may balance the use of technology and classroom learning (hybrid or blended models); or may incorporate some lesser use of technology into a predominantly classroom-based setting.

The rapid evolution of technology coupled with a more sophisticated understanding of learner needs has led to advanced difmensions of TBL that extend beyond basic instruction and content delivery. Technology, in particular, has the potential to extend pedagogy through its ability to facilitate learners‘ interaction with the content and to individualise content. In addition, it has the potential to change the ways in which learners interact with other learners and instructors. Traditional passive learning primarily relies on static content versus active learning engagement that ideally uses flexible material shaped by the needs of the individual learner. Early distance learning opportunities were famously passive with the technological component often limited to reading on a computer monitor rather than a book. As communication technologies and delivery platforms evolved, so did the opportunities for more active learning that allowed for applying knowledge, solving problems, practicing skills, and receiving feedback on progress. TBL may focus learning on the content (as in early online courses) or on the learner by individualising content. Means *et al.* (2014) described some of the ways in which TBL may be designed to meet the needs of less prepared adult learners to include: use of spaced, quick assessments of learning and cumulative, comprehensive examinations; including practice assessment items that require students to generate answers and provide feedback as quickly as possible; providing feedback that addresses the nature of a student‘s misunderstanding and include tips for remediation; and applying the ―Goldilocks‖ principle in selecting just the right problem difficulty.

2.1.2.1 Continuum of technology-based learning

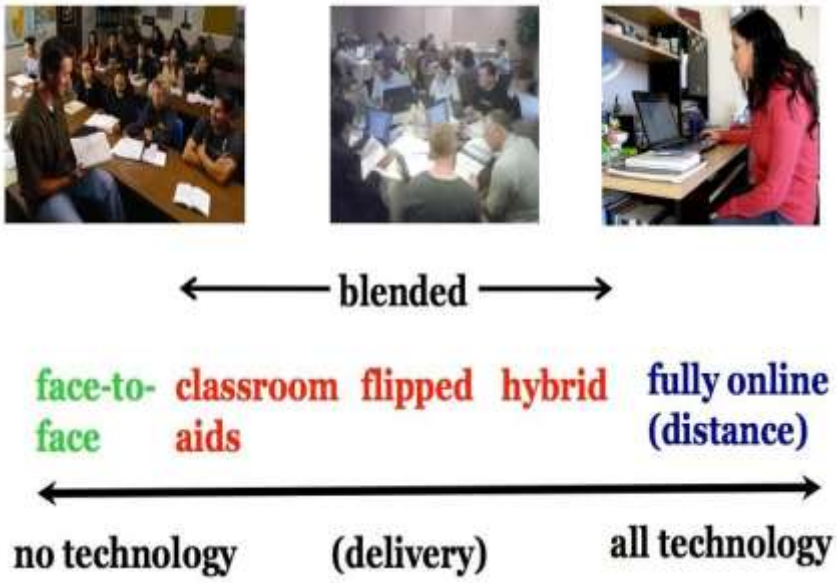

Figure 2.2 Continuum of Technology-Based Learning (adopted from Bates & Poole, 2003)

At its most basic, TBL can be characterised by the degree to which technology is the primary source for learning. In this simplified conception, one can imagine a continuum of models based on the relative amount of technology used. From a definitional perspective, a learning model in this review is characterized as technology-only, blended, or traditional based on the proportion of learning that depends on technology (Dunham *et al.,* 2011). At one extreme is technology-only learning, in which electronic technology is the medium for all learning and teaching. A typical example is a completely online, self-paced course. At the other end is traditional, in which neither instructor nor learner uses technology. A traditional, in-person, instructor-led, paperbased classroom is the archetype. Between the extremes of technology-only and traditional classroom-based models are blended, or hybrid, models. Blended models, which represent the dominant paradigm in TBL, are those where instruction is delivered both using technology and in a traditional classroom.

In this work, technology-only, blended, and traditional approaches are not discrete categories but rather points along a continuum (Gan *et al*., 2014). Further complicating the definitions, models often are categorised on the basis of how content is delivered (rather than received) and the boundaries between technology-only and blended vary within the literature. For example, experts vary in their characterisation of online learning models, which are often synonymous with technology only approaches, based on the amount of instruction delivered online. Quantifying the amount of content transmitted or delivered is a simpler measurement task than quantifying the most-effective media for that content (that is, the learning).

2.1.2.2 *Benefits and challenges of technology-based learning*

Technology-based learning comes with substantial benefits for the human capital and society. Most of all, it offers geographic reach and a scalability of training and educational efforts that face-to-face interaction cannot achieve. It also offers a wide range of learning modes and an opportunity to track progress and measure outcomes as a seamless part of learning. However, as with all technology applications, the use of technology in itself poses some new challenges. In technology based learning process, the most significant problem is the digital divide, which still splits the countries into digital haves and digital have-nots. In addition, transferring learning into a technology based learning environment creates additional challenges for educators and training designers.

Benefits of technology based learning

There are numerous advantages to technology based learning in comparison to face-to-face learning. Gudanescu (2010) articulate some of the primary benefits to be the following:

Accessibility for all the persons who intend to follow any type of courses, learning matched to learners‘ need, scalability; timely update, streamlined and effective learning delivery.

Others were listed in Patil (2014) to include;

Technology has made learning easier, affordable and convenient; E-learning makes student more technology savvy; Most convenient way to perceive degree in higher education; It is the flexible, self-paced method of education to attain degree; Saves time and can be done along with daily works; Can log on and complete their studies any time the student wants; Acquisition of technological skills through practice with tools and computers; No age-based restrictions on difficulty level, i.e. students can go at own pace.

Challenges of technology based learning

The introduction of technology-based learning at all educational levels is not without challenges. They include:

Digital Divide: The digital divide directly affects technology-based learning implementation since a significant portion of the population still does not have access to computers or to the internet. Internet use is lowest for low income people, those who are over 50 years old, the unemployed, and individuals who have never attended college.

Social Loafing: technology-based learning is also more likely to produce ―social loafing,‖ in which learners reduce their level of effort when they perceive that doing so will not have negative social effects.

Accommodation for Individuals with Disabilities: Access to technology-based learning courses for individuals with disabilities can also pose a challenge. While technology-based learning generally

offers access options for those disabilities, accommodations must be made in order for technology-based learning to be accessible.

Compatibility: Another challenge for technology-based learning is the need for compatible technology.

Development Costs: Another disadvantage of technology-based learning is high upfront development costs, which can require significant programs, because they spent so many hours developing the materials and so few students enrolled in the course.

Lack of Credibility: Technology based learning degree programmes still lack the level of credibility of traditional degree programmes (Gudanescu, 2010).

Technologies in shorter period of time become obsolete. Hence the learner has to upgrade the equipment; User has to spend time in learning and using the technology; Equipment used are expensive; Some of the technologies are not very user friendly; hence the learner faces difficulty in its use Patil (2014).

2.1.2.3 *Recognising the factors affecting Nigeria's technological growth*

Recognising issues that are responsible for the problem of technological growth is strategic to attainment of technological emancipation Nigeria deserves. The factors affecting Nigeria's technological growth can be grouped into two, namely, internal and external factors (Chete *et al.*, 2016; Isioto *et al.*, 2017).

Internal Factors

Taking an inward look it has been acknowledged that the attainment of technological growth will depend on the development of strategic industrial policy structure and infrastructural base for the implementation of such policy for global economic competiveness. This will in turn require the development of efficient, accountable, transparent, and participatory governance, the creation of strong, efficient, and effective public service institutions to engender government effectiveness, the establishment of a competitive private sector-led business environment characterised by sustained microeconomic stability and the enhancement of national security and improvements in the administration of justice. The following are internal factors bedeviling the economic and technological growth of this country. These are: porous infrastructural base, high index of corruption and internal security.

Porous infrastructural: Base The current infrastructure base in Nigeria is grossly inadequate in terms of capacity and quality and is not capable of catering for the anticipated industrial development. Despite government investments, Nigeria still has huge infrastructure deficits, particularly with regards to power generation. The current power generation capacity is less than 2000 Megawatt, which is about 20 per cent of the estimated national demand. A key challenge for government and the private sector is to build a modern, efficient, and effective infrastructure network within the next five to ten years.

High index of corruption: Nigeria ranks highly in the Corruption Perception Index. This has implication for investment and the flow of foreign investment into the country. Previous anticorruption policies implemented in Nigeria have been targeted at enforcement measures rather than addressing the root causes. The root causes of corruption in Nigeria have been identified to include social insecurity and over-centralisation of resources at the centre. Even though there are

suitable laws and viable institutions to fight corruption in Nigeria, the greatest challenge is in formulating a strategic plan of action to deal with the root causes.

Internal security: The internal security of Nigeria has become a very big challenge in recent times. Internal conflicts, kidnappings, insurgency, including religious, ethnic and economic crisis, have had effects on the economy, most notably by scaring investors from certain parts of the country. Even though insecurity of lives and properties had become noticeable following the civil war and the subsequent military regimes which directly intensified urban violence, the recent upsurge of violence and insurgency in the country heightens the need to comprehensively address the persistent causes of social tension as a risk factor to Nigeria as an investment destination.

Lack of purposeful leadership: Selfishness or selfish interest on the part of our leaders is a jinx that needs to be broken for Nigeria to record any meaningful technological growth. Yet Government attitude towards breaking the jinx of technological backwardness in Nigeria is laughable. Leaders are easily distracted by their selfishness and quest to accumulate wealth for themselves and their generation yet unborn. Nigeria is probably the only country in the world where you can find all brands of cars without any one having been designed and made by Nigerians.

Government attitude towards policy implementation: Nigeria had had several national development plans. The first National Development Plan (1962-68), was formally launched in 1962. The Second National Development Plan (1970-74) was launched when Nigeria‘s newly acquired the status of a major petroleum producing country. The Third National Development Plan (1975-80) was launched at the height of the oil boom. The Fourth National Development Plan (1981-85) coincided with the inception of a global economic recession which sparked declining foreign exchange earnings, balance of payment disequilibrium and unemployment in the

Nigerian economy. As a result, the structural adjustment programme (SAP) was adopted in 1986, as an alternative framework for addressing the weaknesses and ineffectiveness of previous development planning efforts (Chete *et al.,* 2016).

But all these development plans, including the economic transformation agenda, otherwise known as Nigeria Vision 20: 2020 suffered shipwreck because of implementation gap. Generally, lack of adequate implementation on the part of our leadership has been the bane of Nigeria‘s technological growth. The Nigeria‘s Vision 2020 embodies Nigeria‘s blueprint for an industrial revolution, its aspiration to undergo catch up. The Vision 2020 document predicts that by the year 2020 – some seven years from now – Africa‘s most populous nation and the world‘s 6th largest crude oil exporter will have undergone the type of catch-up industrialisation that will catapult it into the ranks of the 20 largest global economies. This is realisable if the document will be fully implemented. In an address to the Nigerian Economic Summit Group [NESG] in

October 2008 President Umaru Yar‘Adua returned to the Vision 2020 theme, admitting, however, that its realisation faces serious constraints posed by a lack of ‗purposeful leadership‘, a definite roadmap and growth inducing environment. This remark, Isioto *et al.* (2017) said has already unfolded the problem of lack of implementation to the detriment of this laudable document and subsequently, the possibility of the vision 2020 being a mirage.

Industrial policies after independence: The Nigeria industrial policies after independence were not vision oriented. For instance, the major industrial policy that Nigeria embarked upon after independence was import substitution industrial policy. The major thrust of this policy was:

building of assembly plants in Nigeria; importation of completely knocked down parts into Nigeria to be assembled in these plants;

The establishment of steel plants, like Delta Steel Plant and Ajaokuta Steel Plant, and associated foundries that were to produce automobile parts that would be assembled in already established assembly plants;

The establishment of machine tool companies like, Oshogbo Machine Tool Company, which were supposed to produce capital goods. According to Isioto, *et.al* (2017), the import substitution industrial strategy did not go beyond the stage of building the assembly plants, as the technical partners know that if Nigeria stops importing completely knocked down parts, their companies in Europe would automatically stop production and eventually fold up. It meant that Nigeria would no longer be a market for European.

Non-involvement of engineers in technological decision making: Science and technology researches require the technocrats who have the technical knowhow. Government and decision makers take technological decisions without consulting Nigerian engineers and technologists (through the Nigerian Society of Engineers, NSE) who are the key players in the field of engineering and possess the experience and technical knowhow to contribute towards the effectiveness of any technological developmental decision (Chete *et al.,* 2016; Isioto *et al.,* 2017).

External Factors

Negative influence posed by the colonial masters: The British came to Nigeria among other reason, for economic reason- as a ready market for their sprits, dane guns, mirrors and other goods. Before the advent of colonialism Nigerians were involved in many aspects of industrial and practical arts. They made their own hoes and other implements for farming. The colonialists discouraged further development of Nigerian technology as they reasoned it was a threat to the smooth marketing of goods imported from Europe. The author further asserted

that ―ogogoro‖ was termed illicit gin by the colonialists, and whoever was caught producing, marketing, or consuming it was frustrated.

Relegation of indigenous knowledge: The advent of modern technology is largely thought by many agricultural experts to have impeded the development of local and indigenous knowledge in the fields of agriculture in Nigeria. The usefulness of this indigenous knowledge (technology) is however all encompassing as it is the basis for agriculture, health care, food preparation, education, environmental conservation and a host of other activities (Isioto *et al.,* 2017). This in essence means that indigenous technology is the basis of modern technology and should not have been relegated.

Wrong philosophy of western education: Western education is the main and proper channel for technological emancipation provided it is built on appropriate philosophy of education. The philosophy of Nigerian education during the colonial period was built on the wrong philosophy as can be confirmed by the statements of Lord Lugard and Rev. J. C. Taylor who said respectively: ―The chief function of government primary and secondary schools among primitive communities is to train the more promising boys from the village schools as teachers for those schools, as clerks for the local native courts, and as interpreters: (Lord Lugard 1921)‖. ―I looked upon them as the commencement of our missionary work. We lost no time and began to teach them the A. B. C.‖ (Taylor 1857)‖. It is therefore not surprising that apart from the Yaba Higher College that was established in 1947 to produce middle level technical manpower, the colonialist only established secondary schools that were meant to produce clerks, missionaries, and interpreters. The aspect of education which emphasises skill and practical competence was however not an integral part of the nation‘s western educational system as at that time (Chete *et al.,* 2016; Isioto *et al.,* 2017).

Conflicting interest in transfer of technology: While the receiver wants technology to bring independence, modernity, and prosperity, the donors do not want receivers to be lifted up but only want to create supplies of what they need and maintain markets for what they produce. For instance some countries did not want Nigeria to have steel mills so as to make Nigeria a dumping ground for steel products.

Selfishness in controlling transfer of technology: Technology is usually kept as a preserved property of the donor and thus the exclusive control is vested in them. The donors determine how far and how much the receiver can use the technology by retaining production of spare parts and other components. The technology can only be viable as long as it serves the goal of the donors with little or no concern for the receiver. For instance, provision of tractors for farmers yet they cannot determine when they will have access to it. This is selfishness.

Transfer of the appropriate technology: The technology that suits one environment may not suit the other. There can even be differences between environments within a country. It is therefore necessary to compare and identify the systems viz-a-viz the environment and make sure the technology is appropriate for the new environment.

2.1.2.4 *Modes and tools of technology-based learning*

The followings are some of the modes of technology-based learning articulated by Patil (2014);

Audio

Any learning done via listening to any material is an audio method of learning. It is an electrical or other representation of sound. Digital audio, representation of sound in a form processed and/or stored by computers or other digital electronics. Audio refers to audible content in media production and publishing. The radio has been around for a long time and has been used in

educational classrooms. Recent technologies have allowed classroom teachers to stream audio over the internet. There are also webcasts and podcasts available over the internet for students and teachers to download.

Deakin.edu.au (2014) reported that from the audio cassettes of the 1970s to digitally recorded music on an invisible Cloud, audio has come a long way as a teaching and learning aid and is an extremely valuable method for capturing and presenting information. Audio provides a quick, cost-effective alternative to text for connecting with your students and providing upto-date content, interviews, discussions or lecture materials. Audio has a demonstrated capacity to facilitate authentic engagement, allowing students to connect in various ways to the outside world as both listeners and publishers. Audio can easily be created with many desktop tools and small digital recording devices such as smartphones.

Video

Video is an electronic medium for the recording, copying and broadcasting of moving visual images. This method is used by any visual learners or students who learn best by seeing the material rather than hearing or reading about it. Teachers can access video clips through the internet instead of relying on DVDs or VHS tapes. Websites like YouTube are used by many teachers. Teachers can use messaging programs such as Skype, Adobe Connect, or webcams, to interact with guest speakers and other experts. There is an increased retention and better results when video is used in a lesson. Systematic video development method creation holds promise for creating video models that positively impact student learning.

Video, as suggested in deakin.edu.au (2014), is also a popular tool used to engage learners and enhance a learning experience. Anyone with a digital camera, webcam, tablet or smartphone can now create and edit a movie. YouTube statistics highlight the widespread use of video

online, with more than 4 billion hours of video watched each month and 72 hours of video being uploaded every minute (YouTube Statistics, 2013). Videos are an excellent way to present and elaborate concepts, demonstrate a procedure or gain an understanding of learning in action.

Benefits of using audio and video in teaching

Having audio and video available to students can support their learning in the following ways. It provides diverse teaching techniques for learning; it gives the teacher a voice – this can reduce the feeling of isolation for cloud based students, but also helps located students feel connected; it can be used to simplify and explain complex problems; it allow students to access the learning materials as often as required; allows students to learn at their own pace, with instant playback, rewind and pause; reduces frequently asked questions from students; It can be re-used (deakin.edu.au, 2014).

Computers, tablets and mobile devices

Recent technology has resulted in development of desktops, laptops, iPads, tablets, MacBooks which are been used extensively in market. These devises have been contributed at large extent in learning. Paper is now being replaced by E-learning. Computers and tablets allow students and teachers access to websites and other programs, such as Microsoft Word, PowerPoint, Excel, PDF files, and images. These tools help learners to express their ideas. Excel helps the mathematical working of the study. PowerPoint helps the presentation of the study done by the learner. Graphs, Pie charts, diagrams helps learner to analyse the data studied which helps to give a better result.

Blogging

A blog (a truncation of the expression web log) is a discussion or informational site published on the World Wide Web and consisting of discrete entries ("posts") typically displayed in reverse chronological order (the most recent post appears first). The blogs can be single user or multiple users. A majority is interactive, allowing visitors to leave comments and even message each other on the blogs, and it is this interactivity that distinguishes them from other static website. Bloggers do not only produce content to post on their blogs, but also build social relations with their readers and other bloggers. Students and teachers can post their thoughts, ideas, and comments on a website. Blogging allows students and instructors to share their thoughts and comments on the thoughts of others which could create an interactive learning environment.

Webcams

Creation of virtual classroom has been facilitated by these Webcams. A webcam is a video camera that feeds or streams its image in real time to or through a computer or computer network. When "captured" by the computer, the video stream may be saved, viewed or sent on to other networks via systems such as the internet, and email as an attachment. When sent to a remote location, the video stream may be saved, viewed or on sent there. Unlike an IP camera (which uses a direct connection using Ethernet or Wi-Fi), a webcam is generally connected by a USB cable, FireWire cable, or similar cable, or built into computer hardware, such as laptops. Webcam helps in establishment of video links, permitting computers to act as videophones or videoconference stations, where the students can learn through this video conferencing. Other popular uses include security surveillance, computer vision, video broadcasting, and for

recording social videos. Webcams are known for their low manufacturing cost and flexibility, making them the lowest cost form of video telephony.

They have also become a source of security and privacy issues, as some built-in webcams can be remotely activated via spyware. This web classroom is easy to set up and reduces the travel expense and is a solution oriented program. Hence these technologies are now becoming more and more popular.

Whiteboards

A whiteboard (also known by the terms marker board, dry-erase board, dry-wipe board, penboard, and the misnomer grease-board) is a name for any glossy, usually white surface for nonpermanent markings. Whiteboards are analogous to chalkboards, allowing rapid marking and erasing of markings on their surface. This is a common feature of many virtual meeting, collaboration, and instant messaging applications. The term whiteboard is also used to refer to interactive whiteboards. This method allows teachers and students to write on the touch

Screen casting

A screencast is a digital recording of computer screen output, also known as a video screen capture, often containing audio narration. The term screencast compares with the related term screenshot; whereas screenshot generates a single picture of a computer screen, a screencast is essentially a movie of the changes over time that a user sees on a computer screen, enhanced with audio narration. Screencasts can help demonstrate and teach. Educators may also use screencasts as another means of integrating technology into the curriculum. Students can record video and audio as they demonstrate the proper procedure to solve a problem on an interactive whiteboard. This method allows users to share their screens directly from their browser and make the video available online so that the viewers can stream the video

directly.

2.1.2.5 *Synchronous and asynchronous learning modes and tools*

E-learning may either be synchronous or asynchronous. Synchronous learning occurs in realtime, with all participants interacting at the same time, while asynchronous learning is selfpaced and allows participants to engage in the exchange of ideas or information without the dependency of other participants′ involvement at the same time (Kaplan, 2017). Synchronous learning refers to the exchange of ideas and information with one or more participants during the same period. Examples are face-to-face discussion, online real-time live teacher instruction and feedback, Skype conversations, and chat rooms or virtual classrooms where everyone is online and working collaboratively at the same time. Since students are working collaboratively, synchronised learning helps students become more open-minded because they have to actively listen and learn from their peers. Synchronized learning fosters online awareness and improves many students' writing skills (Al-Asfour, 2012).

Asynchronous learning may use technologies such as learning management systems, email, blogs, wikis, and discussion boards, as well as web-supported textbooks, hypertext documents, audio video courses, and social networking using web 2.0. At the professional educational level, training may include virtual operating rooms. Asynchronous learning is beneficial for students who have health problems or who have child care responsibilities. They have the opportunity to complete their work in a low-stress environment and within a more flexible time frame. In asynchronous online courses, students are allowed the freedom to complete work at their own pace. Being a non-traditional student, they can manage their daily life and school with and still have the social aspect. Asynchronous collaborations allow the student to reach

out for help when needed and provides helpful guidance, depending on how long it takes them to complete the assignment. Many tools used for these courses are but not limited to: videos, class discussions, and group projects. Through online courses, students can earn their diplomas faster, or repeat failed courses without being in a class with younger students. Students have access to an incredible variety of enrichment courses in online learning, and still participate in college courses, internships, sports, or work and still graduate with their class.

Computer-based training (CBT)

Computer-based training (CBT) refers to self-paced learning activities delivered on a computer or handheld device such as a tablet or smartphone. CBT initially delivered content via CD-ROM, and typically presented content linearly, much like reading an online book or manual. Computer-based training is conceptually similar to web-based training (WBT), which is delivered via Internet using a web browser. Assessing learning in a CBT is often by assessments that can be easily scored by a computer such as multiple-choice questions, dragand-drop, radio button, simulation or other interactive means. Assessments are easily scored and recorded via online software, providing immediate end-user feedback and completion status. Users are often able to print completion records in the form of certificates. CBTs provide learning stimulus beyond traditional learning methodology from textbook, manual, or classroom-based instruction. CBTs can be a good alternative to printed learning materials since rich media, including videos or animations, can be embedded to enhance the learning. However, CBTs pose some learning challenges. Typically, the creation of effective CBTs requires enormous resources. The software for developing CBTs is often more complex than a subject matter expert or teacher is able to use. The lack of human interaction can limit

both the type of content that can be presented and the type of assessment that can be performed and may need supplementation with online discussion or other interactive elements.

Flipped classroom

This is an instructional strategy in which computer-assisted teaching is integrated with classroom instruction. Students are given basic essential instruction, such as lectures, before class instead of during class. Instructional content is delivered outside of the classroom, often online. The out-of-class delivery includes streaming video, reading materials, online chats, and other resources (Hall & DuFrene, 2016). This frees up classroom time for teachers to more actively engage with learners.

Audio and video

Video technology according to Dieker *et al.* (2009) has included VHS tapes and DVDs, as well as on-demand and synchronous methods with digital video via server or web-based options such as streamed video and webcams. Telecommuting can connect with speakers and other experts. Interactive digital video games are being used at K-12 and higher education institutions (Biocchi, 2011). Radio offers a synchronous educational vehicle, while streaming audio over the internet with webcasts and podcasts can be asynchronous. Classroom microphones often wireless can enable learners and educators to interact more clearly. Screen casting allows users to share their screens directly from their browser and make the video available online so that other viewers can stream the video directly. The presenter thus has the ability to show their ideas and flow of thoughts rather than simply explain them as simple text content. In combination with audio and video, the educator can mimic the one-on-one experience of the classroom. Learners have the ability to pause and rewind, to review at their own pace, something a classroom cannot always offer. Webcams and webcasting have enabled

the creation of virtual classrooms and virtual learning environment (Shiao, 2013). Webcams are also being used to counter plagiarism and other forms of academic dishonesty that might occur in an e-learning environment.

Computers, tablets and mobile devices

Computers and tablets enable learners and educators to access websites as well as applications. Many mobile devices support m-learning (Kolpashnikova & Bartolic, 2019). Mobile devices such as clickers and smartphones can be used for interactive audience response feedback (Tremblay, 2010). Mobile learning can provide performance support for checking the time, setting reminders, retrieving worksheets, and instruction manuals (Terras & Ramsay, 2012). Such devices as iPads are used for helping disabled (visually impaired or with multiple disabilities) children in communication development as well as in improving physiological activity (Campaña & Ouimet, 2015). Computers in the classroom have been shown to increase rates of engagement and interest when computers and smart devices are utilised educationally in classrooms (Schindler *et al.,* 2017)

Collaborative and social learning

Collaborative learning is a group-based learning approach in which learners are mutually engaged in a coordinated fashion to achieve a learning goal or complete a learning task. With recent developments in smartphone technology, the processing powers and storage capabilities of modern mobiles allow for advanced development and the use of apps. Many app developers and education experts have been exploring smartphone and tablet apps as a medium for collaborative learning. Group webpages, blogs, wikis, and Twitter allow learners and educators to post thoughts, ideas, and comments on a website in an interactive learning environment (Courts & Tucker, 2012). Social networking sites are virtual communities for people interested

in a particular subject to communicate by voice, chat, instant message, video conference, or blogs. The National School Boards Association found that 96% of students with online access have used social networking technologies, and more than 50% talk online about schoolwork. Social networking encourages collaboration and engagement and can be a motivational tool for self-efficacy amongst students (Pilgrim & Christie, 2011).

Whiteboard

The term whiteboard is also used metaphorically to refer to virtual whiteboards in which computer software applications simulate whiteboards by allowing writing or drawing. This is a common feature of groupware for virtual meetings, collaboration, and instant messaging. Interactive whiteboards allow learners and instructors to write on the touch screen. The screen markup can be on either a blank whiteboard or any computer screen content. Depending on permission settings, this visual learning can be interactive and participatory, including writing and manipulating images on the interactive whiteboard.

Virtual classroom

A virtual learning environment (VLE), also known as a learning platform, simulates a virtual classroom or meetings by simultaneously mixing several communication technologies. Web conferencing software enables students and instructors to communicate with each other via webcam, microphone, and real-time chatting in a group setting. Participants can raise hands, answer polls, or take tests. Students can whiteboard and screencast when given rights by the instructor, who sets permission levels for text notes, microphone rights, and mouse control (Farwell, 2013). In higher education especially, a virtual learning environment (VLE) is sometimes combined with a management information system (MIS) to create a managed learning environment, in which all aspects of a course are handled through a consistent user

interface throughout the institution. Physical universities and newer online-only colleges offer to select academic degrees and certificate programs via the Internet. Some programs require students to attend some campus classes or orientations, but many are delivered completely online. Several universities offer online student support services, such as online advising and registration, e-counseling, online textbook purchases, student governments, and student newspapers. Due to the COVID-19 Pandemic, many schools have been forced to move online. As of April 2020, an estimated 90% of high-income countries are offering remote learning, with only 25% of low-income countries offering the same (Vegas, 2020).

Augmented Reality

Augmented reality (AR) provides students and teachers with the opportunity to create layers of digital information, including both virtual world and real-world elements, to interact within real-time. AR technology plays an important role in the future of the classroom where human / Artificial Intelligence co-orchestration takes place seamlessly (Sharples, 2013). Students would switch between individual and collaborative learning dynamically, based on their own learning pace, while teachers, with the help of AR, monitor the classroom and provide necessary interventions in cases where computer systems are not yet designed to handle. In this vision, the technology's role is to enhance, rather than replace, human teachers' capabilities.

Learning Management System (LMS)

A learning management system (LMS) is software used for delivering, tracking, and managing training and education. It tracks data about attendance, time on task, and student progress. Educators can post announcements, grade assignments, check on course activity, and participate in class discussions. Students can submit their work, read and respond to discussion

questions, and take quizzes (Courts & Tucker, 2012). An LMS may allow teachers, administrators, students, and permitted additional parties (such as parents, if appropriate) to track various metrics. LMSs range from systems for managing training/educational records to software for distributing courses over the Internet and offering features for online collaboration. The creation and maintenance of comprehensive learning content require substantial initial and ongoing investments of human labor. Effective translation into other languages and cultural contexts require even more investment by knowledgeable personnel (Sarasota *et al.*, 2013).

Computer Assisted Instruction (CAI)

Computer Assisted Instruction (also called Computer Aided Instruction) is the use of computer and its accessories in providing learning experiences and self-directed instructions to a learner using tutorial and simulation packages, with little or no assistance from instructors. In developed countries, the use of computer as a teaching tool has reached an advanced stage (Mudasiru & Adedeji, 2010). Sharma (2017) understands CAI as an interactive instructional technique whereby a computer is used to present the instructional material and monitor the learning that takes place. Okebukola (2013) postulated that CAI can be applied to all ages and forms of education, from pre-school to professional school and even in many employment areas. It can also be used in a wide range of fields including all the main disciplines in elementary and secondary school.

2.1.2.6 *Technology of education*

The term ―technology of education‖ refers to application of theories and laws/rules in education and related disciplines for the purpose of improving the quality of education. Such related disciplines include: sociology/sociology of education, philosophy/philosophy of

education, psychology/psychology of education, communication, technology, among others. Technology of education is a component of educational technology that is involved in the use of systems approach to promote high quality education. Furthermore, this aspect of educational technology is concerned with the use of systematic and scientific procedures in educational practice. Simply put, technology of education refers to the application of the systems approach to educational enterprise. Its main concerns include issues bothering on identification of educational problem, analysing the problem, setting objectives, suggesting solution strategies, synthesizing the processes, embarking on evaluation and providing feedback.

2.1.2.7 *Perspectives on use of technology in education*

All students (from elementary through high school) need greater exposure to a plethora of technologies in the classroom, but many schools may not be meeting this need (Bolkan, 2012). Many students are found to have the capability to use technology, as well as the access to do so at home, and many of those utilise it for educational purposes (Ehrlich *et al.*, 2013). It was found that those in positions of authority at the schools are responsible for setting expectations for technology use. However, throughout all schools participating in the study, there was an inconsistency regarding how much technology is actually used for instruction. The variation in student and teacher use in the different schools is directly related to the culture for technology integration. In the schools with a more positive culture towards technology integration, more students and teachers tended to utilise technology.

It is important for the future generation of teachers to learn how to teach in a manner that will best reach their students. Teacher training begins at the collegiate level. The number of colleges and universities using electronic learning (or e-learning) has been increasing, though there is a gap in the research pertaining to student adaptability. Infrequent technology users were found

to have difficulty in implementing technology for teaching, while frequent technology users felt accomplished in creating a technology supported environment (Meyer *et al.,* 2011). This gap is then carried over into the K-12 schools where the future teachers will teach. As was seen in the study completed by Ehrlich *et al.* (2013), if the culture of technology integration is well in place for pre-service teachers, it will carry into the classroom.

Barriers to the use of Technology in Education

Littlejohn *et al.* (2016) summarised those barriers to be, the lack of leadership in the public sector, lack of assigned responsibilities to organise learning programmes, and lack of tutors on the established platforms. In Kent *et al.* (2016) words, the perceived technological fit of evolving technical systems is the main barrier in conducting such programs in educational settings. Generally, the barriers of technology support systems of education can be divided into two main categories: social barriers and technical barriers.

Social Barriers

Sharrock (2015) stated that in the social dimension, the first aspect of challenges is the value of these systems on the national level. There are many differences in ethnic, national beliefs, and common understanding towards the features of these new settings. Luaces *et al.* (2015) believed that the main barrier in the social dimension relates to individual concerns. A subcategory in this respect is socialisation. The term stands for the fear to lose social contacts among colleagues when individual exchange during learning activities becomes technically mediated. Margaryan *et al.* (2015) observed that another subcategory in this regard is the concern about misunderstanding colleagues due to the loss of information richness. Individuals fear to get hold of experiential and tacit knowledge if collaboration shifts to virtual platforms. They added that another barrier is related to the characteristics and value of information and

knowledge such as a lack of mutual trust which means employees have concerns about sharing information within the organisation or they fear to lose their position; therefore, they are not apt to share what they know about best practices. Phan *et al.* (2016) expressed that the quality of information is a subcategory of the social dimension. The subcategory lack of quality may appear to be related to the value of information; however, it is focused more on the nature of digital, online information.

Muñoz-Merino *et al.* (2015) declared that ICT skills and knowledge about open E-Learning is another main category to approach barriers on the social dimension. Issues such as a low level of objective competence levels, the low familiarity with frameworks like IPR issues as well as technical practices of the applications, and the lack of knowledge about virtual learning platforms can lead to resistance of change. Finally, Vu *et al.* (2015) believe that one important aspect of social barriers deals with learners‘ cognitive and personal backgrounds which includes the lack of common identity and knowledge backgrounds, differences in curricula and training programs, and the orientation to experts or experienced colleagues.

Technical Barriers

The second main category of e-learning barriers deals with the technical dimension. Many researchers focused on this dimension and emphasised the challenges that they had in their studies, for instance, Watson *et al.* (2016) argued that the low availability of technology which embraces the subcategories shortage of appropriate infrastructure and software can be the main barrier in many contexts. To Wiebe *et al.* (2015), the low quality of broadband connections which impede the inter-connectivity among administrations is the main barrier. Related to this aspect, a lack of common data references, definitions, and channels which impede a data and information exchange via technical means (Margaryan *et al*., 2015), concerns about security

and privacy (Luaces *et al*., 2015), restricted the access to online resources and platforms in technical manner (Phan *et al.*, 2016) are some other barriers that learners are faced with in their educational contexts. However, Zhang (2016) expressed that many universities around the world focused on dual mode universities which are courses in both traditional face to face interaction as well as online or virtual courses. Nevertheless, in the education sector, developing countries are facing problems like lack of skilled teachers, educational infrastructure, and technology access to enhance the education at different levels. Barak *et al.* (2016) believed that lack of resources including furniture, buildings, qualified teachers and learning material are the main obstacles in promoting open and distance learning.

2.1.2.8 *Student motivation through technology use in school*

A study by Godzicki *et al.* (2013) focused on the element of motivation amongst elementary and middle school students. They implemented a technology-supported learning environment and targeted certain problematic behaviors. Among these targeted behaviors were noncompletion of homework, unpreparedness for class, and sleeping/putting their heads on their desks. The authors found that students were more likely to engage in an activity simply because technology is being used. However, almost 50 of surveyed teachers used technology for 80 or fewer minutes per day. After implementing a technological intervention, students stated that they felt teachers provided activities relevant to them, and motivation and engagement went up 9% for all students (Godzicki *et al.*, 2013).

One method of technological intervention is that of the WebQuests; lessons where all of the information comes from the internet. In his study, Halat (2013) examined the viewpoint of students in 4th and 5th grade on the use of WebQuests in the classroom. The Webquests utilized for this study were compiled online through editing software called FrontPage. After

the student participants were introduced and given their own WebQuests to complete, the students were given a questionnaire. It was found that the students enjoyed the use of the WebQuests, and experienced increased motivation to learn.

Research suggests that the presence of embedded systems does not necessarily influence student motivation, but Koshino *et al.* (2013) noted that finding was based on several factors. The most notable factor limiting use of the system is the slow CPU (central processing unit) performance. To solve this problem, researchers developed a new educational board titled E+ and introduced it to third grade students. After a one year observation, the students were polled to gauge their motivation levels. The authors found several of the problems presented by traditional education were overcome by E+, and students felt their understanding of the material increased.

2.1.2.9 *Perceptions of technology in daily life*

Almost every teacher will agree that a ringing cell phone disrupts academic performance, but the practices regarding cell phones range from outright banning of electronic devices to much more relaxed policies. Most teachers believe that electronic devices are unnecessary for the students to have in the classroom, where students see technology as an integral, day-to-day life item and essential for safety (Thomas *et al.*, 2013). Some teachers continue to lecture students in a manner that may not engage learners. Their students, therefore, tend to believe that a classroom that is disconnected from the so-called ‗real world' is artificial and fake (Baker *et al.*, 2012). PowerPoint software allows a teacher to present information in a visual manner (Goodin, 2012), however teachers who relied primarily on this technology were often found as authoritative and the technology was seen as a negative (Baker *et al.*, 2012). This image of the authoritarian is furthered when instructors continue to limit or control the use of technology

in the classroom, creating a learning barrier. It should also be noted that the authors spoke to the instructors, and the consensus was that the modern-day student also lacks the self-control and maturity level necessary to have electronics in the classroom, hence the rules governing classroom electronics (Baker *et al.*, 2012).

From the cell phones that sit in our pocket, to the car we drive to work, and the machine that makes our coffee in the morning, it is safe to say that technology is a part of everyday life whether it is a conscious decision to use it or not (Egbert, 2009). It would be counterintuitive for a teacher to utilise outdated techniques designed during a time when there was no technology in the classroom if the average student is utilising technology on a day-to-day basis. A paradigm shift in modern pedagogy must occur if teachers are to more fully integrate technology into classroom instruction. Teachers will have more approaches to engage students in learning activities through a technology based learning environment. Student perspectives on school-based learning will change and students may be motivated in the classroom and achieve at higher levels.

2.1.2.10 *Integrating technology into classrooms*

Information technology has become common place in the classroom, helping to elevate and replace outdated pedagogical techniques and offering teachers the ability to design curriculum in advance with regards to differentiation. Zimlich (2015) argued that even with regards to the amount and use of specific technology in the classroom, and even though some technology may not have originally been designed to align with educational goals, many teachers still find ways to integrate technology into the classroom. In his study, six graduates from the master‘s level certification program at the University of Alabama were followed in the professional world to observe their lesson plan effectiveness using technology. It was found that the quantity

of technology in the classroom was not the deciding factor about whether or not the technology implementation was a success, but rather the quality of the specific use of technology on behalf of the teacher. This quality helps the teachers stand out in the minds of the students. The plethora of tools and the user-friendly nature of technology offer students a unique ability to collaborate with peers (teachers and students alike). Google Drive and Google Doc technology offers students the ability to work on a collaborative document (similar in nature to documents, spreadsheets) with one or more co-authors who are in different locations. Weblogs (or blogs for short) also offer users similar opportunities, allowing someone to publish comments and ideas in a public forum where a reader can then comment. This type of technology gives students the ability to publish ideas and thoughts about their own learning, sharing thoughts similar to a discussion session in a classroom.

According to Jackson *et al.* (2011), Integrating technology with standard curriculum can not only give students a sense of power, but also allows for more advanced learning among broad topics. However, these technologies require infrastructure, continual maintenance and repair – one determining element, among many, in how these technologies can be used for curricula purposes and whether or not they will be successful. Examples of the infrastructure required to operate and support technology integration in schools include at the basic level electricity, Internet service providers, routers, modems, and personnel to maintain the network, beyond the initial cost of the hardware and software. Technology contributes to global development and diversity in classrooms while helping to develop upon the fundamental building blocks needed for students to achieve more complex ideas. In order for technology to make an impact within the educational system, teachers and students must access to technology in a contextual

matter that is culturally relevant, responsive and meaningful to their educational practice and that promotes quality teaching and active student learning (Song & Owens, 2011).

However, technology integration can in some instances be problematic. A high ratio of students to technological device has been shown to impede or slow learning and task completion. In some, instances dyadic peer interaction centered on integrated technology has proven to develop a more cooperative sense of social relations. Success or failure of technology integration is largely dependent on factors beyond the technology. The availability of appropriate software for the technology being integrated is also problematic in terms of software accessibility to students and educators (Yu, 2013). Another issue identified with technology integration is the lack of long-range planning for these tools within the educative districts they are being used.

2.1.2.11 *Student-centered learning environments*

Grismore (2012) states that ―educational technology meets the needs of a diverse group of learners while assisting teaching in getting all students to achieve at high level‖. This research suggests that, through the proper use of technology integration, all students can have a high level of achievement. However, this same integration can have the opposite effect when not utilized appropriately. He further claimed that it becomes easy for a teacher to use technology ―for technology‘s sake―, thereby becoming ineffective. There are a variety of approaches to technology integration that exist to help all students become academically successful. In a three-step model presented by Norris and Lefrere (2011), there are allowances for a change in roles of the faculty, mentors, and allows for a dynamically updated curriculum (which allows teachers to make changes quickly to support the needs of their students). First, information (which is easily accessed by the internet) helps learners find information. Next, collaboration

must occur. Finally, the participants will pass on learned experiences. Other research supports this approach to technology integration to create more inclusive learning environments (Norris & Lefrere, 2011).

This idea of using technology to quickly respond to students can be utilized in a variety of instructional settings. The Enhancing Education Through Technology (Ed-Tech) Program in Vermont aims to close the achievement gap by providing access to a variety of technology (such as smart computing devices or software), to use data for improving the school, and to support teachers through online courses and a variety of other services (Margolin *et al.*, 2011). It was found that the Ed-Tech program was successfully implemented by teachers, and promoted student-centered instruction. The Florida Center for Institutional Technology proposed a Technology Integration Matrix (2014) that allows educators to effectively use technology and create a meaningful learning environment. This matrix allows teachers to evaluate their own curricula and technology integration, and determine how best to progress. According to the Technology Integration Matrix (2014), the progression of technology integration follows this progression: Entry, Adoption, Adaptation, Infusion, and Transformation. In this case, Entry refers to a teacher who has no prior technology utilisation, and Transformation refers to a teacher who has full and complete technology utilisation.

2.1.2.12 *Digital technology*

In the 21st century, today‘s bark, slates, ink, pencils and paper are digital technologies. The rapid uptake and use of digital technologies, or digitalisation (Richardson *et al.*, 2013), has taken place throughout society during the past few years. As in society, the uptake and use of digital technologies has permeated schools and has therefore had an impact on schools (Säljö,

2010). In the move toward digitalised classrooms, students, teachers and school leaders have increasingly supplemented pencils, pens and paper in classrooms with digital technologies such as laptops, tablets, interactive whiteboards and smartphones (Richardson *et al.*, 2013). There appear to be many definitions for the concepts of digital technologies and Information and Communication Technology (ICT), as well as for Technology Enhanced Learning (TEL) (Laurillard & Masterman, 2010) as for enhancing teaching and learning through the use of these technologies. In this thesis, these concepts refer to the uptake and use of laptops, interactive whiteboards and smartphones, and that involve enhancing teaching and learning through the use of these technologies. As the uptake and use of digital technologies continues to increase in classrooms throughout the world, teachers and students find themselves working with their own laptops or tablets in the form of One-to-One (1:1) initiatives, meaning one laptop or tablet per student (Richardson *et al.*, 2013). The possibilities for teaching and learning and creating supportive conditions for TBL appear to be strong. The same can be said for the expectations for new work methods for students, teachers and school leaders through the digitalization of schools. Furthermore the effects of this technology appear to have an impact on all levels of the school organization, from students, to teachers, to school leaders, and for the school as an organization (Olofsson *et al.*, 2011).

Digital technology-enhanced instruction offers numerous learning benefits because it is characterised by images, sounds, graphics, text and animation, which could attract and sustain students learning lifespan. It also enhances learners' interaction and supports a nonlinear way of teaching and learning. This non-linear method of instruction provides the learner with the opportunity to take control of his/her learning and enables them to explore the learning content effectively (Yaki *et al.*, 2020).

2.1.2.13 *Digital tools*

The choice of digital tools for the classroom is based on the recommendations from the government and the school board. For example, *Google Apps for Education*; this digital tool is also online software which contains more tools within. According to the website *Google for Education* (edu.google.com [nd]) for this tool contains tools such as: *Gmail (Google mail), Google Drive, Google Docs, Google Classroom, Google slides, Google Forms, Google Calendar, Google Sheets, and Google Vault*. All of these services are provided 15 gigabytes of storage space that is shared. For example, if you have 10 gigabytes of files on your Drive you only have 5 *gigabytes* left for all the other services. *Gmail* is a free webbased e-mail service that provides users storage for electronic messages, and provides the ability to search for specific messages. *Gmail* can be accessed through the mobile/tablet apps for *iOS* and Android. *Google Drive* is a file storage and synchronisation service developed by *google*, which allows users to store files in the cloud, synchronise files across devices, and share files. *Google Docs* is a free web-based application in which documents and spreadsheets can be created, edited and stored online. Files can be accessed from any computer/tablet/mobile with internet connection and a full-featured web-browser.

Google Docs is compatible with most presentation software and word processor applications. *Google Classroom* is a mission control for students and teachers. One can create classes, distribute assignments, send feedback and assessment, but also make it easier for students and teachers to connect outside and inside of schools. Students can see assignments on the work page in *Google Classroom*, in class stream, or on the class calendar. All class material is automatically filed into *Google Drive* folders. *Google Slides* is a presentation editor in *Google Docs* and *Google Drive* productivity suite. *Google Slides* is an online presentations app that

allows you to show off your work in a visual way. *Google Forms* let you plan events, make a survey or poll, give students a quiz, or collect other information in an easy, streamlined way. One can create forms from *Google Drive* of from an existing spreadsheet that record the responses to the newly created form. *Google Calendar* is a time-management and scheduling calendar service developed by *Google*. It became available on the web and as mobile/tablets apps for the Android and *iOS* operating systems. *Google Sheets* is a web-based application that allows users to create, update and modify spreadsheets and share the data live online. The Ajax-based program is compatible with Microsoft Excel. Spreadsheets can also be saved as *HTML* files. *Google Vault* lets you retain, hold, search, and export data to support your organization‘s archiving and eDiscovery needs Vault supports: *Email* messages. *Google Sites* makes it easier to create and publish internal team sites, project sites, event sites, or other internal sites. No technical skills are required and you can collaborate with others to create and refine sites, just like other *Google Docs*. These digital tools are used by the *iPad* device in schools, however, *iPads* are a physical hardware tool used for these mentioned software apps above from *Google Apps for Education*. The *iPad* is easy to move around and to use everywhere the student and teacher wishes for, therefore, the school choose to use the *iPad* over a laptop because they are functional for apps and softwares.

According to Lundh and Thomasson (2013), technical development has accelerated a lot in our schools, mostly toward digital tools and digital texts. Since the students are already highly connected to the new technology in their free time, efficient education providers should understand that the students are already exposed to the digital world, Lundh and Thomasson suggest (2013). Thanks to this new technology – smartphones, computers, and tablets – digital writing and digital texts have become more of an everyday thing for students and teachers

alike. However, teachers‘ perceptions and use of digital texts and tools affect their knowledge, experience, interests and identity. Lundh and Thomasson (2013) suggest that every teacher should be able to have an in-service education regarding digital to be able to use the tools properly in their classrooms when teaching their students. Meanwhile, Eriksson and Olsson (2015), mention that most of the implications digital tools offer on information and it is consequences, and also their physical possibilities, are limited by the school boards. They suggest that a teacher cannot change or add tools in their classrooms. Furthermore, Eriksson and Olsson (2015) argues that diversifying teaching and learning methods makes it easier to also include digital tools and texts in the classroom teaching. The majority of the problems with digital tools that face a teacher involve technical challenges, which complicates planning. Lundh and Thomasson (2013) suggest that technical problems can take some time to deal with; therefore, each and every teacher should be given an opportunity for an in-service education on the chosen digital tool that their school decides upon.

2.1.2.14 *Game based learning*

Game-based learning: Learning is a result of exploration and thought. Game-based learning, a best practice using technology, is an old concept of learning with a new digital face. Gamers will agree video games and educational games cause players to discover and use critical thinking skills. As Whitton (2012) describes, game-based learning (GBL) is learning by active play through games. Another definition of GBL is ―any digital game that can be used in a learning context‖ (DeGrove *et al.*, 2012). GBL has become more preferable in motivating students‘ learning. It is therefore of utmost importance to innovate in the current

teaching practices to enhance learner involvement, comprehension, cooperation and motivation (Gil-Domenech & Berbegal-Mirabent, 2019). The growth of mobile, smart devices

has resulted in the suggestion that this may provide new opportunity to engage students in active learning. Games should have two enticing qualities; competition and engagement. Digital games create active engagement. The game-based learning theory is grounded on the idea that engagement is in performing tasks while playing conditions stimulate the brain for active learning. Digital games are designed to integrate content material with game play; this allows the brain to process information from short to long-term memory. Understanding how children process and store information is particularly important for educators. Game-based learning has paved the way for a new digital form of learning. Whitton (2012) states that game-based learning can be seen in both primary, and secondary schools, universities, adult education, military training, and medical practice. Digital games create active engagement which supports problem-solving skills in learning environments, provide a safe environment of play which allows students to learn from their failures, scaffolding through life simulations which helps students learn how to deal with possible real-life failures. Games are great educational tools used across content areas for review. Game-based learning is often associated with implementing educational games, understanding the impacts of GBL, and the planning of game-based educational approaches (Sadler *et al.,* 2015).

Brown *et al.* (2018) indicated that digital game-based learning (DGBL) is increasingly being used as an alternative learning tool for teaching science in higher education. To support this, Bahnamnia *et al.* (2020) have stated that digital game-based learning (DGBL) is increasing; therefore, the application of DGBL technology (tablets and smartphones) has the potential to influence biology students' ability to develop creative and critical thinking skills. This is further supported through the process of digital game development for teachers to teach science in the school environment and the use of mobile smartphones as a tool that adds value to the world

of education, biology teachers included. Mobile game based learning (mGBL) has shown great potential for increasing engagement, creativity and authentic. To name a few, mGBL could produce positive feedback from students, as it increased the interest level to learn biology through game, which 2D graphics can be further enhanced into 3D Modelling tools (Rozaidi & Ismail, 2018). However, mGBL‘s great potential on biology education for teachers remains very limited. A new game on the web being used in online and traditional learning environments is Kahoot!.

Plump and LaRosa (2017) as well as Wang and Tahir (2020) stated that, Kahoot! is an eLearning platform which provides an engaging environment that supports learning and adds active participation in the classroom. In order to enhance the students' engagement and active learning, an online game-based learning using Kahoot! application can be the one of the suitable methods to achieve these objectives. Teachers should utilize it in the classroom as it will make the students be more active by communicating, collaborating and think critically among themselves.

Kahoot! allow teachers to create questions with answers and students can compete for points. The game can be activated on the web and several classes can play against each other. The game requires a code and students can contribute to the game anytime during an assigned game time period making it useable for distance students. Kahoot! According to Plump and LaRosa (2017), Kahoot! (https://getkahoot.com/) is an online global educational brand that offers a free student response platform resembling the popular trivia game Quizzo. Kahoot!
Is reminiscent of previous clicker technology with the exception that it is free and easy to learn and use. Educators use Kahoot! to create game-based quizzes, discussions, and surveys. To start, instructors register for a free account by going to https://create.kahoot.it. Once registered,

educators can select from millions of free public games and adapt them as necessary or create their own. The process is easy and straightforward. Educators launch games for classroom use by going to https://create.kahoot.it, signing in, selecting a particular game, and then clicking ―play‖ to open the game. The game‘s home page displays a game pin at the top of the screen. Students sign in using the web address https://kahoot.it to access the platform. Kahoot! can be used with smartphones, tablets, or laptop computers. Students can choose one device per person or select team mode to use one device per team. All they must do once they access the web address is enter the game pin displayed on the instructor‘s screen. Students do not need to register for an account or download an application, which can waste time and further complicate the use of technology. All of this makes the se up time and process easy and efficient, both important considerations for classroom instructional use.

Generally, Kahoot! is used as a supplemental teaching tool in classes no larger than a group of 30 students, approximately once a week, and for about 15 minutes. Kahoot! can be played by over 4,000 players at a time; however, the company recommends instructors to contact its support team for advice if they plan to use it with more than 1,000 participants. Once everyone has answered the question, or the time the instructor set for answering the question expires, the correct answer is displayed on the instructor‘s screen and the aggregate results shown in bar graph form. The game keeps track of each student‘s or team‘s answers, awards points, and ranks players based on speed and accuracy. The top five leaders are displayed after each question.

2.1.3 Concept and nature of Biology

Biology is the study of living organisms and the systemic processes that occur within them (Umar, 2011). Davies, *et al.* (2013) opined that biology is a study of the natural science that studies life and living organisms, including their physical structure, chemical processes, molecular interactions, physiological mechanisms, development and evolution. Biology serve as the baseline for a wide range of science, technology, engineering and mathematics (STEM) disciplines including biochemistry, medicine, biotechnology, food technology and pharmacy, just to name a few. In understanding some of the complex processes that are inherent to biological systems, it is relevant for students to engage in experimental learning to enhance visualization of micro-scientific phenomena and their conceptual understandings (Duyilemi *et al.*, 2014). Biology is a science that deals with the study of living things; it attempts to understand the teeming diversity of life on earth which we are all part of (Ramalingam, 2016). On a similar note, Oxford Advanced Learners Dictionary, (2018) viewed biology as a scientific study of the life and structure of plants and animals. It is the study of the way in which the body and cells of living things behave.

Biology is the scientific study of life (Hillis *et al.,* 2020). It is a natural science with a broad scope but has several unifying themes that tie it together as a single, coherent field. For instance, all living organisms are made up of cells that process hereditary information encoded in genes, which can be transmitted to future generations. Another major theme is evolution, which explains the unity and diversity of life. However, all living organisms require energy to move, grow, and reproduce, as well as to regulate their own internal environment (Hillis *et al.,* 2020). Biology is a core subject that is mandatory for science students in all secondary schools in Nigeria as it is a pre-requisite to the study of many courses relevant to humanity which

include the following; Medicine, Pharmacy, Biochemistry, Agriculture, Anatomy, Physiology, Botany, Zoology, Microbiology, Cell Biology, Ecology, Entomology, Immunology, Molecular biology, Evolutionary, Genetics and population dynamic among others.

Biology has certain characteristics which distinguish it from other spheres of human endeavour, these characteristics define the nature of biology. Humans have always been curious about the world around them. The inquiring and imaginative human mind has responded to the wonder and awe of nature in different ways. One kind of response from the earliest times has been to observe the physical and biological environment carefully, look for any meaningful patterns and relations, make and use new tools to interact with nature, and build conceptual models to understand the world; this human endeavor is Biology. But Biology is ultimately a social endeavor, t is knowledge and knowledge is power. With power come wisdom and liberation or as sometimes happens unfortunately, power can breed arrogance and domination. Biology has the potential to be beneficial or harmful, emancipative or oppressive. History, particularly of the twentieth century, is full of examples of this dual role of Biology. In a progressive forward-looking society, Biology can play a truly liberating role, helping people out of the vicious circle of poverty, ignorance and superstition. Biology, tempered with wisdom, is the surest and the only way to human welfare. This conviction provides the basic rationale for Biology education (Venugopal & Nagarajan, 2013).

2.1.3.1 *Concept of biology education*

Biology plays a very crucial role in the life of every individual worldwide. Aina (2013) stated that Biology education is important to any growing economy like Nigeria; this is because

Biology has been made central focus in some human activities including being a solution to the problem of food security, health, hygiene, family life, poverty reduction, management and conservation of natural resources and biotechnology. There are numerous ways through which individuals derive benefits from the knowledge of biology education these includes: Biology education helps an individual understanding body parts and its functions; helping individual to be aware of the need to maintain good health such as eating adequate food, clean water, good sanitation also to prepare individual for vocational and professional careers such as medicine, dentistry, agriculture and so forth (Aina, 2013). Biology education as an aspect of natural science have been found useful in solving many issues related to human life in our society (Nigeria inclusive). Biology Education is education in biology which generally aims at training individuals to understand himself or herself, the parts of his or her body and how the body parts function. Hence, the application of principles of education in teaching and learning of biology is known as biology education. It is the art of teaching and training in order to inculcate or transfer the knowledge of biology to students (Okenyi, 2012). For this can afford them the opportunity of contributing meaningfully to the development of the society in one way or the other.

Objectives of biology education

The major objectives of biology education in Nigeria according to Okenyi (2012) are; To develop confidence in biology teachers and enhance the ability to adapt to the changing situation in science and the technological oriented society; To produce knowledgeable, highly motivated, professional and effective teachers of biology who will be able to develop in students an appreciation and understanding of biological processes and principles; To view biology as a processes of inquiry into the living world; To analyze the activities of living things

in their environment; To demonstrate practical skills in handling scientific apparatus; To demonstrate excellence and professional competence in teaching secondary school biology; To inculcate positive scientific attitude and value in the society and promote positive disposition towards biology, science and the scientific enterprise; To apply concepts and methods acquired in new areas of study and in everyday situation.

Challenges of biology education in Nigeria

Despite all the things biology can accomplish in the nation‘s development, there are many challenges militating against it especially in Nigeria. These challenges can be viewed under the following headings, as itemized by Okenyi (2012);

Security**:** Security issue in Nigeria has been worrisome for years now because of the insurgence of the Boko Haram sect. People in Nigeria live in fear of the uncertainty of death from bomb explosions or gunshots from the terrorists or from armed robbers and many a time from kidnappers. The lives of nationals living in Nigeria are in perpetual danger due to kidnapping (Aina, 2010). Lecturers and students don‘t know their fate every day until they retire to bed at night because of armed robbers, the recent attack on a northern university where student and lecturers were cold bloodedly murdered still remains fresh in the academic arena. Science infrastructures built with huge amounts of money for schools in which Biology departments in such schools are part of its beneficiaries were also destroyed while gas and oil installations are vandalized too. The resultant effects of these are on education. Many parents have lost their jobs and the effect is on the children. These children could not complete their education and eventually had to drop out of schools. Majority of these dropout students are very brilliant scholars who could have become renowned Biology educators the country would be proud of.

Corruption**:** Corruption has eaten deep into the Nigerian system and it is manifesting in every sector of education including biology. In Nigeria today it is not what you know but whom you know. Appointment and admission into higher institutions of learning are no longer based on merit but on whom you know and the amount you can offer for such job or space for admission. Purchases of biology equipment for schools are no longer done transparently since it is either the chief executive of the school or many of his or her relations will do the supply. In this case they neither supply according to the required specification nor the required quantity. In most cases they don‘t even supply anything thereby leaving most of the biology laboratories empty or with fake and obsolete biology equipment which are useful for nothing but for mere demonstration. Money meant for staff training are diverted to personal account while selection of those who benefit in staff training is on whom you know syndrome. All these will bounce back on the quality of biology educators Nigeria produces. Employment is also no longer based on merit; those who are qualified for teaching biology are not given employment because they don‘t have godfathers in the government. Teaching appointment is done based on neptotism and favoritism. This is affecting the biology education in Nigeria.

Teacher: Biology teachers are key factors to be considered when talking about improvement of biology education in any nation. There are shortages of qualified biology teachers in Nigerian schools, and the so called biology teachers are not professionally qualified. They may have the knowledge of the subject but lack the method. Aina (2010) in his study of challenges and prospects of science teaching affirmed that there are unqualified science teachers in the country. These teachers for many years have not upgraded their certificates by going for in-services training, this affects their output and it is a problem to the development of science education of which biology is one of them.

Lack of Proper Curriculum Development: In biology education improvement in Nigeria, the relevance of biology education curricular cannot be ignored. Biology education has not been given an appropriate place in the Nigerian school curriculum. The, bulk of what is taught in schools is imported from other developed countries. It is therefore necessary to have a curriculum reform to enhance quality biology teaching in Nigeria.

Inadequate Fund: There is no adequate fund for the provision of conducive and enabling environment to facilitate the effective teaching and learning of biology process as well as research. Tertiary institutions are statutorily expected to be engaged in research to enrich the process of social development and not to be engaged in teaching only. These expectations are not adequately met due to inadequate funds as research in biology requires huge investments and capital which ordinary individuals cannot cope with.

The prospects of biology education in Nigeria

The prospect of biology education is very slim. Poor governance is significantly slowing progress towards biology education and undermining the quality of biology education services. Despite the challenges of biology education in Nigeria, some prospects are reviewed under the following headings:

Health Care and Education**:** Biology has many applications, both in the natural environment and the environment of health and education. Studying biology allows health care workers to understand the living systems of the body and to apply the knowledge in direct ways to recover and maintain the physical health of both animal and human patients. Biology education, if improved by the government will help the biology educators to teach the study of life to future generations.

Understanding living system and critical thinking: Biology education will help to increase understanding of living systems and to allow people to consider the system in relationship to self and other organisms in the natural environment.

Employment: Biology education in Nigeria will prepare the Nigeria for a career working in either an educational institution or an industry in which you can be directly involved in the research and development of drugs, food related items and biotechnology. Through biology education one can also become qualified to work for the government in managing an environmental research of animals, river system or biological waste. If biology education is well improved in Nigeria, people will also be able to learn many of the skills needed to succeed in business like in the fishery business.

Programme goals: Biology education will provide a comprehensive education in biology that stress scientific reasoning and problem solving across the spectrum of discipline within biology. It will enrich students with opportunities for alternative education in the area of biology through undergraduate research, internships and studying abroad.

Learning aspect: Biology education will help the learner to be able to read, understand, and critically interpret the primary biological literature in his/her area of interest and to apply basic ethical principles to basic and applied biological/biomedical practice and will understand the role of biology/biomedical science and practitioners in society.

Role of ICT in biology teaching and learning in the 21st century

Biological science deals with the scientific study of living organism in relation to their living environment and various interactions between living things and environment. The traditional

content of biology has been replaced by modern discoveries in the fields of different aspect of biology such as cell biology, basic genetics, and biotechnology and bioremediation. Biology as a subject has both theory and practical aspects. ICT has opened new channels like, online distance learning, e-learning, virtual campuses, e-coaching-education, e-journal, etc. It has provided opportunity for the learner to use maximum senses to get the information (Senthilkumar *et al.*, 2014).

Learning of biology can be made easier and more comfortable by integrating ICT tools in instructional strategies for teaching biology. Many students of biology can make use of ICT for easy understanding. ICT can change conventional classroom into smart classroom or smart city and improve teaching-learning process in biology. ICT simplifies the part of teaching as a visual presentation. The use of ICT in higher education level, the information can be delivered very easily and helps the students to understand the particular topic with proper visualization and enjoy the new learning experiences. ICT has the following advantages; eliminate time barriers in education for learners as well as teachers, eliminate geographical barriers as learners can log on from any place, asynchronous interaction is made possible leading to thoughtful and creative interaction, enhanced group collaboration made possible via ICT, new educational approaches can be applied, it can provide speedy dissemination of education to target groups, it enhances the international dimension of educational services, it allows for just in time and just enough education for employees in organizations, it can also be used for non-formal education like health campaigns and literacy campaigns (Senthilkumar *et al.*, 2014).

2.2 Theoretical Framework

2.2.1 Technology acceptance model (TAM)

Technology adoption and success remain significant for information systems researchers and have been extensively studied by using various theoretical perspectives and models. The most notable model includes the Information System success model, task technology fit model. However, the most widely used model employed by past studies is the Technology Acceptance Model (TAM) that emphasizes technology adoption by individuals based on perceived ease of use and usefulness. The technology acceptance model has been widely employed and empirically tested in past studies of technology acceptance (Turmin *et al.*, 2016).

The technology acceptance model was initially created by Davis (1986) and further developed by Davis *et al.* (1989) with the aim of producing a model for computer technology acceptance based on TRA but excluding subjective norms. Davis (1986) justified the elimination of subjective norms as there is not enough information available to participants about the social influence during the stage of acceptance testing. Figure 2.2 depicts the TAM, which assumes that when someone is introduced to a new technology, his or her decision to use it will be influenced by a number of factors. The extended technology acceptance model (Venkatesh & Davis, 2000) and the unified theory of acceptance and use of technology (Venkatesh *et al.*, 2003) were developed as an extension of the TAM.

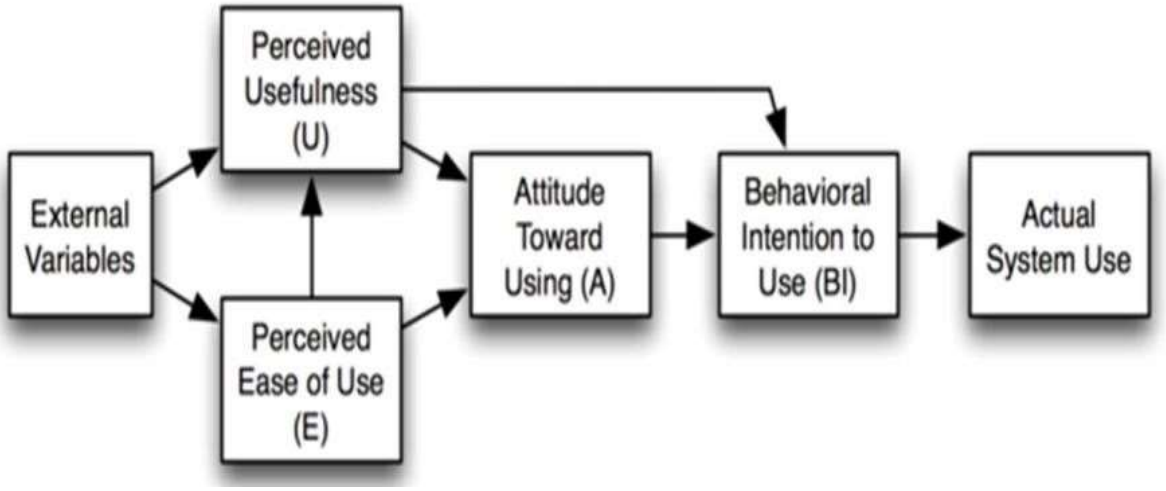

Figure 2.2 Technology Acceptance Model (adopted from Davis *et al.*, 1989)

Primarily, the TAM is composed of five constructs; perceived ease of use (PEOU), perceived usefulness (PU), attitude towards behavior (ATB), behavioural intention (BI), and actual system use (ASU). Figure 2.2 shows that the actual system use is directly influenced by behavioural intention, which is affected by both attitude towards behaviour and perceived usefulness. Attitude towards behaviour is directly influenced by perceived ease of use and perceived usefulness alike. The TAM primarily depends on two variables, perceived ease of use and perceived usefulness, to examine an individual‘s beliefs and attitude toward computer technology acceptance (Davis *et al.*, 1989). Perceived ease of use affects perceived usefulness directly, and both perceived ease of use and perceived usefulness are influenced by external variables. In their final model, Davis *et al.* (1989) eliminated the construct of attitude toward behaviour because of its weak mediation of the effect between perceived usefulness and behavioural intention. Furthermore, the direct influence of perceived usefulness on intention was strong. On the other hand, attitude was not successful in medicating the relationship between perceived ease of use and intention. Figure 2.3 depicts the revised version of the

original TAM. Hence, the study adopted the revised Technology Acceptance Model by Davis *et al.* (1989).

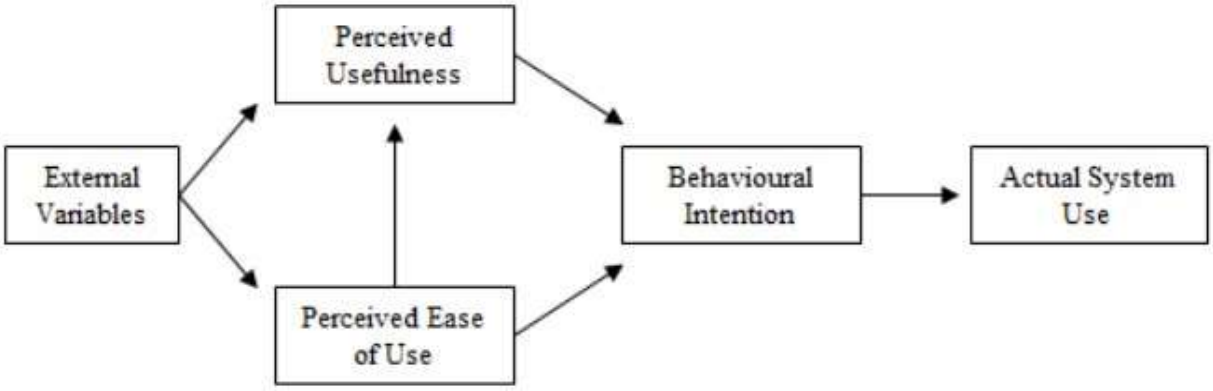

Figure 2.3 Revised Technology Acceptance Model

Source: Davis *et al.* (1989)

Despite the wide adoption, the TAM is not problem-free. First, the TAM has failed to explain the reasons for which an individual would perceive the investigated technology useful (Venkatesh & Davis, 2000) and easy to use (Venkatesh, 2000). Another limitation is that the TAM explained around 40% of variance in behavioural

intention, which was deemed low (Davis *et al.*, 1989; Venkatesh & Davis, 2000). Thus, extending the TAM with external

variables might improve its explanatory power. Finally, previous research has revealed results that are contradicted by the original TAM. For example, Shroff, *et al.* (2011) concluded that perceived usefulness does not influence the students‘

attitude toward using e-portfolios and attitude does not affect behavioural intention.

Furthermore, Muniasamy, *et al.* (2014) found that the students‘ behavioural intention

to use LMS is not affected by their attitude.

2.2.1.1 *The variables of technology acceptance model used in this study*

Perceived usefulness

Davis (1989) defines perceived usefulness as the prospective user‘s subjective probability that using a specific application system will enhance his or her job or life performance. Yaki *et al.* (2020) viewed it as the extent to which an individual believes that using a particular device, system or technology will impact positively on their job performance. Perceived ease of use stands as the key behavioral construct in the technology acceptance model (Davis, 1989). Perceived usefulness is a key construct in the TAM (Davis, 1989). The significance of PU was suggested by various technology models, such as the TAM (Davis, *et al.*, 1989); the A-TAM (Taylor & Todd, 1995a); the TAM2 (Venkatesh & Davis, 2000); the model of PEOU determinants (Venkatesh, 2000); and the TAM3 (Venkatesh & Bala, 2008). Perceived usefulness can be defined as the degree to which an individual believes that utilising the technology under investigation would improve his or her performance (Davis, 1986). For the purpose of this study, PU refers to the extent to which pre-service Teachers think that employing technology-based learning would improve their performance. According to the TAM (Davis, 1989), pre-service Teachers perceiving technology-based learning as useful are more likely to use the system. Compared to other constructs, the meaning of PU is similar to the performance expectancy construct in the UTAUT (Venkatesh, *et al.*, 2003) and the UTAUT2 (Venkatesh, *et al.*, 2012). Perceived usefulness was assumed to be a direct antecedent to BI in various models, such as the TAM, the A-TAM, the TAM2, the model of PEOU determinants, and the TAM3. Furthermore, it was found (Davis, 1993) that PU is a direct determinant of Actual Use. In comparison to PEOU, PU has stronger influence on user intention and behaviour (Davis, 1989). Many studies in the acceptance of e-learning systems

(AlGahtani, 2016; Tarhini, *et al.*, 2017; Almazroi, *et al.*, 2016; Ramírez Anormaliza, *et al.*, 2016; Ma, *et al.*, 2013) supported the same result.

Many studies highlighted the significance of PU in predicting individuals‘ intention to use elearning systems. Using the TAM3, Al-Gahtani (2016) asserted a positive relationship between PU and BI at King Khalid University in Saudi Arabia. With the same model, Almazroi *et al*. (2016) revealed that the Saudi students‘ intention to use cloud e-learning systems is positively influenced by PU. Al-Aulamie (2013) proposed and confirmed the effect of PU on BI in the context of Saudi higher education. More importantly, the statistical analysis revealed that PU is the strongest determinant of BI among the proposed variables. Using the TAM, studies (Alenezi, *et al.*, 2010; Al-Mushasha, 2013; Muniasamy, *et al.*, 2014) demonstrated a positive relationship between PU and BI of e-learning systems in Saudi Arabia. Apart from Saudi Arabia, studies (Abdullah & Toycan, 2017; Tanduklangi, 2017; Tarhini, *et al.*, 2017; Amin, *et al.*, 2016; Hwa, *et al.*, 2015; Mohammadi, 2015; Baharin, *et al.*, 2015; Lee, *et al.*, 2014; Majdalawi, *et al.*, 2014; Tarhini, *et al.*, 2014a) concluded that the students‘ perceived usefulness has a positive influence on their intention to use LMS. The same result was supported with students in an e-learning environment (Shah *et al.* 2013), websites for learning (Sharma & Chandel, 2013), library mobile applications (Yoon, 2016), and e-portfolios (Abdullah *et al.*, 2016). In contrast, Park (2009) found that PU does not have a positive influence on the students‘ intention to use LMS in South Korea. In line with the previous literature with regard to technology acceptance, this research postulates that perceiving technology-based learning useful leads to the pre-service Teachers‘ intention to use the system.

Perceived ease of use

Perceived ease of use is a key construct in the TAM (Davis, 1989). Past studies proclaim that ease of use plays a pivotal role in the actual usage behavior of information-oriented technologies (Akman & Mishra, 2017). The significance of PEOU was suggested by various technology-acceptance theories, such as the TAM (Davis *et al.,* 1989); the A-TAM (Taylor & Todd, 1995a); the TAM2 (Venkatesh & Davis, 2000); determinants of PEOU (Venkatesh, 2000); and the TAM3 (Venkatesh & Bala, 2008). Perceived ease of use can be defined as the extent to which an individual believes that utilising the technology under investigation would not require significant effort (Davis, 1986). In the context of this research, PEOU refers to the extent to which pre-service Teachers feels that using technology-based learning would be easy. In line with the TAM (Davis, 1989), pre-service Teachers perceiving technology-based learning as easy to use, they are more likely to use the system. Furthermore, PEOU was postulated to be an antecedent to PU and BI in various technology models, such as the TAM, the TAM2, the model of PEOU determinants, and the TAM3. Compared to other constructs, the meaning of PEOU is similar to the effort expectancy construct in the UTAUT (Venkatesh, *et al.,* 2003) and the UTAUT2 (Venkatesh, *et al.,* 2012). The influence of PEOU on PU was suggested by various studies. Using the TAM3, Al-Gahtani (2016) asserted a positive relationship between PEOU and PU at King Khalid University in Saudi Arabia. With the same model, a study (Almazroi, *et al.,* 2016) revealed that the Saudi students‘ perceived usefulness of cloud e-learning systems is positively influenced by PEOU. Al-Aulamie (2013) proposed a direct relationship between PEOU and PU to investigate the acceptance of LMS by undergraduate students at three universities in Eastern Region, Saudi Arabia. AlAulamie (2013) used a multivariate analysis technique and confirmed that PEOU is an important

determinant of PU. Sharma and Chandel (2013) revealed a strong relationship between PEOU and BI when students use websites for learning. Concerning e-portfolios, a study

(Abdullah, *et al.*, 2016) demonstrated that the students‘ behavioural intention is positively influenced by PEOU in the United Kingdom. Moreover, studies in the context of e-learning systems concluded an indirect effect of PEOU on BI through PU (Tarhini, *et al.*, 2016; Baharin, *et al.*, 2015). By contrast, Amin *et al.* (2016) concluded that PEOU does not have a positive influence on the students‘ intention to use LMS in Bangladesh. The same result was reached by Baharin *et al.* (2015) with Malaysian students, and Mohammadi (2015) with Iranian students. In library mobile applications, Yoon (2016) revealed that the students‘ perceived ease of use does not have a positive influence on their behavioural intention in South Korea. Following most studies and theories, this research expects that when students perceive technology-based learning (TBL) easy to use, they are most likely to intend to use the TBL.

Perceived ease of use (PEOU) according to Davis (1989), can be defined as the degree to which the prospective user expects the target system to be free of effort. According to TAM, ease of use and perceived usefulness are the most important determinants of actual system use. These two factors are influenced by external variables. The main external factors that are usually manifested are social factors, cultural factors and political factors. Social factors include language, skills and facilitating conditions. Political factors are mainly the impact of using technology in politics and political crisis. The attitude to use is concerned with the user‘s evaluation of the desirability of employing a particular information system application.

Personal moderators

Considering demographic characteristics is important when evaluating technology-based learning systems. Several studies (Claar, *et al.,* 2014; Alenezi, 2011; Al-Gahtani, 2016; Tarhini, *et al.,* 2016; Tarhini, 2013) demonstrated the effect of demographic characteristics on the students‘ acceptance of e-learning systems. Furthermore, understanding the effect of demographic characteristics on technology acceptance may help, in turn, to spread technologies. The moderation effect occurs when one variable (such as gender) affects the strength or direction of a relationship between two variables (Hair, *et al.,* 2017). Venkatesh *et al.* (2003) examined eight models and demonstrated that the explanatory power of six out of the eight models increased after extending the models with moderators. For example, they concluded that after the inclusion of voluntariness, gender, and age as moderators into TPB, the explanatory power was raised to 36%, 46%, and 47%, respectively. The TAM, in particular, was criticised for the lack of moderating variables (Venkatesh, *et al.,* 2003). Venkatesh *et al.* (2003) found that the explanatory power was raised to 52% after the inclusion of a gender moderating effect into the TAM. From a methodological standpoint, investigators usually assume that data were collected from identical participants and analyse the full set of data.

However, this assumption is not always correct (Hair, *et al.,* 2017; Hair, *et al.,* 2018; Sarstedt, *et al.,* 2011). The collected data, in most cases, incorporate a number of varied personal characteristics of users, such as gender, age, educational level, and previous experience. Not considering those differences between users may contribute to incorrect interpretations of the results (Hair, *et al.,* 2012). For example, when the relationship between two constructs is negatively significant for more-experienced participants and positively significant for less-experienced participants, the analysis of the full set of data might not find any significance.

This highlights the importance of investigating the personal differences between the participants. The present study aims to adopt gender as a moderator.

Gender is one of the demographic characteristics that has an influence on individual perception, attitude, and behaviour. Venkatesh, *et al.* (2012) declared that gender plays an important role in explaining user behaviour in information systems. In terms of e-learning, review studies on gender (Goswami & Dutta, 2016; Shaouf & Altaqqi, 2018) found that gender is an important variable in e-learning. Research has uncovered differences between male and female students in perception (Al-Youssef, 2015), patterns of use (Ng & Tan, 2017), and acceptance of LMS (Tarhini, *et al.,* 2014a). Understanding the differences between male and female students toward computer technologies enables teachers to choose the appropriate learning processes for each gender and contributes to the advancements of technologies (Goswami & Dutta, 2016). This is in disagreement with the works of (Arenas-
Gaitán, *et al.*, 2010; Dečman, 2015; Khechine, *et al.* 2014; Raman, *et al.*, 2014; RamírezCorrea, *et al.*, 2015; Wong, *et al.*, 2012) who all concluded that gender does not moderate the use of e-learning systems.

Behavioural intention (BI)

The significance of behavioural intention arises from various theories and models, such as TRA (Fishbein & Ajzen, 1975); TPB (Ajzen, 1985); the TAM (Davis, *et al.* 1989); A-TAM (Taylor & Todd, 1995a); the TAM2 (Venkatesh & Davis, 2000); the model of PEOU determinants (Venkatesh, 2000); and the TAM3 (Venkatesh & Bala, 2008). Behavioural intention can be defined as an individual‘s aim or plan to perform the behaviour (Fishbein & Ajzen, 1975). In the context of this study, BI refers to the pre-service Teachers‘ aim or plan to use technology-based learning in colleges of education. According to technology acceptance

theories, including TRA, TPB, the TAM, the TAM2, the TAM3, and the model of PEOU determinants, BI is the only predictor of AU and provides evidence of the persons‘ willingness to use the technology. In the TAM (Davis, 1989), the actual use of a technology is influenced by a persons‘ intention to use this technology, which is predicted by PEOU and PU. Past literature in e-learning systems indicated that the relationship between BI and AU is well-established. Based on the TAM, studies (Mohammadi, 2015; Baleghi-Zadeh, *et al.*, 2017; Tarhini, 2013) revealed that the students‘ actual use of LMS is positively influenced by BI. Consistent with the previous studies and theories, this research expects that the students‘ intention to use technology-based learning contributes to their actual use of the system.

Behavioral intention according to Davis (1989), is the measure of the likelihood of a person employing the application. Alharbi and Drew (2014) defined it as attitude towards use. It is ones‘ belief (positive or negative) about using a new technology. Here in this study, technology acceptance model (TAM) is used to assess if the pre-service Teachers are ready to accept technology based learning for their study. Their perception (perceived usefulness and ease of use) will influence, greatly, their intention to acceptance technology based learning. Hence, the study employed technology acceptance model (TAM) to assess technology based learning among pre-service Biology teachers in Colleges of Education in Niger State.

2.2.1.2 Reasons for selecting the technology acceptance model

The proposed model for this research is based on the TAM (Davis *et al.*, 1989) and derived from the published literature concerning perception and adoption within the context of educational technologies. The adoption of the TAM stems from, among several others, the following considerations:

The TAM is a well-recognised theory for understanding the acceptance and use of technologies (Alharbi & Drew, 2014; Tarhini, *et al.*, 2014b; Tang & Chen, 2011; Aljeeran, 2016; Al-Busaidi & Al-Shihi, 2010). The TAM has been used to investigate the acceptance of different technologies (such as computer applications, mobiles, email, and Internet) under different situations (like culture and time) with different moderators (such as gender, age, organisations, experience, and educational level) and different users (teachers, students, and professionals). Supporting the popularity of the TAM, Davis (1989) has been cited more than 43,000 times, and the work of Davis *et al.* (1989) has been employed more than 22,300 times, according to Google Scholar (as of January 27, 2019). Nabavi *et al.* (2016) alone reviewed 191 research papers regarding technology continuance intention and found that the TAM is the second most popular model after the information system continuous model. The robustness and effectiveness of the TAM are well established in the field of information systems (Amin, *et al.*, 2016). The TAM has the flexibility to add more variables to the original model and to examine the influence of those external variables on the acceptance and use of technologies in a straightforward manner (Yoon, 2016; Revythi & Tselios, 2019; Aljeeran, 2016).

2.3 Empirical Studies

2.3.1 Studies on perception and demographic characteristics (gender)

Egbo *et al.* (2011) studied gender perception and attitude towards e-Learning: A case of business students, university of Nigeria. The main aim of this research study is to clearly understand and measure students' attitudes and perceptions towards the effectiveness and acceptance of e-learning. In this paper, data from a survey of four hundred and fifteen undergraduate students at the University of Nigeria, Enugu Campus about their attitude and perception to the use of e-learning in teaching, learning and research was analysed. A

descriptive–correlation survey approach was used. Students (n = 415) filled in a web-based closed-question questionnaire. Descriptive and inferential statistics were used to analyze the data using SPSS. Questionnaires received were analyzed putting the students' perceptions in relation to gender, age, knowledge of computers, and attitudes to advantages and disadvantages of e-learning.

Results showed that: majority of the students (respondents) were exposed to computer use prior to the adoption of e-learning; there is the tendency that female students would accept ICT use more than their male counterparts; and finally, their perception on the e-learning components as used in the research has an average rating. It was recommended that Nigerian universities should adopt the use of ICT (e-learning) in their teaching and learning to enhance quality education in our Universities. The major gap between this study and the current study is that, it is carried out in Southern Nigeria (Enugu State), and it measured the attitude and perceptions of business student towards eLearning. Another gaps is, females outperformed their male counterparts.

Taher (2012) conducted a research on ―applying the Technology Acceptance Model to Online Learning in the Egyptian Universities. The purpose of the research is to identify the determinants of students' acceptance of online learning and to investigate how these determinants can shape students' intention to use online learning. A conceptual framework based on the Technology Acceptance Model (TAM) was modified. A questionnaire was developed and used to solicit information from the 153 undergraduate students who used online learning in DBMU. The results reveal that students' perception of ease of use, usefulness, attitudes towards online learning, and the social influence of students' referent group were identified as significant determinants of students' intention to practice online learning. The

possibility of using the social influence of students' referent group, students' perceived ease of use, students' perceived usefulness and their attitudes towards online learning to predict their behavioral intention to use online learning was also confirmed. The only gap that exists between this study and the current is the study scope and geographical scope. The former was carried out on online learning in Egypt, while the latter was on technology-based learning in Niger State, Nigeria.

Okazaki and Renda-dos Santos (2012) conducted a study to ascertain the ―understanding elearning adoption in Brazil: Major determinants and gender effects. The objective of this study is to examine factors influencing e-learning adoption and the moderating role of gender. This study extends the technology acceptance model (TAM) by adding attitude and social interaction. The new construct of social interaction is applied to the South American context. Gender effects on e-learning adoption from educators‘ perspectives have seldom been explored. The data collection takes place in three major Brazilian universities. In total, 446 faculty members responded to the questionnaire. Our structural equation modeling reveals that ease of use and perceived usefulness are significant antecedents of attitude, which in turn affects intention. However, unlike the original TAM, perceived usefulness is not a direct driver of intention. In terms of moderation, gender affects three relationships: (1) ease of use –› perceived usefulness; (2) perceived usefulness –› attitude, and (3) intention –› actual behavior. The analysis is carried out in a single country; thus, caution should be taken in generalization of the results. The findings will help academics, educators, and policy makers to better understand the mechanism of e-learning adoption in Brazil.

Suri and Sharma (2013) worked on ―the impact of gender on attitude towards computer technology and eLearning: An Exploratory Study of Punjab University, India. This study aims

to understand the relationship between gender and attitude towards e-learning. Literature shows that gender plays a key role in understanding the differences in perception towards usefulness of technology and ease of use but with regards to attitude and perception towards e-learning diverse views have been presented. This paper analyses the effect of gender on attitude towards computer technology and e-learning collectively. It also analyses the impact of gender on the usage of the basic e-learning forms like uploading/downloading course content, interactive videos and pod casting. A questionnaire was developed to collect the necessary data. Scale on Computer and e-learning attitude (SCAELA) was constructed and validated. In this study 477 students enrolled in various courses across many departments in Panjab University Chandigarh were analyzed.

The results showed that no significant relationship exists between gender and attitude towards computer and e-learning. The usage of various eLearning forms also showed a nonsignificant relationship with gender. The future developments in e-learning can take note of this finding while developing e-learning tools which are efficient. The major distinguishing factor between this study and the current study is that it aimed to understand the relationship between gender and attitude towards e-learning, the current study investigated the perceived ease of use, usefulness and behavioural intention of pre-service teachers.

The results from the work of Gambari *et al.* (2013) on ―Students‘ perception towards the use of computer-assisted instruction for learning Mathematics In Minna, Niger State, shows that there is no gender difference in the perception of male and female students towards the use of computer-assisted instruction for learning mathematics. This study examined students‘ perception towards the use of CAI for learning mathematics in Minna, Niger State, Nigeria. Gender influence on their perception was also examined. Participants were 540 students (270

male and 270 male) from six secondary schools in Minna, Nigeria. The data were collected through questionnaire and analyzed using percentage, mean, t-test and ANOVA statistics. Findings revealed that majority of the students have positive perception towards the use of CAI. No significant difference among students‘ perception towards the use of CAI for learning mathematics based on school type. Similarly no significant difference was established based on gender. The implication is that the student perceived the use of CAI as a mean of improving their performance in mathematics, therefore, it was recommended among others that adequate ICT infrastructure should be provided with relevant mathematics CAI packages in Nigerian schools. This finding is in agreement with the results of Yusuf and Balogun (2011) which established no significant difference between male and female student-teachers‘ attitudes and use of ICT. This study varies from the current study in that it was carried out on Mathematics and not Biology.

Adeleke and Alaba (2013) researched on ―influence of gender and attitude on pre-service teachers towards on-line instruction in a selected university in South-western Nigeria. The study examined the influence of gender and attitude on pre-service teachers on habitual use of online instruction in faculty of Education at Obafemi Awolowo University, Ile Ife, Nigeria. The sample size of 300 part two Education students (150 male and 150 female) was used as sample for the study. Data were collected using 12 items structured questionnaire. The reliability of the questionnaire was determined using Cronbach Alpha and a reliability coefficient of 0.86 was obtained. The results showed that gender was significant in the usage of online learning. It was also revealed that female Education students showed higher habitual use of online learning than the male. It also revealed that gender significantly influence attitudinal constructs. Female pre-service teachers were found to have higher habitual use. It

was therefore, concluded that gender was a determinant factor in the use of online instruction. Not only this, students‘ actual system usage was determined by their perceived ease of use and usefulness. The most feasible gap between this study and the current study is that gender was a determinant factor, and also the geographic scopes vary.

Bain and Rice (2014) studied ―the influence of gender on attitudes, perceptions, and uses of technology. Data were collected from 59 sixth grade students to examine their attitude towards uses of technology by means of The Computer Survey TCS), computer logs, interviews, classroom observations, field notes, and student work. One of the major findings of the study was that gender differences in attitudes, perceptions, and uses of computers were not found to be significant. The results of this study indicate that gender does affect students‘ attitudes towards technology for the participants of the study. The majority of females do not perceive computers as being difficult for themselves, other females or males. However, several males indicated they were better at using the computer than females.

Ramírez-Correa *et al.* (2015) worked on gender and acceptance of e-Learning: A multi-group analysis based on a structural equation model among college students in Chile and Spain‖. The scope of this study was to evaluate whether the adoption of e-learning in two universities, and in particular, the relationship between the perception of external control and perceived ease of use, is different because of gender differences. The study was carried out with participating students in two different universities, one in Chile and one in Spain. The Technology Acceptance Model was used as a theoretical framework for the study. A multigroup analysis method in partial least squares was employed to relate differences between groups.

The four main conclusions of the study are: (1) a version of the Technology Acceptance Model has been successfully used to explain the process of adoption of e-learning at an undergraduate level of study; (2) the finding of a strong and significant relationship between perception of external control and perception of ease of use of the e-learning platform; (3) a significant relationship between perceived enjoyment and perceived ease of use and between results demonstrability and perceived usefulness is found; (4) the study indicates a few statistically significant differences between males and females when adopting an e-learning platform, according to the tested model. The main difference between this study and the current study is that the former is a correlational study of a European country (Spain) and Western South-American countries (Chile), whereas, the latter only investigated the preservice teachers' perceived usefulness, ease of use and behavioural intention to the use technology in Niger State, Nigeria.

Akturk *et al.* (2015) conducted a study titled ―Analyzing pre-service teachers' attitudes towards technology. The purpose of this study was to analyze attitudes of pre-service teachers towards technology and some variables that predict these attitudes (gender, daily duration of internet use, and the number of technical devices owned). 329 pre-service teachers attending the education faculty of a large university in central Turkey participated, on a volunteer basis, in this study, where relational survey model was used as the research method. Research findings reveal that pre-service teachers' attitudes towards technology are positive and at the same time, the attitudes of male pre-service teachers towards technology are more positive than their female counterparts. As a result of the stepwise multiple regression analysis where factors predicting pre-service teachers' attitudes towards technology, it was found that duration of daily internet use was the strongest predictor of attitudes towards technology. It was

recommended among others that, in order to increase pre-service teachers‘ attitudes towards technology in a positive direction, they should more engage using technologies such as the computer and the internet during their education.

Adedoja and Morakinyo (2016) studied gender influence on undergraduates students‘ acceptance of mobile learning instruction using technology acceptance model (TAM). In this study, 216 undergraduate students of the University of Ibadan were exposed to mobile learning platform using the Technology Acceptance Model. The model contained the following variables: perceived usefulness, perceived ease of use, attitude, peer-influence, behavioural intention to use, interest, technology self-efficacy and acceptance. The paper discussed gender influence on these variables. The results shows that there is no significant difference between male and female pre-service teachers‘ perceived usefulness of mobile learning after their exposure to mobile learning platform ($t = -0.32$; $df = 214$, $P > 0.05$). This implies that both male and female undergraduate student perceived mobile as useful for their learning. It also revealed that there is no significant difference between male and female undergraduate students‘ perceived ease use ($t = -0.41$; $df = 214$; $P > 0.05$), behavioural intention ($t = -1.26$; $df = 214$; $P > 0.05$) and attitude ($t = --0.23$; $df = 214$; $P > 0.05$) of mobile devices for learning after their exposure to mobile learning platform. In conclusion, there is no doubt that gender-related issues would continue to be topics of discourse among academics as far as technology acceptance and use are concerned. This is because all along women are being discriminated against since they are being denied equal opportunities with men. They are often subjected to negative stereotype perception. This study therefore recommended that policy awareness of potential gender difference related to technology use is put in place due to manifest gender differences in the past. Also, there should be policy effort aimed at improving female access

to technology resources. Unlike the foregone study, the finding of the current study revealed there is significant difference between male and female pre-service teacher‘ behavioural intention.

Alambaigi and Ahangari (2016) worked on ―Technology Acceptance Model (TAM) as a predictor model for explaining agricultural experts‘ behavior in acceptance of ICT. This study aimed to develop Technology Acceptance Model (TAM) model to explain adoption of information technologies process, a Descriptive – correlation study was conducted and data were collected through a survey. Statistical population was West Azerbaijan Agricultural Extension agents who 120 of them were selected randomly using the Krejcie and Morgan table. A questionnaire was employed to measure the variables in the model. Its validity was confirmed by a panel of experts. The Cronbach's alpha coefficient ranged between from 0.704 to 0.816 show satisfied reliability. For data processing, partial least squares (PLS) method as a new approach to structural equation modeling was used. The results showed that among three variables for development of technology acceptance model including Job relevance, experience and organization willingness to invest, the first and second show significant effects. Thus, Job relevance and experience as an external variable was added to the basic TAM. Other relations between variables in basic technology acceptance model in current study were also seen significant. Their developed TAM can explain 64% of the actual behavior of employee in information technology utilization. This study was conducted using Agricultural Extensionists‘ behavioural intention towards ICT acceptance in West Azerbaijan which is the most realizable gap to be bridged.

Unal (2017) surveyed pre-service computer teachers‘ tendencies towards the use of mobile technologies: A technology acceptance model perspective. Drawing on the Technology

Acceptance Model (TAM), this exploratory study examines the pre-service teachers‘ adoption of mobile technologies through the factors of current use, instructional use and future use in their teaching practices. Participants were 466 pre-service computer teachers enrolled at a public university in Turkey. A questionnaire developed by the researchers was used to collect data. Results indicated that the current use and instructional use factors had a strong positive correlation and also there was a similar correlation with the factor of future use and current use. Relationships between current, instructional, and future use of mobile technologies explained within the context of perceived usefulness, ease of use, and behavioural intention constructs of the TAM. While TAM is generally used to assess individuals‘ current views or behaviours about accepting or adapting to the new technologies, a conclusion may be derived from this study that TAM may also be useful to explain the tendencies in the future use of technology for different purposes. The statistical population of this study was pre-service computer teachers enrolled at a public university in Turkey, and it was conducted on mobile technology which are the two gaps the researcher tried to fill.

Hussein (2017) conducted a research titled ―Leading to intention: The role of attitude in relation to technology acceptance model in e-Learning. The objective of the study is to investigate the attitude of university students about the use of E-learning based on the Technology Acceptance Model. This research is to analyze the relationship of university students‘ intention to use e-learning with three antecedents include attitude, perceived usefulness and perceived ease of use. A survey method was used to 151 students by using a questionnaire as a tool. Participants were selected using random sampling. The informed consent was obtained from participants as for ethical consideration. Findings indicated that attitude was a significant predictor towards student‘s intention to use ELearning. As a result,

it is seen that students' attitude plays an important role in contributing to the intention to use e-learning system. The relationship between those three constructs: attitude, perceived ease of use and perceived usefulness with intention to use, were analyzed using Pearson correlation and multiple regression analyses. According to the result above, attitude is significant with the intention to use E-learning by having p-value = .003 while perceived ease of use and perceived usefulness were not a significant predictor on the intention to use Elearning. The result also found that attitude is an important factor that contributes to the intention to use E-Learning with a value of $\beta = 0.431$. The results indicate that they have a positive relationship with each other.

Weng *et al.* (2018) conducted a research on ―A TAM-based study of the attitude towards use intention of multimedia among school Teachers. In this study, the technology acceptance model (TAM) was used as the basic model to explore the effects of the information technology (IT) environment on the perceived usefulness, perceived ease of use, and attitude towards using multimedia, and the relevance and influence of these attitudes on behavioral intention. There are 2317 teachers in Chiayi county, and 460 participants were selected by stratified random sampling. The results showed that the ease of use of the multimedia material would enhance the intention to use. The attitude toward use also influences the intention to use.

Sakkathivel and Ramu (2018) investigated the influence of gender over technology acceptance model (TAM) towards using smart phones. The study conducted in the Sultanate of Oman among 296 smart phones users. The study used SEM approach to identify the influence. It was found that; 1) gender elicit a negative influence over perceived usefulness towards using smart phones; 2) male elicit a positive influence over perceived ease of use; 3) female elicit a negative influence over perceived ease of use towards using smart phones.

Todo (2018) worked on ―Applying the technology acceptance model in understanding academics‘ behavior to adopt learning management system in their profession. This paper presents a study using the technology acceptance model (TAM) as an attempt to analyze Indonesian lecturers‘ behavioral intention to use LMS, using the core constructs in TAM; perceived ease of use, perceived usefulness, and attitude toward usage. The study added lecturers‘ field of study and their amount of teaching hours as external variables. The result of this research suggests TAM was applicable in measuring Indonesian lecturers‘ behavioral intention to use LMS. Furthermore, it also confirms the original TAM‘s findings. The study analyzed the data using median and frequency to read respondents PEOU, PU, and A. and recommended that, it would be better if there is a reliability assessment using Cornbach Alpha. The two gaps to be filled in this study are- it attempt to analyze lecturers‘ behavioral intention to use LMS, secondly it was carried out in Indonesian.

Joo *et al.* (2018) studied factors influencing pre-service teachers‘ intention to use technology: TPACK, teacher self-efficacy, and technology acceptance model. This study aimed to investigate structural relationships between TPACK, teacher self-efficacy, perceived ease of use, and perceived usefulness for pre-service teachers who intend to use technology, based on the Technology Acceptance Model (TAM). A total of 296 responses from the College of Education from three Korean universities were analyzed by employing the structural equation modeling methods. The results indicated that pre-service teachers‘ TPACK significantly affected teacher self-efficacy and perceived ease of using technology. The teachers‘ TPACK also positively influenced their perceived ease of using technology and perceived usefulness of technology in the classroom. Finally, teacher self-efficacy, perceived ease of use, and perceived usefulness of using technology affected teachers‘ intention to use technology.

However, TPACK did not directly affect their intention to use technology. Based on the findings, it was suggested that, in future studies, pre-service teachers in elementary schools could be recruited in order to compare those results with the current findings on student middle- and high-schoolteachers. Subsequent research could also examine how teachers use technology in practice.

Vululleh (2018) worked on ―determinants of students‘ e-learning acceptance in developing countries: An approach based on Structural Equation Modeling (SEM). This study validates the extended technology acceptance model by incorporating two intrinsic motivation attributes, namely, quality of life and social influence in developing countries such as Liberia. This quantitative study used an online survey to collect data from 269 secondary and post-secondary students in Liberia (N=269). Responses from the survey were analyzed using the structural equation modeling. The results indicated that student‘s behavioral intention to accept and use e-learning developing countries was significantly affected by their perceived usefulness (β=0.133, $p<0.01$), perceived ease of use (β=0.191, $p<0.01$), quality of life (β=0.412, $p<0.01$) and social influence. It was concluded e that the acceptance and use of elearning in Liberia will be popular among students despite limiting issues previously discussed. This study results also showed that apart from the mechanics of specific technologies involved in such educational solutions, successful implementation of e-learning is also based on behavioral and social factors. The most observable gap to be filled in this study is that it was carried out on e-learning using secondary and post-secondary students in Liberia.

Liao *et al.* (2018) conducted a research on the topic ―applying technology acceptance model (TAM) to explore users‘ behavioral intention to adopt a performance assessment system for e-book production. The study applied technology acceptance model (TAM) to explore the

behavioral intention of students in technological colleges and universities and use a webbased performance assessment system as a tool to evaluate their technical proficiency in ebook production. This study also applied structural equation model as a vehicle to test the hypotheses and relationships in the research to verify external effects of ―computer selfefficacy‖. Results indicated that users‘ perceived usefulness and perceived ease of use could directly affect users‘ willingness to adopt an e-book production assessment system. In particular, the influence of perceived usefulness (0.72) was more significant than that of perceived ease of use (0.30). It was concluded that the technology acceptance model can be applied to explain users‘ willingness to adopt a web-based assessment system. In conclusion, the analysis results of this study indicate that computer self-efficacy has a significant, positive, and direct influence on users‘ perceived usefulness and perceived ease of use. It also indirectly affects users‘ willingness. Therefore, if users‘ computer self-efficacy is improved,

they will consider a web-based e-book production performance assessment system more useful and easier to use. Their willingness to use the system will also increase as a result.

Yaki *et al.* (2020) investigated digital technology in childhood instruction, friend or foe: Childhood Teachers‘ perspective in Minna, Niger State. A descriptive cross-sectional survey was adopted for this study. All childhood educators in Minna Metropolis form the population of the study. 93 children teachers were selected as the sample size using simple random sampling. Three research questions and one hypothesis guided the study. The data were collected using structured questionnaires on teacher's perceived usefulness, ease of use and behavioural intention to use digital technology for children instruction. The instrument was pilot tested and using Cronbach Alpha and the instrument yielded a reliability coefficient of between 0.72, 0.70 and 0.74. The data were analysed using Mean, Standard Deviation and

independent t-test. The findings of the study showed that childhood educators perceived digital technology to be useful for children instruction; their perceived ease of use and behavioural intention to use was also positive. The result also indicated that there is no significant difference in the perceived usefulness between male and female teachers. It was concluded that digital technology is perceived as a friend and not a foe among the population. It was recommended among others that digital technologies and enabling environment to be made available for children instruction. The only gap to be filled in this study is that it investigated digital technology in childhood instruction, using childhood educators in Minna Metropolis as the statistical population.

Lee *et al.* (2020) conducted a research titled ―understanding the interaction between older adults and soft service robots: Insights from robotics and the technology acceptance model. In this regard, they examine soft service robots‘ potential to help care for the elderly. Using an extended technology acceptance model as a theoretical lens, they conducted the study with 79 older adults to examine the degree to which they would accept a soft service robot in the home environment. They performed multiple regression analysis to test the hypothesized model. The predictors explained 66.3 percent of intention‘s variance in the model. In this evaluation, they found perceived ease of use ($\beta = 0.163$; p-value < 0.05), perceived usefulness ($\beta = 0.421$; p-value < 0.01), and subjective norms ($\beta = 0.380$; p-value < 0.01) as significant predictors that positively influenced older adults‘ intention to adopt and use soft service robots. However, they also found that perceived anxiety ($\beta = 0.046$; p-value $= 0.568$) and perceived likability ($\beta = 0.011$; p-value $= 0.901$) did not significantly predict older adults‘ intention to adopt and use soft service robots. We discuss the implications, limitations, and future research directions that arise from these findings.

Mohd and Nur (2021) conducted a study on ―modelling the successful integration of mobile augmented reality technology (MART) among Malaysian pre-service teachers. The Technology Acceptance Model (TAM) was adapted as the theoretical grounding of the study in explaining and predicting pre-service teachers‘ decision to integrate mobile augmented reality technology. Data of the study was gathered from 303 Malaysian pre-service teachers and were analysed using the descriptive analysis of SPSS and Partial Least Square (PLS) of Structural Equation Modelling (SEM). Findings from the study demonstrate that pre-service teachers‘ readiness to integrate MART is at a moderate level. The study also suggested that pre-service teachers‘ perceived usefulness has the most significant direct effect on their decision to integrate MART. On the basis of these findings, users would also perceive the technology as useful and free of effort whenever it able to address their needs and enable greater personalization of the learning experience with it. Hence, systematic consideration should be outlined in ensuring successful design and development process of MART happen. Lastly, the proposed model for Malaysian pre-service teachers‘ MART integration will allow this study to serve as a guide and reference for the teachers, school organizations, teachers training institutions and the government in establishing a standard of successful integration of mobile augmented reality technology (MART) into education system. The two gaps to be filled are; the study was on mobile augmented reality technology (MART) integration among Malaysian pre-service teachers, the pre-service teachers‘ readiness to integrate MART is at a moderate level which is one the reasons that prompted the researcher to conduct the current study on technology-based learning instead.

Emilia and Ravi (2021) researched on a topic ―analysis of the influence of perceived usefulness, perceived ease of use and attitude toward using technology on actual to use halodoc

application using the technology acceptance model (TAM) method approach. Through this research, an analysis of the acceptance of the Halodoc application was carried out using the technology acceptance model (TAM) method approach with the measurement variables used, namely perceived usefulness (usability), perceived ease of use (attitude), attitude toward using technology (attitude), actual to use (actual use). The results of research conducted using linear regression testing stated that partially the perception ease of use variable (effect) had no effect on attitudes towards technology use (attitude), perceptions of ease of use (influenced) had a positive effect on attitudes toward technology use (attitude), then simultaneously, perceptions of usefulness (benefits) and perceptions of ease of use have a positive effect on attitudes toward use of technology (attitudes), and attitudes towards using technology partially have a positive effect on actual use (actual use).

Widanengsih (2021) studied technology acceptance model to measure customer's interest to use mobile banking. This study uses the Structural Equation Model method with SmartPLS 3.0 software, to examine the effect of perceived usefulness and perceived ease of use on attitudes and interests in using M-Banking on respondents, namely 100 state-owned bank customers in Jakarta. The results showed that perceived usefulness has no significant effect on attitudes, perceived ease of use has significant effect on attitudes, perceived usefulness has no significant effect on interest using mobile banking, perceived ease of use has no significant effect on interest using mobile banking and attitudes have significant effect on interest using mobile banking. In this study, the data analysis used was partial least square analysis; the data used was obtained by distributing questionnaires to respondents. Quantitative data is data in the form of computable numbers, which is obtained from the calculation of the questionnaire that will be carried out related to the problem under study. Data analysis was performed using

the component-based SEM method using PLS as the analytical tool in this study. In the use of the PLS method, an indicator is declared valid if it has a loading factor above 0.70 against the intended construct. Based on the test results the perceived usefulness variable is 7 statements, perceived ease to use variable is 7 statements, attitudes variable is 8 statements and interest using mobile banking is 6 statements. Of the four variables, all statements are declared valid because all of them have a loading factor above 0.70. The main gaps the researcher intended to fill are those of the study scope and geographic coverage of the study. On a general note, after reviewing all the literatures under empirical studies the researcher observed that none of these studies was conducted on technology-based learning in the Nigerian context. Only few of them were conducted in

Nigeria (Niger State specifically), but majority of the studies were carried out in Asian and Southern-American countries.

2.3.2 Summary of Literature Review

This chapter assessed technology-based learning among pre-service Biology teachers in Colleges of Education. The discussion covers a range of topics including information and communication technology (ICT) in the contemporary world, the benefits of using ICT in education, constraints to the use of ICT in teaching biology, the concept and nature of technology-based learning, the continuum of technology-based learning, the benefits and challenges of technology-based learning, the factors affecting Nigeria's technological growth, modes and tools of technology-based learning, the advantages of using audio and video in teaching, perspectives on the use of technology in education, barriers to the use of technology in education, motivating students through technology use in school, perceptions of technology in daily life, integrating technology into classrooms, creating student-centered learning

environments, digital technology, the concept and nature of Biology, the objectives of Biology education, the challenges and prospects of Biology education in Nigeria, and the role of ICT in Biology teaching and learning in the 21st century.

To support this study, the Technology Acceptance Model (TAM) was used as a theoretical framework. TAM emphasizes the adoption of technology by individuals based on their perceived ease of use and usefulness. The model was developed to investigate the behavior of users of new technology. The study adopted TAM to assess technology-based learning among pre-service biology teachers. The literature review revealed several studies on gender, perception, and attitude towards e-learning, as well as the impact of gender on the attitude towards computer technology and e-learning. Other studies included applying the Technology Acceptance Model to Online Learning, understanding e-learning adoption , students‘ perception towards the use of computer-assisted instruction for learning Mathematics, influence of gender and attitude on pre-service teachers towards on-line instruction, the influence of gender on attitudes, perceptions, and uses of technology, gender and acceptance of e-Learning, analyzing pre-service teachers‘ attitudes towards technology, gender influence on undergraduates students‘ acceptance of mobile learning instruction, Technology Acceptance Model (TAM) as a predictor model for explaining agricultural experts behavior in acceptance of ICT, pre-service computer teachers‘ tendencies towards the use of mobile technologies, the role of attitude in relation to technology acceptance model in e-Learning, a TAM-based study of the attitude towards use intention of multimedia among school Teachers, the influence of gender over technology acceptance model (TAM) towards using smart phones, applying the technology acceptance model in understanding academics‘ behavior to adopt learning management system in their profession.

The study also reviewed literature on factors influencing pre-service teachers‘ intention to use technology, determinants of students‘ e-learning acceptance in developing countries, applying technology acceptance model (TAM) to explore users‘ behavioral intention to adopt a performance assessment system for e-book production, digital technology in childhood instruction, friend or foe: Childhood Teachers‘ perspective, understanding the interaction between older adults and soft service robots: Insights from robotics and the technology acceptance model, modelling the successful integration of mobile augmented reality technology (MART), analysis of the influence of perceived usefulness, perceived ease of use and attitude toward using technology on actual to use halodoc application, using technology acceptance model to measure customer's interest to use mobile banking.

However, the literature review revealed five gaps in the research. First, there was a lack of literature on technology-based learning. Second, there was a lack of literature on the perceived usefulness of technology-based learning. Third, there was a lack of literature on the perceived ease of use of technology-based learning. Fourth, there were few literatures on the behavioral intention of pre-service teachers' technology-based learning in Nigerian Colleges of Education. Fifth, most of the studies were carried out outside Nigeria and out of the few ones that were carried out in Nigeria, only two were conducted in Niger State. This study aims to fill these research gaps and extend the existing knowledge by assessing technology-based learning among pre-service biology teachers in Colleges of Education in Niger State. The literature reviewed provides a basis for this research and concludes with an identification of the research gaps.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY 3.1 Research Design

This study adopted a cross-sectional survey design. Surveys are conducted to gather information that reflects the population‘s attitudes, behaviors, opinions, and beliefs that cannot be observed directly. The success of survey research depends on how closely the answers that

people give to survey questions match how people think and act in reality (Arevik, 2014). In a cross-sectional design, data are collected from many different individuals at one point in time, the researcher can only observe variables without influencing (manipulating) them. It is a cost-effective and easy way to gather initial data and identify correlations that can then be explored in a longitudinal study (Thomas, 2020). Cross-sectional studies are the most dominant design because of budget limitations, time restrictions, and the required effort (Sekaran & Bougie, 2016). For this reason, a crosssectional design was selected; thus, data were collected only once within a specific period. This decision was because using a longitudinal design to collect data several times over a period was beyond the resources (time and cost) available for this research.

3.2 Population of the Study

The population of this study comprises of 2452 pre-service Biology teachers in Colleges of Education in Niger State, and the target population is 897 NCE II pre-service Biology teachers. This is because they have spent one academic session in the school and have covered a large volume of the syllabus, hence the desired result is guaranteed. The population is presented in a tabular form below;

Table 3.1 Population of all pre-service Biology teachers in Colleges of Education in Niger State.

S/N	INSTITUTION	POPULATION
1	College of Education, Minna	1379
2	Federal College of Education, Kontagora	1073

TOTAL	**2452**

Source; (Head of Department office 2021)

Table 3.2 Population distribution of NCE II pre-service Biology teachers according to course combinations.

S/N	INSTITUTION	COURSE COMBINATION	POPULATION
1	College of Education, Minna	Bio/Chemistry	201
		Bio/Computer	98
		Bio/Integrated Sci	153
		Bio/Math	07
2	Federal College of Education, Kontagora	Bio/Chemistry	180
		Bio/Math	09
		Bio/Integrated Sci	168
		Bio/Physics	55
TOTAL		**897**	

Source; (Departmental examiners' office 2021)

3.3 Sample and Sampling Techniques

The sample size of this study is 277 pre-service Teachers, which was determined using Taro Yamene's formula for sample size determination mathematically expressed as;

$$n = \frac{N}{1 + N(e)^2}$$

Where;

N:- in this study, signifies the target population

n:- signifies the sample size e:- signifies the

acceptable sampling error (0.05).

The study adopted a multi-stage sampling technique to carefully select the respondents. Purposive sampling was employed to select two Colleges of Education (C.O.E Minna and F.C.E Kontagora) because they are the only colleges that offer Biology courses. NCE II preservice teachers were then randomly selected using simple random sampling method.

3.4 Research Instrument

The instrument for data collection for this study is an adapted structured questionnaire. The questionnaire is titled ―Questionnaire on Assessing Technology-Based Learning among preservice Biology teachers (QATAPBT), in accordance with the research questions raised and the literatures reviewed. The instrument was used to elicit information on Technology-Based Learning among Pre-Service Biology Teachers in the study area. QATAPBT consist of four sections (Sections A, B, C and D). Section A was used to collect respondents‘ demographic information, section B contained 10 items on pre-service teachers‘ perceived usefulness of technology-based learning, C contained 10 items on pre-service teachers‘ perceived ease of use and D contained 10 items on behavioural intention of pre-service teachers. A 5 point Likert scale of Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD) was used and was rated from 5 points to 1 point. A decision rule was set in which grand mean score of 3.0 was the bench mark for agree while grand mean score below 3.0 was considered as disagree. The questionnaire yielded a reliability coefficient index of 0.83, 0.79 and 0.83 for perceived usefulness, perceived ease of use and behavioral intention respectively. This shows that the instrument was highly reliable for the study.

3.5 Validity of the Research Instrument

The instrument for data collection was validated by experts from Educational Technology and Science Education Departments of Federal University of Technology, Minna, and a

psychologist from FCT College of Education, Zuba. The drafted questionnaire was given to the experts for face and content validity to ascertain the appropriateness of the questionnaire items. All the corrections, suggestions and modifications made were effected in the final draft.

3.6 Reliability of the Research Instrument

To ascertain the reliability of the instrument for this study, 20 NCE III pre-service biology teachers from College of Education, Minna that are part of the population but not part of the sample were chosen randomly and used for pilot study. Cronbach Alpha method was used to determine internal consistency of items and it yielded a reliability coefficient index of 0.83, 0.79 and 0.83 for perceived usefulness, perceived ease of use and behavioral intention respectively. This agrees with Taber, (2016) who reported that Cronbach alpha scores greater than 0.70 are considered as indicative of acceptable reliability.

3.7 Method of Data Collection

The researcher took ethical and administrative measures before starting the study. Approval was obtained from the colleges and departments under study by presenting introductory letters from the Head of Department of Educational Technology at the Federal University of Technology, Minna. The letters clearly stated the purpose of the researcher's visit to the schools. To ensure a high response rate, the questionnaires were administered with the assistance of research assistants who were familiar faces to the students from each college under review. Two days before the questionnaire administration, the researcher informed and prepared each research assistant in the colleges under study. The researcher then visited the colleges with 300 copies of the questionnaires, which were handed out to the respondents by

the research assistants. After completion, 277 of the returned questionnaires were used for analysis.

3.8 Method of Data Analysis

The data collected were analysed using descriptive and parametric inferential statistical tools. Descriptive statistics such as Mean and Standard Deviation were used to answer the research questions. The data for the hypotheses were converted from ordinal to interval scale and independent sample t-test was used to test the null hypotheses raised at 0.05 level of significance. The analysis was carried out using Statistical Package of Social Science (SPSS Version 21).

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Answers to Research Questions

4.1.1 Research question one

What is the pre-service Biology teachers‘ perceived usefulness of technology-based learning in Colleges of Education in Niger State?

To answer this research question, the mean and standard deviation was employed, and the analysis is presented in Table 4.1

Table 4.1: Mean and Standard Deviation of pre-service Biology teachers perceived usefulness of technology-based learning

S/No	ITEMS	N	X	Std	Decision
1	Technology-based learning makes me think critically on how to achieve my learning objectives.	277	4.08	.435	Agree
2	experience fulfillment each time I download biology lecture materials online.	277	4.17	.379	Agree
3	Technology-based learning motivate me to learn, thereby enriching my understanding of the concepts of Biology	277	4.22	.413	Agree
4	Technology-based learning provide a stimulating Biology learning environment, and utilizing it is such a good idea	277	4.10	.382	Agree
5	Technology-based learning captivates learners‘ attention during learning through graphics and pictures	277	4.14	.348	Agree
6	experience technophobia (technological anxiety) when utilizing technology-based learning platform to study Biology	277	2.21	.824	Disagree
7	Technology-based learning maximizes interactivity among students. Utilizing it in the teaching and learning of Biology will enhance creativity	277	4.08	.362	Agree
8	People remember less of what they hear, more of what they see and hear, and most of what they see, hear and do. The fact that the computer can exercise	277	4.06	.334	Agree

	various senses and present information in a variety of media can enhance the learning process				
9	The potential benefit of technology-based learning is accompanied with some challenges that may have negative impact on the learners, hence the aim of integrating it into teaching and learning of Biology might be defeated	277	2.21	.803	Disagree
10	Using technology is an innovation, I will seek opportunities to adopt it for learning of Biology concepts	277	4.10	.302	Agree
	Grand Mean		**3.74**		**Agree**

Table 4.1 shows the results of pre-service Biology teachers‘ perceived usefulness of technologybased learning. The average mean of 3.0 was the bench mark for agree and less than 3.0 for disagree on each item. Consequently, items 1-5, 7, 8 and 10 shows the mean of between 4.08– 4.22 and the grand mean of 3.74, indicating that technology-based learning is perceived as useful for learning of Biology concepts. The finding of item 6 (X=2.21) and 9 (X=2.21), which are negative items show that the respondents did not agree that they experience technophobia when utilizing technology-based learning and the aim of integrating it into teaching and learning of Biology might be defeated.

4.1.2 Research question two

What is the pre-service Biology teachers‘ perceived ease of use of technology-based learning in Colleges of Education?

Mean and standard deviation was used to answer this research question, and the analysis is presented in Table 4.2

Table 4.2: Mean and Standard Deviation of pre-service Biology teachers' perceived ease of use of technology-based learning

S/No	ITEMS	N	X	Std	Decision
1	I can use technology to learn with less or without any form of assistance.	277	3.60	.763	Agree
2	Utilizing technology-based learning for learning Biology is easy and user friendly	277	4.17	.379	Agree
3	I find technology-based learning very flexible for learning Biology concepts	277	4.22	.413	Agree
4	Using digital technology is easy, simple and understandable	277	3.58	.778	Agree
5	I get stressed by the use of digital technologies for learning purpose	277	2.58	.850	Disagree
6	I find it cumbersome to use digital technologies	277	1.91	.371	Disagree
7	I need to consult the user manual often when using digital technologies	277	1.97	.293	Disagree
8	Revising my course-wares is easier with technology-based learning	277	3.57	.798	Agree
9	I find it easy to recover from errors encountered while using digital technologies	277	3.60	.763	Agree
10	I am rarely frustrated when using the digital technologies	277	3.77	.622	Agree
	Grand Mean		**3.30**		**Agree**

Table 4.2 presents the results of pre-service Biology teachers' perceived ease of use of technology-based learning. The average mean of 3.0 was the bench mark for agree and less than 3.0 for disagree on each item. However, items 1–4 and 8–10 shows the mean of between 3.57– 4.22, and the grand mean of 3.30, indicating that technology-based learning is perceived as easy to use in learning of Biology concepts. The finding of item 5-7 (X=2.58, 1.91 & 1.97), which are negative items show that the respondents did not agree that they; get stressed, found it cumbersome, need to consult the user manual often when using digital technologies.

4.1.3 Research question three

What is the behavioural intention of pre-service Biology teachers towards technology-based learning in Colleges of Education?

Mean and standard deviation was used to answer this research question, and the analysis is presented in Table 4.3

Table 4.3: Mean and Standard Deviation of the behavioural intention of pre-service Biology teachers towards technology-based learning

S/No	ITEMS	N	X	Std	Decision
1	I consider technology-based learning as innovation, and I am ready to adopt it for learning of Biology	277	4.12	.418	Agree
2	I believe that I possess adequate skills to use digital technologies for learning of Biology	277	3.71	.635	Agree
3	Based on my experience, I am very likely to use digital technologies in my learning	277	4.11	.502	Agree
4	I think it is valuable to use technological tools in learning.	277	4.14	.348	Agree
5	I am ready to accept and adopt technology-based learning for all Biology courses with enabling environment	277	4.14	.348	Agree
6	It is a positive influence for me to use technology in learning of Biology concepts	277	4.04	.204	Agree
7	Technology-Based Learning would increase my level of productivity	277	4.14	.348	Agree
8	I basically intend to utilize technology-based learning for learning Biology	277	4.10	.302	Agree
9	I plan to use technology-based learning very often in future learning	277	3.96	.196	Agree
10	I will recommend the utilization of technologybased learning in the Biology classes	277	4.07	.259	Agree
	Grand Mean		**4.05**		**Agree**

Table 4.3 presents the results of the behavioural intention of pre-service Biology teachers towards technology-based learning. The average mean of 3.0 was the bench mark for agree and less than 3.0 for disagree on each item. The results indicates that, items 1-10 shows the grand mean of 4.05,

translating that pre-service Biology Teachers have positive attitude towards technology-based learning.

4.1.4 Research question four

What is the male and female pre-service Biology teachers‘ perceived usefulness of technologybased learning in Colleges of Education?

Mean and standard deviation was used to answer this research question, and the analysis is presented in Table 4.4.

Table 4.4: Mean and Standard Deviation of male and female pre-service Biology teachers perceived usefulness of technology-based learning.

Gender	N		Std. Deviation	Mean Difference
Male	127	37.55	1.91	
				0.34
Female	150	37.21	2.30	

Table 4.4 shows the mean and standard deviation of male and female pre-service Biology teachers perceived usefulness of technology-based learning. From the result, the mean with standard deviation of male pre-service Biology teachers are $\bar{X}$ = 37.55 and SD = 1.91 while the mean with standard deviation of female pre-service Biology teachers are $\bar{X}$ = 37.21 and SD =

2.30 with a mean difference of 0.34 in favour of the female pre-service Biology teachers. This shows that female had higher mean rating than their male counterparts on the perceived usefulness of technology-based learning.

4.1.5 Research question five

What is the male and female pre-service Biology teachers‘ perceived ease of use of technologybased learning in Colleges of Education?

Mean and standard deviation was used to answer this research question, and the analysis is presented in Table 4.5.

Table 4.5: Mean and Standard Deviation of male and female pre-service Biology teachers perceive the ease of use of technology-based learning.

Gender	N		Std. Deviation	Mean Difference
Male	127	32.83	2.53	
				0.28
Female	150	33.11	2.54	

Table 4.5 shows the mean and standard deviation of male and female pre-service Biology teachers perceived ease of use of technology-based learning. From the result, the mean with standard deviation of male pre-service Biology teachers are $\bar{X}$ = 32.83 and SD = 2.55 while the mean with standard deviation of female pre-service Biology teachers are $\bar{X}$ = 33.11 and SD =

2.54 with a mean difference of 0.28 in favour of the female pre-service Biology teachers. This shows that female had higher mean rating than their male counterparts on the perceived ease of use of technology-based learning.

4.1.6 Research question six

What is the behavioural intention of male and female pre-service Biology teachers towards technology-based learning in Colleges of Education?

Mean and standard deviation was used to answer this research question, and the analysis is presented in Table 4.6.

Table 4.6: Mean and Standard Deviation of male and female pre-service Biology teachers' behavioural intention towards technology-based learning.

Gender	N		Std. Deviation	Mean Difference
Male	127	40.88	1.64	
				0.64
Female	150	40.24	1.56	

Table 4.6 shows the mean and standard deviation of male and female pre-service Biology teachers' behavioural intention towards technology-based learning. From the result, the mean with standard deviation of male pre-service Biology teachers are $\bar{X}$ = 40.88 and SD = 1.64 while the mean with standard deviation of female pre-service Biology teachers are $\bar{X}$ = 40.24 and SD = 1.56 with a mean difference of 0.64 in favour of the male pre-service Biology teachers. This shows that male

had higher mean rating than their female counterparts on the behavioural intention towards of technology-based learning.

4.2 Testing of Research Hypotheses

Three research hypotheses were formulated and tested at 0.05 level of significance, using independent samples t-test as follows:

4.2.1 Hypothesis one

There is no significant difference in the mean response of male and female pre-service Biology teachers' perceived usefulness of technology-based learning**.**

Table 4.7: Independent samples t-test of male and female pre-service Biology teachers' perceived usefulness of technology-based learning.

Gender	N	df		Std. Deviation	t-value	p-value
Male	127		37.55	1.91		
		275			1.315	0.190 ^{ns}
Female	150		37.21	2.30		

NS: Not Significant at 0.05 (p>0.05) level of significance

Table 4.7 shows that there is no significant difference between male and female pre-service teachers' perceived usefulness of technology-based learning ($t = -1.315$; $df = 275$, $P > 0.05$). Hence, the null hypothesis was not rejected. This implies that both male and female pre-service teachers' perceived technology-based learning as useful for their learning. This could be attributed to the fact that most of them possess or have access technology devices and they can access their learning content on the go.

4.2.2 Hypothesis two

There is no significant difference in the mean response of male and female pre-service Biology teachers‘ perceived ease of use of Technology-based learning.

Table 4.8: Independent samples t-test of male and female pre-service Biology teachers' perceived ease of use of technology-based learning.

Gender	N	df		Std. Deviation	t-value	p-value
Male	127		32.83	2.53		
		275			-.937	0.349 [ns]
Female	150		33.11	2.54		

NS: Not Significant at 0.05 (p>0.05) level of significance

Table 4.8 shows that there is no significant difference between male and female pre-service Biology teachers‘ perceived ease of use of technology-based learning platform (t = -.937; df = 275; P > 0.05). This implies that both male and female pre-service Biology teachers‘ found it easy to use technology-based learning for their learning. Hence, the null hypothesis was not rejected. This could be attributed to the fact that most of them are digital natives, only a few are digital immigrants.

4.2.3 Hypothesis three

There is no significant difference in the mean response of male and female pre-service Biology teachers‘ behavioural intention towards technology-based learning.

Table 4.9: Independent samples t-test of male and female pre-service Biology teachers' behavioral intention towards technology-based learning.

Gender	N	df		Std. Deviation	t-value	p-value
Male	127		40.88	1.64		
		275			3.330	0.001 sig
Female	150		40.24	1.56		

Sig: Significant at 0.05 ($p<0.05$) level of significance

Table 4.9 shows that there is significant difference between male and female pre-service Biology teachers' behavioral intention towards technology-based learning ($t = 3.330$; $df = 275$; $P < 0.05$). Hence, the null hypothesis was rejected. This means that both male and female pre-service Biology teachers have different behavioural intention towards technology-based learning.

4.3 Summary of Findings

The following are the summary of findings:

i. pre-service Biology teachers in Colleges of Education in Niger State perceive technology-based learning useful for their studies. ii. pre-service Biology teachers in Colleges of Education in Niger State perceive technology-based learning to be easy to use.

iii. pre-service Biology teachers in Colleges of Education in Niger State have positive attitude towards technology-based learning and are ready to use it very often in their future learning .

iv. there is no significant difference in the mean response of male and female pre-service

Biology teachers‘ perceived usefulness of technology-based learning**.**

v. there is no significant difference in the mean response of male and female pre-service biology teachers‘ perceived ease of use technology-based learning.

vi. there is significant difference in the behavioural intention of male and female pre-service biology teachers towards technology-based learning.

4.4 Discussion of the Findings

The study's findings clearly demonstrate that pre-service biology teachers view technology-based learning as highly valuable for comprehending biology concepts. These findings are consistent with the research of Al-Aulamie (2013), which identified perceived usefulness as the most significant determinant of behavioural intention among the proposed variables. Additionally, Muniasamy *et al.* (2014) showed a positive relationship between perceived usefulness and behavioural intention of e-learning systems in Saudi Arabia, while Abdullah and Toycan (2017) and Tanduklangi (2017) concluded that students' perceived usefulness has a positive influence on their intention to use LMS. Similarly, students in an e-learning environment (Shah *et al.,* 2013), websites for learning (Sharma & Chandel, 2013), library mobile applications (Yoon, 2016), and e-portfolios (Abdullah *et al.,* 2016) all reported the same result. Liao et al. (2018) discovered that users' perceived usefulness and perceived ease of use could directly impact their willingness to adopt an e-book production assessment system, while Mohammed *et al.* (2019) found that students perceived the usefulness and ease of use of the WhatsApp platform for learning biology to be positive. Furthermore, pre-service public undergraduate teachers have a positive perception of computer-based examinations (Yaki & Gaiya, 2020), and preservice teachers have positive perceptions regarding the perceived ease of use, perceived usefulness, and behavioural intentions to adopt Computer-Based Examination. Akhigbe *et al.* (2021) disclosed that pre-service teachers have positive perceptions regarding the perceived ease of use, perceived usefulness and

behavioural intentions to adopt collaborative mobile learning as a pedagogical alternative to face-to-face instruction. This research contradicts the findings of Park (2009), who found that perceived usefulness does not have a positive influence on students' intention to use LMS in South Korea. However, in line with previous literature regarding technology acceptance, this research posits that perceiving technology-based learning as useful leads to pre-service teachers' intention to use the system. It is noteworthy that Nikolopoulou and Gialamas (2013) reported teachers' negative attitudes towards digital technology for teaching, which could be attributed to their negative perceptions of it.

The study also found that pre-service Biology teachers perceive technology-based learning to be easy to use. This agrees with the results of Sharma and Chandel (2013) who revealed a strong relationship between perceive ease of use and behavioural intention when students use websites for learning; Abdullah, *et al.* (2016) who demonstrated that the students‘ behavioural intention is positively influenced by perceive ease of use in the United Kingdom. Moreover, studies in the context of e-learning systems concluded an indirect effect of perceived ease of use on behavioural intention through perceived usefulness (Tarhini, *et al.,* 2016; Baharin, *et al.,* 2015). It also concurs with the findings of Yaki *et al.* (2020) who found that digital technology is easy to use for children instruction and the teachers have a positive intention to use digital devices in their classroom. By contrast, Amin *et al.* (2016) concluded that perceived ease of use does not have a positive influence on the students‘ intention to use LMS in Bangladesh. The same result was reached by Baharin *et al.* (2015) with Malaysian students, and Mohammadi (2015) with

Iranian students. In library mobile applications, Yoon (2016) revealed that the students‘ perceived ease of use does not have a positive influence on their behavioural intention in South Korea. Weng *et al.* (2018) showed that the ease of use of the multimedia material would enhance the intention

to use. Following most studies and theories, this research expects that when students perceive technology-based learning (TBL) easy to use, they are most likely to intend to use the TBL.

The study further reveals that pre-service teachers have a positive behavioural intention towards technology-based learning. This finding supports that of Alharbi and Drew (2014) who conducted a research study on the use of Technology Acceptance Model to examine academics‘ behavioural intention to use technology such as learning management systems. They found that respondents‘ perceived usefulness, perceived ease of use, and behavioural intention towards technology integration was positive. This finding could be attributed to pre-service teachers perceive usefulness and ease of use of digital technology which could have influenced their intention to adopt technology-based learning. Taher (2012) reveal that students' perception of ease of use, usefulness, attitudes towards online learning, and the social influence of students' referent group were identified as significant determinants of students' intention to practice online learning. Akturk *et al.* (2015) found that pre-service teachers‘ attitudes towards technology are positive and at the same time, the attitudes of male pre-service teachers towards technology are more positive than their female counterparts. To negate this finding, Hussein (2017) brought forth that perceived ease of use and perceived usefulness were not a significant predictor on the intention to use E-learning.

The study also found that there is no significant difference in the mean response of male and female pre-service teachers‘ perceived usefulness and perceived ease of use of technology-based learning. The findings vindicated the claims of Adedoja and Morakinyo (2016) who indicated that there is no significant difference between male and female pre-service teachers‘ perceived usefulness of mobile learning after their exposure to mobile learning platform. It also revealed that there is no significant difference between male and female undergraduate students‘ perceived ease use. Sakkathivel and Ramu (2018) who also found that; 1) gender elicit a negative influence over

perceived usefulness towards using smart phones; 2) male elicit a positive influence over perceived ease of use; 3) female elicit a negative influence over perceived ease of use towards using smart phones. It also corresponds to the findings of Nwanchukwu, (2019) who pointed that there is no significant difference in the mean response of male and female preservice teachers‘ perceived usefulness, perceived ease of use, attitude, self-efficacy and level of preparedness towards electronic teaching in Niger State

In disparity, Egbo *et al.* (2011) showed some level of discrepancy by saying that there is the tendency that female students would accept ICT use more than their male counterparts. Adeleke and Alaba (2013) showed that gender was significant in the usage of online learning. It was also revealed that female Education students showed higher habitual use of online learning than the male. It also revealed that gender significantly influence attitudinal constructs. Female preservice teachers were found to have higher habitual use. It was therefore, concluded that gender was a determinant factor in the use of online instruction. Suri and Sharma (2013) found also that no significant relationship exists between gender and attitude towards computer and e-learning. Ramírez-Correa *et al.* (2015) indicates a few statistically significant differences between males and females when adopting an e-learning platform. The study also found that there is significant difference in the mean response of male and female pre-service teachers‘ behavioural intention towards technology-based learning. This negates the claim of Quadri and Aniah (2021) who stated that there was no significant difference between attitude of male and female lecturers‘ on the use of mobile technologies for instructional delivery in Colleges of Education. Eyo, (2021) indicated that there was no significant difference between male and female secondary school biology teachers‘ on attitude to the use information communication technology (ICT) in teaching.

CHAPTER FIVE 5.0 CONCLUSION AND RECOMMENDATIONS 5.1 Conclusion

Based on the findings of this study, it can be concluded that technology-based learning is perceived by pre-service teachers as both useful and easy to use. Furthermore, their intention to adopt

technology-based learning is positive. Technology is seen as a useful tool that can enhance learning at all levels of education. Therefore, integrating technology into classroom instruction is an important topic in educational discourse. The findings show that technology has infiltrated the personal and instructional life of pre-service teachers, as demonstrated by their positive perception and intention to integrate technology into classroom instruction. Respondents perceived technology to have no or minimal negative effects, making technology-based learning a friend rather than a foe.

The study found no significant differences between male and female pre-service teachers in their perceived usefulness and ease of use of technology-based learning. However, there were slight differences in the mean response of their intention to adopt technology-based learning. Gender did not play a significant role in respondents' perception, suggesting that pre-service teachers, regardless of gender, have a positive perception towards technology-based learning. This study provides a theoretical understanding of pre-service teachers' perception of technology-based learning. Effective technology integration must begin at the very first stage, ensuring that preservice teachers can make the best use of it. Proper implementation and support by school management are crucial for the success of technology-based learning. Teachers must be given time to learn and explore technology-based learning, facing the "trial-and-error" phase before they are completely comfortable with its usage for teaching and learning. Technology-based learning components promote active learning and ownership of the learning experience for students. It provides students with immediate opportunities to research topics they are studying in class and build on information acquired from traditional classroom instruction. The use of technology in teaching and learning is more about practicality than theories, and it can provide students with access to the best programs offered by a variety of educational institutions.

5.2 Recommendations

The following recommendations were made based on the findings of this study:

i. according to the study, technology-based learning is both useful and easy for pre-service teachers to use. Therefore, lecturers should consider utilizing it in the classroom to enhance teaching, stimulate interest, and improve academic performance. In order to effectively implement technology-based learning, devices should be provided for use in Colleges of Education.

ii. the study also found that pre-service teachers have a positive attitude towards technologybased learning. Therefore, the National Commission for Colleges of Education and other stakeholders should create an enabling environment for their effective use of technologybased learning platforms. Regular orientations, symposia, conferences, seminars, and workshops should be organized to keep pre-service teachers up-to-date with the latest technological trends.

iii. gender-related issues are still a concern when it comes to technology acceptance and use. Policymakers should be aware of potential gender differences related to technology use and take steps to address them. Teachers should also encourage all students, regardless of gender, to feel confident about using computers.

iv. to support the integration of technology into education, government, non-governmental organizations, alumni associations, and other association should provide schools with necessary infrastructure, such as computer systems, software, manpower, and routine maintenance.

v. additionally, more research should be conducted in this field, and funding should be provided by organizations such as the National Educational Research and Development Agency and other research institutes.

vi. finally, these findings can serve as a reference point for future research on technology integration in education.

5.3 Contributions to Knowledge

The study has added to the pool of knowledge in the following ways:

i. the study has pointed out the potential benefits of adopting technology-based learning for instructions at all levels of education; ii. it has added to the pool of knowledge and provided a reference point for other researchers to build upon in the search for knowledge and sharing of ideas;

5.4 Suggestions for Further Studies

Based on the experience gathered during the course of this study, the following were suggested for future research:

i. this study was carried out on ―assessing technology-based learning among pre-service Biology teachers in colleges of education in Niger State‖. Therefore, similar studies could be replicated in other tertiary institutions in other states of the Federation with larger samples; ii. the study also employed technology acceptance model by Davis, (1989), therefore, other technology acceptance models could be used as a basis for determining relevance of technology-based learning in learning Biology;

iii. similar studies could be conducted in other science subjects like Chemistry, Physics, Basic science and so on; iv. further studies should be conducted to investigate the extent of utilisation and the effectiveness of technology-based learning for instructions;

v. gender as a veritable moderator in most research works should be emphasised and recognised in the areas of technology integration and acceptance (adoption); vi. research could be carried out

to assess pre-service teachers‘ awareness, readiness and interest to adopt technology-based learning for instructions.

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APPENDIX A

QUESTIONNAIRE ON ASSESSING TECHNOLOGY-BASED LEARNING AMONG PRE-SERVICE BIOLOGY TEACHERS

Dear Respondent,

This questionnaire is designed to elicit responses from you on the aforementioned subject. Kindly go through the questionnaire objectively and indicate your views. I guarantee that all information supplied will be treated with strict confidentiality.

Technology-based learning (TBL) is the way of learning using the electronic technology such as internet, intranet, audio and video conferencing, webcasts etc. It is the learning that takes place partially or entirely via electronic technology. TBL offers numerous learning benefits because it is characterised by images, sounds, graphics, text and animation, which could attract and sustain students learning lifespan.

Thank you for the kind gesture.

SECTION A: Respondent's Data

Name of Institution…….

Gender: Male ( ) Female ( )

SECTION B: Pre-service Biology teachers' perceived usefulness of technology-based learning in Colleges of Education in Niger State.

S/N	ITEM	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	Technology-based learning makes me think critically on how to achieve my learning objectives.					
2	I experience fulfillment each time I download biology lecture materials online.					
3	Technology-based learning motivate me to learn, thereby enriching my understanding of the concepts of Biology					

4	Technology-based learning provide a stimulating Biology learning environment, and utilizing it is such a good idea					
5	Technology-based learning captivates learners' attention during learning through graphics and pictures					
6	I experience technophobia (technological anxiety) when utilizing technology-based learning platform to study Biology					
7	Technology-based learning maximizes interactivity among students. Utilizing it in the teaching and learning of Biology will enhance creativity					
8	People remember less of what they hear, more of what they see and hear, and most of what they see, hear and do. The fact that the computer can exercise various senses and present information in a variety of media can enhance the learning process					
9	The potential benefit of technology-based learning is accompanied with some challenges that may have negative impact on the learners,					
	hence the aim of integrating it into teaching and learning of Biology might be defeated					
10	Using technology is an innovation, I will seek opportunities to adopt it for learning of Biology concepts					

SECTION C: Pre-service Biology teachers' perceived ease of use of technology-based learning in Colleges of Education in Niger State

S/N	ITEM	Strongly Agree	Agree	undecided	Disagree	Strongly Disagree

1	I can use technology to learn with less or without any form of assistance.					
2	Utilizing technology-based learning for learning Biology is easy and user friendly					
3	I find technology-based learning very flexible for learning Biology concepts					
4	Using digital technology is easy, simple and understandable					
5	I get stressed by the use of digital technologies for learning purpose					
6	I find it cumbersome to use digital technologies					
7	I need to consult the user manual often when using digital technologies					
8	Revising my course-wares is easier with technology-based learning					
9	I find it easy to recover from errors encountered while using digital technologies					
10	I am rarely frustrated when using the digital technologies					

SECTION D: Behavioral intention of pre-service Biology teachers towards technology- based learning in Colleges of Education in Niger State

S/N	ITEM	Strongly Agree	Agree	undecided	Disagree	Strongly Disagree
1	I consider technology-based learning as innovation, and I am ready to adopt it for learning of Biology					
2	I believe that I possess adequate skills to use digital technologies for learning of Biology					
3	Based on my experience, I am very likely to use digital technologies in my learning					

4	I think it is valuable to use technological tools in learning.					
5	I am ready to adopt technology-based learning for all Biology courses with enabling environment					
6	It is a positive influence for me to use technology in learning of Biology concepts					
7	Technology-based learning would increase my level of productivity					
8	I basically intend to utilize technology-based learning for learning Biology					
9	I plan to use technology-based learning very often in future learning					
10	I will recommend the utilization of technology-based learning in the Biology classes					

APPENDIX B

Instrument Validation Evidence

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT OF EDUCATIONAL TECHNOLOGY

Dear Sir/Madam,

Instrument Validation Form

The bearer is a student of the above named University and Department. She/he is conducting a research and you have been selected as one of those with requisite expertise to validate his/her instrument. Kindly grant him/her all necessary assistance to make the exercise a success.

Your competency and expertise was considered as factors that will serve to improve the quality of his/her research instrument. We therefore crave for your assistance in validating the instrument. The completion of the form serves as evidence that the student actually validated the instrument.

Thanks for your anticipated assistance.

10 MAR 2021
P.M.B. 65 Minna, Niger State
Sign..... .../3/2021

Head of Department (Signature, Date & Official Stamp)

Student's Surname BASA Other Names AHMED

Registration Number [illegible] Programme MASTERS

Title of the Instrument COLLE SKILLS ON ASSESSING TECHNOLOGY BASED LEARNING AMONG Pre-SERVICE Biology Teac

ATTESTATION SECTION

Summary of the Remark on the Instrument Satisfactory

I hereby attest that the above named student brought his instrument for validation

Name of Attester Dr. [illegible] Fatima

Designation Lecturer

Name and Address of Institution F.U.T. Minna

Phone Number [illegible] E-Mail [illegible]

Please comment on the following

1. Appropriateness of the instrument for the purpose it's design for
2. Clarity and simplicity for the level of the language used
3. Suability for the level of the targeted audience
4. The extent in which the items cover the topic it meant to cover
5. The structuring of the Questionnaire
6. Others (grammatical errors, spelling errors and others
7. General overview of the Instrument

Suggestions for improving the quality of the Instrument

1.
2.
3.
4.
5.

Name of Validator Dr Falade

Area of Specialization

Name of Institution FUNAI Designation Lecturer

Signature Date 13/12/21

Thank You

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT OF EDUCATIONAL TECHNOLOGY

Dear Sir/Madam,

Instrument Validation Form

The bearer is a student of the above named University and Department. She/he is conducting a research and you have been selected as one of those with requisite expertise to validate his/her instrument. Kindly grant him/her all necessary assistance to make the exercise a success.

Your competency and expertise was considered as factors that will serve to improve the quality of his/her research instrument. We therefore crave for your assistance in validating the instrument. The completion of the form serves as evidence that the student actually validated the instrument

Thanks for your anticipated assistance.

Dr. C. S. Tukura

... University of Technology
10 MAR 2021
P.M.B. 65 Minna, Niger State
Sign...... 10/3/2021

Head of Department (Signature, Date & Official Stamp)

Student's Surname: BABA

Registration Number: M.Tech/SSTE/... Other Names: AHMED

Programme: MASTER'S

Title of the Instrument: QUESTIONNAIRE ON ASSESSING TECHNOLOGY-BASED LEARNING AMONG PRE-SERVICE BIOLOGY TEACHERS

ATTESTATION SECTION

Summary of the Remark on the Instrument: The Instrument is reliable and adequate for data-rich research.

I hereby attest that the above named student brought his instrument for validation

Name of Attester: DR. AUWALU SAMINU

Designation: CHIEF LECTURER

Name and Address of Institution: FCT, COE ZUBA, ABUJA.

Phone Number: 08039400497 E-Mail: auwal751@gmail.com

Please comment on the following

1. Appropriateness of the instrument for the purpose it's design for: Appropriate for the design.
2. Clarity and simplicity for the level of the language used: Clear and Concise
3. Suability for the level of the targeted audience: Suitable for the target Population.
4. The extent in which the items cover the topic it meant to cover: Rich Content Coverage.
5. The structuring of the Questionnaire: Well structured.
6. Others (grammatical errors, spelling errors and others: Not any.
7. General overview of the Instrument: Data-rich

Suggestions for improving the quality of the Instrument

1. The Biology teachers should have been Categorized
2. According to Specialty of Area of Study.
3.
4.
5.

Name of Validator: Dr. OLUWALU SAMUEL

Area of Specialization: EDUCATIONAL PSYCHOLOGY.

Name of Institution: FCI, COE, ZUBA Designation: CHIEF LECTURER

Signature: [signature] Date: 30/7/21

Thank You

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT OF EDUCATIONAL TECHNOLOGY

Dear Sir/Madam,

Instrument Validation Form

The bearer is a student of the above named University and Department. She/he is conducting a research and you have been selected as one of those with requisite expertise to validate his/her instrument. Kindly grant him/her all necessary assistance to make the exercise a success.

Your competency and expertise was considered as factors that will serve to improve the quality of his/her research instrument. We therefore crave for your assistance in validating the instrument. The completion of the form serves as evidence that the student actually validated the instrument

Thanks for your anticipated assistance.

10 MAR 2021
P.M.B. 65 Minna, Niger State

Dr. C.S. Tukur ..... Sign 10/3/2021

Head of Department (Signature, Date & Official Stamp)

Student's Surname BABA ..... Other Names ABDUL

Registration Number MTECH/SET/2018/8466 Programme MASTERS

Title of the Instrument QUESTIONNAIRE ON ASSESSMENT OF TECHNOLOGY-BASED LEARNING AMONG PRESERVICE BUSINESS TEACHERS

ATTESTATION SECTION

Summary of the Remark on the Instrument The instrument is relevant for use on the students it was designed .....

I hereby attest that the above named student brought his instrument for validation

Name of Attester DR. M.U.S. KOROKA

Designation LECTURER I

Name and Address of Institution FUT, Minna

Phone Number 08035965281 E-Mail .....

Please comment on the following

1. Appropriateness of the instrument for the purpose it's design for ..... Appropriate .....
2. Clarity and simplicity for the level of the language used ..... Very Clear .....
3. Suability for the level of the targeted audience ..... Very Suitable .....
4. The extent in which the items cover the topic it meant to cover ..... All the topical issues are well covered .....
5. The structuring of the Questionnaire ..... Well Structured .....
6. Others (grammatical errors, spelling errors and others) ..... There are minor errors which pointed out by the instrument to be corrected .....
7. General overview of the Instrument .....

Suggestions for improving the quality of the Instrument

1. All the corrections and gaps pointed out should be attended to
2. .....
3. .....
4. .....
5. .....

Name of Validator ..... DR. M. U. S. KOROKA .....

Area of Specialization ..... Business Education (PhD) .....

Name of Institution ..... F.C.E. Minna ..... Designation ..... Lecturer .....

Signature ..... Date 13/07/21

Thank You

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT OF EDUCATIONAL TECHNOLOGY

Dear Sir/Madam,

Instrument Validation Form

The bearer is a student of the above named University and Department. She/he is conducting a research and you have been selected as one of those with requisite expertise to validate his/her instrument. Kindly grant him/her all necessary assistance to make the exercise a success.

Your competency and expertise was considered as factors that will serve to improve the quality of his/her research instrument. We therefore crave for your assistance in validating the instrument. The completion of the form serves as evidence that the student actually validated the instrument.

Thanks for your anticipated assistance.

Dept. of Educational Technology
Federal University of Technology
10 MAR 2021
P.M.B. 65 Minna, Niger State

Dr. C.S. Tukur ..... Sign 10/3/2021

Head of Department (Signature, Date & Official Stamp)

Student's Surname BABA Other Names ATIMES

Registration Number MTech/SSTE/PT/20[illegible]/8465 Programme MASTERS

Title of the Instrument THE SUITABILITY OF ASSESSING TECHNOLOGY-BASED LEARNING AMONG BIOLOGY PRE-SERVICE BIOLOGY TEACHERS

ATTESTATION SECTION

Summary of the Remark on the Instrument The instrument is good for administration to the respondents

I hereby attest that the above named student brought his instrument for validation

Name of Attester Dr. C.S. Tukur

Designation Senior Lecturer

Name and Address of Institution F.U.T. Minna

Phone Number 08177371886 E- Mail [illegible]

Please comment on the following

1. Appropriateness of the instrument for the purpose it's design for ..... Appropriate .....
2. Clarity and simplicity for the level of the language used ... The level of the language used is clear and simple .....
3. Suability for the level of the targeted audience ... Suitable for the level of the targeted participants .....
4. The extent in which the items cover the topic it meant to cover ... The items adequately covered the topic it meant to cover .....
5. The structuring of the Questionnaire ..... Well Structured .....
6. Others (grammatical errors, spelling errors and others ... Minimal .....
7. General overview of the Instrument ..... Good .....

Suggestions for improving the quality of the Instrument

1. Subject the instrument to Psychology
2. Experts to check on Inclusion of items
3. .....
4. .....
5. .....

Name of Validator ... Dr. C.S. Tukura

Area of Specialization ... Educational Technology

Name of Institution ... F.U.T. Minna ... Designation ... Lecturer

Signature ..... Date ... 12-07-2021

Thank You

APPENDIX C

RELIABILITY RESULT

Scale: PERCEIVED USEFULNESS

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded[a]	0	.0
	Total	20	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.827	10

Scale: PERCEIVED EASE OF USE

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded[a]	0	.0
	Total	20	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items

Scale: BEHAVIOURAL INTENTION

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded[a]	0	.0
	Total	20	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.829	10

APPENDIX D

ANALYSIS OUTPUTS

Hypothesis One

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
PERCEIVED USEFULNESS	Equal variances assumed	2.032	.155	1.315	275	.190	.338	.257	.257	.844
	Equal variances not assumed			1.335	274.895	.183	.338	.253	.253	.836

Hypothesis two

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper

PERCEIVED EASE OF USE	Equal variances assumed	.792	.374	-.937	275	.349	-.287	.306	-.888	.315
	Equal variances not assumed			-.938	268.055	.349	-.287	.306	-.888	.315

Hypothesis three

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
BEHAVIOURAL INTENTION	Equal variances assumed	.002	.965	3.330	275	.001	.642	.193	.262	1.021
	Equal variances not assumed			3.317	262.707	.001	.642	.194	.261	1.023