Exploring Technology Lecturers' Instructional Strategies to Prepare Basic Technology Pre-Service Teachers for Twenty-First Century Teaching

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A thesis submitted in fulfilment of the academic requirements for the degree of Doctor of Philosophy in Technology Education,
School of Education, University of KwaZulu-Natal

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September 2024

DECLARATION

(i) I, Fatai Oladotun Dahunsi (220112291) declare that: The research reported in this thesis, except where otherwise indicated, is my original work.

(ii) This thesis has not been submitted for any degree or examination at any university

(iii) This thesis does not contain other person's data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.

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a) The words have been re-written but the general information attributed to the author(s) has been acknowledged; and

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(v) The work described in this thesis was carried out in the School of Education, University of KwaZulu-Natal, from July 2021 to September 2024 under the supervision of Prof. Asheena Singh-Pillay.

(vi) Ethical clearance was granted prior to undertaking the fieldwork.

[redacted]

Date: 1-10-24

As the candidate's supervisor I, Prof. Asheena Singh-Pillay, agree to the submission of this thesis.

[redacted]

Date: 1-10-24

DEDICATION

This thesis is dedicated to God Almighty, the source of all wisdom and knowledge. It is through God's grace, guidance and blessings that enable me to undertake and complete this academic journey. To God be the glory, forever and ever. Amen.

ACKNOWLEDGEMENTS

I am incredibly grateful to God for guiding me through the completion of this study. I acknowledge that without God's support and mercy, I am nothing.

I want to express my deepest gratitude to my wonderful supervisor, Prof. Asheena Singh-Pillay, whose invaluable guidance, expertise, kindness, encouragement and unwavering support have been instrumental in completing this study. Your dedication to my academic and personal growth has been truly inspiring. Almighty God will reward you abundantly.

I sincerely appreciate my beloved wife, Ayodele Dahunsi and my lovely son, Toluwani Dahunsi for their steadfast support throughout this challenging journey. Your unconditional love, encouragement and sacrifice have been a constant source of strength and motivation.

I am grateful to all the participants who contributed to this research, as this study would not have been possible without your involvement.

I would like to express my gratitude to the Tertiary Education Trust Fund (TETFund) for the sponsorship. Also, to Mr. and Mrs. Dayo Balogun, Dr Tolu Balogun, Dr Blessing Chidozie, Dr M. J. Alegbe and his wife, and Dr Oguntunde (Archbishop) and his wife for their tremendous support. Also, I like to extend my thanks to my brothers, Adeolu Dahunsi, Oladotun Oluwa, Adeola Olamoyegun, Dr Oluwole Ajala, Dr. Shina Akintolure, Saheed Balogun (Balo), and Emmanuel Bethel, for their encouragement and advice.

To my Pastor and other ministers of God: Bright Harbor, Mr & Mrs. George Kennedy, Gabriel Agbolade, Okoro, Taiwo Olorunfemi and Mrs. Omotayo, thank you for your prayers and counsel. Also, my friends and colleagues who contributed to the success of this study. I thank Dr Taiwo Adebeshin (Archbishop), Dr A. O. Lapite, Dr S. R. Adelaja, Mrs. Ayegunle, Engr. Segun Olumoroti, Femi Alalade, Dare Runsewe and others.

ABSTRACT

The Nigerian National Policy on Education emphasizes the importance of quality teachers and technology integration in classrooms. However, studies show that Nigerian lecturers are not adequately equipping pre-service teachers with essential twenty-first-century skills. There is a need for further research on how lecturers prepare pre-service teachers with these skills to ensure they are ready for twenty-first century teaching. This study explored Technology lecturers' instructional strategies to prepare basic technology pre-service teachers for twenty-first-century teaching. The study was conducted at AB University, Lagos. Nigeria. The qualitative research approach was used with the case study as the research design. A purposive sampling technique was used to select seven (7) Basic Technology lecturers in the Department of Technology Education at AB University, the Basic Technology curriculum for the Basic Technology teacher education programme and Basic Technology teaching portfolios were used as secondary data sources for the study. The instruments used for the study included individual semi-structured Interviews, document analysis, observation, post-observation interviews and focus group interviews. The data was then analysed using thematic analysis. The study's findings revealed that lecturers employ technology-enhanced instructional strategies such as problem-solving, critical thinking, and graphic communication in teaching pre-service teachers; the lecturers also use brainstorming, demonstrations, discussions and project-based learning in preparing the pre-service teachers. The findings also revealed that lecturers employ these strategies because of the design process which undergirds technology teaching and assessment. The researcher recommends that university management prioritize providing relevant digital technologies and resources for teaching and learning technical subjects within teacher training programmes. Additionally, regular in-service training, seminars, and workshops should be organized for lecturers, to keep them updated on teaching and learning innovations. Furthermore, the study suggests conducting similar research in different locations or institutions within the Nigerian context to create a comprehensive, technology-infused curriculum for training pre-service teachers.

KEYWORDS: Pre-service teachers, twenty-first century, teaching, technology, instructional strategies.

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LIST OF ACRONYMS

4Cs - Communication, Collaboration, Critical Thinking, and Creativity

CAST – Center for Applied Special Technology

ICT - Information and Communication Technology

ILE - Innovative Learning Environments

MKO - More Knowledgeable Other

MoE - Ministry of Education

MOODLE - Modular Object-Oriented Dynamic Learning Environment

NBS - National Bureau of Statistics

NPE – National Policy on Education

OECD - Organization for Economic Co-operation and Development

OER - Use of Open Education Resource

PD - Professional Development

TVET – Technical and Vocational Education and Training

UNESCO – United Nation Educational, Scientific and Cultural Organisation

www - World Wide Web

ZPD - Zone of Proximal Development

CHAPTER ONE

INTRODUCTION

The twenty-first century has ushered in significant transformations in Information and Communication Technology, social and economic systems, and educational frameworks globally. These changes have reshaped people's daily lives worldwide and influenced how students learn and live. To keep up with the rapid advancements of the twenty-first century, individuals and countries must acquire essential life skills from kindergarten through university and beyond. These skills enable people to effectively navigate and adapt to sudden and emerging changes (Panich, 2012). Due to these rapid changes and new skills requirement, education must evolve to equip students with learning and innovation skills and proficiency in information, media, technology, and essential life and work skills. Preparing individuals to thrive in a constantly changing environment is a critical goal that requires appropriate adaptation from all stakeholders (Chongkolklang, 2018).

Studies have shown that high school graduates often lack the essential skills to compete in the global market (World Economic Forum, 2018). The traditional classroom model, where students sit in rows and engage in rote memorisation to pass tests, is outdated. Graduates from such a system are at a significant disadvantage and are not equipped to adapt to the rapidly changing global market (Lim, 2023). Over recent decades, the competencies required for workers have shifted. Lim (2023) asserts that employers now demand higher-level thinking skills, technological and information literacy, and adaptable work habits from all employees, not just the elite. They seek workers who can ask questions, think critically, and solve problems (Gedye & Beaumont, 2018). If the education system continues on its current trajectory, students will not be adequately prepared for future job demands, as they are being trained for roles that are becoming obsolete (Metilda & Neena, 2016). Teachers and their training are at the heart of developing twenty-first century skills among learners (Darling-Hammond & Oakes, 2019). This means that there is a relational interplay between the development of 21st century skills and the teaching strategies used. The teaching strategies teachers use impact the kinds of 21 st century skills developed in students. 21st Century Skills refers to the core competencies that students need to thrive in today's world and future workplace. These skills include:

- Critical thinking and problem solving: The ability to analyse complex problems, evaluate evidence, and develop innovative solutions
- Communication and collaboration: Being able to clearly express ideas and work effectively

with others across different platforms and contexts

- Digital literacy: Understanding and effectively using technology, including information literacy and media literacy
- Creativity and innovation: Generating original ideas and approaching challenges with fresh perspectives
- Adaptability and self-direction: Being able to learn independently and adjust to changing circumstances
- Social and cross-cultural skills: Working effectively with people from diverse backgrounds

Thus, 21st Century Teaching, encompasses the pedagogical approaches and methodologies teachers use to develop the above mentioned 21st century skills in students. It includes amongst others:

- Integration of technology in meaningful ways to enhance learning
- Student-centered learning environments that promote active engagement
- Project-based and inquiry-based learning approaches
- Emphasis on collaboration and peer learning
- Real-world problem solving and authentic learning experiences
- Formative assessment and continuous feedback
- Personalized learning pathways that accommodate different learning styles

The relationship between 21 st century teaching and the development of 21st century skills is symbiotic: 21st Century Teaching is specifically designed to cultivate 21st Century Skills. The teaching methodology aims to create learning environments and experiences that naturally develop these essential competencies. For example, when teachers use project-based learning (21st Century Teaching), they simultaneously develop students' collaboration, critical thinking, and problem-solving abilities (21st Century Skills).

The above swift changes in how knowledge is acquired and which knowledge counts, implore teachers to reflect on and revise their teaching practices to meet the expectations of the twenty-first century teaching and learning requirements. Therefore, teachers must reassess and modify their teaching strategies to help students develop the necessary skills for the twenty-first century, ensuring they are prepared for further education and job market demands. The teacher can no longer be the sage on stage, nor are the chalkboard, textbook, and notepads the only

tools relied on. Teaching is learner-centered and requires new instructional strategies. Therefore, the twenty-first century teaching and learning environment requires teachers to embrace strategies that promote twenty-first century learning outcomes, such as creativity, critical thinking, communication and collaboration, to align teaching objectives with skills needed in the twenty-first century world of work (Kivunja, 2014 & Mopara & Sanrattana, 2023). It is explicit that the development of twenty-first century skills is dependent on teachers and the training they receive. It is acknowledged by Sotsaka and Singh-Pillay, 2020 and Singh-Pillay, 2023 that the quality of education in schools is linked to the quality of teacher training programmes. Researchers have called for better-trained pre-service teachers with a strong foundation in content, pedagogy and technological knowledge that meets the needs of the twenty-first century (Chigona, 2015; Banks *et al*. 2014). Thus, lecturers are required to use twenty-first century technology-enhanced instructions in their training of pre-service teachers. Not much is known about the strategies used to integrate these skills in teaching and assessments of pre-service teachers (Care *et al.,* 2018; Gonz´alez-Salamanca *et al.,* 2020). In response to the above-mentioned gap identified in the literature, this study explored technology lecturers' instructional strategies to prepare Basic technology pre-service teachers for twenty-first-century teaching. This chapter describes the background of the study, its purpose, objectives, research questions, significance, and the definition of critical terms.

1.1 Background and context of the study

The Federal Republic of Nigeria recognises Nigeria's poor education, especially on critical issues such as governance, teacher quality, infrastructure, and the disconnect between higher education curriculum and the workplace (Nigeria Ministry of Education, MoE, 2018). According to Okolie, *et al* (2014), in recent years, there has been a significant rise in poor academic performance of students in basic technology, in many Nigerian public schools. Therefore, studies were recommended on training Basic Technology pre-service teachers for the twenty-first century to revamp the educational systems. The most critical challenge in education is developing strong, competent teachers (Imhangbe, *et al,* 2023). Qualified teachers play a pivotal role in fostering twenty-first century skills through exemplary instructional practices that integrate these skills into their teaching and assessment methods. To do this effectively, teachers must possess the values, knowledge, and skills necessary for implementing twenty-first century education (Darling-Hammond & Oakes, 2019). Therefore, teacher education programs should design plans to prepare pre-service teachers to meet the demands of twenty-first century skills education. The preparation of teachers for promoting these skills is twofold: it involves enhancing both pedagogical and personal skills and cultivating twenty-

first century skills in student teachers. Additionally, it includes providing student teachers with sufficient training and practical experience to apply these skills in classroom settings (Valli *et al.,* 2014). Consequently, preparing student teachers to teach twenty-first century skills requires their instructors to model these skills in their teaching practice, and expand their knowledge. Furthermore, student teachers should have opportunities to apply this new knowledge in real-life situations (Häkkinen *et al.,* 2017). The argument put forth in this study is that the quality of training that Basic Technology pre-service teachers receive impacts the quality of their teaching when they join the teaching profession. Research by Chigona (2014) has shown that teachers are likely to teach how they were taught. Therefore, the poor quality of teacher education that pre-service teachers receive would more likely perpetuate poor classroom teaching and, subsequently, poor quality of education in many schools (Phillips & Condy, 2020). Studies by Keane *et al*. (2013) and UNESCO (2010) illuminate how teachers should address the development of twenty-first-century skills by using technology to support learning, promote team collaboration, and foster students' creativity and knowledge transfer. According to the above researchers, twenty-first-century lecturers aim to create learning environments that foster the development of twenty-first-century skills among pre-service teachers to facilitate teaching and learning in the fourth industrial revolution (4IR).

Studies by Owo and Ajie (2020), Butler-Adam (2018), and Chigona (2015a) reveal that Nigerian lecturers are failing to equip pre-service teachers with twenty-first-century critical skills, namely Creativity, Critical thinking, Communication, and Collaboration needed for their future teaching practices. The implications are that teaching objectives, strategies, and assessments should align with skills required in the twenty-first century workplace, where pre-service teachers will eventually end up (Kivunja, 2014). The Nigerian National Policy on Education (NPE) acknowledges the pivotal role of quality teachers in providing quality education at all levels of the education system. Thus, it pledges that teacher education should take cognisance of changes in methodology, regularly expose teachers to professional innovations, and incorporate information technology.

The studies above call for further research into how lecturers prepare pre-service teachers with twenty-first-century skills. The realisation that the acquisition of the 4Cs (Creativity, Critical thinking, Communication and Collaboration) by Basic science and technology pre-service teachers relies on the choice made by lecturers about their teaching strategies, their agency, and

professional learning, thus, became essential to explore lecturers' instructional strategies to prepare basic technology pre-service teachers for twenty-first-century teaching**.**

Against Nigeria's desire to prepare her citizens to be relevant in the rapidly changing society, it is pertinent to explore how technology lecturers train basic technology pre-service teachers for twenty-first century teaching.

1.2 Purpose of this study

This study explored Technology lecturers' instructional strategies to prepare basic technology pre-service teachers for twenty-first-century teaching at a Nigerian university.

1.3 Research Objectives

The objectives of this study are:

1.3.1 To identify the Twenty-First Century skills lecturers develop in basic technology pre-service teachers.

1.3.2. To ascertain lecturers' instructional strategies for preparing pre-service teachers to teach in the twenty-first century.

1.3.3 To establish why lecturers develop instructional strategies to prepare basic technology pre-service teachers to teach in the twenty-first century the way they do.

1.4 The research questions that guided this study are:

1. Which twenty-first century skills do lecturers foreground in their teaching?
2. What instructional strategies do lecturers employ when preparing basic technology pre-service teachers to teach in the twenty-first century?
3. Why do lecturers use these instructional strategies to prepare basic technology pre-service teachers to teach in the twenty-first century the way they do?

1.5 Rationale for the Study

The Nigerian Ministry of Education (MoE) recognised the importance of technology literacy in the twenty-first century and has implemented various initiatives to promote technology integration in classrooms. In 2014, the Nigerian Ministry of Education (MoE) launched the Technology Education Curriculum for basic education, emphasising the development of

students' technological skills. This curriculum aligns with global trends and stresses the need for teachers to be prepared to incorporate technology into their teaching practices. Despite all these efforts, lecturers' technology integration in preparing pre-service teachers is not fully understood, as many studies have been conducted on pre-service teachers' failure to integrate technology into their practice. A survey conducted by Hämäläinen (2022) and Durham (2022) revealed that pre-service teachers often feel unprepared to integrate technology into their future classrooms. It is visible that educators have not fully tapped into the potential of technologies in education. Hence, this study sought to explore how technology lecturers can effectively prepare pre-service teachers in basic technology for the demands of teaching in the twenty-first century.

Globally, technology is being integrated into educational settings to enhance teaching and learning. Therefore, it is important to ensure that basic technology pre-service teachers are adequately equipped, with the necessary skills and knowledge to integrate technology into their future teaching. Pandita and Kiran (2023) noted the impact of technology on student engagement and achievement. Therefore, there is a need for teachers to receive adequate training in instructional strategies to promote technology integration. Similarly, Prasojo, *et al* (2018) found that pre-service teachers exposed to technology integration strategies were better equipped to navigate the challenges of twenty-first-century teaching. However, there is a lack of research specifically focusing on the instructional strategies employed by technology lecturers in Nigeria.

This study aims to address the gap in the existing literature. Analysis of instructional approaches technology lecturers use during pre-service teacher training programs will shed light on effective strategies that prepare future educators. Understanding how technology lecturers incorporate this knowledge into their instructional strategies can contribute to pre-service teachers' teaching and learning experiences for twenty-first-century teaching. Findings from this study will contribute towards the effective integration of technology into teacher education programmes and enhance the preparedness of pre-service teachers to fulfill the demands of twenty-first-century classrooms.

1.6 Significance of the study

This study is significant theoretically, as it will contribute to more profound insights into the constructs that interface to lecturers' instructional strategies, to promote twenty-first-century

skills among basic technology pre-service teachers. This insight into instructional strategies might help to rethink how lecturers could transform their teaching to prepare pre-service teachers with twenty-first-century skills. The findings of this study have the potential to impact dual settings, i.e., lecturers' practice and pre-service teacher education programmes. Both lecturers and teacher preparation institutions' professional development policymakers will benefit from the practical outputs of the research study. The study's findings will highlight the need for teacher training institutions to equip lecturers with the skills they will use to model the appropriate teaching practices to prepare pre-service teachers for the twenty-first century. It is vital that when lecturers design teaching and learning activities, they take into consideration the nature of outcomes they want to achieve, such as twenty-first-century skills.

1.7 Research Design:

The Research Design for this study is a qualitative case study that explored technology lecturers' instructional strategies to prepare basic technology pre-service teachers for twenty-first-century teaching. Creswell and Creswell (2018) define a case study as a unique research design used in qualitative studies within the Social Sciences. The case study focuses on a single entity, a person, group/s, or organisation, an event, action, or situation. Similarly, Yin (2017) defined a case study as research using various data sources to explore contemporary phenomena.

The case explored in this study was how technology lecturers prepare basic technology pre-service teachers for twenty-first-century teaching. The context was bound to a Basic Technology pre-service teacher training programme at a Nigerian university (BA University).

This study adopted purposive sampling to select the participants for accurate data. Maniram and Maistry (2018) asserted that purposive sampling is a deliberate act of choosing a participant based on the attributes he/she possesses. Technology lecturers were selected based on their knowledge and experience to obtain the relevant information required for this study. The interpretive paradigm was embraced for this study. Cohen, Manion and Morrison (2017) stated that the interpretive paradigm seeks to understand the subjective world of human experience to derive meaning from shared experience. This study intended to gain a deep insight into how technology lecturers use instructional strategies to prepare basic technology pre-service for twenty-first-century teaching.

1.8. Overview of Chapters

Chapter One provides the background to the study, the rationale, its purpose and objectives, the research questions guiding the study, and the significance of the study. It also provides a brief synopsis of the research design and research findings.

Chapter Two presents a review of the related literature, locally and internationally, concerned with using Instructional strategies in teaching and learning.

Chapter Three focuses on the conceptual framework underpinning this study, which draws from the P21 framework and Singh-Pillay and Samuel's notion of ecological agency.

Chapter Four research methodology is highlighted. Research paradigm, research design, case study approach, location of the study and sampling, data generation processes, and instruments were discussed: these include individual interviews, focus group interviews, lesson observation, and document analysis used in exploring how technology lecturers use instructional strategies to prepare basic technology pre-service teachers for twenty-first century teaching. The chapter concludes with data analysis strategies used.

Chapter Five features the analysis of instructional strategies used by technology lecturers to train basic technology pre-service teachers for twenty-first-century teaching.

Chapter Six, focuses on analysis of how technology lecturers use instructional strategies to prepare basic technology pre-service teachers for twenty-first century teaching. The analysis was guided by the theoretical framework of P21 Framework for twenty first century.

In Chapter Seven, the emerging themes related to Research Question 3 are presented.

Chapter Eight ends the thesis, with a summary of findings from the study and highlights recommendations emanating from the findings.

1.9 Concept Clarification

The following concepts were examined:

1.9.1 Basic Technology Education

Basic technology is an aspect of Technical and Vocational Education Training (TVET) and a compulsory pre-vocational subject at Junior Secondary Schools in Nigeria. It comprises the following units: Auto-mechanics, Building Technology, Electrical/Electronic Technology, Metalwork, Woodwork, and Technical drawing. It is recognised as an essential subject in developing any nation technologically. Competent teaching of Basic Technology can lead to technological greatness. According to the Federal Government of Nigeria (NPE, 2004), Vocational and Technical Education aims to provide trained manpower in the Applied Sciences, Technology, and Business.

The objectives are as follows: provision of vocational orientation for advanced training in technology, provision of basic technology literacy for everyday living, and stimulation of creativity. To attain the stated objectives, satisfactory teaching methods must be delivered for outstanding implementation. The Basic Technology curriculum includes the following: Information and Communication Technology (ICT), Technology and You; Safety, maintenance, and processing; Drawing practice; Tools and machine; Applied Electrical/Electronics; Power and Energy; Maintenance and Building.

1.9.2 Pre-Service Teachers

Pre-service teachers are individuals enrolled and are engaged in certified course work, supervised field experiences and purported to prepare them for the teaching practice (Dorsah, *et al*, 2022; Wang, 2023)

1.9.3 Instructional Strategies

An instructional strategy is a concept, guideline, or technique for conducting, measuring, and evaluating teaching and learning (Freeman, 2022; Seechaliao, 2017). Also, Instructional strategy concerns how learners' process information at a particular level of pedagogy to contribute to cognitive load related to direct instruction within the educational system (Lange *et al*., 2022). Teachers must use different methods or techniques for effective class control,

active learning, and participatory learning since learners learn at different rates and in different ways.

1.10. Summary of Chapter One

This chapter introduced the study: exploring technology lecturers' instructional strategies to prepare basic technology pre-service teachers for twenty-first century teaching at a Nigerian university.

The background to the study, the rationale, the purpose, objectives, and research questions guiding the study and its significance, were discussed. Moreover, a brief synopsis of the research design, research findings, and an overview of subsequent chapters were featured.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature relevant to this study, which explored how Technology lecturers train basic technology pre-service teachers for twenty-first-century teaching at a Nigerian university. The literature reviewed is presented under the following sections in response to the focus of the study:

- Conceptualisation of Instructional Strategies
- Twenty-first century constructivist instructional strategies
- Teaching with digital technology in the twenty-first century
- Pre-service teacher preparation in the twenty-first century
- The role of the Lecturer in twenty-first century teaching and learning
- The Nigerian context

2.2 Conceptualisation of Instructional Strategies

According to Freeman (2022) and Seechaliao (2017), instructional strategy is a concept, guideline, plan or technique for conducting, measuring, and evaluating teaching and learning. Ofodu (2012) concurred that instructional strategies are teachers' techniques, methods, and skills in teaching and learning. Instructional strategies provide learners with the how and what of content delivery, so lecturers can decide on the activities or tasks for specific content to help students' comprehension. There is an intricate relationship between instructional strategies a teacher uses and the kinds or types of skills developed in learners. According to Kibirige and Maake (2021), instructional strategies play an important role in students' performance. Also, teachers need to use appropriate instructional strategies to improve students' performance. There are many instructional strategies to choose from, each associated with a particular teaching and learning theory. For example, traditional instructional strategies (linked to behaviourist learning theories) regard learners as passive consumers of knowledge. Behaviorist theories align with teacher-centred instruction, where knowledge is transmitted from the teacher to the student. In such contexts recall and memorisations are skills that are valued in learners. The emphasis is on student performance in examinations rather than lifelong learning (Von Glaserfeld, 1995).

In contrast, twenty-first century instructional strategies (linked to constructivism and

connectivism teaching and learning theory) espouse teaching strategies that engage learners

actively as co-constructors of knowledge. Chalkiadaki (2018) defines twenty-first-century skills as encompassing a broad range of skill sets and professional attributes, including creativity, divergent thinking, critical thinking, teamwork, developed cognitive and interpersonal skills, social and civic competencies, etc. These skills are identified as problem-solving, critical thinking, creativity, analytical ability, communication, collaboration, leadership ability, awareness of national and global issues, adjustability, flexibility, cultural and information literacy, civic and social responsibility, and enterprise (Nigeria's National Policy on Education, 2014; UNESCO, 2015). As a result of the increasing demand for twenty-first-century learning skills, pre-service teachers need to be prepared for teaching shortly (Faculty of Education, Mahasarakham University, 2016).

The constructivist learning theory emphasises student-centred principles, experiential learning, and active engagement to promote meaning-making when learning is linked to the context and learners' prior knowledge. Connectivism acknowledges using digital tools to mediate learning within a student-centred approach. Teachers may use different methods or techniques for effective class control and be active and participatory since learners learn at different rates and ways (Lange *et al.* 2022). The factors that affect lecturers' choice of instructional strategies are linked to their content knowledge, technology knowledge, teaching and learning outcomes, and professional development (Shulman, 1987). This implies that the place of instructional strategies in the educational system cannot be over-emphasized in the teaching and learning process.

The potential of Information and Communication Technology (ICT) for enhancing twenty-first-century skills through functionalities that enhance the capacities for communication, collaboration, critical analysis, and creative use of knowledge and information-finding are yet to be fully tapped by many developing countries, including Nigeria (Lewin & McNicol, 2015; McNulty, 2018). Suppose Nigeria as a nation must participate actively in the twenty-first-century economy, then the country must give considerable attention to better instructional strategies and resources, including Information and Communication Technology (ICT).

2.3. Twenty-first-century constructivist instructional strategies

This section reviews technology-enhanced instructional strategies associated with the constructivist teaching philosophy. Twenty-first century educators are expected to use effective

and innovative instructional strategies that foster the 4Cs (Creativity, Critical thinking, Communication and Collaboration) in the students. Critical thinking is the ability to analyse, evaluate, interpret, and synthesize information to solve complex problems. In the 21st century context, it involves analysing and evaluating evidence, arguments, and beliefs, making connections between information and arguments, interpreting information and drawing conclusions, reflecting critically on learning experiences and processes and solving unfamiliar problems in conventional and innovative ways. Critical thinking is vital to navigate and process vast amounts of available information, solve increasingly complex global challenges, making informed decisions in personal and professional life and to enable innovation and advancement in all fields. The ability to generate new ideas, think outside conventional boundaries, and find innovative solutions is regarded as creativity. It includes generating original ideas and solutions, refining, and analysing ideas, being open to diverse perspectives and viewing failure as a learning opportunity. Creativity is quintessential to drive innovation in technology and business, solve novel problems in unprecedented situations and supports entrepreneurship and economic growth. Communication involves effectively expressing thoughts and ideas using various forms and contexts, including written and oral forms, listening effectively to decipher meaning and using technologies. Communication is necessary for global collaboration and understanding, for effective leadership and teamwork and key to building relationships and resolving conflicts. Collaboration involves working effectively with diverse teams to achieve common goals, being flexible and willing to compromise, sharing responsibility for collaborative work, valuing individual contributions and understanding global perspectives. It is important to develop the above-mentioned 21st century skills during teaching as the demands of the workforce is not static, it requires require adaptable, innovative thinkers with strong interpersonal skills, the ability to work collaboratively with solution and to be able to communicate digitally. These skill sets are important as they are transferable across different careers and contexts, they support lifelong learning and adaptability, enable innovation and problem-solving, foster global citizenship and understanding and prepare students for unknown future challenges. Instructional strategies, for example technology enhanced strategies, that favour the development of the above skills sets are required if we are to prepare learner for a changing workforce.

Twenty-first century technology-enhanced instructional strategies are not new ideas, but rather a repackaging of established and accepted instructional strategies facilitated by technologies. In 2010, UNESCO recommended that twenty-first-century education is a means to empower students to become active participants in transforming the twenty-first century learning environment, using technology that has already transformed other sectors of society

(UNESCO, 2010). Therefore, the study explores the literature on teaching strategies that educators use to help empower students to participate actively in transforming the twenty-first century learning environment. Constructivist teaching strategies are based on the belief that learning occurs as students are actively involved in knowledge construction, instead of passively receiving facts from the teacher (Shah, 2019). Therefore, the critical constructivist teaching strategies that promote the realisation of the 4Cs will be explored. These include collaboration, project-based, and digital simulations.

2.3.1. Collaborative strategy

Collaboration is a teaching strategy sometimes referred to as cooperative or teamwork. It involves the educator identifying individual student's strengths within a group or team of students (Steyn, 2017). Collaborative teaching strategy activities vary, mostly centering on students' active exploration of course materials in small groups of two or more, working together to achieve a common goal (Shaikh & Khoja, 2012). This implies that student's ability to develop skills that equip them to be functional within a team setting becomes vital for their personal and team success. Today's students are not passive learners. Instead, they expect to be fully engaged and directly involved in learning. A study by Abdel and Collins (2017) shows that students enjoy class discussions and interactive classroom environments over the traditional top-down dissemination teaching method. The modern generation of students tends to embrace social learning environments; they are familiar with building social networks and using technology to seek and share information. Studies reveal that students informally use social platforms for learning-related activities (Musungwini *et al*., 2014; Rajesh & Michael, 2015; Cao *et al*., 2013). Therefore, lecturers need to tap into these collaboration patterns, habits and students' current contexts of social sharing activities. Literature shows that educators must use platforms that the students are already familiar with before introducing them to new ones (Rajesh & Michael, 2015; Cao *et al*., 2013). Using familiar and existing knowledge serves the purpose of engaging students without bombarding them with new technology and information all at once, which may have adverse effects. Thus, this inductive approach to teaching supports the general constructivist teaching principle that students learn better if educators link new

knowledge to existing knowledge - concrete to abstract (Lyon, 2015; Lawless & Pellegrino, 2007).

Collaboration in education is deeply rooted in Vygotsky's social constructivist learning theory (Vygotsky, 1978). He argues that there is a natural social nature of learning, reflected in group-based learning. Vygotsky suggests the notion of the Zone of Proximal Development (ZPD), which highlights the difference between a student's independent ability and what can be achieved cognitively under the guided support from more knowledgeable others. Dahal and Bhat (2023); Robinson and Persky. (2020) highlight that while self-directed learning may rely on personal responsibility and self-confidence, getting assistance from knowledgeable others is just as crucial in achieving learning goals. Therefore, this implies that a collaborative teaching strategy supports student-centred teaching and learning. This approach stimulates students' interests and gives them a voice in learning.

In a teaching environment, collaborative activities are designed to give students responsibility for their learning, as well as develop their social interaction skills (Tunjera *et al*., 2014). In the globalised twenty-first century, social interaction skills are critical, as they help communicate and interact with individuals from various backgrounds. More importantly, sharing knowledge with others gives students access to more knowledge sources through these social interactions. Before the advent of technology, collaborative learning mainly occurred in face-to-face situations, whereby students physically sat and worked together in smaller groups or teams. Each group member brings their experience and skills to achieve the goal of their group task. The developments in society today mean that it is not always possible for people to meet because of different geographical placements, busy schedules, where students come from, etc. This has the potential to affect the successful running of teaching programmes and learning goals. However, because technology can link students and reduce space and time, collaborative learning can be facilitated with the help of ubiquitous technology (Mäkitalo *et al*., 2012).

Similarly, studies reveal that many twenty-first century students have access to digital tools, especially mobile phones connected to social media (Singh-Pillay, 2023; Romrell *et al.*, 2014; Rajesh & Michael, 2015). Therefore, students can connect academic and personal experiences seamlessly through these digital tools. Technology offers platforms to search for information, virtually communicate, publish their outcomes, and create artefacts (Kumi-Yeboah, *et al*, 2020; Angeli & Valanides, 2009; Bomah, 2015). Using technology to develop artefacts allows

students to demonstrate creative thinking and social construction of knowledge, thereby exhibiting the desired 4Cs (Keane *et al.*, 2013).

Researchers indicate that lecturers using structured collaborative activities with technology tools encourage students to think critically, generate ideas, share opinions, and creatively construct knowledge together (Ruiz-Rojas et al., 2024; Liu, 2013; Chen *et al*., 2015). This learning process is not limited to the classrooms' four walls. Students use technology to learn and master skills and share artefacts with others. The advent of Web 2.0, which in familiar terms is referred to as the World Wide Web (www), facilitated the collaboration and sharing of information via social media, blogging and web-based communities (Rajesh & Michael, 2015). In this case, students get to share their opinions and receive feedback from fellow and more knowledgeable students. Lombe (2010) recommends that educators adopt technology-enhanced instructional strategies that enable an inclusive environment that caters to different student learning styles and levels. Therefore, lecturers' technology knowledge of applications that support collaboration in teacher preparation gives pre-service teachers a platform to interact with content, educators and other students. Using technology-enhanced collaborative instructional strategies facilitates deep and more authentic student-centred learning. To sum up, although collaboration can be done without technology, researchers have documented that students are motivated and accomplish more when they use technology. In their study on teaching Science with blogs, Jaipal-Jamani and Figg (2015) assert that technology-enhanced collaborative instructional strategies foster the transformation of teachers' theoretical teaching ideas into their teaching practice. Selecting the appropriate technology tool for collaboration requires students to synthesise their technology knowledge and intended teaching strategy. In other words, to make sure technology is appropriate to achieve a learning goal, consider its accessibility to students (Ally & Tsinakos, 2014).

2.3.2 Project-based learning

Project-based Learning (PBL) is an instructional approach built upon learning activities that challenge students to solve authentic problems (Singh-Pillay, 2023). The basic principles of Project-Based Learning reflect the Vygotskian learning strategy that emphasises the role of collaboration and social learning in constructing knowledge (Yaman, 2014). In Project-Based Learning strategies, students can work in small groups or as individuals over an extended period, from a week to a semester. Students demonstrate their knowledge and skills by developing an artefact or presenting their solution to an authentic audience (Singh-Pillay, 2024;

Neo *et al*., 2007). In solving authentic problems, they develop deep content knowledge and critical thinking, creativity, collaboration, and communication skills in the context of solving an authentic problem (Keane *et al*., 2013). De La Paz & Hernández-Ramos (2013, p. 4), indicate that in Project-Based Learning, the role of the lecturer becomes more of a "designer, director, coach, facilitator, mentor and advisor" than they are a dispenser of information and instructions. Problem-solving is one of the critical and basic skills anticipated in the twenty-first century. Therefore, using Project-Based Learning is essential as it develops in the student's real-life problem-solving techniques. In this era of globalisation and technological revolutions, problem-solving can be executed more efficiently and at larger scales than would have been accomplished without technology (Tiantong & Teemuangsai, 2013). Technology, therefore, assists the students in keeping abreast of their learning and gives them continuous access to current information, which they may use to solve problems. Technology offers students a variety of tools to engage with content and fellow students. Project-based learning, in its nature, demands a consistent exchange and sharing of vast amounts of information when done in a group. The use of technology makes the access to and processing of information more manageable (Chai *et al*., 2013). In this study, lecturers' technology-enhanced Project-Based Learning instructional strategies, benefit students by actively sharing ideas through inquiry with one another, as well as working collaboratively to research and create projects that reflect their knowledge in a more informal environment.

2.3.3 Simulations

The term simulation has been used in various ways, but this study uses the term in ways consistent with the definitions cited below. Mtshali (2023, p76) defines an educational simulation as "a computer program that models some phenomenon or activity and is designed to have participants learn about the phenomenon or activity through interactions with it".

Simulations are computer programs that imitate a natural phenomenon in a simplified form designed to meet specific learning goals (Singh-Pillay, 2024). Computer simulations, for example, gaming, are usually highly visual and highly kinaesthetic. Simulations are explicitly linked with a constructivist pedagogy as students actively engage with the program, enabling discovery, experimentation, practice, and the active construction of knowledge based on concrete examples, in a risk-free environment. According to Harder (2018), simulations provide students with an autonomous way of learning, motivating them to reach the highest level of their abilities. In their study, Garofalo and Trinter (2013) observed that instructional

simulations can potentially engage students in "deep learning" that empowers deeper understanding. Researchers note that using technology-enhanced simulation in learning activities enhances understanding that develops through applying and manipulating knowledge within context (Henrie, 2016; Romrell *et al*., 2014; Johnson *et al*., 2013). Technology-enhanced simulations are particularly useful for constructive learning in any discipline. As argued in this study, technology has the potential to play a key role in facilitating learning. For instance, through simulations, students can relate to real-life phenomena in a way they can understand better, i.e. simulation can show students how the four-stroke engine of a vehicle works, which students cannot see through the naked eye or on a static picture.

Lecturers' understanding of teaching and learning, which informs current teacher education trends, is critical to providing relevant and appropriate teaching with technology in the twenty-first century. Therefore, this section indicates that using constructivist theory can help guide effective teaching with technology in the twenty-first century, informing them what is anticipated. In any learning environment, the educator's role determines the learner's learning experiences. The next section consulted literature on teaching with digital technology in the twenty-first century.

2.4 Teaching with digital technology in the twenty-first century

In this section, an exploration of the literature on the importance of teaching with technology related to the study's goals is presented. Teaching with technology comprises two fundamental key terms to this study – teaching and technology. The definition of teaching, as defined in the Merriam-Webster online dictionaries (2019), is to guide someone to acquire knowledge. This definition of teaching suggests the facilitation of knowledge acquisition compared to imposing knowledge. Technology refers to tools and machines that may be used to solve real-world problems (Bates, 2015). Since the meaning of technology refers to tools and machines in general, this study will use the term technology to refer to digital technology resources. Digital technology is all electronic devices and applications using computer programs (Harmon, 2018). Therefore, when teaching with technology, it is how educators use digital technology to facilitate knowledge acquisition. Student-centred typically refers to forms of instruction that give students opportunities to lead learning activities, participate more actively in discussion, design their learning projects, explore topics that interest them and generally contribute to their course of study design.

2.4.1. Lecturers' competency to teach with technology

Lecturers are consistently encouraged to teach with technology in their classrooms to advance learning and engage students in the twenty-first century (Schlebusch *et al,* 2024; Liu, 2013). Technology is a critical component in twenty-first century educational change and reform (Schrum & Levin, 2013); however, it is ineffective when viewed as an isolated component of education (Kurt, 2014). Teaching with technology is more than just "… delivering the traditional curriculum" (Richardson, 2013, p. 11). The literature shows that there are several technology intervention programmes designed to prepare lecturers to teach with technology in their practice (Abedi, 2023; Koehler *et al.*, 2014; Lynch, 2013; Saad *et al*. (2012); Hur *et al.* (2010); Puentedura, 2009). However, studies reveal that many lecturers do not effectively use technology in their daily practice to support learning because of the lack of awareness among lecturers about the technology's potential to transform learning activities (Uerz *et al.*, 2018). There is a general agreement on the need to integrate technology into teaching. However, there is hesitancy about practical implementation. This is either because educators are unaware of technology's affordances or they do not know how to effect it in their disciplines (Uerz *et al.*, 2018).

Meaningful technology integration is believed to begin with technologically competent and confident educators (Abedi, 2023; Buabeng-Andoh, 2012). In this regard, educators acquire new technological skills and competencies and a conceptual grasp of the power of technology in education. The process of acquiring technological knowledge is continuous as technology is dynamic; it keeps improving because the needs and demands for technology keep changing. Berrett, Murphy and Sullivan (2012) identified challenges to successful technology integration as the lecturer's lack of understanding of what the technology can do and their inability to make informed decisions on the effective use of the technology in their teaching practice. Studies are increasingly showing that technology is successfully used for instruction, learning, and assessment. Therefore, lecturers need to be competent in linking technology resources for the right kind of purpose and understanding the opportunities it has in their respective teaching disciplines.

Researchers claim that effective use of technology in teaching enables educators to assist students in learning what they need to know (Singh-Pillay, 2024; Abedi, 2023; Ng'ambi, 2013). Some reservations remain about the definition of effective use of technology (Lim *et al*., 2013). They went on to define technology as a tool that facilitates practice, but on its own, no

technology can fix an undeveloped educational philosophy or compensate for inadequate practices. Teaching with technology is not a simple matter, because of the diverse methods determined by the students and learning environments. However, researchers have indicated factors that influence the effectiveness of technology use, such as the extent to which teachers are trained and prepared to implement it, the level of access, and the provision of adequate technical support (Foulger *et al*., 2017; Schleicher, 2014; Rana, 2012; Mukhari, 2016).

Lecturers face challenges in deciding what types of technology to use and how to use them (MacMillan Culp *et al*., 2005). The lack of appropriate standards, holistic approaches and limited initiatives grounded in educational theories has distended the challenges. Researchers suggest that there is not one ideal type or correct way to use technology; rather, it should be appropriate for meeting the learning and teaching objectives (Summak & Samancıoğlu, 2011). Therefore, this implies that each technology will likely be used differently depending on the envisioned teaching and learning outcomes. For example, one educator can use PowerPoint to display text (in this case, using it as a substitute or replacing text written on chalkboard with text typed on slide); another can use the same PowerPoint application to stimulate learning, i.e. using colours, images, videos and shapes). Educators must consider how technology will support the curriculum and how integrating technology into instruction will support the instructional goals. Dalia and Chowdhury (2017) suggested that technology applications should complement classroom instructional strategies and use them to reinforce, enhance, and elaborate on existing instructional practices.

Experts in educational technology suggested that technology can enhance learning by providing the following functions in teaching:

i. Drilling and practising of content;

ii. Accessing and gaining knowledge from many sources;

iii. Visualising difficult-to-understand concepts;

iv. Interacting with data, engaging in hands-on learning, and receiving feedback; and

v. Managing information, solving problems, and producing sophisticated products. (Roblyer & Doering, 2014)

Fu (2013), in a study, has shown that the appropriate use of technology can connect learning to real-life situations and that learning can occur anytime and anywhere through technology. Similarly, Kozma (2005) demonstrated that technology can help deepen students' content knowledge, engage them in constructing their knowledge, and support the development of

complex thinking skills. They further reported that technology alone cannot create this teaching and learning environment. Educators must know how to structure lessons, select resources, guide activities, and support this learning process. However, many traditionally trained teachers are unprepared for these tasks. Therefore, exploring and understanding their current practices is important to help equip them with skills for current teacher knowledge expectations.

Researchers stated that technology can be an instructional tool in teaching and learning. The appropriate use of technology in teaching and learning opens up new knowledge and provides a tool that has the great potential to challenge existing knowledge. Many studies indicate that educators' attitudes and beliefs toward technology's role in the classroom, as well as their technological skill levels, influence the types of activities they use technology for and how often they integrate technology into the curriculum (Umugiraneza et al., 2018; Gibson *et al.*, 2014; Buabeng-Andoh, 2012). On the other hand, some studies found a significant relationship between teachers' beliefs towards technology and their instructional technology practices (Mumtaz, 2000; Palak & Walls, 2009). However, a study exploring teachers' use of technology for Mathematics in KwaZulu Natal schools reports that teachers with access to technological instructional resources and training held broader beliefs than their colleagues who had no access (Umugiraneza *et al*., 2018).

Agbo (2015) conducted a study on 'Factors that could influence the use of Information and Communication Technology (ICT) among educators. They reported that guidance from the head of the department is very important in encouraging the development of electronic lesson materials and computer use for specific subjects in the teaching-learning environment. The study found that the success of integrating technology into the teaching-learning interaction among school teachers depends on the support provided by the school's Principal. Other studies have supported this notion by highlighting that educators are likely to find relevance and motivation in technology integration as they see it modelled by their peers (Goodwin *et a*l., 2014). This highlights the importance of training sessions where educators share how they use technology in their fields. This is similar to the Japanese concept of lesson study (Stigler & Hiebert, 2016), whereby a small group of educators come together to discuss their achievements, progress, and challenges in their practices. This will have a major impact as the educators will be able to discuss technology integration, at a relatable level and look at technology from a perspective of how it complements pedagogy.

Fu (2013) acknowledges that learning is an ongoing lifelong activity, in which people change their expectations by seeking new knowledge, thereby departing from traditional approaches, in this case, moving from teaching approaches, whereby learning was determined by the educator alone. Lecturers and students alike desire to explore new sources of knowledge, therefore, technology has become an indispensable resource. Technology increases access to knowledge by exposing students and educators to a wide range of information. This suggests that lecturers must innovate and adapt new technology-enhanced teaching styles for twenty-first century needs. For lecturers to adapt to new teaching styles, researchers report on the importance of continued professional development for educators specifically focussed on current trends in twenty-first century education (Lindqvist, 2015; Gregory & Salmon, 2013).

2.4.2. Lecturers' Professional Development

Research indicates that educators' ability to integrate technology into the curriculum is the most important factor in successfully using technology (National Education Association, 2008). According to Johnson, *et al* (2016), educators reported inadequate training to integrate technology into their teaching practice. Researchers (Bowman, *et al* 2020) recommended that before Professional Development (PD) is designed, the educator's current level of technological skills should be understood, and, therefore, the designers should be informed of what is known so that they may build on it. Researchers established that a needs-based survey, administered before Professional Development sessions, helped design training matching educators' teaching goals (Ismail & Alkhazali, 2019).

Research has not identified any one best model of effective professional development; effective approaches include:

✓ Providing educators with relevant training in the skills needed for successful technology integration strategies (Schrum & Levin, 2013)

✓ Providing educators with hands-on experiences using new skills and developing units in realistic settings with authentic learning tasks

✓ Educators Modelling of appropriate and relevant technology integration strategies (Alberta Education, 2017)

✓ Peer teammates to share strategies for technology integration, as well as discussion and reflection for ongoing opportunities with other educators, based on their experiences with technology integration (Lewis, 2016)

✓ Linking Professional Development to specific disciplines.

This necessitates that institutions or faculties design custom-made Professional Development (PD) that works in their context and with their educators' specifications and the needs of the students. These customised professional development interventions must be tailor-made to meet twenty-first century teaching and learning outcomes.

Haleem, *et al* (2022) reviewed the existing literature on the necessary elements that enable educators to integrate technology as a meaningful pedagogical tool. They recommended that Professional Development provide educators with authentic discipline-related examples, supporting the positive impact of technology-based and student-centred instruction. For example, it can provide educators with opportunities to observe various technology integration models, which they can then apply in their practice. Also, Professional Development needs to help educators understand the difficulties they anticipate, when using technology in their lecture rooms and present effective contingencies to rectify them (Abedi, 2023).

Professional Development designers should ensure that educators understand that the ultimate objective of technology integration, is to advance the teaching and learning process and its outcomes. Fu (2013) specified that good planning and management for technology integration requires a special understanding of specific hardware and software related to the curriculum. Developing a pedagogical model requires a strong link between theory and application to help educators overcome the obstacles faced in technology integration (Akram *et al*., 2022). Professional development and pre-service teacher training are also indispensable to supporting the curriculum with technology integration. Backfisch *et al*., 2021, in their study on 'Technology integration in schools', stated that although teachers had sufficient skills, were innovative, and easily overcame obstacles, they did not integrate technology consistently as a teaching and learning tool. The reasons are outdated hardware, lack of appropriate software, technical difficulties and student skill levels. The study found that professional development significantly influences how well technology is embraced in the classroom. This implies that teachers' training programmes often focus more on basic skills and less on the integrated use of technology in teaching. Despite the numerous plans to use technology in schools, teachers have received little training in their educational programmes. The study concluded that simply teaching basic technology skills is inadequate, if teachers are to integrate technology into their instruction constructively. More emphasis should be placed on advanced skills in teacher education programmes, to provide teachers with authentic opportunities to experience and develop lessons that integrate technology in a meaningful context.

Schlinder *et al*. (2017) suggested that educators keep an open mind about technology integration in teaching and learning. Therefore, this implies that educators must be exposed to contemporary teaching strategies to adapt new instruments into their teaching practices. Similarly, Palak and Walls (2009) established that teachers use technology mainly to support their existing teaching approaches and rarely to foster student-centred learning. However, Yildirim (2007), in their research that examined educators' use of technology in Turkish schools, found that educators use technology more frequently to prepare hand-outs and tests than to promote the 4Cs (Communication, Collaboration, Critical Thinking, and Creativity). One possible explanation the authors gave was a lack of models for using technology, to facilitate learning and limitations related to contextual factors, such as class size and student ability.

Janssen, *et al* (2019) found that pre-service teacher preparation does not provide sufficient technology knowledge to support technology-based instruction, nor does it successfully demonstrate appropriate methods for integrating technology within a subject discipline. Therefore, the need for subject specific training should be provided in pre-service teachers' professional teaching curricula, and technology skills must be applied in the lecture rooms to model effective and relevant technology-enhanced teaching strategies (Oigara & Wallace, 2012; Koh & Sing, 2011). To help educators cope with these difficulties, Serdyukov (2017) suggested that, rather than only providing education theories, educational technology researchers should also document examples of how educators accomplish meaningful and effective technology integration to meet their pedagogical and content goals.

Milton (2013) reported that when technology is taught in pre-service teacher preparation programmes, the emphasis is often placed on teaching about technology, instead of teaching with technology. Hence, inadequate preparation to use technology is one of the reasons that educators do not, systematically use technology in their teaching practice. Educators lack the necessary skills and thus, need to be given opportunities to practice using technology in their pre-service teacher training programmes, so that they can be exposed to ways in which technology can be used to augment constructivist student-centred activities. Lecturers are more likely to adopt and integrate technology in their pre-service teacher preparation disciplines when Professional Development in the use of technology provides them time, to practice with the technology and to learn, share and collaborate with colleagues (Byrd, 2017). The statement suggests that Professional Development which helps lecturers update their technology skills may aid technology integration. To promote technology integration in teacher preparation

institutions, lecturers should adopt strategies that make technology part of their teaching routine.

For the case of Professional Development in technology and administrative support, most scholars and past studies suggested that, to a large extent, these two variables positively affected technology implementation (Darling-Hammond *et al*., 2017). Due to the lack of training on how to apply teaching with technology, few scholars like Mooij and Smeets (2001) in Holland believed that possessing technology skills does not warrant the use of computers in teaching. On the other hand, McKnight, et al (2016) emphasise the reinforcement of specific technology skills for teaching, such as graphing software, video editing, etc. This suggests that professional development should train teachers in relevant technology skills. This study aims to explore and understand lecturers teaching with technology in their pre-service teacher preparation.

2.4.3. Administrators support

Focusing on the importance of institutions' technology integration policy, Raman *et al*., 2019 indicated that effective technology integration depends on the perceptions and vision of institutions' leaders, rather than educators' technology integration skills. In their study of new technology for teaching and learning, Backfisch *et al*. (2021) reported that administrative support is critical to successfully integrating technology into teaching and learning processes. It is argued that the administrator's responsible for providing the necessary conditions, such as implementing a technology integration policy, incentives and resources. The authors stated that for the adoption of technology to be effective and sustainable, "administrators themselves must be competent in the use of the technology, and they must have a broad understanding of the technical, pedagogical, administrative, financial, and social dimensions of technology in education" (Backfisch *et al*., 2021, p.64).

Yang (2008), in a case study, 'Examining university students and academic understanding of Information and Communication Technology (ICTs) in higher education at Curtin University of Technology', reported that university educators who received support from administrators had a high commitment to adopting technology for teaching and learning. Data in the study suggested that the adoption of technology in teaching and learning would be promoted by greater support of the change at the administrative level of the university.

2.4.4 Availability of technological resources and technical support

A critical factor contributing to the promotion of innovation is the availability of infrastructure resources: hardware, in terms of the technology available in the institution for students and educators, for educational purposes, and the quality and functioning of equipment (capacity, speed, and access to the internet) as well as, available software applications. However, the availability of technology alone is insufficient and must be accompanied by technical and pedagogical support. The current study, exploring literature on the availability of technological resources and technical support, deals specifically with issues on actual technological resources and technical support available to lecturers at the research site.

In a study, Johnson *et al*. (2016) classified barriers to technology integration in teaching and learning into two categories, first and second order. The first order, which are external barriers beyond educators' control, includes a lack of technological resources and technical support. The second order, are internal to the educator, mainly influenced by personal philosophical beliefs. Lack of technological resources and technical support, as well as lack of professional development for teachers are other areas of first-order barriers to technology integration. Khan, Hasan and Clement (2012) stated that the reasons for Bangladesh educators' ineffective implementation of ICT in teaching and learning, were lack of appropriate infrastructure, support from administrators, inadequately trained educators, and scarce qualified ICT coordinators, that could help train educators to integrate technology into their practices. Dionys (2012), in a study in Cambodia reported similar findings, as lacking both infrastructure and technological resources. Hudson and Porter (2010) made similar finding in their study of Mathematics teacher. They identified lack of professional training and support as barriers to technology integration in Mathematics instructional strategies. In their study, Amuko, Miheso-O'Connor & Ndeuthi, (2015) found that 40% of the participants mentioned that they lacked technical support and appropriate infrastructure, with regards to technology integration. In their study, Jaipal-Jamani and Figg (2015) reported that lack of technical support, as one of the major barriers that resulted in computers being underutilized in the classes. Educators do not use technology in teaching when they have no immediate access to help, in case something goes wrong. Research has shown that the provision of adequate technical support is critical to the success of technology integration programmes (Poole, 2008). Technical specialists must be able to answer questions quickly, maintain or repair hardware, supply loaners, and install software. The availability of technical support means that educators and students alike have

access to technology resources that are functional at all times. This implies access to immediate resolution of technical challenges users encounter is important. The failure to provide technical support may hurt how teaching with technology is implemented. Support teams should, therefore, be equipped with knowledge and resources that facilitate effective response times. Robinson and Kay (2010) recommended that a single technical specialist support no more than 30 computers for effective service delivery. This reduces the length of downtimes in technology use. This study sought to explore how Technology lecturers use instructional strategies to train basic technology pre-service teachers for twenty-first-century teaching in a Nigerian university. Therefore, it was important to explore the literature on the availability of technological resources and technical support, which goes beyond educator's control.

2.5 Pre-service teacher preparation in the twenty-first century

The transition to successful technology integration in teaching and learning indicates the need for a shift in pedagogical approaches and reforms in teacher preparation programmes. This, therefore, requires specific technology integration standards; studies show that many lecturers and pre-service teachers feel unprepared to teach with technology (Pozas &Letzel, 2023; Bergeson, 2021; Stokes-Beverley & Simoy, 2016). In this section, I sought to understand how lecturers prepare pre-service teachers to teach with technology in the twenty-first century.

Teacher preparation is an important component of education and the society's development. A critical element within teacher education relates to how teachers are prepared to address twenty-first century needs. Mufidah (2019) defines teacher preparation as programmes designed to prepare pre-service teachers to become professional teachers. Teachers are central to any education system, as they are the ones who see that curriculum programmes are successfully implemented. They manage and create conducive environments that produce twenty-first century teaching and learning outcomes. This implies that teacher preparation programmes should provide pre-service teachers with professional knowledge that meets twenty-first century expectations. In this study, it is important to explore how technology integration is taught in pre-service teacher preparation programmes.

Most teacher preparation programmes are designed to provide four (4) years of coursework that includes fundamental theoretical foundations of education, content-specific courses organised in grade level, classroom management approaches, professional studies and teaching practice internships (Kimathi & Rusznyak, 2018). Teaching practice (TP) internships start in their first year and continue until their fourth year of the teacher preparation programme.

Teaching Practice allows hands-on training in real classroom dynamics and management, as they are mentored and relate their theoretical knowledge to practice. Despite the major shifts in educational policy, researchers mention that the quality of education across Africa has not improved (Chigona, 2015). Amongst the key concerns attributed to this was the issue of inadequately prepared teachers. Hennessy *et al,* (2022), while reflecting on pre-service teacher preparation programmes, asserts that most of the existing programmes fail to address the needs of modern classrooms. Pre-service teachers are expected to gain confidence in delivering content with the aid of technological resources and perform tasks as informed by their professional teaching knowledge.

However, there are concerns that traditional models of teacher education are not fully capable of producing teachers for the changing times (Durak, 2021; Santos & Castro, 2021). Gomes (2017), for example, asserts that traditional teacher education programmes fall short in preparing teachers and states that contemporary teacher preparation practices need to go beyond training pre-service teachers in isolation and give them more practical and sustainable teaching techniques that meet twenty-first century requirements. Similarly, Lieberman and Miller (1990) draw attention to the fact that many contemporary approaches to teachers' training have focused on traditional models with no links to current needs, making it difficult for teachers to teach effectively in a developing context. Teaching in a digital age requires educators to explore new teaching strategies (McKnight *et al*., 2016). Therefore, this suggests that lecturers are expected to migrate from traditional to modern approaches in their pre-service teacher preparation programmes.

Choy, Wong and Gao (2009) conducted a mixed study to examine pre-service teachers' technology integration before and after a technology integration course. They compared the findings before and after the integration course. The researchers concluded that teacher education programmes need to increase awareness of the benefits of integrating technology with student-centred learning approaches. They further argued for exploring technology integration models that align with student-centred teaching strategies. This finding supports the objective of this study about adopting technology-enhanced student-centred teaching approaches. The perpetually changing technology-driven environments necessitate that education be structured to meet current needs while anticipating emerging trends and challenges for students (Akyeampong *et al*., 2011). For a successful and quality education, it is critical to position teacher preparation programmes in ways that benefit schools and learners. Henceforth, teacher preparation institutions should ensure that their teacher preparation

programmes produce well-prepared pre-service teachers. However, Chigona and Chigona (2013) report that pre-service teachers are inadequately prepared for twenty-first century classrooms. Teacher preparation programmes must guide pre-service teachers toward the abilities, strategies, and ways of thinking for teaching today and tomorrow. The urge for adequately prepared pre-service teachers must start by cultivating appropriate teaching knowledge anticipated in a professional teacher, bearing in mind the current need, to foster critical thinking, analysis, and knowledge application in learners.

Changes in the demand for skills have profound implications for the competencies that lecturers need to acquire to model twenty-first century teaching skills, for pre-service teachers (Ananiadou & Rizza, 2010). The quality of pre-service teacher preparation programmes is considered the most significant in realising transformation in education (Deacon, 2014). Lecturers are challenged to design learning that meaningfully integrates content, pedagogy, and technology in ways that foster the development of twenty-first century skills. To adequately prepare pre-service teachers, lecturers must have a broad background and understanding of classroom developments (Katitia, 2015). The study (Deacon, 2014) suggested improvements in initial teacher preparation where lecturers must practice and develop their pedagogy in teacher preparation programmes, as informed by contemporary teaching and learning theories. Modelling good practice is recommended as a key developmental tool in teacher preparation (Abadzi, 2012). Several studies emphasise the need for training and equipping lecturers first (Ching *et al*., 2013, Tiba, 2018; Tondeur *et al*., 2012). In reading for this study, the researcher did not find many studies looking specifically at how lecturers develop their professional teaching practice or in-service training to acquire new teaching and learning developments. Therefore, this highlights discernible gaps in the existing literature, providing lucid directions for future research into technology use. A review of the existing literature shows that technology integration is mediational and entails an evolving process, not a final product. Achieving successful integration of technology requires an effort from three main stakeholders: lecturers, pre-service teachers, and institution administrators. Understanding the pre-service teacher preparation in the twenty-first century, informs the researcher what lecturers need to stay current, with the prevailing knowledge in twenty-first century education. The next section explores lecturers' roles in twenty-first century teaching and learning.

2.6 The role of the lecturer in twenty-first century teaching and learning

In twenty-first century teaching and learning, the educator's role is to engage and facilitate student's meaning-making process (knowledge construction). The educator's focus should be guiding students by creating an appropriate learning environment that leads them to develop their understanding of the content. Therefore, lecturers must design lectures that align technologies with content and pedagogy to meet learning outcomes successfully. Also, they should act as models, mentors, and coaches of twenty-first century knowledge and skills to pre-service teachers (Partnership for 21st Century Learning, 2015). The following subsections explore these roles in detail.

2.6.1 Lecturers as designers of twenty-first century teaching experiences

The goal of twenty-first century teaching is to provide learning environments for students that incorporate authentic learning, assessment, and personal development. Twenty-first century is characterised by the mastery of information, embedded knowledge and understanding, and the advanced use of technology in society, as people develop higher-order skills such as the 4Cs (Creativity, Critical thinking, Communication, and Collaboration). Therefore, the lecturer's role as a designer entails creatively designing, relevant and meaningful learning activities that engage students' minds, thereby taping into the development of the 4Cs.

Technology seamlessly supports a twenty-first century learning environment by giving access to and incorporating an online wealth of resources and outside knowledge. Lecturers ' ability to design teaching and learning activities that expand the spatial spaces of the four walls, is a critical skill for twenty-first century learning outcomes. The Organization for Economic Co-operation and Development (OECD) Innovative Learning Environments (ILE) argues that a contemporary learning environment should innovate the elements and dynamics of its "pedagogical core" (OECD, 2017, p.18). The twenty-first century is dominated by language that describes comparative thinking, design thinking, project-based learning, game-based learning, strength-based learning, personalised learning, collaborative learning, blended learning, and kinaesthetic learning (Pearlman, 2008; Donovan & Green, 2014; Leggat, 2015). This language highlights the demand for both educators and learners, to be able to navigate through a highly technical world with so many information sources. As pedagogical practices evolve, educators rediscover their values, priorities, and conceptualisations of the teaching and learning processes and environment. The twenty-first century requires an in-depth understanding of the current learning environment's needs and what students are expected to

achieve, to fit into and operate in such an environment. Lecturers are also expected to demonstrate skills they expect pre-service teachers to acquire. In the next section, the researcher discusses the role of the lecturers in modelling expected teaching practice.

2.6.2 Modelling twenty-first century teaching practices

Singh-Pillay and Naidoo (2022) posit that the role of an educator is to model knowledge construction through 'reflection-in-action'. Lecturers significantly influence pre-service teachers' readiness, understanding, and views of teaching with technology. Several studies have argued that modelling technology use, especially by lecturers, is possibly a successful strategy for pre-service teachers' effective technology integration (Neal & Eckersley, 2014; Westbrook *et al*., 2013; Divaharan, 2011). Teachers' preparation programmes remain central for modelling, training, and implementing the effective use of technology-enhanced learning. For pre-service teachers to learn to implement digital pedagogy into their teaching effectively, they must first see it modelled effectively by lecturers. This is crucial in that it gives the pre-service teachers a demonstration of how to use technology in context practically. Oigara and Wallace (2012) mention that pre-service teachers must be modelled using current instructional technologies to learn to incorporate digital pedagogy. They recommend that lecturers model various digital pedagogical tools in their teacher preparation programmes, to help understand how to implement digital pedagogy that facilitates learning. Modelling provides pre-service teachers with examples of teaching with technology, that helps achieve desired learning outcomes. This may assist in elaborating on or providing alternative technological representations of how to meet the objectives of those activities. The pre-service teachers are in an ideal position to see how lecturers use technology from an educator's perspective, and they, as the learner in this case, can practically assess its effectiveness. This allows them to formulate more creative ways of implementing technology-enhanced teaching activities.

2.6.3 Coaching and mentoring twenty-first century teaching experiences

Coaching and mentoring lecturers can significantly affect the development of pre-service teachers during this twenty-first century transition and change. Coaching is defined as a way of having a thought-provoking conversation, which helps individuals maximise their personal and professional potential (London Leadership Academy, 2014). Mentoring involves a senior member sharing their knowledge and experiences, creating new networks between the mentee and mentor (London Leadership Academy, 2014). In this study, coaching and mentoring are

two teaching strategies that lecturers can use to help improve their professional development in teaching with technology, as well as implement it into their teaching practice.

Coaching and mentoring fit within a constructivist paradigm. Constructivists emphasise that people develop meaning through their interactions with the environment. In line with this, coaching and mentoring encourage a student-centred approach. Thus, coaching and mentoring as a learning strategy differ from the behaviourist lecturer-centred approach. The coach often facilitates non-directive methods, encouraging the students to find their presumed solutions to a given scenario. Lecturers facilitate the development of effective teaching practices that transform learning and, therefore, are expected to be competent in the new skills, which deal with these new changes to be effective mentors.

Since the main role of educators in developing twenty-first century skills is facilitating effective technology-enhanced teaching practices, lecturers inevitably need to excel in innovative competencies, that deal with these current changes (Westbrook *et al*., 2013; Oigara & Wallace, 2012). Studies recommending teacher preparation improvements argue that lecturers need relevant school experience and should develop pedagogy in teacher preparation programmes that are being promoted and aligned with school curricula (Neal & Eckersley, 2014; Oigara & Wallace, 2012; Kadzera, 2006). A knowledgeable coach inspires students, by showing them good practice in action. Lecturers are expected to be competent in effective teaching, with technology skills that they want to inculcate among their pre-service teachers: they need to continuously seek innovative and better ways of knowledge acquisition through improved skills. Against this backdrop, technology can play a big role in helping students attain twenty-first century skills, because of the opportunities it offers in facilitating learning.

2.6.4 Scaffolding

Scaffolding is an instructional strategy that moves students progressively towards an incremental and deeper understanding of content, leading to independence and critical thinking in solving problems (Taber, 2018). In other words, the educator enhances learning by building on students' experiences and current knowledge as they learn new skills. Similarly, (Tondeur. Scherer, Baran, Sidding, Valtonen, & Sointu, 2019) assume that when students are given the support they need while learning new skills, they stand a better chance of using that knowledge independently. Scaffolding instructional strategy resonated with this study, as it supports and helps develop twenty-first century skills.

An educator using instructional scaffolding employs a student-centred approach, which affords students ownership of their learning while decreasing the teacher's role in the process (Singh-Pillay & Sotsaka, 2021). The concept of scaffolding is directly related to Vygotsky's Zone of Proximal Development (ZPD): a student constructs knowledge with the guidance of a more knowledgeable other (Shabani *et al*., 2010). Vygotsky's Zone of Proximal Development (ZPD) is defined as the distance between what children can do by themselves and the learning outcomes that they can be helped to achieve, with competent assistance (Sotsaka & Singh-Pillay, 2020). Lecturers act as the more knowledgeable others in this study: scaffolding facilitates students' ability to build on prior knowledge and internalise new knowledge. An important aspect of scaffolding is that the scaffolding provided by the more knowledgeable other (MKO) is gradually withdrawn as the student's abilities and self-reliance increase. The goal of the lecturer, when using the scaffolding teaching strategy, is for the pre-service teacher to become an independent and self-regulating student and problem solver (Hardman & Amory, 2015). (Lange et al., 2016) classify two major steps involved in scaffolding:
(i) Development of instructional plans to lead the students from what they already know, to a deep understanding of new material, and
(ii) Execution of the plans; the educator supports the student-centred learning process.

According to Hartman & Lange (2012), scaffolding includes models, cues, prompts, hints, partial solutions and think-aloud modelling. Instructional scaffolds are designed to assist educators engaged in student-centred learning activities. According to Gaffney and Rodgers (2018), there are six main scaffolding characteristics:

1. Providing clear direction; reducing students' misconceptions of what is expected. Lecturers need to know of, and about any learning difficulties and misconceptions, students have concerning technology integration, to develop step-by-step guidelines that illustrate what students must do to achieve their learning goals.

2. Clarifies the purpose of the learning activity as the educator sets out what needs to be achieved at the end of the activity: Students understand the objective of doing the work and its importance as it relates to the broader content areas.

3. Keeps students engaged with their task, as they follow the guidelines proposed by the knowledgeable other. The students can make decisions about which pathways to choose, but they cannot wander too far off the pathway.

4. Clarifies expectations and incorporates assessment and feedback: expected outcomes are clearly stated from the beginning of the activity. Illustrations of the exemplary work, rubrics, and standards of excellence are shown to the students. In the context of this study, lecturers set up exemplary teaching practices, integrated with technology and high standards.

5. Points students to worthy sources, since educators provide possible sources for students to reduce confusion, frustration, and time. The students may decide which of these sources to use. Lecturers identify effective teaching with technology strategies and recommend that pre-service teachers explore how best to use them in practice.

6. Reduces uncertainty, surprise, and disappointment; for example, educators test their lessons to determine possible problem areas and refine the lesson to eliminate difficulties to maximise learning.

Despite the envisaged importance of scaffolding in constructivist learning, Milton (2013) indicates the complexity of its representation and educators' difficulties in understanding it. Despite its difficulties, scaffolding plays an important role; lecturers can set guidelines to help pre-service teachers comprehend teaching with technology strategies. Lecturers scaffold pre-service teachers learning, by designing and implementing student-centred approaches and technology-enhanced lessons.

To sum up, the lack of lecturers' facilitative, cooperative, collaborative and student-centred teaching approaches deprives pre-service teachers of opportunities, for more robust and universal solutions to problems. Effective teaching occurs in the twenty-first century classroom environment, when teachers bring together knowledge of content and instructional strategies, which will make students understand concepts by incorporating digital technology. According to CAST (2011), technology supports different pathways and provides students with multiple means of knowledge representation, expression and engagement using audio, digital text, video and images. The question is how to use technology to enhance student-centred learning, by employing specific technological tools and using specific technology-related instructional strategies in teachers' preparation programmes.

2.7. The Nigerian context

The use of digital technology can produce a quality Education system (UNESCO, 2012), and its use in the Nigerian educational system will improve the quality of the educational system and transform it into a world-class education standard. The use of technology in education has provided students and teachers with an unlimited number of options for classroom learning. Aying, Awang, and Ahmad (2019) stated that digital technology in teaching can increase students' interest and understanding of a subject. Among the many advantages of digital technology is the possibility of interacting; it enables the implementation of visual and interactive instructional activities (Garcia, Reyes, & Godinez, 2017; Hernández, Orrego, & Quiñones, 2018). Wylie (2016) conducted a study to ascertain the academic potential and benefits of mobile applications. The researcher found that apart from its benefits as a learning tool, learners' vocabulary and understanding of content improved. Also, students were more motivated to do well and prepared for class than their counterparts who did not use them.

The utilization of technology for learning dates back to the 1970s with television, then, progressed to video teleconferencing in the 1980s, to computers in the classroom in the 1990s, mobile technology, and now to social media technologies (Harnish, *et al*. 2018) and smart technology in the twenty-first century. Each of these stages of utilization has witnessed significant roles in the development of the education system, globally. According to the K4D Emerging Issues report series (2019), the partnership for twenty-first century learning (P21) has put forward a framework to describe the student learning outcomes and support systems necessary for the effective utilization of technology in learning, in the twenty-first century. They asserted that learning in the twenty-first century is not about teachers using a few gadgets or equipment to teach, but about learners having the opportunity to access, create, contribute, and communicate effectively within the learning system.

McArthur, *et al*. (2018) stated that the integration of information and communication technologies (ICT) has added another layer to the twenty-first century literacy requirements. These are a set of needed skills, and also a set of technological practices within the society. McArthur *et al*. 2018 further identified digital literacy by categorizing its skills into information access, online participation, computer ability, search engine skills, and skills required to evaluate information.

The evolution of digital technology in education has put learning in the palm of both teachers and their learners, most especially through the use of mobile technology which includes tablets, digital cell phones, iPods, etc. According to Moemeke (2019), digital technology has become helpful in implementing different learning techniques. The influence of mobile devices on education cannot be ignored (Dias & Victor, 2017). The use of these digital tools is mostly preferred by this generation of students because it allows them to be integrated into the learning process (Hussin, 2018).

Some digital technologies that are revolutionizing classrooms and learning in the twenty-first century include the following: flipped classrooms, Internet connection, the iPod, E-Readers, Use of Open Education Resource (OER) facilities, such as Moodle (Modular Object-Oriented Dynamic Learning Environment), technology such as laptops, desktops, compact disks, videos, Televisions, projectors, etc. have also proved effective on students learning, webcasts, podcasts, blogs, webcam for video conferencing, screen casting, Artificial intelligence, and robotics.

The Federal Government of Nigeria recognized the potential of digital technology in its educational system. This dates back to the National Policy on Computer Education (FME, 1988) which emphasized the need for primary school pupils to be introduced to basic computer skills, the use of the computer to facilitate learning, and basic use for typing, computation, and data entry. For secondary school, they have related goals that were to be achieved at a higher level. The tertiary institutions were also required to teach computer science as a discipline and to integrate it into school administration and instruction. However, the implementation was not effective. The National Policy on Education (NPE, 2004), emphasized the need for the integration of Information and Communication Technology (ICT) in the Nigerian educational system. This goes beyond computer literacy to the level of ICT and the infrastructure. These major areas were emphasized in the Nigerian National Policy for Information Technology (FRN, 2001). They are to empower youths with ICT skills, prepare them for competitiveness in a global environment, and integrate ICT into the mainstream of education and training, and establishment of ICT institutions. To achieve these objectives, nine major strategies were outlined. These include:

i. Making ICT compulsory at all educational institutions
ii. Developing ICT curricula for all levels of education
iii. Using ICT in distance education
iv. ICT companies' investment in education

v. Giving study grants and scholarships on ICT
vi. Training the trainers' scheme for youth corps services on ICT
vii. ICT capacity building at the zonal, state, and local government levels
viii. Establishing private and public dedicated ICT institutions
ix. Working with international and domestic initiatives to transfer ICT knowledge.

According to Voogt *et al*. (2013), Information and Communication Technology (ICT) skills are a prerequisite for acquiring other twenty-first century skills. To enhance students' ICT skills, pre-service teachers need to be provided with opportunities to take advantage of ICT in teaching and learning (Ertmer & Ottenbreit-Leftwich, 2014). Tondeur *et al*. (2017) focused on pre-service teachers and their use of technology. In their study, they investigated the relationship between beginning teachers' pre-service educational programs and their actual use of technology in the classrooms. The researchers found that beginning teachers were willing to use technology. Also, they were aware of how these technologies are important to improve teaching and learning processes. However, there were misunderstandings about how to integrate technology effectively. On the other hand, the results of Tondeur *et al*. (2017) study found a strong relationship between pre-service learning experiences and the degree to which teachers used technology post-graduation.

Presently, educational institutions in Nigeria, especially teacher training institutions, are yet to tap fully from the potentials of digital technology in the delivery of knowledge and curriculum, as embedded in the National Policy on ICT in Education. There is a technological gap between the progress of the society and instructional activities of the teacher in the classroom (Bhattacharjee & Deb, 2016).

Technological gaps exist in Nigeria because of factors militating against the integration of digital technology in our teaching and learning process. Some of these factors include insufficient numbers of computers, epileptic power supply, internet network failure, lack of ICT skills, difficulty in integrating ICT into instruction, scheduling computer time, insufficient computer peripheral devices, inadequate software, insufficient teaching time, lack of qualified ICT personnel, cost of equipment, management attitude and lack of technical assistance among others. Okwudishu (2005) indicated that the unavailability of some ICT components in schools hampers teachers' use of it. The various challenges that have been raised have to be addressed for Nigeria to use technologies effectively to enhance her educational system.

2.8. Conclusion

This chapter presents a review of the relevant literature of the study. The review provides insights into the significance of instructional strategies employed by technology lecturers to prepare pre-service teachers for the twenty-first century. It discusses the concept of instructional strategies as it relates to both, the behaviourist and the constructivist learning and teaching theories. The review delves into the twenty-first century instructional strategies that pre-service teachers need to develop and teach with digital technology in the twenty-first century. Furthermore, the review examines the challenges that lecturers confront in implementing instructional strategies to prepare pre-service teachers for the twenty-first century, such as professional development, administrators' support, technological resources, and technical support. Conclusively, the review highlights the role of lecturers in twenty-first century teaching and learning. The next chapter presents the conceptual framework of the study.

CONCEPTUAL FRAMEWORK

3.1. Introduction

In this chapter, the conceptual framework that underpinned this study is presented. According to McMillan and Schumacher (2001), a conceptual framework directs every aspect of the study, from the research questions to the methodology, until the researcher makes sense of the generated data. Cohen, Manion and Morrison (2018) maintain that a conceptual framework draws on one or more formal theories (in part or whole) and other concepts and empirical findings from the literature. It maps out the critical concepts intertwined with the topic, the data generation method and the analysis.

As mentioned, this study explored Technology Lecturers' Instructional Strategies to Prepare Basic Technology Pre-Service Teachers for Twenty-First-Century teaching at a Nigerian university. The concept of agency is closely related to curriculum and how lecturers negotiate their responsibilities. Thus, the conceptual framework draws on the P21 framework for twenty-first-century learning and Singh-Pillay and Samuel's (2017) notion of ecological agency.

3.2. Conceptual framework

As mentioned above, the conceptual framework for this study is an amalgam of the P21 framework and the notion of ecological agency. First, the P21 framework will be discussed, followed by the ecological agency.

P21 Framework for 21st Century Learning was developed with input from teachers, education experts, and business leaders to assist practitioners in embracing and developing twenty-first century skills in their teaching. In this study, the Framework for 21st Century Learning (P21) was considered as a relevant framework for examining Technology lecturers' instructional strategies to prepare basic technology pre-service teachers for twenty-first-century teaching at a Nigerian university. Barrot (2019) describes the Framework for 21st Century Learning (P21) as an approach designed to help lecturers integrate 21st-century skills into the teaching of core academic subjects. The author remarks that this framework envisions a dynamic and integrated approach to education that prepares students not only with knowledge but also with the skills, attitudes, and values necessary for success in the rapidly changing 21st-century landscape. The P21 framework describes the skills, knowledge, and expertise students must master to succeed in work and life. The framework is a blend of content knowledge, specific skills, expertise, and

literacies developed within a institution. However, the framework does not consider the institutions context or ecology. As such the P21 framework does not fully address the challenges lecturers may face in integrating these skills in their teaching. The ecological context of the institution will determine what is possible in terms of developing 21 st century skills in students. Thus, there is a need to extend the existing P21 framework to include the ecological context. I draw on Singh-Pillay and Samuel's concept of ecological agency (2017), to further understand how lecturers/teachers navigate their institutional ecology when preparing basic technology pre-service teachers to teach in the twenty-first century. In the context of this study, when a technology lecturer embraces the P21 framework with the necessary support systems such as standards, assessments, curriculum and instruction, professional development, and learning environments, students ought to become actively involved in the learning process and acquire the much needed 21-Century skills. In an attempt to clearly define the skills, content knowledge and literacies that students would need to be successful in their future endeavours, the Partnership for 21st Century Learning (P21; 2016) created a framework that includes:

(a) Life and career skills;

(b) Learning and innovation skills;

(c) Information, media, and technology skills; and

(d) Key subjects (Partnership for 21st Century Learning, 2016).

Like the components of an ecosystem, which are interdependent, so are the components of the P21 framework. Figure 3.1 represent the interconnected/interdependent components of the P21 framework required during teaching and learning to develop twenty-first century skills.

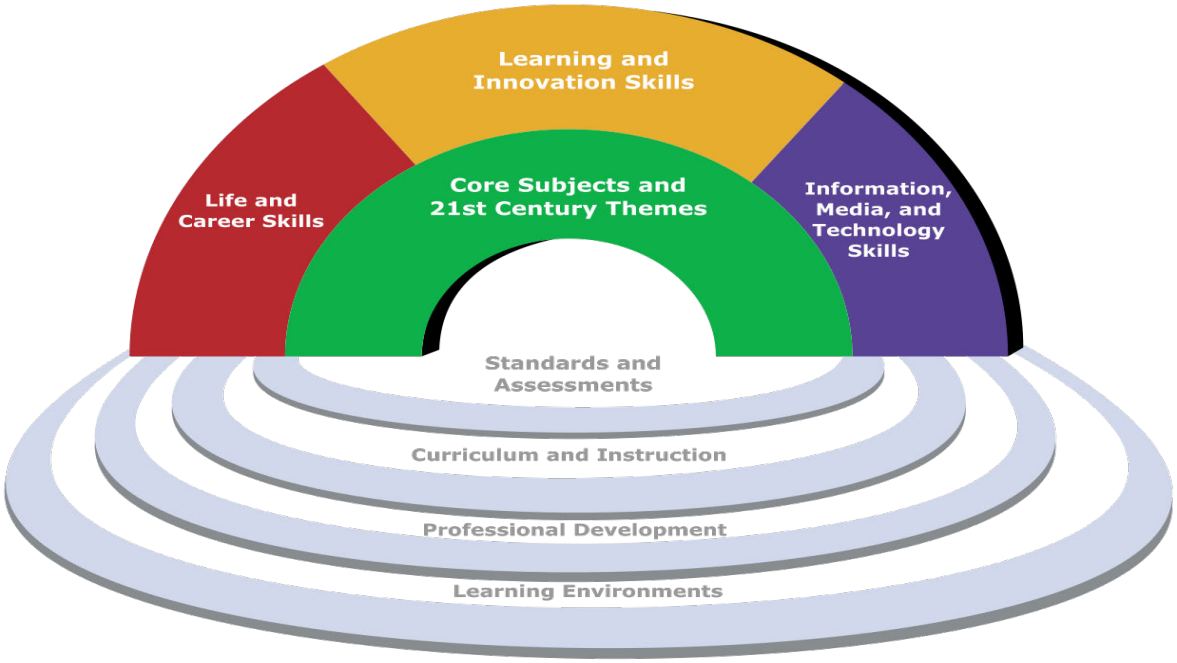

Figure 1 - P21 Framework for 21st Century Learning

Source: www.p21.org/framework

This means developing core academic subject knowledge and understanding among students linked to the curriculum, assessments, instructional strategies, and the school ecosystem. These links are quintessential for developing twenty-first century skills such as critical thinking, creativity, innovation, collaboration, problem-solving, and effective communication. Figure 3.2 below are the skills associated with each core component of the P21 framework.

All parts of the framework, (a) life and career skills, (b) learning and innovation skills, (c) information, media, and technology skills and (d) Twenty-first century themes describe proficiencies or literacies students should develop and can be integrated and developed in any teaching lesson (Partnership for 21st Century Learning, 2016). Each core component will be discussed next.

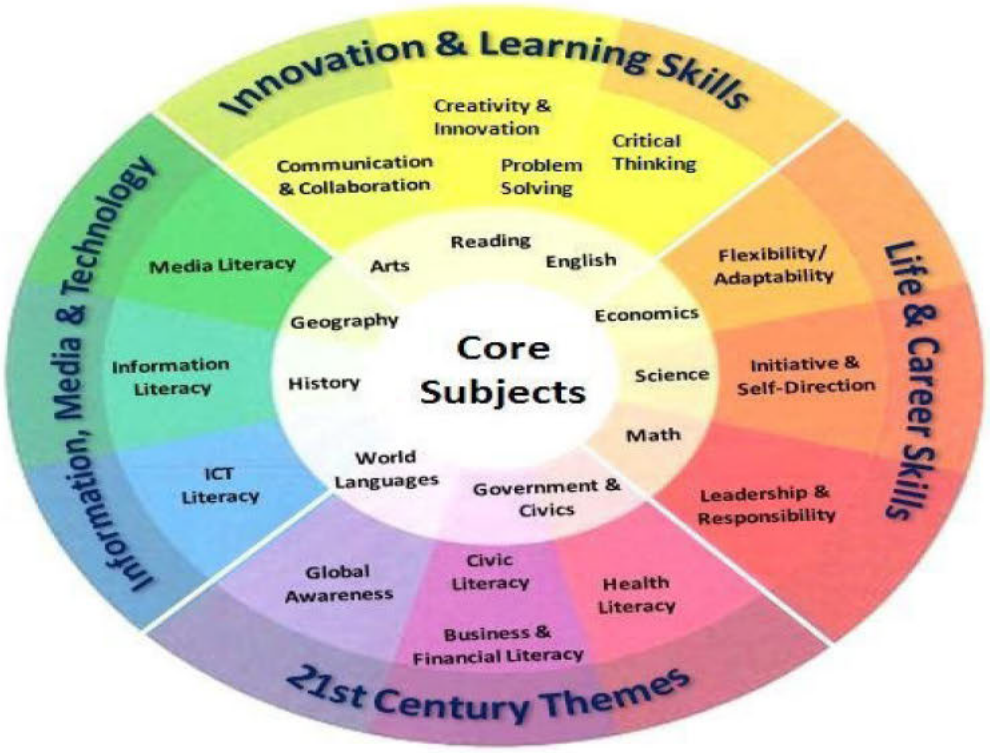

Figure 3.2. The Twenty-first Century skills associated with each component of the P21 framework.

Source: www.p21.org/framework

3.2.1. Learning and innovation skills

Learning and innovation skills are those skills that prepare learners for a more complex life and work environment. It includes creativity, innovation, critical thinking, problem-solving, communication, and collaboration.

Creativity and innovation include thinking creatively, working creatively with others, and implementing innovations. In other words, it entails brainstorming to create new ideas, refining, analysing, and evaluating the idea to improve creativity. It also involves communicating the idea effectively to others, being open and responsive to new perspectives or critiques, understanding the limitations of the new idea, and incorporating input to improve the idea. It

entails the understanding that creativity and innovation are cyclic processes.
Using different types of reasoning, for example, inductive and deductive reasoning, analysing how parts of a whole interact to produce outcomes, evaluating evidence or alternative points of view, making connections between evidence, critique, and evaluations, making judgements, reflecting critically on the learning and process, listening to decipher meaning, and intentions, articulating thoughts and ideas effectively using oral, written or graphical communication embraces the notion of critical thinking and problem-solving.

Communication and Collaboration entail the ability to communicate in various contexts using multiple modes of communication (verbal and non-verbal), demonstrating the ability to work effectively and respectfully with diverse teams, exercising flexibility and willingness to help make necessary compromises to accomplish a common goal, and assume shared responsibility for collaborative work and value the individual contributions made by each team member.

3.2.2. Information, media and technology

People in the twenty-first century live in a technology and media-rich environment. They are expected to have access to an abundance of information, deal with rapid changes in technology tools, and the ability to collaborate and make individual contributions on an unprecedented scale. To be effective in the twenty-first century, citizens and workers must exhibit various functional and critical thinking skills related to information, media, and technology.
Thus, individuals must be able to access and evaluate information, use and manage information, analyse media, create media products and be Information and Communication Technology (ICT) literate.

3.2.3. Life and career skills

Today's life and work environments demand more than thinking skills and content knowledge. Students must rigorously develop life and career skills to navigate the complexities of the globally competitive information age. This includes:

- Adapting to varied roles, job responsibilities, schedules, and contexts
- Working effectively amid ambiguity and shifting priorities
- Incorporating feedback effectively
- Handling praise, setbacks, and criticism positively
- Understanding, negotiating, and balancing diverse views and beliefs to reach workable solutions, especially in multicultural settings

- Setting goals with both tangible and intangible success criteria
- Balancing short-term tactical goals with long-term strategic objectives
- Managing time and workload efficiently
- Working independently and being self-directed learners who go beyond basic mastery to explore and expand their learning and expertise
- Demonstrating a commitment to lifelong learning
- Reflecting critically on past experiences to inform future progress
- Respecting cultural differences and working effectively with people from diverse social and cultural backgrounds
- Setting and achieving goals despite obstacles and competing pressures
- Using interpersonal and problem-solving skills to influence and guide others toward a common goal
- Leveraging the strengths of others to achieve a common objective
- Acting responsibly with the larger community's interests in mind

3.2.4. Twenty-First century themes

To achieve twenty-first century outcomes for students, standards, assessments, curriculum, instruction, professional development, and learning environments must be aligned to create a cohesive support system. The twenty-first century standards aim to build understanding across and among core subjects, as well as twenty-first century interdisciplinary themes, emphasise deep understanding rather than shallow knowledge, engage students with the real-world data, tools and experts they will encounter in college, on the job, and in life; students learn best when actively engaged in solving meaningful problems. Assessment of twenty-first century skills includes high-quality formative and summative classroom assessments, helpful feedback on student performance, and a balance of technology-enhanced, formative and summative assessments. Twenty-first century curriculum and instructions focus on providing opportunities for applying twenty-first century skills across content areas and for a competency-based approach to learning, enabling innovative learning methods that integrate the use of supportive technologies, inquiry and problem-based approaches and higher-order thinking skills, encouraging the integration of community resources beyond school walls.

Twenty-First Century Professional Development equips teachers with the skills to employ various strategies, like formative assessments, to effectively reach diverse students and foster environments that support differentiated teaching and learning. It highlights opportunities for integrating twenty-first century skills, tools, and teaching strategies into classroom practice,

helping teachers identify which activities to replace or de-emphasise. It also demonstrates how a deeper understanding of the subject can enhance problem-solving, critical thinking, collaboration, communication, and technology integration. The programme also promotes knowledge sharing among practitioner communities through face-to-face, virtual, and blended communications.

Since the above P21 model does not take into consideration the institutional context or teacher agency, I draw on Singh-Pillay and Samuel's concept of ecological agency (2017), to further understand how lecturers/teachers navigate their institutional ecology when preparing basic technology pre-service teachers to teach in the twenty-first century. These scholars see agency as an emergent phenomenon of the ecological context through which it is enacted, in this instance the institutional context (AB University). This type of agency gives teachers/lecturers the freedom to respond and adapt during curriculum reform.

This perspective of agency helps us to understand how humans are able to be reflexive and creative, acting counter to societal constraints, but also how individuals are enabled and impeded by their social and material environments. This type of agency gives teachers the freedom to respond and adapt to evolving curriculum demands such as developing twenty-first century skills.

3.3. Conclusion

In this chapter, the conceptual framework for the study was presented. The conceptual

framework is an amalgam of the P21 framework and Sing-Pillay and Samuels' notion of Ecological agency. In the next chapter, the methodology will be discussed.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

This chapter discusses the procedure undertaken in carrying out this research, and it begins with the context of the study, researcher positionality, research paradigm, research approach, research design, sampling techniques used, research instruments, ethical considerations, data generation plan, data analysis, limitations of the study and ends with a chapter summary.

4.2 Context of the study

The study was conducted at the AB University (Pseudonym) in Lagos State, Nigeria, within the Department of Technology Education. Lagos State is situated in the coast region of south western Nigeria. According to the National Bureau of Statistics (NBS), Lagos State is the second most populous state in Nigeria with a population of 12,772,884 people (NBS, 2020).

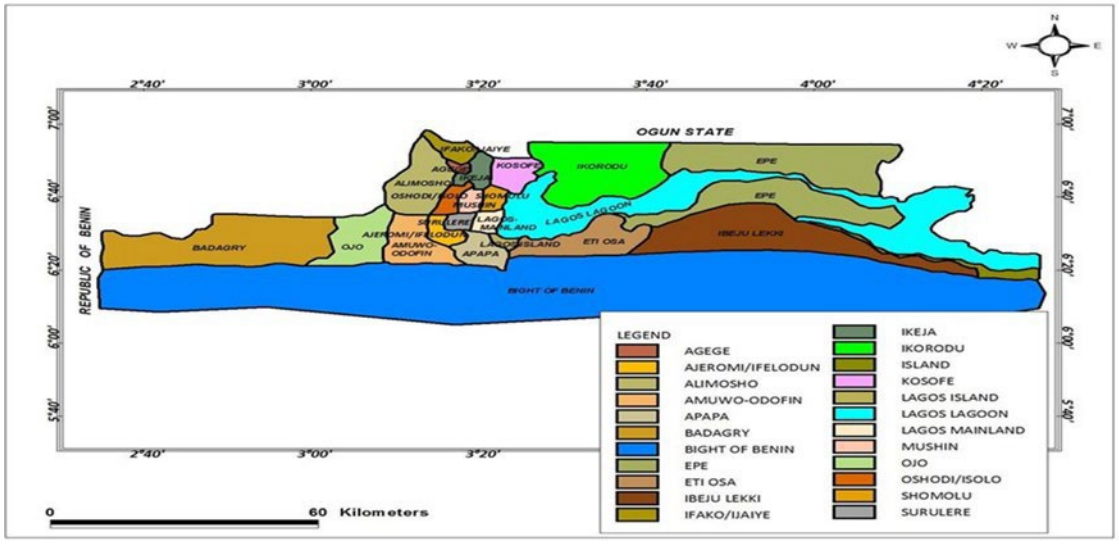

Figure 4.1. Map of Lagos State, Nigeria.

Source: Ministry of Physical Planning, Lagos State. Nigeria.

Also, it is the commercial centre of Nigeria. The institution has 7 colleges namely, College of Humanities Education, College of Science Education, College of Information & Technology Education, College of Vocational & Entrepreneurship Education, College of Management & Social Science Education, College of Specialised & Professional Education, and College of

Language & Communication Arts. The university offers full-time and part-time studies to the undergraduate & sandwich students in all the faculties. This study was conducted at the College of Information &Technology Education, in the Department of Technology Education. The student population of the university is about 7,000. The duration of the Basic Technology teacher-training programme is four years. AB University is a tertiary institution in Lagos State, Nigeria, focused on training teachers and education professionals. The university aims to produce quality teachers and address the shortage of educators in Lagos State.

The research study was conducted in this department because basic technology pre-service teachers are trained there. The sample for this study includes the Basic Technology lecturers, Basic Technology teacher education curriculum, and Basic Technology teaching portfolios.

4.3.Researcher Positionality

Charmaz (2014, p. 13) explains that 'if we start with the assumption that social reality is multiple, processual, and constructed, then the researcher's position, privileges, perspective, and interactions must be considered as an inherent part of the research reality. It, too, is a construction'. I am a lecturer at a Nigerian university and as such I dealt with two types of biases, namely participant bias and researcher biases. Participant bias occurred when the participant chooses to agree with me just to complete the interview. To overcome participant bias I framed questions that are open-ended asked the question in different ways. To circumvent my biasness, I maintained a reflective journal (not part of data generation), I engaged in member checking of transcripts, discussed my analysis at postgraduate cohorts.

4.4.Research Paradigm

A paradigm is a set of beliefs guiding a research study (Kivunja & Kuyini, 2017). Similarly, Cohen *et al*. (2018) concur that paradigm constitutes the abstract beliefs and principles that shape how one sees the world. Moreover, Norris *et al.* (2017) identify five paradigms: positivism, interpretivism, emancipatory, critical and pragmatism.

According to Creswell and Creswell (2017), paradigms differ based on their ontology (the nature of reality), epistemology (nature of knowledge), axiology (values associated with areas of research and theorising) or methodology (strategies of gathering, collecting and analysing data). The interpretive paradigm aims to understand the social world by interpreting human behaviour, beliefs, attitudes and perceptions. It considers the multiple lived experiences of

participants that are socially constructed. This is the ontology of the interpretative paradigm. This means that the researcher cannot define reality alone in the interpretative paradigm. Furthermore, the interpretive paradigm believes that knowledge of participants' experiences can only be gained through interaction between the researcher and the participants. This is the epistemology of the interpretative paradigm. The interaction between the lecturers and the researcher is a crucial component of the data-gathering phase and cannot be disregarded because interpretivists believe that reality is socially constituted. The epistemological implications of this on my research were that during the interviews and observations, my relationships with the lecturers were considered professional and focused on the research questions during the enquiry. To gain insights into the participants' lived experiences, the interpretative paradigm requires a study to embrace qualitative methods such as interviews and observations.

This study, which sought to explore Technology Education lecturers' instructional strategies to prepare Basic Technology pre-service teachers for twenty-first-century teaching, embraced the interpretive paradigm as it enables researchers to have a better understanding, knowledge, and experience of how people make sense of the contexts in the way they think and do things (Bertram & Christiansen, 2015). In this instance, the interpretive paradigm is suitable for this study because it enabled the researcher to gain insights into how Technology Education lecturers prepare Basic Technology pre-service teachers for twenty-first century teaching, using qualitative methods.

4.5. Research approach

The research approach is the method or procedure of studying a phenomenon emanating from philosophical assumptions, worldviews and the theoretical lens to gain a complex and detailed understanding of the phenomenon (Creswell, 2018). Guided by the interpretative paradigm's ontological and epistemological assumptions, this study explored Technology lecturers' instructional strategies to prepare Basic Technology pre-service teachers for twenty-first century teaching, embracing a qualitative approach. According to Cohen et al. (2018), the qualitative approach focuses on in-depth, context-specific, rich, subjective data and meanings from the participants.

Creswell and Poth (2018) assert that in qualitative research, participants make sense of and interpret certain phenomena in terms of meaning. The qualitative research approach was appropriate for this study as it enabled the researcher to explore, understand, explain, and

clarify situations, perceptions, feelings, and attitudes from the participants' perspectives. The place of the qualitative research approach cannot be over-emphasised as it provides in-depth, rich data on a particular phenomenon (Smith, 2018). Adopting a qualitative research approach for this study is simply to enable the researcher to explore, understand, explain, and clarify situations, perceptions, feelings, and attitudes (Kumar, 2019). Furthermore, Johnson and Christensen (2019) are of the view that qualitative research uses multi-dimensional strategies for the data generation process, to ensure the trustworthiness of the data generated from the participants. This is also in line with Crossman (2017) that qualitative methods are humanistic; people's words, stories, and experiences cannot be reduced to statistical equations as this would lose sight of the human side of social life.

According to Mitchell and Clark (2018), qualitative research offers numerous advantages that enable the researcher to generate rich data. In this study, data will be generated from participants in their natural settings through document analysis, individual semi-structured interviews, observation and focus group interviews about Technology lecturer's Instructional Strategies to prepare Basic Technology pre-service teachers for twenty-first century teaching. The researcher did not rely on a single data source but various sources of data generation methods to make sense of the data.

4.6.Research Design

Research design refers to the conceptual structure within which research is conducted. It describes a flexible set of guidelines that define inquiry strategies (Denzin, 2018). On a similar note, Kumar (2019) perceives it as a procedural, operational plan that a researcher undertakes. It serves as a roadmap detailing how the research process will unfold, including methods of collecting data, selecting study samples and specific sites, and analysing the data. This study adopts a case study design. Yin (2018) describes a case study as an empirical method of investigating contemporary phenomena in-depth, to gain a clear understanding of the phenomena within its real-world and contextual settings. It allows for extensive inquiry and systematic in-depth study of a particular case, for example, a person, group of people, institution, organisation, etc., to gain a more comprehensive understanding of a phenomenon (Yin, 2018). A case study is the pertinent method of inquiry, mainly if the research questions are 'how' or 'why' questions that attempt to understand a social phenomenon (Yin, 2018). It takes a holistic research approach. It focuses on gaining knowledge and making sense of reality through conducting an in-depth investigation of an entity in a real-life context (Njie, 2014). Njie (2014) argues that research involving in-depth and thick data descriptions provides a

comprehensive understanding of a phenomenon when systematically analysed.

A case study enables an in-depth investigation of a single person, group, event, or community to generate new ideas. A case study may take different forms: exploratory, descriptive and explanatory (Yin, 2018). An exploratory case study is a suitable means of eliciting information to seek new insights and clarify one's understanding of a process or problem. The exploratory approach provides new and detailed information or insight about a phenomenon through the research findings, which could inform policy or serve as the background for further research. Descriptive case studies focus on providing narrative accounts, while an explanatory case study deals with hypothesis testing. Bearing Yin's classification in mind, this study embraces an exploratory case study approach based on the purpose of the study.

In this study, the case explored is the Instructional Strategies of lecturers. The context is bound to AB University, Basic Technology pre-service teacher training programme. The rationale for case study design is also to use multiple sources and data collection and analysis methods. Using multiple sources of data generation/analysis increases the study's trustworthiness. The case study design sets the sampling parameters and suggests the methods of generating data. These two aspects are discussed in the following sections.

4.7. Sampling Technique

Sampling involves deciding which people, settings, events or behaviours to include in the study (Bertram & Christiansen, 2014). Sharma (2017) asserts that sampling is essential for data collection, interpretation and presentation of findings. It is crucial because it enables researchers to choose participants and data collection methods rationally. For this study, the selection of participants was guided by the research design. The specified criteria of the case and the context required that participants be technology lecturers preparing basic technology pre-service teachers to teach in the twenty-first century. They were purposively selected. Purposive sampling, also known as subjective sampling, is a non-probability sampling technique in which participants are selected from a study population based on well-defined criteria, relying on the researcher's discretion and conviction to achieve the study's objectives. Therefore, the purposive sampling procedure depends on the researcher's knowledge and judgement of the context of the study (Obilor, 2023).

According to Cohen *et al*. (2018), purposive sampling is a deliberate act of choosing a participant based on the attributes he/she possesses. It is not done randomly; the researcher finds people who can provide the relevant information needed for the study based on their

experiences or knowledge.

Since the study sought to explore the Instructional Strategies of Technology lecturers in preparing Basic Technology pre-service teachers for twenty-first century teaching, the following were purposively selected: The Basic Technology curriculum for the Basic Technology teacher education programme at AB University, Seven (7) Basic Technology lecturers in the Department of Technology Education at the university and their teaching portfolios. Seven lecturers were invited to participate in this study.

The study context, namely AB University, was selected based on convenience sampling. Convenience sampling is a non-probability sampling method where units are selected for inclusion because they are the easiest for the researcher to access. The researcher resides near AB University.

4.8. Data generation plan:

In qualitative research, the term data generation is preferred over data collection as the process entails intellectual, analytical and interpretative activities rather than measurements. According to Forrester and Sullivan (2018), data collection involves collecting evidence geared towards answering the research questions, which can be in the form of words and not numbers but can also be imaged. Thus, it is necessary to have a data generation plan for a study. The data generation plan for the study is reflected in Table 4.1. It shows the research questions, data source, data generation instrument, and data analysis.

Data was generated in three phases. Phase one involved generating data through the interviews (Appendix 15); in the second phase, observations (Appendix 17-23) and lesson plan (Appendix 7-13) were conducted, and in phase three, focus group interviews were conducted (Appendix 16).

Table 4.1. Data generation plan

RESEARCH QUESTIONS	DATA GENERATION PHASE	DATA SOURCES	INSTRUMENTS USED	ANALYSIS
1. What twenty-first century skills do lecturers foreground in their teaching?	1	Basic Technology lecturers	Focus group Interview	Thematic
2. What instructional strategies do lecturers employ when preparing basic technology pre-service teachers to teach in the twenty-first century?	2	Basic Technology lecturers Basic Technology teaching portfolios	Observation Document analysis/teaching portfolio	Thematic
3. Why do lecturers use these instructional strategies to prepare basic technology pre-service teachers to teach in the twenty-first century the way they do?	3	Basic Technology lecturers	Post observation interviews Focus group Interviews	Thematic

4.9.Data collection instruments

In the section below, the instruments used for data generation are analysed. A wide range of instruments was used to capture data to answer the research questions: focus group interviews, observation, post-observation individual interviews, and document analysis. The instruments listed were used because of their suitability in collecting qualitative data as determined by the research design.

4.9.1. Focus group interviews

As described by Cohen & Manion., *et al*. (2018), a focus group is a form of group interview in which reliance is placed on the interaction within the group, which discusses a topic supplied by the researcher, yielding a collective rather than an individual view. Yin (2018) also emphasises that the groups are focused because you have gathered individuals who previously have had some common experience; in this instance, they are all technology lecturers. Focus group interviews aim to obtain rich data that will provide me with valuable insight into why lecturers implement these instructional strategies the way they do.

Furthermore, focus group interviews will help elicit rich texts as participants build on each other's ideas and comments to provide in-depth and value-added insights on the particular twenty-first century skills developed in basic technology pre-service teachers to teach in the twenty-first century. Before the focus group interviews, a protocol that involved a schedule of questions designed to answer my research questions, but still allow the participants to engage freely and give their insights as they related to the phenomenon under research was prepared (see Appendix 14 for focus group interview schedule). Thus, the interview questions were related to the twenty-first century skills developed by basic technology pre-service teachers. The focus group interviews were audio recorded.

4.9.2. Document analysis

Document analysis was used in conjunction with other data collection methods as a means of triangulation to corroborate findings and improve the credibility of the research study (Mackieson, 2019). Included in the document analysis was the AB University curriculum for Basic technology and lecturers' teaching portfolios to gain insight into instructional strategies used to develop twenty-first century skills in pre-service Basic Technology teachers. Therefore, the inspection and analysis of lesson plans offered great insight into technology lecturers'

professional practices related to instructional strategies to develop twenty-first century skills in pre-service Basic Technology teachers.

4.9.3. Observation

Observations entail being present and recording impressions of what occurs, then interpreting the meaning of the observed behaviour (Cohen *et al.*, 2017). Observations occur in real-world settings, where programmes are subject to change and redirection. With fieldwork observations, researchers are in direct contact with the setting and the people they observe. This direct observation gives researchers first-hand experience and thus enables them to generate detailed descriptions of the setting, the activities, interactions and participants' experiences. Observation also allows the researcher to compare what is written in official programmes to what occurs. First-hand experience on-site is also essential in providing insights that might be missed if the researcher relied only on other people's descriptions of the setting (Creswell & Creswell, 2017). Good inquiry through observation thus documents what is happening. Through direct observation, a researcher sets out to document, accept and understand the complexities of a changing situation, including what may be unanticipated but emerges as essential in understanding the participants' experiences.

In light of the aforementioned ideas, an observation schedule was designed with the assistance of university researchers to focus on how lecturers plan their lessons and teach courses that promote the development of twenty-first century skills in pre-service Basic Technology teachers. Seven lecturers who have been purposively selected to participate in this study had three lessons observed (each lesson was 45 minutes). These observations were audio recorded.

4.9.4. Individual semi-structured interviews

An interview is a qualitative data collection technique that involves a one-on-one conversation between a researcher and interviewee, designed to obtain an in-depth understanding of participants' experiences, perceptions, opinions, feelings and knowledge about the phenomenon under investigation (Rosenthal, 2016). It involves posing open-ended questions and follow-up probes by the interviewer, intending to capture the in-depth experiences of respondents (Rosenthal, 2016). Stemming from an interest to thoroughly understand the Instructional Strategies Technology lecturers use in preparing Basic Technology pre-service teachers for twenty-first century teaching at AB University, the use of individual interviews in the process of data collection was deemed necessary and rather inevitable if in-depth insights into the subject under exploration were to be achieved. In support of Rosenthal's notion of

interviews, Alshenqeeti (2014) propounds that interviews are powerful in eliciting narrative data that allows researchers to investigate people's views in greater depth. Thus, the method was incorporated as one of the data collection instruments in this study.

One of the advantages of interviews is that they provide room for clarification of ambiguous questions posed, and it is easier for respondents to talk to an interviewer than to write long responses on questionnaires. The interviewer can pick up on non-verbal clues from the interviewee that could be useful in interpreting responses to questions (Cohen *et al*., 2018). Several different styles of interviews are widely used in the field of research, and these can be categorised into three groups, namely, structured, semi-structured and unstructured (Braun, 2013). In the context of interviews, the semi-structured interview style suited my research. This approach was expected to optimise gaining rich and precise responses from participants. I prepared an interview guide before the interview session. This comprises a set of questions that probe the participant to respond within the scope of the topic.

The researcher used the approach of prompts and probing questions to engage with participants, manage the flow of the interview and determine the course of the conversation, keeping the environment of the proceedings in control as the respondents freely expressed their ideas and interpretations of the phenomenon discussed. Prompts allow interviewees to expand further, clarify particular issues, and re-direct them to the focus of the discussion if they tend to divert, and probing questions allow the researcher to uncover more profound levels and hidden meanings of the topic under discussion (Robinson, 2023). Thus, the choice of interviews was perceived as ideal in conducting this study to optimize gaining deeper insights and understanding into Technology lecturers' Instructional Strategies to prepare Basic Technology pre-service teachers for twenty-first century teaching. The interviews were audio recorded.

4.10. Gaining access to research and ethical considerations

The success of any empirical research lies in the researcher's ability to establish good rapport with their informants throughout the study process (Creswell, 2018). This provides a sound basis for gathering rich information through participant interviews and observations. Gaining access to fieldwork is critical and a prerequisite to conducting research, and that involves finding and securing participants before the actual research (Cohen *et al*., 2018). Researchers' access to a site is determined and controlled by gatekeepers as they have the power to grant or withhold access to individuals required for the research (Clark, 2011). Preceding the fieldwork procedures, ethical considerations about gaining access to sites and participants were

established for this study. Formal authorisation from the UKZN research office was sought via the ethics committee (see Appendix 1, for the Ethical Clearance Certificate). A letter was sent to the Vice Chancellor of AB University as a formal request seeking informed consent, detailing, among other issues, the central purpose of the study, the right of participants to voluntarily participate or withdraw from the study at any time without victimisation, assurance about protecting the confidentiality of participants and procedures of data collection (see Appendix 2, for the gatekeepers' consent). Consent was also sought from the technology lecturers, and permission was granted (see Appendix 4, for the informed consent letter to participants).

In order to adhere to the ethical standard during this research project, the following rights and responsibilities were assumed: the rights of participants taking part in the research, circumventing harm to participants, avoiding undue intrusion, obtaining informed consent, rights to confidentiality and concealment and the rights of participants during data dissemination (Creswell, 2013). This study gathered sensitive information from technology lecturers about their instructional strategies to prepare basic technology pre-service teachers to teach in the twenty-first century. As a result, the identities of lecturers and the university needed to be protected. Their anonymity and confidentiality by the use of pseudonyms was assured. Ensuring the above ethical considerations gave the participants the confidence to share their views without fear of exposure. Moreover, this assurance contributed to a trustworthy environment, allowing high participation and openness during the focus group interviews. As a result, participants were quite willing to be involved in the study and saw it as an opportunity to share their instructional strategies experiences.

The rights of individuals (participants or respondents) participating in a research study are expressed as informed consent, anonymity, privacy and confidentiality (Cohen *et al*., 2011). Informed consent entails ensuring that the participants taking part in a study must have the legal and mental capability to accept the responsibility of taking part in a study. Also, it ensures their right to withdraw as and when they wish to, particularly if the participants did not clearly understand the purpose of the study.

Participants were assured they could withdraw from the study at any time and would be guaranteed confidentiality and anonymity. It was realised that gaining access is an iterative process. It entailed dealing with various gatekeepers at each stage of the research. Participants and gatekeepers were assured, in writing, that the findings of the research would not be used

for any purpose other than for the Doctoral Dissertation and Scholarly Publications. They were also informed that the data would be stored for five years at the university and thereafter disposed of. Interview transcripts, reflections, and photographs will be shredded, and audio tapes will be incinerated.

4.11. Data analysis

"Qualitative data analysis involves organising, accounting for and explaining the data; in short, making sense of data in terms of the participants' definitions of the situation, noting patterns, themes, categories and regularities" (Cohen *et al*., 2018, p. 537). Scholars such as Creswell (2013), Mouton (2001) and Cohen *et al*. (2018) consider that data analysis consists of the following tasks:

- Preparing and organising the data,
- Reducing the data into themes, and
- Representing the data in figures, tables or discussions.

While these three tasks were undertaken in this study when answering the research questions, data analysis is not linear. Instead, it is, as Creswell (2013, p.228) says, "Inductive", "iterative", "eclectic", and "interpretive". Data analysis entails working from specific data sets to develop general codes and patterns.

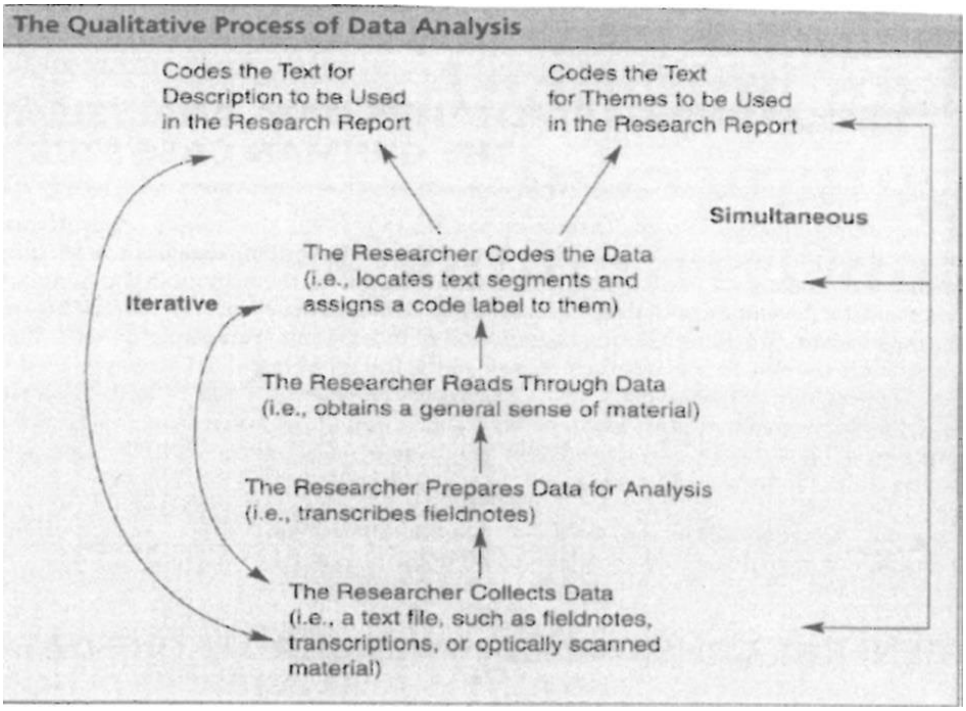

Figure 4.2. Diagrammatic representation of data analysis (adapted from Creswell, 2012, p. 137

All lesson observations, individual interviews, and focus group interviews were transcribed verbatim and sent to participants for member checking to see if information had been captured accurately. The transcripts were labelled P1 to P7 according to the participants' pseudonyms. The transcripts were read several times and coded in response to the constructs of my conceptual framework. Coding refers to relating standardised remarks in transcripts and grouping them into sections (Adler & Clark, 2008). The "open-coding" approach, where "concepts" are used to convey the information derived from the data collection methods was adopted (Flick, 2006, p. 297). Open coding was accomplished using the "line-by-line and phrase-by-phrase" technique (Cohen et al. 2011, p. 561). Codes were regrouped into themes. Roulston (2010, p. 150) describes thematic analysis in qualitative research as "sorting and classifying codes into groupings or clusters". Braun and Clarke (2006, p.19) also mention that "thematic analysis reports experiences, meaning and the reality of participants".

The links or interplay between the constructs of my conceptual framework were traced across the data from all instruments and then juxtaposed.

4.12. Research Rigour

In qualitative research, the study's credibility is measured regarding rigour, accuracy, trustworthiness of findings, and comparability of results. Research rigour is an element of precision that must demonstrate the strength of the research design and appropriateness of methods used to answer research questions in an undoubtedly thorough and accurate manner to guarantee the credibility of the research findings (Cypress, 2017). The trustworthiness of any qualitative research is measured based on the study to demonstrate multi-dimensional aspects of quality such as credibility, transferability, dependability and confirmability (Connelly, 2016). A researcher's ability to conduct a rigorous study, maintain consistency and provide thorough detail throughout all the research stages foregrounds the study's trustworthiness and credibility (Nowell, 2017). To demonstrate a high degree of competence and abide by the ethical practices of research, ensuring the rigour, trustworthiness, and credibility of the study, The Researcher used diverse strategies that included crystallisation, data validation, and verification of participants' responses through member checking. Measures of research rigour addressed in the study are discussed below.

4.12.1. Crystallisation

Crystallisation is a qualitative research strategy used to enhance the validity of research findings by applying multiple theoretical and methodological approaches to develop a

comprehensive understanding of phenomena (Flick, 2018). In support of using crystallisation in qualitative research, Carter (2014) adds that merging information from different sources is an effective strategy for gaining an in-depth understanding of an examined phenomenon and helps check the consistency of data gathered. This study implemented data crystallisation through various data generation methods, including individual interviews, document analysis, observations and focus group interviews.

4.12.2. Member checking

Transcripts were emailed to participants for member checking and reaffirmation to ensure data collection accuracy. Member checking is a qualitative technique of exploring the accuracy and credibility of data by returning interview transcripts to participants to allow them to validate and verify data and confirm if it resonates with their experiences (Birt, 2016). This validation exercise enables participants to reconstruct their narrative, provide additional data, bring the participant's voice to the fore, allow the researcher to find out if there are any disconfirming voices, and potentially enhance data accuracy (Birt, 2016). Additionally, Morse (2018) propounds that through verification, the researcher can ensure the adequacy and appropriateness of data quality, which will further enhance pattern or category formation into different themes when data is coded for analysis. After member checking, interview transcripts were also read several times before coding began. During coding, the constructs of my theoretical framework were used to code the data generated into categories. Related categories were linked together to form themes.

4.12.3. Credibility and data validation

Credibility is a quality measure that establishes that research findings follow participants' contributions and articulate the data collected (Kumar, 2019). According to Creswell (2017, p. 206), "validation" in qualitative research is an attempt to assess the "accuracy" of the findings, as best described by the researcher and the participants. To ensure the credibility of my study, data validation, and credibility were achieved through re-engaging with all participants in the focus group interviews to reaffirm their responses, asking for further elaboration, and verifying if they agreed with the information gathered as initially articulated during focus group interviews. As member checking explained earlier, focus group member checking was also implemented whereby original interview transcripts were returned to participants to allow them to validate and verify the accuracy of their responses to check if there is harmony and consistency.

4.13. Limitations

The study was conducted at AB University in Nigeria, in the Department of Technology Education, where the Basic Technology lecturers were participants. The observation of three lessons over a short period is a limitation in itself. This was addressed by conducting individual semi-structured interviews with lecturers, which allowed them to introspect on their instructional strategies used to prepare basic technology pre-service teachers to teach in the twenty-first century. Another limitation is that this study privileged the preparation of basic technology pre-service teachers to teach in the twenty-first century, and the findings are context-specific. The findings of this study could not be generalised. There is a need for further studies to validate the findings of this study in other teacher training institutions using a similar population.

4.14 Conclusion

This chapter presents an overview of the methodological approach used in conducting the study. The study falls within the interpretive paradigm, and it is qualitative research that uses a case study design of inquiry. The procedures involved in the preparation and collection of data were also outlined. Data collection instruments include observations, individual interviews, focus group interviews, and document analysis. Research instruments like interview schedules and focus group interview schedules were prepared before collecting the data. Measures to ensure the validity and trustworthiness of the study were also discussed.

CHAPTER FIVE

PRESENTATION OF FINDINGS AND DISCUSSION: RESEARCH QUESTION 1

5.1. Introduction

Pre-service teacher training programmes play a critical role in promoting the development of twenty-first century skills among pre-service teachers to meet the demands of twenty-first century education. For pre-service teachers, this demand for twenty-first century skills occurs at two levels, namely, a pedagogical level and a personal level. To meet these demands, two things ought to occur. First, lecturers must model twenty-first century skills in their instructional strategies and practice. Second, pre-service teachers must have the space and multiple opportunities to apply these skills in assessments and the classroom setting (Alahmad et al., 2021). This chapter presents data to answer **Research Question 1**: **Which twenty-first century skills do lecturers foreground in their teaching?**

Data from the focus group interviews with the lecturers is used to answer research question one. The chapter is organised as follows: It first presents data about participants' biographical data and participant excerpts on the twenty-first century skills they claim to highlight in their teaching. This is followed by a discussion of the skills, and the chapter ends with a conclusion.

5.2. Biographical data of participants

This study explored Technology lecturers' instructional strategies to prepare basic technology pre-service teachers for twenty-first century teaching at a Nigerian university. Seven technology lecturers were purposively sampled to participate in this study.

The biographical data of the participants are reflected in Table 5.1. on the next page.

Table 5.1. ***Biographical data of participants***

PARTICIPANT	SEX	DESIGNATION	EDUCATIONAL BACKGROUND	AREA OF SPECIALISATION	TRAINING FOR TEACHING IN THE 21ST CENTURY
P1	Male	Senior Lecturer	PhD, Industrial Technical Education: Mechanical	Automobile Technology	None
P2	Male	Senior Lecturer	PhD, Mechanical Engineering; PGDE	Automobile Technology	None
P3	Male	Assistant Lecturer	Masters, Industrial Technical Education	Woodwork Technology	None
P4	Male	Graduate Assistant	Bachelors, Technology Education	Building Technology	None
P5	Female	Lecturer 2	PhD, Industrial Technical Education	Building Technology	None
P6	Male	Lecturer 1	Masters, Industrial Technical Education	Woodwork Technology	None
P7	Male	Senior Lecturer	Masters, Industrial Technical Education	Automobile Technology	None

As is visible from Table 5.1, three participants in this study have their PhD, three have Master's degrees and one has a Bachelor's degree. While gender is not the focus of this study, six of the participants are males and one participant is female, confirming the trends identified in the literature (Wang & Degol, 2017; Qazi *et al*., 2022; Sultan, 2018) that males dominate technology and engineering education. None of the seven participants attended a professional development workshop to capacitate them to teach in the twenty-first century. Scholars such as Borko (2004), Darling-Hammond and Oakes (2019) and Granger *et al*. (2019) contend that teachers are vital in the execution of educational reforms and stress that teachers need support to carry out this task. Thus, professional development is the cornerstone of any proposed educational change, such as developing twenty-first century skills among pre-service teachers. If lecturers learn twenty-first century skills and instructional strategies, they will have a teacher-centred experience that can be brought into the classroom (Robb, 2016). They will put their knowledge and expertise into practice in the classroom, which, in turn, will lead to more effective results for their students in terms of student-centred experiences. In other words, to meet the needs of basic technology pre-service teachers to teach in the twenty-first century, lecturers should possess twenty-first century skills. Norrena *et al*. (2011), in their study of Finish teacher education, further highlighted that many teacher educators do not have sufficient

knowledge of twenty-first century skills and lack the competencies to integrate twenty-first century skills into their teaching. The lack of professional development for lecturers elucidates the shortcomings in the design of pre-service teacher training and a possible lack of knowledge base in teaching twenty-first century skills. Thus, it would be interesting to note which twenty-first century skills the participants emphasis in their teaching and the instructional strategies they use to develop these skills.

5.3. Which twenty-first century skills do lecturers foreground in their teaching?

According to the Partnership for 21st Century Skills (2015), twenty-first century skills are a sustainable blend of knowledge, skills, and expertise in daily and professional life. This broad definition captures the evolving demands of the modern world, where merely having technical knowledge is insufficient without the ability to apply it creatively and effectively. Data from the focus group interviews were used to ascertain which twenty-first century skills are emphasised during teaching.

Figure 5.1, highlights the skills lecturers foreground in their teaching.

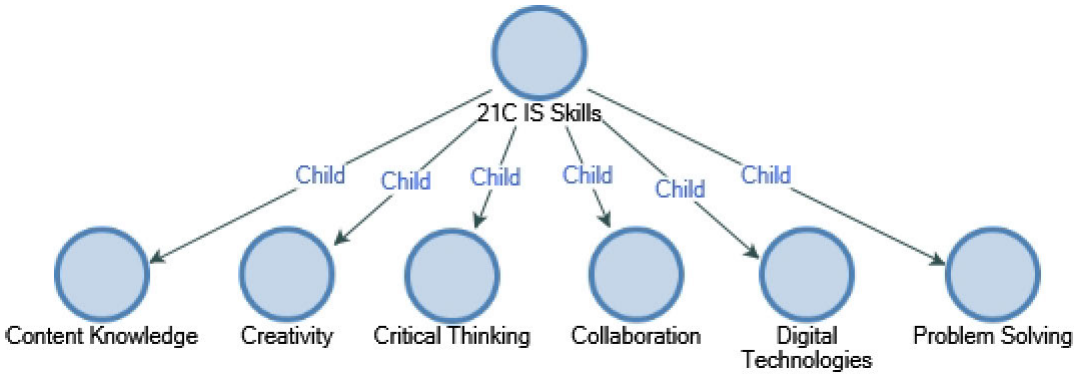

Figure 5.1. *Twenty-First Century skills lecturers foreground in their teachings*

These skills include content knowledge, creativity, critical thinking, collaboration, digital technology, and problem-solving. Additionally, a manual review of the responses confirms that most of the participants use these six skills to prepare pre-service teachers, as shown in the following excerpts:

Students must be able to think critically and solve real problems in daily life; they must transfer knowledge from technology, for example, to fix a leaking tap and design and make their cupboard. This is the nature of all technical subjects (P3, focus group interview)

Design thinking is critical in technology, which I emphasise in my classes. We know that the design process drives technology. You cannot have technology without design, so for me, it is about design, problem-solving, generating innovative ideas, trying them, evaluating them, and coming up with the best solution or product (P6, focus group interview).

For me, it is graphical communication. Being able to make and read visual representations is how we communicate in building technology (P4, focus group interview)

Hands-on, manipulative skills are important in automobile technology, for example, assembling a motor, stripping a gearbox and reassembling it, and detecting and resolving the problem (P7, focus group interview).

The interview responses show that students are encouraged to think critically and solve real-life problems, such as fixing a leaking tap or designing a cupboard. This approach underscores the importance of transferring theoretical knowledge into practical applications, a skill that is indispensable in daily life and professional settings. Much attention is paid to design thinking, a critical component of technology education. It involves a comprehensive process of generating innovative ideas, trying them out, evaluating the results, and arriving at the best solution or product. This iterative design thinking process fosters creativity and innovation, crucial to technological advancements, employability, and entrepreneurship. In all technology-related subjects, hands-on skills are critical. Students learn by assembling and disassembling components such as motors and gearboxes, which hone their technical skills and enhance their problem-solving abilities through practical engagement. Another skill that the lecturers foreground is graphical communication. Graphical communication is emphasised as the primary mode of communication in technology-related subjects. It facilitates effective communication of complex ideas and technical information in a visual form, making it a vital competency for students to master.

Lecturers perceive these skills as important twenty-first century skills to develop in Basic technology pre-service teachers, to assist them in addressing problems and developing innovative, creative solutions for local and global issues. The insights from the interviews reveal that educators place a strong emphasis on developing skills that go beyond traditional rote learning. The focus on critical thinking, problem-solving, and design thinking reflects a shift toward cultivating higher-order thinking skills. The above findings are consistent with those of Breed (2019), Roslaniec (2018), and Stauffer (2020), who contend that critical

thinking, problem-solving and design thinking are highly valued by employers and are essential for students to navigate complex challenges in both local and global contexts. These scholars maintain that these skills allow students to think outside the box, generate innovative ideas, solve complex problems methodically, devise strategic solutions, make informed choices, and develop new products.

Lecturers in this study are implicitly embedding sustainable skills in their teaching practices. These skills are transferable across various contexts and times, ensuring that students are well-equipped for the evolving demands of the workforce. Integrating theoretical knowledge with practical application is a recurring theme, be it through design thinking or hands-on activities. This approach ensures students can apply their learning meaningfully, enhancing their competence and confidence. Encouraging students to generate innovative ideas and solutions is pivotal. This prepares them for technological advancements and fosters an entrepreneurial mindset, crucial in today's fast-paced and competitive world. Figure 5.2 below, illuminates the higher-order thinking skills that lecturers emphasise in their teaching.

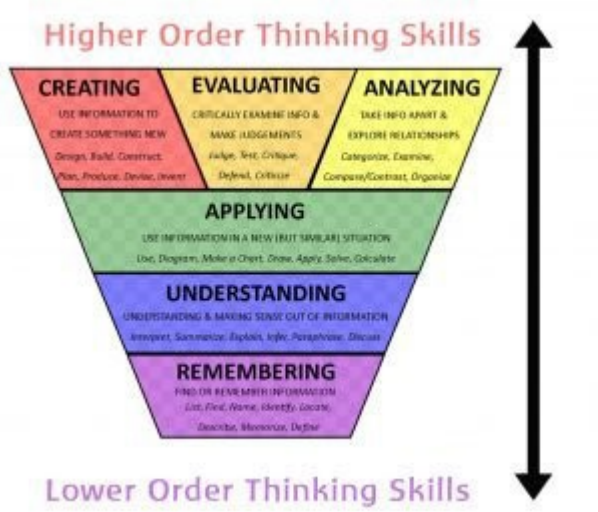

Figure 5.2. Showing order of thinking skills

This finding is consistent with Toro's (2019) research, which states that business leaders are increasingly asking education institutions to develop problem-solving, critical thinking, and communication skills, often called twenty-first century skills.

The P21 Framework states that students should be able to elaborate, refine, analyse and evaluate their work ideas to improve and maximise creative efforts. Furthermore, the framework states that twenty-first century students must be able to articulate their thoughts and

ideas using oral, written and non-verbal communication skills (Partnership-for-21st-Century-Skills, 2013). It seems that lecturers emphasise developing basic technology pre-service teachers' critical thinking, creativity and graphical communication and tend not to foreground collaboration and ICT literacy which are reflected as working methods and tools for working in Figure 5.3 below.

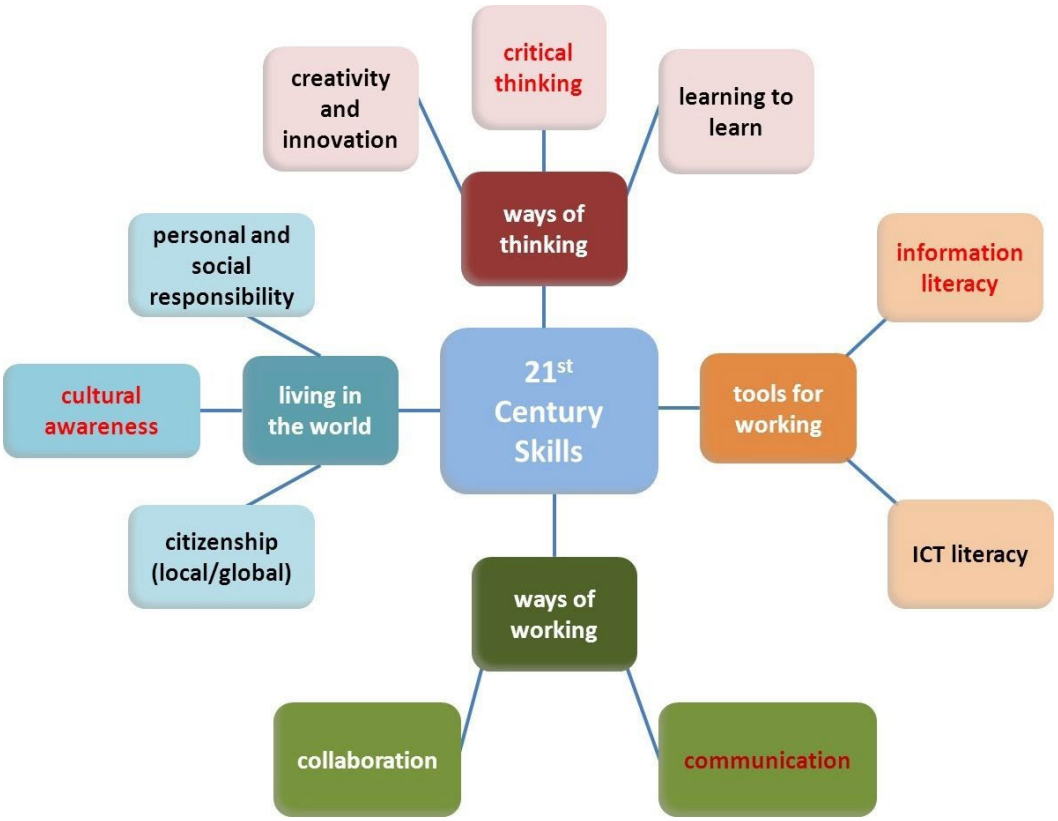

Figure 5.3. Twenty-first century skills

Collaboration and ICT (Information and Communication Technology) literacy are not new concepts; they have been considered valuable skills for centuries. Historically, collaborative efforts and technological advancements have driven human progress. From the teamwork required to build ancient civilisations to the development of the printing press, these skills have always been integral to societal development. However, the rapid advancement of modern societies in recent decades has dramatically amplified the need for these competencies. Today, every student must acquire and master collaboration and ICT (Information and Communication Technology) literacy to thrive in a complex, interconnected world, regardless of their future occupation. This necessity extends beyond mere technical skills; it encompasses the ability to effectively communicate, solve problems collaboratively, and adapt to new technologies and environments.

In light of these demands, pre-service teacher training programs play a crucial role. These programs must provide multiple opportunities for pre-service teachers to acquire, develop, and practice collaboration and ICT literacy skills within inclusive classroom settings. Such training ensures that future educators are proficient in these areas and equipped to foster these skills in their students. Inclusive classrooms, where diverse learners interact and collaborate, offer an ideal environment for practising these competencies, preparing teachers to manage and nurture various abilities and backgrounds.

Researchers and practitioners agree that an education system designed to meet the "demands of life, work, and citizenship in the twenty-first century" must be built on a solid human capital base (Darling-Hammond & Oakes, 2019, p. 1). This means that teacher preparation programs must go beyond traditional pedagogical methods. They need to focus on curricular demands that address the evolving learning needs of students. These programs should emphasise critical thinking, creativity, digital literacy, and the ability to work collaboratively in diverse teams.

Moreover, integrating twenty-first century skills into teacher training involves a comprehensive approach. This includes coursework, theoretical knowledge, and practical, hands-on experiences. Pre-service teachers should engage in real-world teaching scenarios where they can apply and refine their skills. Collaborative projects, technology integration workshops, and partnerships with schools for practicum experiences are essential components of this training.

Furthermore, professional development for in-service teachers is equally important. Continuous learning opportunities should be provided to help current educators stay updated with new teaching strategies, technologies, and collaborative methods. This lifelong learning approach ensures teachers can adapt to changes and continue providing high-quality education.

In summary, the need for collaboration and ICT (Information and Communication Technology) literacy has never been more critical. As society progresses, these skills become essential for all students, regardless of their future careers. Pre-service teacher training programs must prioritize these competencies, providing ample opportunities for future educators to develop and practice them in inclusive settings. By doing so, we prepare teachers to meet the curricular demands of the twenty-first century and equip students with the skills necessary for success in life, work, and citizenship. Teachers should be competent in designing and managing the classroom learning environment to support collaborative work within groups that can work

independently (Trilling & Fadel, 2009). Managing an active learning environment that promotes collaboration and effective communication between students, demands that teachers themselves be effective.

5.4. Conclusion

This chapter responded to research question one. Data obtained via the focus group interviews was used to address research question one. The analysis of the Focus Group Interviews underscores the importance of a holistic approach to education that prioritises critical thinking, problem-solving, practical skills, and innovation. According to this study's conceptual framework, lecturers emphasise the development of learning and innovative skills, including creativity, critical thinking and problem-solving. By highlighting these twenty-first century skills, educators prepare students to be adaptive, resourceful, and proficient in addressing real-world challenges. This approach aligns with the demands of the modern workforce and equips students with the sustainable skills needed for lifelong success. Lecturers tend not to accentuate the development of collaborative and Information and Communication Technology (ICT) skills in pre-service basic technology teachers. The next chapter responds to research question two.

CHAPTER SIX

PRESENTATION OF FINDINGS AND DISCUSSION: RESEARCH QUESTION 2

6.1 Introduction

The preparation of pre-service teachers to effectively teach in the twenty-first century necessitates a multifaceted approach where teacher educators play a critical role. These educators must exemplify twenty-first century skills in their teaching methodologies to provide a robust knowledge base for pre-service teachers. These skills encompass a range of competencies, such as critical thinking, creativity, collaboration, communication, and technological literacy. This modelling is crucial because it allows teacher educators to create a dynamic and engaging learning environment where pre-service teachers can observe and learn these skills, thereby internalising the pedagogical approaches and technological competencies essential in modern education (Häkkinen *et al*., 2017). Pre-service teachers should learn about twenty-first century skills theoretically and have ample opportunities to apply them in practical settings. Scholars such as Martinez (2022), Waren *et al*. (2015) and Rustique and Stam (2013) argue that trainee teachers would benefit from learning opportunities that focus on instructional strategies that demonstrate attainment of content knowledge, college and career readiness skills and curriculum design that differentiates and scaffolds instruction for diverse learners. The previous chapter highlighted the skills lecturers foregrounded in basic technology pre-service teachers. This chapter answers research question two: **What instructional strategies do lecturers employ when preparing basic technology pre-service teachers to teach in the twenty-first century?** Data from lesson observation and analysis of lesson plans were used to ascertain the instructional strategies lecturers used when preparing pre-service teachers to teach in the twenty-first century. The chapter ends with a conclusion.

6.2. What instructional strategies do lecturers employ when preparing basic technology pre-service teachers to teach in the twenty-first century?

Lecturers should model in their teaching practice what they expect their students to do in their future classrooms; otherwise, the students would fail to fulfil their duties and roles as teachers. (Fourie, 2015). Analysis of the lesson observation and lesson plan data indicates that lecturers use two categories of instructional strategies to develop content knowledge and lesson planning. Each of these instructional strategies will be presented next.

6.2.1. Instructional strategies used by participants to develop content knowledge

Instructional strategies foster students' participation in learning activities, provide a sense of reasonability, and direct application of learning principles to achieve educational objectives. Technology is a subject that requires interaction between the learner and the concepts. In other words, technology subjects require learners to be active participants, to promote a better understanding of concepts rather than rote learning and memorisation. This means that traditional teacher-centred teaching methods, such as the chalk-and-talk strategy, are not favoured in teaching technology. Therefore, it is pertinent that the teachers apply learner-centred teaching methods and actively involve the learners throughout the learning process. Figure 6.1 and the excerpts below reveal the instructional strategies used by the participants to train basic technology pre-service teachers.

Figure 6.1 ***Word cloud representation of the instructional strategies used by participants***

The transcribed lesson observation was first analysed with the Orange data mining tool to get the word cloud representation of the contents and manually to get their actual statements.
The most frequently used words include questioning, demonstration, lecture, project-based learning, blended learning, brainstorming, and cooperative learning. It could be inferred that the participants use questioning, demonstration, lecture, project-based learning, blended learning, brainstorming, and cooperative learning among others to develop their content knowledge.

The manual study of their transcribed lesson observations further buttresses these facts. Some of the statements are presented in the following excerpts:

Brainstorm how you would address the defects encountered at some schools regarding the shortage of desks and chairs. (P6: Lesson observation)

Demonstrate how you would teach transmission systems and control using brainstorming as an instructional strategy. (P7: lesson plan)

The word cloud and excerpts above illuminate lecturers' instructional strategies when preparing pre-service teachers to teach in the twenty-first century. Brainstorming is used to foster creativity, problem-solving, and application of content. It is used to get basic technology pre-service teachers actively involved in the engagement with content knowledge, reconstruction, and application of knowledge to solve a local problem. Brainstorming is usually a group activity whereby each member uses a creativity technique to find a conclusion for a specific problem; the ideas are shared, and a list of ideas is generated. However, basic technology pre-service teachers are encouraged to brainstorm ideas individually at this institution (see Chapter 5, which indicates that group and collaboration are skills not foregrounded during teaching).

Individual brainstorming enables basic technology pre-service teachers to think freely, move into new areas of thought, and create numerous new ideas and solutions without criticism of their ideas. The instructional strategy of brainstorming favours and advances the development of critical twenty-first century skills in basic technology pre-service teachers, such as generating ideas, and promotes problem-solving and critical and creative thinking skills.

Recent studies have shown that individual brainstorming, as opposed to group brainstorming, can lead to a greater diversity of ideas and more original solutions. Paulus *et al*. (2021) found that individuals working alone generated more unique and varied ideas than those working in groups. This suggests that individual brainstorming can be particularly effective in fostering creativity and innovation, crucial skills for twenty-first century teachers.

Additionally, fostering critical thinking, innovation, evaluating, refining skills, problem-solving and reflection through brainstorming is essential in preparing pre-service teachers for the challenges of contemporary classrooms. A recent article by Brookhart (2023) underscores the necessity of these skills in navigating complex educational environments, advocating for

instructional strategies that promote independent thought and innovative solutions. During individual brainstorming, the pre-service teachers need to get an opportunity to learn to teach so they can make sense of and share experiences with others.

While traditional group brainstorming has benefits, individual brainstorming in the context of basic technology pre-service teachers has shown to be effective in cultivating essential twenty-first century skills. By encouraging independent idea generation, lecturers can better prepare future teachers to address modern classrooms' diverse and dynamic needs.

It is worth noting that while individual brainstorming is preferred as an instructional strategy, basic technology pre-service teachers are not encouraged to integrate technology into the brainstorming session to enhance engagement and outcomes. This finding aligns with findings in Chapter 5, which indicates that lecturers do not foreground the development of digital literacy. The study by Timotheou, *et al* (2023) demonstrated that using digital tools for brainstorming can help pre-service teachers better organise their thoughts, collaborate asynchronously, and refine their ideas with the help of online resources. This approach aligns with the growing emphasis on digital literacy and competency in modern education.

Demonstrations are an instructional strategy the lecturer uses to prepare basic technology pre-service teachers to teach in the twenty-first century, as can be gathered in the excerpts below.

.... you will learn about machine assemblage and graphical communication. Using demonstrations requires a person to be familiar with the object and content knowledge. (P7 Lesson plan)

... demonstration is well suited as an instructional strategy for technical subjects to promote spatial visualisation, identification and graphic communication (P1 lesson observation)

Demonstrations allow for the presentation of materials by showing the object, for example, a car engine, and how to assemble it, so the process of assembling can be learned. In other words, demonstrations combine explanation with handling or manipulating real things, materials and equipment. So, basic technology pre-service teachers can also see and identify the engine's components and know each part's function. This particular finding on the use of demonstrations as an instructional strategy resonates with that Akinbobola and Iktde (2011) and Ramadhan and Surya (2018), who assert using demonstrations as an instructional strategy is linked to the topic and learning objectives, as well as familiarity with the demonstration tool and the related

content knowledge. Demonstrations are used to concretise complex abstract concepts or procedures and teach how to use the tools or procedures appropriately. For example, it would be challenging to visualise and mentally section parts of the car engine without seeing the actual parts and how the parts are assembled to function as a car engine. It is not possible to discuss the assembly of the car engine theoretically. According to Upadhye and Madhe (2022), demonstrations help students understand things that are difficult to visualise and are used to explain various theoretical concepts. Furthermore, these scholars suggest that demonstration as an instructional strategy improves students' performance on practice, assignment, and laboratory investigation examinations and enhances students' understanding of concepts. It is clear from the above discussion that demonstrations are a student-centred method of teaching which promotes students' active participation in learning.

Additionally, research by Raiyn (2016) supports the idea that demonstrations can enhance learning by providing visual representations that align with verbal explanations, catering to multiple learning styles. This multimodal approach ensures that students who may struggle with purely theoretical instruction can benefit from the concrete, hands-on experiences that demonstrations provide. Moreover, demonstrations can bridge the gap between theory and practice, making abstract concepts more accessible and comprehensible. Bolt-Lee (2021) also highlights that demonstrations can increase student engagement and motivation. Demonstrations can make lessons more relevant and interesting by involving students in the learning process and allowing them to see the real-world applications of their learning. This relevance is crucial in keeping students motivated and invested in their learning journey.

Furthermore, demonstrations can serve as a valuable assessment tool. According to Al-Samarraie and Hurmuzan (2018), observing students during demonstrations allows instructors to assess their understanding and skills in real-time. This immediate feedback can help educators promptly identify and address any misconceptions or gaps in knowledge. From the above, it can be seen that demonstrations are a powerful instructional strategy that can significantly enhance the learning experience for basic technology pre-service teachers. By combining explanation with hands-on manipulation of materials, demonstrations make complex concepts more understandable, promote active participation, and bridge the gap between theory and practice. Demonstrations align with various scholars' findings, supporting their effectiveness in improving student performance, engagement, and understanding of concepts.

Project-based learning (PBL) is utilised as an instructional strategy in training basic technology pre-service teachers, as seen in the excerpts below.

In your project design, indicate what measures are taken to troubleshoot, problem solve, critique and evaluate the design and what is innovative or creative about your design. Use local materials to design and present your project. (P6 Lesson observation)

Design a task that uses project-based learning (P4 lesson plan)

From the above testimonies, it is visible that in Project Based Learning, the project is the vehicle for teaching the critical knowledge and skills basic technology pre-service teachers need to learn. The project contains and frames the curriculum and instruction. Students work on a project over some time and engage in solving a real-world problem or answering a complex question. Basic technology pre-service teachers must demonstrate their knowledge and skills by creating and presenting the product and design to a seminar audience. Due to Project Based Learning, basic technology pre-service teachers apply content knowledge and develop critical thinking, problem-solving, evaluating, creativity, self-directed learning, intrinsic motivation and communication skills. The above findings on project-based learning are aligned with that of Edutopia (2014), who asserts that project-based learning is a dynamic classroom approach in which students actively explore real-world problems and challenges and acquire more profound knowledge. Also, scholars such as Alrajeh (2021), Cyprian (2014), and Baysura *et al*. (2016) acknowledge Project Based Learning as an instructional strategy that can be used to enable students to acquire twenty-first century skills. These scholars argued that if pre-service teachers are to be effective at implementing Project Based Learning with their students, they need repeated experiential exposure to the model in their university teacher training programs.

Studies have identified the positive impact Project Based Learning had on students, including increased design proficiency, improved confidence and willingness to approach challenges (Gabuardi, 2021; Thomas, 2000), developed thinking skills (Anazifa & Djukri, 2017) and interdisciplinary competence (Brassler & Dettmers, 2017).

The discussion method of instruction aims to get basic technology pre-service teachers to practice the art of higher-order thinking skills that enable students to interpret, analyse, and manipulate information about the course content material while communicating ideas.

Plan a discussion on drawing different types of triangles. (P1 lesson objectives).

During this discussion, elaborate on your answer by using factual content knowledge (P1 Lesson observation)

Discussion is a valuable teaching technique for developing higher-order thinking skills, enabling students to interpret, analyse, and manipulate information (Clements & Sarama, 2020). During the discussion, students explain their ideas and thoughts rather than merely recount or recite memorised facts and details, as is visible in the excerpt above. During the discussion, basic technology pre-service teachers are not passive recipients of information transmitted from the lecturer. Instead, learners are active participants. As they interact during the discussion, students construct an understanding of the topic.

The excerpts above show that lecturers model various instructional strategies to promote twenty-first century skills among basic technology pre-service teachers in their practice. Basic technology Pre-service teachers receive training on teaching complex ways of thinking, educating lifelong learners, and embracing diversity with differentiated pedagogical practices, as Breed (2019) suggested. Besides building the basic technology pre-service teachers' knowledge base regarding twenty-first century skills, lecturers also use these skills in their instructional practice, an essential reference for prospective teachers (Mestrinho & Cavadas, 2018).

The findings of this study are diametrical to those of Kalu-Uche *et al*. (2015) and Adegoke (2017), who report that teaching remained highly expository and teacher-centred in Nigeria as pre-service teachers are not exposed to instructional strategies that foster problem-solving, brainstorming and critical thinking., rather they are exposed predominantly to lecture methods.

6.2.2. Instructional strategies for lesson planning

Learning how to plan for teaching is essential to a teacher's work. It involves the design of lessons and assessments and reflections or an analysis of the teaching regarding choices concerning purposes (why?), content (what?), and methods (how?) both before and after teaching. The excerpts below highlight how instructional strategy is used to develop pedagogy.

... emphasise the need for a forecast; teaching plan… be guided by the curriculum,,, and check what content must be covered before designing the lesson and planning activities, but all this depends on the student's content knowledge. (P3 method lesson observation)

....build confidence, create an environment for support, critique and learning, skills like classroom management, timing the pace of the lesson, and thinking about how the content could be taught differently, lesson planning is about creativity and problem-solving (P6: method lesson plan objectives)

... drawing from the curriculum content…and aligning the assessment with the objectives, so those objectives are achieved, choosing the correct teaching strategy, providing feedback on lesson presentations, and allowing them to reflect (P4: method lesson observation)

…. this is a practical subject, this is a competency that must be developed in the lessons to have demonstrations and hands-on activities…… how to set up, maintain, and ensure safety in the workshop. (P4: method lesson objective)

From the above excerpts, the intrinsic interconnected relational interplay between forecasting, the curriculum, lesson objectives, content to be covered, assessments, and pedagogy gets elucidated. Lecturers provide opportunities for pre-service teachers to develop their knowledge and skills for planning lessons. Emphasis is placed on the need for forecasting during lesson planning. The lecturer maintains that planning for a lesson demands much more than merely preparing textbook content. Instead, planning lessons involves a complex and interrelated chain of events and decisions about learning activities. The teacher identifies learning outcomes and assessment standards in the planning process. The purpose of the lesson, learners' prior knowledge, sources of information, methods of instruction or teaching strategies, appropriate materials and resources needed, learners' activities, and assessment criteria. Thus, forecasting is construed as a road map to guide the pre-service teacher on the content that needs to be covered in a specific timeframe, the crafting of lesson objectives, the design of assessments and ensuring that the teaching strategies chosen meet these goals effectively.

Moreover, it is explicitly articulated that assessments must be designed to measure whether the objectives have been achieved. Also, the value of consulting the technology curriculum as the guide for ascertaining teaching content comes to the fore. This strategic instructional guide will ensure that the lesson content aligns with educational standards and learning objectives and

that learners receive the required knowledge and skills. The value of the basic technology pre-service teacher's good grasp of content knowledge is critical for lesson planning. Content knowledge is integral to teaching and is needed to make effective instruction possible. For example, limited knowledge of a particular topic can cause a teacher to be unable to define a learner's mistake and, therefore, fail to resolve this problem. Limited knowledge of the content can cause teachers to be uncomfortable when using alternative materials or to use these tools in a way that can cause learners to have incorrect ideas about the topic. These findings are aligned with those of Sahin-Takin (2017) and Van der Merwe (2022), who contend that forecasting is an integral part of lesson planning that should not be overlooked in initial teacher training programmes as it impacts the content covered, the assessment designed and ultimately learners' academic performance especially in exit level examinations.

The excerpts above also show that the method lectures create an enabling atmosphere where pre-service teachers feel supported. The method lectures foster confidence, support, and critique among students. They are also enlightened about skills such as classroom management, timing the pace of the lesson, and innovative teaching methods. Sanchez-Solarte (2019) also notes that classroom management is one of the central elements of every teacher's daily professional experience. Thus, it must be part of any teacher training programme. Additionally, lecturers underscore the practical nature of technical subjects and the need for pre-service teachers to develop competencies in the management of technical workshops. Knowledge of planning, organising, maintaining and managing a workshop lies at the heart of teaching technical subjects, as this is where practical experiments, demonstration, project-based learning, and problem-solving are carried out to transfer knowledge from concepts, principles, and theories to tangible results that can be observed, measured, controlled and re-tested in different conditions. Studies by Osuntuyi (2020) and Arun (2023) highlight the challenges science and technology teachers encounter in procuring, maintaining and repairing faulty laboratory apparatus, as well as maintaining safety in the laboratory. These scholars posit that pre-service teachers should be trained to manage, set up, maintain, and design floor plans and know about safety regulations and first aid as part of their day-to-day duties.

Pre-service teachers are encouraged to think outside the box to make lessons engaging and effective. This means lesson planning is seen as a creative problem-solving process, linking it to twenty-first century skills. By highlighting the above points in the lectures, it is visible that attention is paid to how basic technology pre-service teacher plan lessons, present their lesson and reflect on the feedback provided to improve their practice. The above findings resonate

with that of Konig *et al*. (2020) and Omotayo and Adeleke (2017), who contend that in teacher education programs, pre-service teachers should be provided with opportunities to develop their knowledge of and skills in planning, classroom management, development of appropriate teaching and assessment strategies, workshop/laboratory management, have opportunities to engage on reflective practice to improve planning and practice.

The method lectures are used by lecturers as an effective mechanism to simulate actual teaching in the classroom to enable pre-service teachers to practice planning in a safe environment (Karlstrom & Hamza, 2018). The method lectures are a preview that allows the basic technology pre-service teacher to reason about theoretical aspects of teaching and to rehearse and develop specific aspects of planning in an environment of reduced complexity. The method lectures create opportunities for pre-service teachers to sharpen their skills, especially on reflection based on the feedback received, before entering a more complex and uncertain situation in teaching practice.

6.3. Conclusion

Teacher education programmes should prepare pre-service teachers to meet the demands of twenty-first century education. The nature of pre-service teacher preparation concerning promoting twenty-first century skills is thus dual-layered. It involves promoting pedagogical and personal skills and the cultivation of twenty-first century skills in pre-service teachers, while at the same time training them and giving them sufficient experience to be able to apply the skills in classroom settings (Mestrinho & Cavadas, 2018).

Preparing pre-service teachers to teach twenty-first century skills requires their lecturers to model twenty-first century skills in their teaching practice to develop student teachers' knowledge base. Further, student teachers should be provided opportunities to put this new knowledge into practice in real-life situations (Häkkinen *et al*. 2017).

This chapter responded to research question two: What instructional strategies do lecturers employ when preparing basic technology pre-service teachers to teach in the twenty-first century? Data from lesson observation and analysis of lesson plans were used to ascertain the instructional strategies lecturers used when preparing pre-service teachers to teach in the twenty-first century. The analysis showed that lecturers used two instructional strategies: strategies to develop content knowledge and lesson planning.

Instructional strategies for developing content knowledge include brainstorming, demonstrations, project-based learning and discussion. In contrast, strategies used for lesson planning highlight the intrinsic, interconnected, and interplay between forecasting, the curriculum, lesson objectives, content to be covered, assessments and pedagogy. The above findings resonate with those of scholars like Martinez (2022), Cuadra-Martínez, *et al* (2023), Waren *et al.* (2015), and Rustique and Stam (2013), who assert that trainee teachers must be exposed to instructional strategies that not only deliver content knowledge, but also prepare students for teaching. In summary, preparing pre-service teachers for the twenty-first century involves a comprehensive approach where lecturers model essential skills, and pre-service teachers are given ample opportunities, to practice these skills in real-life contexts. This holistic preparation ensures that future teachers are proficient in content knowledge and equipped with the pedagogical and technological skills, necessary to thrive in modern educational environments. The next chapter presents the findings of research question three.

CHAPTER SEVEN
PRESENTATION OF FINDINGS AND DISCUSSION: RESEARCH QUESTION 3

7.1. Introduction

Lecturers play a crucial role in preparing pre-service teachers for applying twenty-first century skills in the classroom. Besides building the pre-service teachers' knowledge base concerning twenty-first century skills, lecturers also use these skills in their pedagogical practice, an essential reference for prospective teachers (Mestrinho & Cavadas, 2018). The previous chapter focused on lecturers' instructional strategies when preparing basic technology pre- service teachers to teach in the twenty-first century. This chapter provides insights into why lecturers develop instructional strategies to prepare basic technology pre-service teachers to teach in the twenty-first century the way they do. Data from the post-observation and focus group interviews were used to answer research question three. First, the reasons lecturers use these instructional strategies to prepare basic technology pre-service teachers to teach in the twenty-first century are presented, followed by the conclusion.

7.2. Why do lecturers develop instructional strategies to prepare basic technology pre-service teachers to teach in the twenty-first century the way they do?

To determine the answer to this research question, the participants were asked what encouraged them to use the instructional strategies to prepare the pre-service students for the twenty-first century. The responses are in three parts, presented first with map representation as shown in Figure 7.1, the word cloud representation of their response as shown in Figure 7.2, and then thematically.

As shown in Figure 7.1, the participants' responses are divided into two parts. The question posed was about motivation (When you decide to use instructional strategies in your teachings, what informed your decision?), hence the responses are broadly divided into two parts, namely: students and topic requirements. The participants' responses that supported the fact that students are their motivating factors are revealed in the following excerpts:

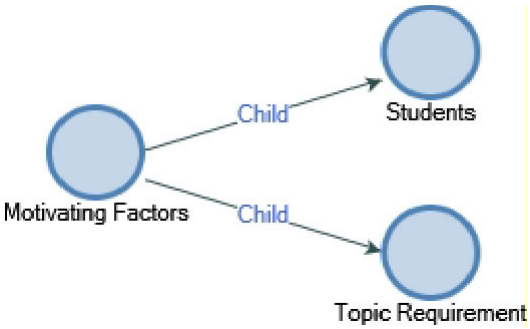

Figure 7.1. ***Map representation of responses on motivation***

What informed my decision on the strategies to use is the students. (P1: Interview)

What informed my decision to use the Instructional strategies is how to impact students' knowledge. (P2: interview)

What informed my decision to use instructional strategies is the students. How to teach them effectively. (P4: interview)

What informed my decision is how I can teach and impart appropriate and adequate knowledge to the students. (P7: interview)

Apart from those who decide to use instructional strategies in their teaching because of students, others motivational factor is the topic required, as revealed in the following excerpts:

Practical activity involves the content and nature of the practical, the thinking skills that are required. The definitions, as a lecturer, you need to define some content for the students. (P1: interview)

The content of the lesson I am taking will determine which of the instructional strategies to use (apply) in a particular class. (P3: interview)

The aspect of the course (lesson) will determine the instructional strategies that will be used. (P5: interview)

The nature of the lesson will inform my decision. Whether via teaching them the theoretical aspect or manipulative aspect (practical). (P6: interview)

As Chapter 5 (section 5.2) mentioned, none of the seven participants attended a professional development workshop to capacitate them to teach in the twenty-first century. According to scholars such as Robb (2016), professional development is the cornerstone of any proposed educational change, such as developing twenty-first-century skills among pre-service teachers. Robb asserts that if lecturers learn twenty-first century skills and instructional strategies, they will have a teacher-centred experience that can be brought into the pre-service training programme. The excerpts below shed insights into why lecturers develop instructional strategies to prepare basic technology pre-service teachers to teach in the twenty-first century the way they do.

The design process undergirds all teaching in technology subjects. The design process foregrounds problem-solving, critical thinking, evaluation, and creativity, essential twenty-first century skills. So, it is natural for us to promote these skills in pre-service technology teachers. This is a part and parcel of technology education it is an integral part of our pedagogy. (P2:Post-observation interview)

Even though there was no professional development for us to prepare pre-service teachers to teach in the twenty-first century, I took it upon myself to read about the P21 framework and integrate these skills in my teaching and design of lessons and assessments. (P6: Focus group interview)

We do not have much support at an institutional level, and we lack funds and up-to-date ICT resources, but we, as a team of technology lecturers, have our learning community to improve our skills and share best practices. (P6: Post-observation interview)

...liaising with industry and colleagues from other institutions to ensure that our teaching and assessments are pitched appropriately so that our pre-service teachers are well-equipped to teach technology at their future schools (P1: focus group interview).

The excerpts present a multifaceted view of the challenges and approaches in teaching technology subjects, mainly focusing on the design process, twenty-first century skills, professional development, and institutional support.

The design process is central to teaching technology, emphasising the development of critical twenty-first century skills. This process involves a structured approach to solving problems, fostering creativity, and enabling critical evaluation. It comprises the following stages: identifying the problem, brainstorming design solutions, creative idea generation, evaluating and critiquing the product design, investigating/researching, creating a product, re-design, applying and communicating graphically (Ohemeng-Appiah, 2021). As such, involving basic technology pre-service teachers in the design process as an instructional strategy and a form of assessment means that quintessential learning and innovation skills and life and career skills are developed. Lecturers using the design process as a platform for all teaching and learning in technology subjects allow pre-service teachers to be better equipped to teach and apply these essential skills in their future classrooms. This finding concurs with that of Singh-Pillay and Ohemeng-Appiah (2016), Lin (2021) and Mavengere *et al* (2021), which emphasise that all teaching in technology depends on the design process. The focus on problem-solving and critical thinking prepares students to tackle real-world challenges, making the design process a cornerstone of effective technology education. The design aspect of the process encourages students to be creative and learn from failures (Carroll, 2015).

Lecturers realise the dire need to promote twenty-first century skills in pre-service teachers as crucial for their development and future teaching careers. By embedding these skills into the curriculum, lecturers ensure that future teachers can effectively integrate them into their teaching practices, preparing their students for the demands of the modern world.

7.2.1 Institutional support to prepare pre-service teachers for the twenty-first century

A question was posed to the participants to understand how the institution supported them in using instructional strategies to prepare pre-service teachers in basic technology for the twenty-first century. Their transcribed responses were first analysed with the Orange data mining tool to get the word cloud representation of the contents and then manually, get their actual responses. The word cloud of responses is presented in Figure 7.2.

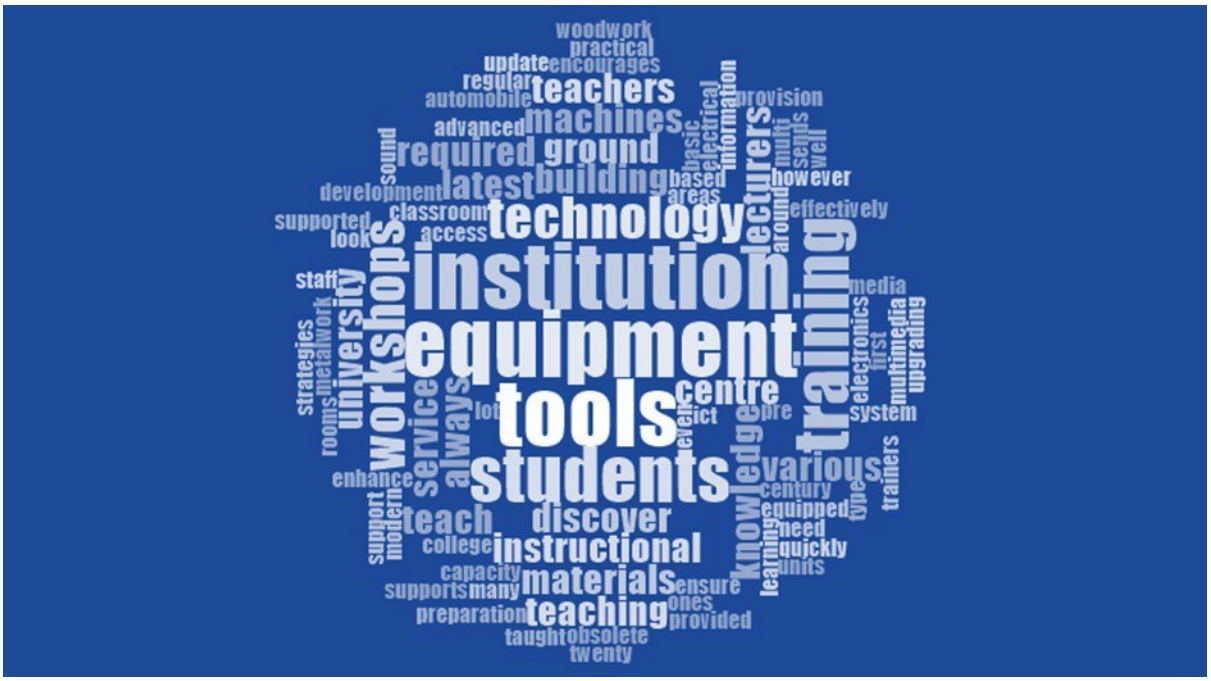

Figure 7.3. ***Word cloud representation of responses on institutional support***

As shown in Figure 7.2, the most prevalent words in the participants' responses are institution, equipment, tools, students, technology, instructional materials, workshop, training, and machines. The question posed was about the kind of support available at the institution to support the lecturers' preparation of pre-service teachers for the twenty-first century. Other than these, a manual study of the transcribed responses shows that the institutional support is inadequate to support the lecturers' preparation of the pre-service teachers for the twenty-first century as presented in the following excerpts:

…. there is a need for upgrading and in-service training, capacity building, and training the trainers. You cannot give what you don't have. Tell me the quality of the students and I will tell you the quality of the teachers. The quality of the teacher determines the output of the students-constant upgrading of the staff and the facilities. (P1: post-observation interviews)

…the institution should provide well-equipped and modern workshops, this will enable students to have sound practical knowledge. Industrial visits should be a regular exercise for the students, to have real practical experience. (P2: post-observation interview)

The support in terms of training of lecturers, provision of equipment, tools and instructional materials for teaching and learning should be improved. (P3: post-observation interview)

...but we need the latest type (equipment, machine, and tools). By utilising modern equipment to teach the students, they can learn faster and better, than ordinary lectures, hence, preparing the pre-service teachers for the twenty-first century. (P4: post-observation interview)

...workshops and multi-media centre, are inadequate to prepare the students for the twenty-first century. Also, the institution should provide a constant power supply to operate the equipment. (P5:post-observation interview)

...workshops for various units; with equipment and tools for teaching, but the equipment is not the modern ones. Also, there is a need for professional development for us to prepare pre-service teachers to teach in the twenty-first century. (P6: post-observation interview)

The institution needs to send the lecturers and other staff for regular staff development training, to update our knowledge on the latest instructional strategies and how to teach the students, effectively. (P7: post-observation interview)

The lack of formal professional development opportunities, institutional support, and resources presents a significant challenge for lecturers. The excerpts highlight the struggles faced by lecturers due to limited institutional support and outdated ICT resources. However, subtly, the lecturers' agency and professional capital get illuminated via the excerpts. Lecturers could embark on proactive measures, such as forming a professional learning community to create a safe space to share best practices and learn from each other. In the process, their collegiality and agentic actions allow lifelong learning, sustainable ties, and strategies to mitigate the challenges they encounter. The collegiality among these lecturers allow them to exercise their collective agency to address the gaps in their teaching capabilities. This collective agency bridges the divide between the lack of institutional support and professional development and skills needed to prepare basic technology pre-service teachers to teach in the twenty-first century. The finding of this study ties in with that of Singh-Pillay and Samuel's (2017) study, which sees agency as an emergent phenomenon of the ecological context through which it is enacted, in this instance the lack of institutional support and professional development.

Also explicit in the above excerpts are the lecturers' commitment to their professional growth and motivation to learn. The individual's effort to learn about the P21 framework and incorporate it into teaching practices demonstrates resilience and a commitment to continuous

improvement. This self-driven approach highlights the importance of lifelong learning and adaptability in the face of professional development gaps.

Collaboration with industry and other educational institutions is essential for aligning teaching practices with current standards and expectations. Educators can stay informed about the latest developments by engaging with industry professionals and colleagues and ensuring that their teaching methods and assessments remain relevant and practical. This collaborative approach helps bridge the gap between academic learning and real-world applications, benefiting pre-service teachers and future students.

The excerpts underscore the importance of the design process in technology education, the need to promote twenty-first century skills, and the challenges posed by limited professional development and institutional support. Despite these challenges, proactive self-education, the formation of learning communities, and collaboration with industry and other institutions provide viable solutions for educators. By leveraging these strategies, technology educators can continue to deliver high-quality education and prepare pre-service teachers for the demands of the modern world.

7.3. Conclusion

This chapter responded to research question three: Why do lecturers develop instructional strategies to prepare basic technology pre-service teachers to teach in the twenty-first century the way they do? Data from the post-observation interviews and focus group interviews were used to answer research question three. The findings reveal that the design process is used to undergird all lesson and assessment designs in technology subjects. The design process promotes the development of critical twenty-first century skills in basic technology pre-service teachers. The lack of institutional support and professional development initiates lectures' agency and professional capital to forge collegial ties, form professional learning communities and partnerships with industries to share best practices, engage in lifelong learning, and ensure that basic technology pre-service teachers are equipped with the relevant skills to teach in the twenty-first century. The last chapter presents the recommendations of the study.

CHAPTER EIGHT
CONCLUSION AND RECOMMENDATIONS

8.1. Introduction

Teachers and their training are at the heart of developing twenty-first century skills (Darling-Hammond & Oakes, 2019). Therefore, teachers must reassess and modify their teaching strategies to help students develop the necessary skills for the twenty-first century, ensuring they are prepared for further education and job market demands. This study explored Technology lecturers' instructional strategies to prepare basic technology pre-service teachers for twenty-first-century teaching at a Nigerian university. The qualitative study responded to the following three research questions:

1. Which twenty-first century skills do lecturers foreground in their teaching?
2. What instructional strategies do lecturers employ when preparing basic technology pre-service teachers to teach in the twenty-first century?
3. Why do lecturers use these instructional strategies to prepare basic technology pre-service teachers to teach in the twenty-first century, the way they do?

Data was generated via observation, post-observation interviews, document analysis and focus group interviews. This chapter reviews the findings, recommendations and conclusions of the qualitative study.

8.2. Summary of research findings

In this section, a summary of the results for each research question is provided in a table, as shown in *Table 8.1* below.

Table 8.1. The highlight of the research findings

RESEARCH QUESTION	OVERALL FINDING
1. Which 21st-century skills do lecturers foreground in their teaching	Problem-solving, Critical thinking, Application, Creativity, Design thinking, Graphic communication
2. What instructional strategies do lecturers employ when preparing basic technology pre-service teachers to teach in the twenty-first century?	Brainstorming Demonstrations Guided discovery Project-based learning Discussion Lesson planning
3. Why do lecturers use these instructional strategies to prepare basic technology pre-service teachers to teach in the twenty-first century the way they do?	The design process undergirds technology teaching and assessment Lack of institutional resources Lack of professional development Lecturer agency

Table 8.1 highlights the overall findings of the study. The skills lecturers foreground in the training of basic technology pre-service teachers are problem-solving, critical thinking, application, creativity, design thinking and graphic communication. The findings of research question one reveal that lecturers ignore collaboration skills, teamwork and digital skills.

The instructional strategies that lecturers model when preparing basic technology pre-service teachers to teach in the twenty-first century include brainstorming, demonstrations, guided discovery, project-based learning, discussion, and lesson planning.

The reasons why lecturers employ the above-mentioned instructional strategies to prepare basic technology pre-service teachers to teach in the twenty-first century include, the design process undergirding all teaching and assessment in technology subjects, lack of institutional resources such as Information and Communication Technology (ICT), lack of professional development and lecturers' agency.

8.3. Discussion on the use of the conceptual framework

The above finding is consistent with Toro's (2019) research, which states that business leaders are increasingly asking education institutions to develop problem-solving, critical thinking, and communication skills, often called twenty-first century skills.

Since this study explored technology lecturers' instructional strategies to prepare basic technology pre-service teachers for twenty-first-century teaching, it drew on all four aspects of the P21 framework during the observation of lessons and interviews.

While the framework is a blend of content knowledge, specific skills, expertise, and literacies developed within a school/institution ecosystem, the analysis of the lessons observed and the post-observation interviews, highlighted that the P21 framework does not cater for teacher agency. Teacher agency refers to the capacity of teachers to act purposefully, to find solutions to the challenges they face, and to direct their professional growth. In this study, the school is construed as an ecosystem, where teaching and learning unfold. Singh-Pillay and Samuel's (2017) notion of ecological agency is embraced into the P21 framework to form the conceptual framework of this study, as depicted in Figure 8.1 below.

Figure 8.1. The conceptual framework for this study

These scholars see agency as an emergent phenomenon of the ecological context through which it is enacted (institutional ecology). This means people have agency in response to a particular context to cope with, overcome, or survive the harsh contextual factor. The agency will, therefore, invariably result from the interplay of individual efforts, available resources, and contextual and structural factors as they coalesce in particular and unique situations. It is an embedded process of engagement influenced by the teachers' past, orientated towards the future, and engaged with the present. The above notion of agency illuminates that agency does not come from anywhere but builds upon past achievements, understandings and patterns of action. This above conceptual framework, which includes teacher agency to the P21 framework, is the knowledge contribution of this study.

8.4. Recommendation

Based on the findings of this study, the following recommendations are made:

8.4.1. Recommendations for University Teacher Education Departments for Resources

The study recommends that the University provide adequate attention and necessary support by providing relevant resources for teaching and learning technical subjects within the Teacher Training Programme. For example, the provision of digital technologies for simulations.

8.4.2. Recommendations for continuous professional development of university technology Lecturers

The findings of this study reveal that the lecturers sampled did not receive any professional development in preparing pre-service teachers to teach in the twenty-first century. To keep abreast with teaching and learning innovation, professional development is vital for lecturers.

8.4.3. Recommendation for further studies

The literature review revealed a paucity of research relating to the training of pre-service teachers to teach in the twenty-first century in Nigeria. Therefore, it is recommended that other studies that relate to this study be conducted in different locations or institutions within the Nigerian context. Findings from different institutions on training pre-service teachers, to teach in the twenty-first century can then be fused, to create a comprehensive curriculum for training pre-service teachers at Nigerian institutions.

8.5. Limitations of the study

The findings of this case study could not be generalised to other teacher education institutions, for the training of pre-service teachers. Instead, there would be a need for further studies to validate the findings of this study to be carried out in other teacher training institutions in Nigeria using a similar population. The trustworthiness of this study is enhanced using various methods.

REFERENCES

Abdel M. & Collins, M. (2017). Students' perceptions of lecturing approaches: traditional versus interactive teaching. *Advances in Medical Education and Practice*. 8. 229-241.10.2147/AMEP.S131851.

Abadzi, H. (2012). Effective Teacher Training in Low-Income Countries: The Power of Observational Learning Research. http://documents.worldbank.org/curated/en/2012/11/18042910/effective-teacher-training-low-income-countries-power-observational-learning-research

Abedi, E.A. (2023). Tensions between technology integration practices of teachers and ICT in education policy expectations: implications for change in teacher knowledge, beliefs and teaching practices. *J. Comput. Educ.* https://doi.org/10.1007/s40692-023-00296-6

Adegoke, B. A. (2017). Effect of Explicit Problem Solving Instruction on Secondary School Students‟ Achievement in Physics. International Journal of Scientific Research in Education, 10(1), 87-101. http://www.ijsre.com

Adeosun, O. (2014). Teacher education programmes and the acquisition of 21st -century skills: Issues and challenges. home.hiroshima.u.ac.jp. Retrieved 24/03/2018

Adler, E. S., & Clark, R. (2008). How It's Done: An Invitation to Social Research. London: Thomson Wadsworth.

Agbo, I.S. (2015). Factors Influencing the Use of Information and Communication Technology (ICT) in Teaching and Learning Computer Studies in Ohaukwu Local Government Area of Ebonyi State. Nigeria. *Journal of Education and Practice*, 6(7): 71–86.

Ahmad, S. A., Yoke, S. K., Yunos, R. M., & Amin, J. M. (2020). Exploring Lecturers' Readiness for 21st Century Education in Malaysian Higher Learning Institutions. *European Journal of Teaching and Education*, 1(1), 15–29. https://doi.org/10.33422/EJTE.2019.10.27

Akinbobola AO, and Ikitde GA (2011).Strategies for teaching mineral resources to Nigeria secondary school science students. African J. Social Res. Dev. 3(2): 130138.

Akram H, Abdelrady AH, Al-Adwan AS and Ramzan M (2022) Teachers' Perceptions of Technology Integration in Teaching-Learning Practices: A Systematic Review. Front. Psychol. 13:920317. doi: 10.3389/fpsyg.2022.920317

Akyeampong, K., Pryor, J., Westbrook, J. & Lussier, K. (2011). *Teacher Preparation and Continuing Professional Development in Africa*. Sussex. https://app.box.com/sierraleoneeducationdocs/1/187375169/1412848487/1.

Alahmad, A., Stamenkovska, T. and Gyori, J. (2021) Preparing Pre-service Teachers for 21st Century Skills Education: A Teacher Education Model GiLE Journal of Skills Development 1(1):67-87. DOI: 10.52398/gjsd.2021.v1.i1.pp67-86

Alberta Education. (2017). Guide to Education: 1–148. papers3://publication/uuid/917AD11C-9736-4808-A337-BD6A7121091F

Ally, M. & Tsinakos, A. (2014). Increasing Access through Mobile Learning. M. Ally & A. Tsinakos, eds. Athabasca: Commonwealth of Learning and Athabasca University, Vancouver. http://www.col.org/PublicationDocuments/pub_Mobile Learning_web.pdf.

Almarashdeh, I., & Alsmadi, M. (2016). Investigating the acceptance of technology in distance learning program. 2016 International Conference on Information Science and Communications Technologies, ICISCT 2016. (pp. 1-5). IEEE.

Alrajeh, T. S. (2021). Project-based Learning to Enhance Pre-service Teachers' Teaching Skills in Science Education. Universal Journal of Educational Research, 9(2), 271 - 279. DOI: 10.13189/ujer.2021.090202.

Al-Samarraie, H., & Hurmuzan, S. (2018). A review of brainstorming techniques in higher education. *Thinking Skills and Creativity*, *27*, 78-91. https://doi.org/10.1016/j.tsc.2017.12.002

Alshenqeeti, H. (2014). Interviewing as a Data Collection Method: A Critical Review. English Linguistics Research, 3, 39-45. https://doi.org/10.5430/elr.v3n1p39

Amuko, S., Miheso, M., & Ndeuthi, S. (2015). Opportunities and Challenges: Integration of ICT in Teaching and Learning Mathematics in Secondary Schools, Nairobi, Kenya. Journal of education and practice, 6(24), 1-6.

Ananiadou, K. & Rizza, C. (2010). ICT Initial Teacher Training: First Findings and Conclusions of an OECD Study. Conference Proceedings: p. 5621-5632. Centre for Educational Research and Innovation. OECD (France) JRC63223

Anazifa, R. & Djukri (2017) Project- Based Learning and Problem-Based Learning: Are They Effective to Improve Student's Thinking Skills? Jurnal Pendidikan IPA Indonesia 6(2):346-355 DOI: 10.15294/jpii.v6i2.11100.

Angeli, C. & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT – TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers & Education,* 52(1): 154–168. http://dx.doi.org/10.1016/j.compedu.2008.07.006.

Arkorful, V., & Abaidoo, N. (2015). The role of e-learning, advantages and disadvantages of its adoption in higher education. *International journal of instructional technology and distance learning*, *12*(1), 29-42.

Arun, Z. (2023). Difficulties of Laboratory physical sciences teaching: Teachers perspectives. *European Journal of Education Studies, 10*(7). doi:http://dx.doi.org/10.46827/ejes.v10i7.4852

Aying, C., Awang, M. M. & Ahmad, A. R. (2019). The Use of Digital Technology as a Medium of Teaching and Learning History Education. *Global Conferences Series: Social Sciences, Education and Humanities (GCSSSEH)* (2)151-155

Backfisch, I., Lachner, A., Stürmer, K., & Scheiter, K. (2021). Variability of teachers' technology integration in the classroom: A matter of utility! *Computers & Education, 166,* 104159. https://doi.org/10.1016/j.compedu.2021.104159

Banks, T., Jackson, D. & Harper, B. (2014). Responding to the call to prepare highly effective teacher candidates in the United States: The curriculum redesign effort in advancing teacher

education. *Higher Education Studies*, 4(2): 9–19. http://www.ccsenet.org/journal/index.php/hes/article/view/34058.

Bates, T.A.W. (2015). Teaching in a Digital Age: Guidelines for designing teaching and learning for a digital age. British Columbia. http://opentextbc.ca/teachinginadigitalage/.

Baysura, O.D., Altun, S. & Yucel-Toy, B. (2016). Perceptions of teacher candidates regarding project-based learning. Eurasian Journal of Educational Research, 62, 15-36. doi:10.14689/ejer.2016.62.3

Bergeson, K. T., & Beschorner, B. (2021). Preservice teachers' use of the technology integration planning cycle: Lessons learned. *Reading Horizons: A Journal of Literacy and Language Arts*, *60*(1), 4.

Berrett, B., Murphy, J. & Sullivan, J. 2012. Administrator Insights and Reflections: Technology Integration in Schools. http://nsuworks.nova.edu/tqr/vol17/iss1/10.

Bertram, C and Christiansen, I (2015) *Understanding Research. An introduction to reading research*. Pretoria: Van Schaik Publishers.

Bhattacharjee. B. and Kamal Deb (2016). Role of ICT in 21st Century's Teacher Education. *International Journal of Education and Information Studies*. 6(1) 1-6

Birt L, Scott S, Cavers D, Campbell C, Walter F. (2016). Member Checking: A Tool to Enhance Trustworthiness or Merely a Nod to Validation? Qual Health Res: 1802-1811. doi: 10.1177/1049732316654870. Epub 2016 Jul 10. PMID: 27340178.

Borko, H. (2004). Professional Development and Teacher Learning: Mapping the Terrain. Educational Researcher, 33, 3-15. http://dx.doi.org/10.3102/0013189X033008003

Bowman, M. A., Vongkulluksn, V. W., Jiang, Z., & Xie, K. (2020). Teachers' exposure to professional development and the quality of their instructional technology use: The mediating role of teachers' value and ability beliefs. *Journal of Research on Technology in Education*, *54*(2), 188–204. https://doi.org/10.1080/15391523.2020.1830895

Brassler, M., & Dettmers, J. (2017). How to Enhance Interdisciplinary Competence—Interdisciplinary Problem-Based Learning versus Interdisciplinary Project-Based Learning. Interdisciplinary Journal of Problem-Based Learning, 11(2). https://doi.org/10.7771/1541-5015.1686

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, *3*(2), 77-101.

Braun, V. and Clarke, V. (2013) Successful Qualitative Research: A Practical Guide for Beginners First Edition.

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative research in sport, exercise and health*, *11*(4), 589-597.

Brookhart, S. M. (2023). *Classroom Assessment Essentials*. ASCD. Breed, C. (2019). Characteristics of 21st century learners. Retrieved from https://bit.ly/2G2IVTD

Brown, R. (2023). Teacher perceptions of critical thinking skills within primary school design and technology. Design and Technology Education: An International Journal, 28(2), 22-37.

Buabeng-Andoh, C. (2012). Factors influencing teachers' adoption and integration of information and communication technology into teaching: A review of the literature Charles Buabeng-Andoh. *International Journal of Education and Development using Information and Communication Technology*, 8(1): 136–155.

Butler-Adam, J. (2018) The Fourth Industrial Revolution and education. *South African Journal of Science*, 114(5–6)

Byrd, N. (2017). Technology-Based Professional Development for Teaching and Learning in K-12 Classrooms. Doctoral study. Walden University. Minnesota.

Cao X, Guo X, Vogel D, Zhang X (2013) Exploring the influence of social media on employee work performance. Internet Res 26(2):529–545. https://doi.org/10.1108/IntR-11-2014-0299

Care, E., Kim, H., Vista, A. & Anderson, K. (2018). Education System Alignment for 21st Century Skills. https://www.brookings.edu/wp-content/uploads/2018/11/Educationsystem-alignment-for- 21st-century-skills-012819.pdf.

Carroll, M. (2015). Stretch, dream, and do - a 21st century design thinking & STEM journey. Journal of Research in STEM Education, 1(1), 59–70

Carter N, Bryant-Lukosius D, DiCenso A, Blythe J, Neville AJ (2014). The use of triangulation in qualitative research. Oncol Nurs Forum; 41(5):545-7. doi: 10.1188/14.ONF.545-547. PMID: 25158659.

CAST (2011) Universal Design for Learning Guidelines version 2.0. Wakefield, MA.

Chai, C.S., Koh, J.H.L. & Tsai, C.-C. (2013). A Review of Technological Pedagogical Content Knowledge. *Educational Technology and Society*, 16(2): 31–51.

Chalkiadaki, A. (2018). A systematic literature review of 21st Century Skills and competencies in primary education. *International Journal of Instruction*, 11(3), 1–16.

Chen, Y.H., Jang, S.J. & Chen, P.J. (2015). Using wikis and collaborative learning for science teachers' professional development. *Journal of Computer Assisted Learning*, 31(4): 330–344.

Chigona, A. & Chigona, W. (2013). South African pre-service teachers' under-preparedness to teach with Information Communication Technologies. *IEEE Xplore*: 239–243.

Chigona, A. (2013). Using multimedia technology to build a community of practice: Pre-service teachers' and digital storytelling in South Africa Agnes Chigona Cape Peninsula University of Technology, South Africa. *International Journal of Education and Development using Information and Communication Technology*, 9(3): 17–27.

Chigona, A. (2014). Using Digital Storytelling to Prepare New Teachers for Multicultural and Digital Natives' Classrooms. EdMedia 2014: World Conference on Educational Media and Technology. Tampere, Finland, June 23–27.

Chigona, A. (2015a). Pedagogical shift in the twenty-first century: preparing teachers to teach with new technologies. *Africa Education Review*, 12(3): 478–492.

Chigona, A. (2015b). Quality of Teacher Education for 21st Century Classrooms. In L. D. Mogari, ed. Towards Effective Teaching and Meaningful Learning in Mathematics, Science and Technology. Limpopo: UNISA Press: 451–457.

Chigona, A., Chigona, W. & Davids, Z. (2014). Educators' motivation on integration of ICTs into pedagogy: case of disadvantaged areas. *South African Journal of Education*, 34(3).

Chongkolklang, S. (2018). A study of learning skills in the 21st century of high school students in Cao Bang Province, Vietnam. *KKU Research Journal (Graduate Studies*), 6(2), 14-24.

Choy, D., Wong, A. F. L. & Gao, P. (2009). Student teachers' intentions and actions on integrating technology into their classrooms during student teaching: A Singapore study. Journal of research on Technology in Education, 42(2), 173-193

Clark, T (2011) Gaining and Maintaining Access: Exploring the Mechanisms that Support and Challenge the Relationship between Gatekeepers and Researchers. Qualitative Social Work 9(2) DOI: 10.1177/1473325009358228

Cohen, L., Manion, L., & Morrison, K. *(2011). Research Methods in Education (7th ed.). London: Routledge.*

Cohen,, Manion and Morrison (2017) Research Methods in Education 8th Edition. Routledge. DOI https://doi.org/10.4324/9781315456539

Cohen, Manion, and Morrison (2018) Research Methods in Education (Eight edition) Abingdon, Oxon. In: UK. Routledge.

Connelly LM. Trustworthiness in Qualitative Research. Medsurg Nurs. 2016 Nov; 25(6):435-6. PMID: 30304614.

Coutinho, C.P and Junior, J.B.B (2009) preparing digitally wise teacher. Higher education, partnership, innovate proceeding 7 – 9 Sept.

Cox, J. (2016). Teaching strategies that enhance higher-order thinking. Retrieved from http://www.teachhub.com/teaching strategies-enhance-higher-order- thinking.

Crespí, P., García-Ramos, J. M., & Queiruga-Dios, M. (2022). Project-Based Learning (PBL) and Its Impact on the Development of Interpersonal Competences in Higher Education. Journal of New Approaches in Educational Research, 11(2), 259-276. doi: 10.7821/naer.2022.7.993

Creswell, J.W. and Plano Clark, V.L. (2011) Designing and Conducting Mixed Methods Research. 2nd Edition, Sage Publications, Los Angeles.

Creswell, J. W. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (5th ed.). Sage.

Creswell J. & Creswell D. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, by Thousand Oaks, CA: Sage Publication, Inc.

Creswell, J. W., & Poth, C. N. (2018). Qualitative inquiry & research design: Choosing among five approaches (4th ed.). Thousand Oaks, CA: Sage.

Crossman, J. (2021). Qualitative research writing: surveying the vista. In *Handbook of qualitative research methodologies in workplace contexts* (pp. 190-211). Edward Elgar Publishing.

Cuadra-Martínez, D., Castro-Carrasco, P., Oyanadel-Véliz, C., González-Palta, I., Živković, P., Sandoval-Díaz, J., & Pérez-Zapata, D. (2023). Pre-service teacher professional identity:

Influence of the teacher educator and the teacher education model. *Education Policy Analysis Archives*, *31*.

Cypress BS. Rigor or Reliability and Validity in Qualitative Research: Perspectives, Strategies, Reconceptualization, and Recommendations. Dimens Crit Care Nurs. 2017 Jul/Aug; 36(4):253-263. doi: 10.1097/DCC.0000000000000253. PMID: 28570380.

Cyprian, T. (2014). Teacher self-efficacy in a project-based learning (PBL) classroom. New York, NY: Freeman.

Dahal A, Bhat N. (2023) Self-Directed Learning, its Implementation, and Challenges: A Review. Nepal J Health Sci. 2023 Jul-Dec; 3(1): 102- 115.

Dalia, H. & Chowdhury, M.O. (2017). Information Technology (IT) and Teaching Method: An Assessment on the Students of Social Science Faculty and Business Faculty of University of Dhaka. *Journal of Information Engineering and Applications*, 7(8). www.iiste.org.

Darling-Hammond, L., Hyler, M.E. & Gardner, M. (2017). Effective Teacher Professional Development. Palo Alto CA. https://learningpolicyinstitute.org/product/teacherprof-dev

Darling-Hammond, L., & Oakes, J. (2019). Preparing teachers for deeper learning. Harvard Education Press. Boston ISBN: 1682532925.

Deacon, R. (2015). Report on the 2013 survey of final year initial teacher education students. *Johannesburg: Joint Education Trust (JET) services*.

De La Paz, S. & Hernández-Ramos, P. (2013). Technology-Enhanced Project-Based Learning: Effects on Historical Thinking. *Journal of Special Education Technology*, 28(4): 1–14.

Denzin, N. K., & Lincoln, Y. S. (Eds.). (2018). The SAGE Handbook of Qualitative Research (5th ed.). Los Angeles, CA: Sage.

Dias, L., & Victor, (2017). Teaching and learning with mobile devices in the 21st Century Digital world: Benefits and Challenges. *Multi-disciplinary studies* (2) 334-387

Dionys, D. (2012). Introduction of ICT and multimedia into Cambodia's teacher training centres. Australasian Journal of Educational Technology, 28(6): 1068–1073.

Divaharan, S. (2011). Learning new technology tools in pre-service teacher education: A model for instructional approach. Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education: 352–363.

Donnelly, R. Fitzmaurice, M. (2005) Collaborative Project-based Learning and Problem-based Learning in Higher Education: a consideration of tutor and student role in learner-focused strategies. Technological University Dublin. Retrieved from https://arrow.tudublin.ie/ltcbk

Donovan, L. & Green, T. (2014). *Creating a 21st Century Teaching and Learning Environment*. Huntington Beach: Shell Educational Publishing.

Dorsah, P., Abukari, M., Tindan, T. and A-ingkonge, B. (2022) Beginning Teaching: Pre-Service Teachers' Experiences with Supported Teaching in Schools. Teacher Education and Curriculum Studies 7(4):140-149. DOI: 10.11648/j.tecs.20220704.15

Durak, Y. H. (2021). Preparing pre-service teachers to integrate teaching technologies into their classrooms: Examining the effects of teaching environments based on open-ended, hands-on and authentic tasks. *Education and Information Technologies*, *26*(5), 5365-5387.

Durham, C. (2022). ‘We just learned from each other’: ESOL pre-service teachers learning to use digital tools across coursework and student teaching. *The Language Learning Journal*, 51(6), 783–796. https://doi.org/10.1080/09571736.2022.2081713

Edwards, C. J. (2022). *Experiences of Teacher Educators Utilizing Technology in Teacher Preparation Programs*. Bowling Green State University.

Ertmer, P. A., Ottenbreit-Leftwich, A. T., & Tondeur, J. (2014). Teachers' beliefs and uses of technology to support 21st-century teaching and learning. *In International handbook of research on teachers' beliefs* (pp. 403-418). Routledge.

Facer, K., & Selwyn, N. (2021). Digital Technology and the Futures of Education: Towards ‘Non-Stupid’ Optimism. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000377071

Faculty of Education, Mahasarakham University. (2016). *Curriculum in education*. Mahasarakham, Thailand: Mahasarakham University.

Flick, U. (2006) Introduction to Qualitative Research. Sage, London.

Flicks (2018) Concepts of Triangulation Managing Quality in Qualitative Research. DOI**:** https://doi.org/10.4135/9781849209441.n4

Forrester, M. and Sullivan, C. (2018). Doing Qualitative Research in Psychology: A Practical Guide Second Edition.

Foulger, T. S., Graziano, K. J., Schmidt-Crawford, D., & Slykhuis, D. A. (2017). Teacher educator technology competencies. *Journal of technology and teacher education*, *25*(4), 413-448.

Foulger, T. S., Wetzel, K., & Buss, R. R. (2019). Moving toward a technology infusion approach: Considerations for teacher preparation programs. *Journal of Digital Learning in Teacher Education*, *35*(2), 79-91.

Fourie, E. and Fourie, U. (2015) As Educators of Teachers, Where and When Do Our Responsibilities End? Journal of Social Science, 42(3): 247-257 (2015) DOI: 10.31901/24566756.2015/42.03.06PRINT: ISSN 0971-8923 ONLINE: ISSN 2456-6756

Freeman, Jackie D. (2022). Effect of the Think-through Math Online Tutorial on Student Achievement Scores in Math. Trevecca Nazarene University. ProQuest Dissertations & Theses, 29062069.

Fu, J.S. (2013). ICT in Education: A Critical Literature Review and Its Implications. *International Journal of Education and Development using Information and Communication Technology*, 9(1): 112–125

Gabuardi, V. M. F. (2021) Project-Based Learning: boosting 21st century skills. IV Sección Educación: competencias, formación y aprendizajes ISSN 1659-3316. https://orcid.org/0000-0002-8401-122X

Gaffney, J. S., & Rodgers, E. (2018). Scaffolding research: Taking stock at the four-decade mark. *International Journal of Educational Research*, *90*, 175-176.

García, M. d. R., Reyes, JR, & Godínez, G. (2017). ICT in higher education, innovations and challenges / The ICT in higher education, innovations and challenges. *RICSH Iberoamerican Journal of Social and Humanistic Sciences,* 6(12), 299-316

Garofalo, J. & Trinter, C. (2013). Using Simulations to Foster Preservice Mathematics Teachers' Self-Assessment, Learning, and Reflections on Teaching. *Mathematics Teacher Educator*, 1(2): 162.

Gedye, S. & Beaumont E. (2018) "The ability to get a job": student understandings and definitions of employability, *Educ. Train*. 60 406–420, https://doi.org/10.1108/ET-10-2017-0159.

Gibson, P.A., Stringer, K., Cotten, S.R., Simoni, Z., Neal, L.J.O. & Howell-moroney, M. (2014). Changing teachers, changing students? The impact of a teacher-focused intervention on students' computer usage, attitudes, and anxiety. *Computers & Education*, 71: 165–174. http://dx.doi.org/10.1016/j.compedu.2013.10.002

Gilkes, A. L. (2020). *Teachers' knowledge and self-efficacy beliefs as factors affecting technology integration practices* (Doctoral dissertation, Walden University).

Gomes, S. F. (2021). *Sustainable Development in Higher Education in Business Sciences: A Multidimensional Analysis in the Portuguese Context* (Doctoral dissertation, Universidade de Coimbra (Portugal)).

González-Salamanca Juan Carlos, Olga Lucía Agudelo & Jesús Salinas, (2020). "Key Competences, Education for Sustainable Development and Strategies for the Development of 21st Century Skills. A Systematic Literature Review*," Sustainability, MDPI,* vol. 12(24), pages 1-17, December

Goodwin, A.L., Smith, L., Souto-Manning, M., Cheruvu, R., Tan, M.Y., Reed, R. & Taveras, L. (2014). What Should Teacher Educators Know and Be Able to Do? Perspectives from Practicing Teacher Educators. *Journal of Teacher Education*: 1–19. http://jte.sagepub.com/cgi/doi/10.1177/0022487114535266.

Granger EM, Bevis TH, Southerland SA, Saka Y, Ke F. (2018) Examining features of how professional development and enactment of educative curricula influences elementary science teacher learning. J Res Sci Teach. 2018; 1–23. https://doi.org/10.1002/tea.21480

Gregory, J. & Salmon, G. (2013). Professional development for online university teaching. *Distance Education*, 34(3): 256–270.

Häkkinen, et al. (2017) Preparing teacher-students for twenty-first-century learning practices (PREP 21): a framework for enhancing collaborative problem-solving and strategic learning skills DOI: 10.1080/13540602.2016.1203772

Häkkinen, Päivi, Teemu Valtonen, Nhi Hoang, Erkko Sointu, Piia Näykki, Anne Virtanen, Johanna Pöysä-Tarhonen, Sanna Järvelä, Kati Mäkitalo, Jari Kukkonen, (2021). How pre-service teachers perceive their 21st-century skills and dispositions: A longitudinal perspective*,Computers in Human Behavior,(* 116)106643, https://doi.org/10.1016/j.chb.2020.106643.

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. Sustainable operations and computers, 3, 275-285.

Hämäläinen, P. (2022). *Indigenous continent: The epic contest for North America*. Liveright Publishing.

Han, J., Park, D., Hua, M. *et al.* Is group work beneficial for producing creative designs in STEM design education? *Int J Technol Des Educ* **32**, 2801–2826 (2022). https://doi.org/10.1007/s10798-021-09709-y

Harder, N. (2018). The Value of Simulation in Health Care: The Obvious, the Tangential, and the Obscure. *Clinical Simulation in Nursing*, 15: 73–74. https://doi.org/10.1016/j.ecns.2017.12.004

Hardman, J. & Amory, A. (2015). Introduction to Cultural-Historical Activity Theory and tool mediation. In V. Bozalek, D. Ng'ambi, D. Wood, J. Herrington, J. Hardman, & A. Amory, eds. Activity Theory, Authentic Learning. Routledge: 9–21.

Harmon, C. (2018). Artificial intelligence and machine learning for all students: A meta-synthesis. Unpublished Master's Thesis, M.ed. Special Education, University of Alaska Southeast

Harnish, R. J., Bridges, K. R., Sattler, D. N., Signorella, M. L., & Munson, M.(Eds.). (2018). The Use of Technology in Teaching and Learning. Retrieved from the Society for the Teaching of Psychology. http://teachpsych.org/ebooks/

Hartman, H. & Lange, V.L. 2012. Instructional Scaffolding. Harvard Educational Review, 57(1), 1-22

Hennessy, S., D'Angelo, S., McIntyre, N., Koomar, S., Kreimeia, A., Cao, L., ... & Zubairi, A. (2022). Technology use for teacher professional development in low-and middle-income countries: A systematic review. Computers and Education Open, 3, 100080.

Henrie, C.R. (2016). Measuring Student Engagement in Technology- Mediated Learning Environments. Brigham Young University.

Hernández, R. M, Orrego, R., & Quiñones, S. (2018). New ways of learning: Teacher training versus the use of ICT. Purposes and Representations, 6(2), 671-685.

Hudson, R. & Porter, A. L. (2010). ICT use to improve mathematics education in secondary schools. Proceedings of the Australian Computers in Education: Digital Diversity Conference (pp. 1-10). Melbourne: Australian Council for Computers in Education.

Hussin, A. A. (2018). Education 4.0 made simple: Ideas for teaching. *International Journal of Education and Literacy Studies*, 6(3), 92.

Hur, J. W., Brush, T. & T. Cullen (2010) Teaching for Application: A Model for Assisting Pre-Service Teachers with Technology Integration. Journal of Technology and Teacher Education. 18(1)

Hur, J. W., Shen, Y. W., Kale, U., & Cullen, T. A. (2015). An exploration of pre-service teachers' intention to use mobile devices for teaching. *International Journal of Mobile and Blended Learning (IJMBL)*, *7*(3), 1-17.

Imhangbe, O. S., Oviawe, J. I., Aluede, O., Obinyan, G., & Oke, T. D. (2023). Challenges and Emerging Perspectives of Quality Assurance and Teacher Education in Nigerian Universities: A Literature Review. *Open Education Studies*, *5*(1), 20220203

Ismail, A. and Alkhazali, T. (2019) Assessing the Impact of an Instructional Design Course on Arabian Gulf University Distance Learning Students' Instructional Design Competencies. *Open Journal of Social Sciences*, **7**, 106-129. doi: 10.4236/jss.2019.79009.

Jaipal-Jamani, K. & Figg, C. (2015). A case study of a TPACK-based approach to teacher professional development: Teaching science with blogs. *Contemporary Issues in Technology and Teacher Education,* 15(2): 161–200.

Janse van Rensburg, J., Rauscher, W. (2022) Strategies for fostering critical thinking dispositions in the technology classroom. *Int J Technol Des Educ* **32**, 2151–2171 (2022). https://doi.org/10.1007/s10798-021-09690-6

Janssen, N., Knoef, M., & Lazonder, A. W. (2019). Technological and pedagogical support for pre-service teachers' lesson planning. *Technology, Pedagogy and Education*, *28*(1), 115–128. https://doi.org/10.1080/1475939X.2019.1569554

Johnson, L., Becker, A.S., Cummins, M., Estrada, V., Freeman, A. & Ludgate, H. (2013). NMC Horizon Report 2013 Higher Education Edition. Austin, Texas: The New Media Consortium.

Johnson, R. B., & Christensen, L. B. (2019). *Educational research: Quantitative, qualitative, and mixed approaches*. Sage publications.

Johnson, A. M., Jacovina, M. E., Russell, D. E., & Soto, C. M. (2016). Challenges and solutions when using technologies in the classroom. In S. A. Crossley & D. S. McNamara (Eds.) Adaptive educational technologies for literacy instruction (pp. 13-29). New York: Taylor & Francis. Published with acknowledgment of federal support.

Kadzera, C.M. (2006). Use of instructional technologies in teacher training colleges in Malawi. A doctoral Dissertation. http://scholar.lib.vt.edu/theses/available/etd-05152006-174707/.

Kalu-Uche, N., Alamina, J and Ovute, A. (2015) Pedagogical Practices in the Teaching of Science in Secondary Schools in Rivers State Nigeria. Journal of Research in Humanities and Social Science Volume 3 ~ Issue 2 (2015) pp: 50-55 ISSN (Online): 2321-9467 www.questjournals.org

Karlström, M., & Hamza, K. (2019). Pre-service science teachers' opportunities for learning through reflection when planning a microteaching unit. *Journal of Science Teacher Education*, *30*(1), 44-62.

Katitia, D.M.O. (2015). Teacher Education Preparation Program for the 21st Century. Which Way Forward for Kenya*? Journal of Education and Practice,* 6(24): 57–63.

Katzenmeyer, M., & Moller, G. (2009). Awakening the sleeping Giant: Helping teachers develop as leaders. Thousand Oaks: Corwin Press.

Keane, T., Keane, W.F. & Blicblau, A.S. (2013). The Use of Educational Technologies to Equip Students with 21 st Century Skills. X World Conference on Computers in Education July 2-5, (2010): 74–82.

Khan, M.S.H., Hasan, M. & Clement, C.K. (2012). Barriers to the Introduction of ICT into Education in Developing Countries: The Example of Bangladesh. *International Journal of Instruction,* 5(2): 61– 80. http://www.e-iji.net/dosyalar/iji_2012_2_4.pdf.

Kibirige & Maake (2021) Effect of Guided Discovery Instructional Strategy on Grade Nine Learners' Performance in Chemical Reactions in Mankweng Circuit, South Africa. *Journal of Technology and Science Education JOTSE*, 1(2): 569-580

Kimathi, F. & Rusznyak, L. 2018. Advancing professional teaching in South Africa: Lessons learnt from policy frameworks that have regulated teachers' work. *Education as Change*, 22(3): 1–25.

Kivunja, C. (2014). Innovative Pedagogies in Higher Education to Become Effective Teachers of 21st Century Skills: Unpacking the Learning and Innovations Skills Domain of the New Learning Paradigm. *International Journal of Higher Education*, 3(4): 37–48.www.sciedu.ca/ijhe

Kivunja, C., & Kuyini, A. B. (2017). Understanding and applying research paradigms in educational contexts. *International Journal of higher education*, *6*(5), 26-41.

Koehler, M.J., Mishra, P., Kereluik, K., Shin, T.S. & Graham, C.R. 2014. The Technological Pedagogical Content Knowledge Framework. In Handbook of Research on Educational Communications and Technology. New York: 101–111.

Koh, J.H.L. & Sing, C.C. 2011. Modeling pre-service teachers' technological pedagogical content knowledge (TPACK) perceptions: The influence of demographic factors and TPACK constructs In Ascilite 2011. 735–746.

König, J., Bremerich-Vos, A., Buchholtz, C., Fladung, I., & Glutsch, N. (2020). Pre–service teachers' generic and subject-specific lesson-planning skills: On learning adaptive teaching during initial teacher education. *European Journal of Teacher Education*, *43*(2), 131-150.

Kozma, R. (2005). ICT, education reform and economic growth. *Retrieved December*, *26*, 2006.

Kumar, R. (2019). Research Methodology: A Step-by-Step Guide for Beginners (Vol. 4). Sage Publications Limited.

Kumi-Yeboah, A., Sallar, A.W., Kiramba, L.K., & Kim, Y. (2020). Exploring the use of digital technologies from the perspective of diverse learners in online learning environments. Online Learning, 24(4), 42-63. https://doi.org/10.24059/olj.v24i4.2323

Kurt, G. 2014. TPACK in practice: A qualitative study on technology integrated lesson planning and implementation of Turkish pre-service teachers of English in *Foreign Language Education and Applied Linguistics ELT Research Journal,* 3(3): 153–166.

Lange, C., Gorbunova, A., Shcheglova, I., & Costley, J. (2023). Direct instruction, worked examples and problem solving: The impact of instructional strategies on cognitive load. *Innovations in Education and Teaching International*, *60*(4), 488-500. https://doi.org/10.1080/14703297.2022.2130395

Lange, C., Costley, J. & Han, S.L. (2016). Informal cooperative learning in small groups: The effect of scaffolding on participation. *Issues in Educational Research*, 26(2): 260–279.

Lawless, K.A. & Pellegrino, J.W. (2007). Professional development in integrating technology into teaching and learning: knowns, unknowns, and ways to pursue better questions and answers. *Review of Educational Research,* 77(4): 575–614.

Leggat, P. (2015). Modern Learning Environments, 21st Century Learning & Curriculum and Future Focused Learning. *Journal of Research on Technology in Education*, 48(3): 194–211.

Lewin, C., & McNicol, S. (2015). Supporting the development of 21st Century Skills through ICT. In Brinda, T., Reynolds, N., Romeike, R., & Schwill, A. (Eds.), KEYCIT 2014: *Key competencies in informatics and ICT* (pp. 181–198).

Lewis, C. (2016). How does lesson study improve mathematics instruction? *ZDM - Mathematics Education,* 48(4): 571–580.

Lim, W.M. (2023). The workforce revolution: reimagining work, workers, and workplaces for the future, Glob. Bus. Organ. Excell. https://doi.org/10.1002/ joe.22218.

Lim, C.P., Zhao, Y., Tondeur, J., Chai, C.S. & Tsai, C.-C. (2013). Bridging the Gap: Technology Trends and Use of Technology in Schools. *Educational Technology & Society*, 16(2): 59–68.

Lin, KY., Wu, YT, Hsu, YT. *et al.* (2021) Effects of infusing the engineering design process into STEM project-based learning to develop pre service technology teachers' engineering design thinking. *IJ STEM Ed* **8**, 1. https://doi.org/10.1186/s40594-020-00258-9

Lindqvist, H.M. (2015). Conditions for Technology Enhanced Learning and Educational Change [Elektronisk resurs]: A case study of a 1:1 initiative. Umeå University. http://umu.divaportal.org/smash/get/diva2:859735/FULLTEXT01.pdf%5Cnhttp://urn.kb.se/resolve?urn=urn:nbn:se:umu:diva-109887.

Liu, S.H. (2013). Exploring the instructional strategies of elementary school teachers when developing technological, pedagogical, and content knowledge via a collaborative professional development program. *International Education Studies*, 6(11): 58–68

Lombe, A. (2010). Using podcasts to mediate reflective learning: a case of a postgraduate programme at a higher education institution. University of Cape Town

Lynch, T. (2013). Writing up Qualitative Research: Methodology. English Language Teaching Center, 2461(2): 1–9. Lyon, L.J. 2015. Development of teaching expertise viewed through the Dreyfus model skill acquisition. *Journal of the Scholarship of Teaching and Learning*, 15(1): 88–105.

Lyon, L.J. (2015). Development of teaching expertise viewed through the Dreyfus model of skill acquisition. *Journal of the Scholarship of Teaching and Learning*, 15(1): 88–105.

Mackieson, P., Shlonsky, A., & Connolly, M. (2019). Increasing rigor and reducing bias in qualitative research: A document analysis of parliamentary debates using applied thematic analysis. *Qualitative Social Work*, *18*(6), 965-980. https://doi.org/10.1177/1473325018786996

Macmillan Culp, K., Honey, M., & Mandinach, E. (2005). A retrospective on twenty years of education technology policy. Journal of Educational Computing Research, 32(3), 279-307.

Mäkitalo, N., Pääkkö, J., Raatikainen, M., Myllärniemi, V., Aaltonen, T., Leppänen, T., Männistö, T. & Mikkonen, T. (2012). Social devices: collaborative co-located interactions in a mobile cloud. In Proceedings of the 11th International Conference on Mobile and Ubiquitous Multimedia. 10:1–10:10. http://doi.acm.org/10.1145/2406367.2406380.

Maniram, R. & Maistry, S. (2018). Enabling well-being and epistemological access through an authentic assessment intervention: A case study of a higher education programme. *South African Journal of Higher Education*. 32. 10.20853/32-6-2982

Martinez, C. (2022). Developing 21st century teaching skills: A case study of teaching and learning through project-based curriculum. *Cogent Education*, *9*(1). https://doi.org/10.1080/2331186X.2021.2024936

Mavengere, N., Pondiwa, S., Matiyenga, T. C., Manzira, F. and Mutanga, A., (2021). The 'New Normal' in Higher Education: Innovative teaching and learning technologies and practices during a crisis. *Advances in Computing and Engineering*, 1 (2), 37-46.

Mawson, B. (2003) Beyond `The Design Process': An Alternative Pedagogy for Technology Education International Journal of Technology and Design Education 13(2):117-128 DOI: 10.1023/A:1024186814591

McArthur, T., Lam-McArthur, J., and Fontaine, L. (2018). Digital Literacy. In The Oxford Companion to the English Language, edited by Tom McArthur, Jacqueline Lam-McArthur, and Lise Fontaine, 2nd ed.

McKnight, K., O'Malley, K., Ruzic, R., Horsley, M., Franey, J.J. & Bassett, K. (2016). Teaching in a digital age: How educators use technology to improve student 198

McMillan, J. H. & Schumacher, S. (2001). Research in Education: A Conceptual Introduction. New York: Longman: 5th

McNulty, N. (2016) Why teaching 21st Century Skills using educational technology is essential [Web log post]. Retrieved from https://www.niallmcnulty.com/2016/07/why-teaching21st-century-skills-using-educational-technology-is-essential

McNulty, N. (2017). How EdTech can equip learners with the right skills for the 4th industrial revolution [Web log post]. Retrieved from https://www.niallmcnulty.com/2017/08/howedtech-can-equip-learners-with-the-right-skills-for-the-4th-industrial-revolution/

McNulty, N. (2018). Are South African schools ready for the 4th industrial Revolution?[Weblogpost] https://www.niallmcnulty.com/2018/07/are-south-african-schoolsready-for-the-4th-industrial-revolution/

Merriam-Webster. (2019). In Merriam-Webster.com dictionary. Retrieved January 4, 2024, from https://www.merriam-webster.com/dictionary/semantics

Mestrinho, N., & Cavadas, B. (2018). Innovation in teacher education: An integrative approach to teaching and learning science and mathematics. In Proceedings (Vol. 2, No. 21, p. 1343). MDPI.

Metilda, R. M. and Neena, P.C. (2016) Gap analysis of employability skills of entry level business graduates based on job-fit theory, Int. J. Soc. Sci. Manag. 3 (2016) 294, https://doi.org/10.3126/ijssm.v3i4.15973.

Milton, M. (2013). Digital literacy and digital pedagogies for teaching literacy : Pre-service teachers' experience on teaching rounds. *Journal of Literacy and Technology*, 14(1): 72

Ministry of Education (MoE, 2018) Education for Change: Ministerial Strategic Plan (2018 – 2022) https://education.gov.ng/wp-content/uploads/2019/03/FINAL-UPDATED-MSP-WITH-COSTING.pdf

Ministry of Education (MoE) (1988). Report on National Policy on Computer Education. Lagos: NERDC Press.

Ministry of Education (MoE, 2004). Ministerial initiative on Education for Nigerian educational system. Abuja: NERDC Press.

Ministry of Education (MoE, 2014). National Policy on Education. (6th Edition). Lagos: Nigerian Educational Research and Development Council (NERDC).

Ministry of Education (FME, 2018) Education for Change: Ministerial Strategic Plan (2018 – 2022) https://education.gov.ng/wp-content/uploads/2019/03/FINAL-UPDATED-MSP-WITH-COSTING.pdf

Ministry of Education (FME) (1988). Report on National Policy on Computer Education. Lagos: NERDC Press.

Ministry of Education (FME) (2004). Ministerial initiative on Education for Nigerian educational system. Abuja: NERDC Press.

Ministry of Education (MoE) (2014). National Policy on Education. (6th Edition). Lagos: Nigerian Educational Research and Development Council (NERDC).

Ministry of Education (MoE). (2004). National Policy on Education (4th ed) Lagos: NERDC Press.

Ministry of Training, Colleges & Universities Requirements (2016) Community Literacy of Ontario, Canada.

Mitchell K. M., Clark A. M. (2018). Five steps to writing more engaging qualitative research. *International Journal of Qualitative Methods*, 17(1) 13 https://doi.org/10.1177/1609406918757613

Moemeke, C. D. (2019). 21st Century Learning Technologies use in Nigerian Classrooms: Issues, Prospects and Challenges. *Approaches in International Journal of Research Development* 5 (1) 135 – 143.

Mooij, T. & Smeets, E. 2001. Modelling and supporting ICT implementation in secondary schools. *Computers and Education*, 36(3): 265–281

Mopara, R. & Sanrattana, W. (2023). Developing Teachers to Develop Students' 21st Century Skills. *World Journal of Education* 13(3) 94-104

Morse J. M. (2018). Reframing rigor in qualitative inquiry. In Denzin Norman K., Lincoln Yvonna S. (Eds.), *The Sage handbook of qualitative inquiry* (5th ed., pp. 796–817). Thousand Oaks, CA: Sage.

Mouton, J. (2001) How to Succeed in Your Master's and Doctoral Studies: A South African Guide and Resource Book. Van Schaik, Pretoria.

Mtshali, T. I., & Singh-Pillay, A. (2023). The Enhancement of Pedagogical Capital by Civil Technology Teachers When Engaged with Practical Assessment Task: A Curriculum Transformation Legacy. *Journal of Curriculum Studies Research*, 5(2), 1- 22

Mufidah, N. (2019). The Development of Pre-Service Teachers' Teaching Performance in the Teaching Practice Program at English Department of State Islamic University of Antasari Banjarmasin. Dinamika Ilmu, 19(1), 97-114.

Mukhari, S.S. (2016). Teachers' Experience of Information and Communication Technology use for Teaching and Learning in Urban Schools: 315

Mumtaz, S. (2000). Factors affecting teachers' use of information and communications technology: a review of the literature. *Journal of information technology for teacher education*, *9*(3), 319-342.

Musungwini, S., Zhou, G.T. & Ruvinga, C. (2014). Harnessing Social Media for Business Success. Case Study of Zimbabwe. *International Journal of Computer Science and Business Informatics* IJCSBI.ORG, 11(1): 80–89. http://www.ijcsbi.org/index.php/ijcsbi/article/download/326/96.

National Bureau of Statistics. (2020). Demographic Statistics Bulletin. Abuja. Retrieved on February 8 2024 from DEMOGRAPHIC BULLETIN 2020.pdf (nigerianstat.gov.ng)

National Education Association. (2008). Technology in Schools: The Ongoing Challenge of Access, Adequacy and Equity. Washington, DC: NEA Policy and Practice Department. Retrieved from http://www.nea.org/assets/docs/PB19_Technology08.pdf.

National Education Association – American Federation of Teachers (NEA – AFT). (2008). Access, adequacy, and equity in education technology: Results of a survey of America's teachers and support professionals on technology in public schools and classrooms. Washington, DC: NEA. Retrieved from http://www.edutopia.org/pdfs/NEAAccess,Adequacy,andEquityinEdTech.pdf.

National Institute of Education (2009) TE21: A Teacher Education Model for the 21st Century. A Report by the National Institute of Education, Singapore.

National Policy on Education 6th Edition (2013). Nigerian Educational Research Development Council (NERDC) NERDC Publisher. Lagos. Nigeria

National Policy on Education. 6th Edition. (2014). Nigerian Educational Research and Development Council (NERDC).

National Policy on Education (2004). (4th ed) Lagos: Nigerian Educational Research and Development Council (NERDC) Press.

Ndihokubwayo, K. (2017). Investigating the status and barriers of science laboratory activities in Rwandan teacher training colleges towards improvisation practice. Rwandan Journal of Education, 4(1), 47-54.

Neal, G., & Eckersley, B. (2014). Immersing pre-service teachers in site-based teacher school-university partnerships. In *Successful Teacher Education* (pp. 31-48). Brill.

Neo, M., Neo, T.-K. & Tan, X.-L.G. (2007). A constructivist approach to learning an interactive multimedia course: Malaysian students' perspectives. *Australasian Journal of Educational Technology*, 23(4): 470–89.

Ng'ambi, D. (2013). Effective and ineffective uses of emerging technologies: Towards a transformative pedagogical model. *British Journal of Educational Technology*, 44(4): 652–661.

Nilsson, P. and Lund, J. (2022) Design for learning – involving teachers in digital didactic design (D 3) Interactive Technology and Smart Education 20(4) DOI: 10.1108/ITSE-08-2021-0143

Njie, B. & Asimiran, S. (2014) Case Study as a Choice in Qualitative Methodology IOSR Journal of Research & Method in Education (IOSRJRME) 4(3):35-40 DOI: 10.9790/7388-04313540

Norrena, J., Kankaaranta, M. & Nieminen, M. (2011). Kohti innovatiivisia opetuskaytanteita. In Valli, P., Perkkila, P., & Valli, R. (2014). Adult Pre-service Teachers applying 21st Century Skills in the Practice. Athens Journal of Education, 1(2), 115-130. https//doi.org/10.30958/aje.1-2-2

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. International journal of qualitative methods, 16(1), 1609406917733847.

Nwoko, J. C., Emeto, T. I., Malau-Aduli, A. E., & Malau-Aduli, B. S. (2023). A systematic review of the factors that influence teachers' occupational wellbeing. International journal of environmental research and public health, 20(12), 6070.

Obilor, E. I. (2023). Convenience and purposive sampling techniques: Are they the same. *International Journal of Innovative Social & Science Education Research*, *11*(1), 1-7.

OECD (2010a) Innovation Strategy A Head Start on Tomorrow, OECD Publishing.

OECD. 2017. The OECD Handbook for Innovative Learning Environments. Paris: OECD Publishing. http://www.oecd-ilibrary.org/education/the-oecd-handbook-forinnovative-learning-environments_9789264277274-en.

Ofodu, G. O. (2012) Instructional Strategies and Resource Utility in Language Teaching among Basic Educators in Twenty First Century Nigeria. Canadian Center of Science and Education journal. 5(5).

Ohemeng-Appiah, F. (2014). *Teaching the design process in the grade 9 technology class*. (Unpublished Master's dissertation), University of KwaZulu-Natal, KwaZulu-Natal, South Africa.

Oigara, J.N. & Wallace, N. 2012. Modeling, Training, and Mentoring Teacher Candidates to Use SMART Board Technology. *Issues in Informing Science and Information Technology*, 9: 297–315.

Okesina, M. (2020) A Critical Review of the Relationship between Paradigm, Methodology, Design and Method in Research. e-ISSN: 2320–1959.p- ISSN: 2320–1940 Volume 10, Issue 3 Ser. I. PP 57-68. www.iosrjournals.org DOI: 10.9790/7388-1003015768 www.iosrjournals.org

Okwudishu, C.H. (2005). Awareness and use of information and communication technology (ICT) among village secondary school teachers in Aniocha South Local Government Area of Delta State. Abraka: Delta State University. Unpublished B.Sc. (LIS) project.

Okolie, U., Elom, E. & Inyiagu, E. (2014). Factors affecting students' performance on basic technology junior secondary school certificate examination. *Journal of Educational Policy and Entrepreneurial Research*, *1*(1), 22-31.

Omotayo, S. A., & Adeleke, J. O. (2017). The 5E Instructional Model: A Constructivist Approach for Enhancing Students' Learning Outcomes in Mathematics. *Journal of the international society for teacher education*, *21*(2), 15-26.

Osuntuyi, E. (2020). Effective workshop organisation and management in vocational and technical education. *IJRAR-International Journal of Research and Analytical Reviews*, *7*(1), 144-148.

Ottenbreit-Leftwich, A. T., et al (2012). Preparation versus practice: How do teacher education programs and practicing teachers align in their use of technology to support teaching and learning? *Computers & Education*, *59*(2), 399-411.

Owo, O. & Ajie, P. (2020). Rejuvenating Technical Vocational Education and Training Programmes in Polytechnics amid the Covid-19 Pandemic for Poverty Reduction and Economic Recovery in Nigeria.

Özdoğru, A. A. (2022). Revisiting Effective Instructional Strategies for Twenty-First-Century Learners. In Educational Theory in the 21st Century: Science, Technology, Society and Education (pp. 175-195).

Palak, D. & Walls, R.T. (2009). Teachers' Beliefs and Technology Practices. Journal of Research on Technology in Education, 41(4): 417–441

Pandita, A., & Kiran, R. (2023). Tapping the Potential of Academic Leadership, Experiential Learning, and Employability of Students to Enhance Higher Educational Institute performance. SAGE Open, 13.

Panich, W. (2012). Ways of creating learning for students in the 21st century. Sodsri-Saritwong Foundation.

Partnership for 21st Century Skills [P21]. (2009). *P21 framework definitions*. Retrieved May 11, 2015 from http://p21.org/storage/documents/P21_Framework_Definitions.pdf

Partnership for 21st Century Learning. (2015). P21 Partnership for 21st Century Learning. Partnership for 21st Century Learning: 9.

Partnership for 21st Century Skills (2008). 21st Century Skills, Education and Competitiveness: A Resource and Policy Guide. http://www.21stcenturyskills.org

Paulus, P. B., Baruah, J., & Kenworthy, J. (2023). Brainstorming: How to get the best ideas out of the "group brain" for organizational creativity. In *Handbook of Organizational Creativity* (pp. 373-389). Academic Press.

Paulus, P. B., Coursey, L. E., & Kenworthy, J. B. (2021). Managing the key processes for team innovation. In *Creative Success in Teams* (pp. 1-17). Academic Press.

Pearlman, B. (2008). Designing New Learning Environments to Support 21st Century Skills. 21st Century Skills. Rethinking how students learn: 116–147. http://www.designshare.com/images/chap6_designing_new_learning_environments.pdf.

Phillips, H & Condy, J. (2020). How are we really teaching our students? A paradox in pedagogy. South African Journal of Higher Education. 34. 10.20853/34-2-3719.

Pozas, M., & Letzel, V. (2023). "Do you think you have what it takes?" Exploring predictors of pre-service teachers' prospective ICT use. Technology, Knowledge and Learning, 28, 823–841. https://link.springer.com/article/10.1007/s10758-021-09551-0

Poole, B.J. (2008). Ten Pillars of Successful Technology Implementation. Education World. Retrieved from http://www.education-world.com/a_tech/tech/tech188.shtml.

Prasojo, L.D., Mukminin, A., Habibi, A., Marzulina, L. Sirozi, M. and Harto, K. (2018) Learning to teach in a digital age: ICT integration and EFL student teachers' teaching practices. Teaching English with Technology, 18(3), 18-32, http://www.tewtjournal.org. 18

Puentedura, R.R. 2009. Learning, Technology, and the SAMR Model: Goals, Processes, and Practice.

Qazi, A., Hasan, N., Abayomi-Alli, O., Hardaker, G., Scherer, R., Sarker, Y., & Maitama, J. Z. (2022). Gender differences in information and communication technology use & skills: a systematic review and meta-analysis. Education and Information Technologies, 1-34.

Raiyn, J. (2016) The Role of Visual Learning in Improving Students' High-Order Thinking Skills. Journal of Education and Practice. ISSN 2222-1735 (Paper) ISSN 2222-288X (Online) Vol.7, No.24, 2016

Ramadhan N, and Surya E (2017).The implementation of demonstration method to increase students' ability in operating multiple numbers by using concrete object. Int. J. Sci. Basic and Appl. Res. 34(2): 62-68.

Raman, A., & Thannimalai, R. (2019). Importance of Technology Leadership for Technology Integration: Gender and Professional Development Perspective. Sage Open, 9(4). https://doi.org/10.1177/2158244019893707

Rana, N. (2012). A study to access teacher educators' attitudes toward technology integration in classrooms. *MIER Journal of Educational Studies, Trends & Practices,* 2(2): 190–205.v

Rajesh, S. & Michael, J. (2015). Effectiveness of Social Media in Education. *International Journal of Innovative Research in Advanced Engineering*, 10(2): 2349–2163. http://ijirae.com/volumes/Vol2/iss10/06.OCAE10094.pdf

Richardson, W. (2013) Students First, Not Stuff. Vol. 70, No. 6 https://ascd.org/el/articles/students-first-not-stuff.

Richardson, V. (2003). Constructivist Pedagogy. Teachers College Record, 105(9): 1623–1640. http://doi.wiley.com/10.1046/j.1467-9620.2003.00303.x

Robb, L. (2016). Student-led discussions develop 21 st century learning skills. Retrieved from https://bit.ly/3Xw8AHw.

Richardson, W. (2013) **Students First, Not Stuff** Vol. 70, No. 6

Robinson, J. D, and Persky, A. M. (2020) Developing Self-Directed Learners. Am J Pharm Educ. 2020 Mar; 84(3):847512. Doi: 10.5688/ajpe847512. PMID: 32313284; PMCID: PMC7159015.

Robinson, O. (2023). Probing in qualitative research interviews: Theory and practice. Qualitative Research in Psychology 20(3):1-16 DOI: 10.1080/14780887.2023.2238625

Robinson, S.R. & Kay, K. (2010). 21st Century Knowledge and skills in Educator Preparation. http://www.p21.org/storage/documents/aacte_p21_whitepaper2010.pdf

Robinson, T.E. & Hope, W.C. (2013). Teaching in higher education: is there a need for training in pedagogy in graduate degree programs? *Research in Higher Education Journal,* 21: 1–11

Roblyer, M.D. & Doering, A.H. (2014). Integrating Educational Technology into Teaching. Sixth. Essex: Pearson Education. www.pearsoned.co.za

Romano, A. (2017) Using Technology In the Classroom. National Education Association Today. National Education Association, Washington, DC 20036-3290. https://www.nea.org/professional-excellence/student-engagement/tools-tips/using-technology-classroom.

Romrell, D., Kidder, L.C. & Wood, E. (2014). The SAMR model as a framework for evaluating Learning. *Journal of Asynchronous Learning Network*, 18(2): 1–15.

Rosenthal, M. (2016). Qualitative Research Methods: Why, When, and How to Conduct Interviews and Focus Groups in Pharmacy Research. Currents in Pharmacy Teaching and Learning, 8, 509-516. https://doi.org/10.1016/j.cptl.2016.03.021

Roslaniec, A. (2018, May 11). 7 Essential 21st-century skills for secondary learners. Retrieved from https://bit.ly/3K3ahZT

Roulston, K. (2010). Considering quality in qualitative interviewing. *Qualitative Research, 10*(2), 199–228. https://doi.org/10.1177/1468794109356739

Rowell, P.M. Developing Technological Stance: Children's Learning in Technology Education. *International Journal of Technology and Design Education* **14**, 45–59 (2004). https://doi.org/10.1023/B:ITDE.0000007362.21793.88

Ruiz-Rojas, L.I.; Salvador-Ullauri, L.; Acosta-Vargas, P. (2024) Collaborative Working and Critical Thinking: Adoption of Generative Artificial Intelligence Tools in Higher Education. Sustainability 2024, 16, 5367. https://doi.org/10.3390/ su16135367

Rustique, E., & Stam, B. (2013). The linked learning advantage: Using linked learning to implement the common core state standards. Stanford Center for Opportunity Policy in Education-Knowledge brief. http://edpolicy.stanford.edu/publications/pubs/661.

Saad, B., Abderrahman, H., & Neggaz, F. Z. (2019). *The Use of Educational Technology in EFL Teaching and Learning* (Doctoral dissertation, Université Ibn Khaldoun-Tiaret-).

Saad, R., Othman, K., Khir, M. R. M., & Hassan, N. D. (2017). Determining the Influencing Factors of E-Learning at Higher Educational Institutions in Malaysia. *ICOPS2017 eProceedings*, 88.

Sahin-Taskin, C. (2017) Exploring Pre-service Teachers' Perceptions of Lesson Planning in Primary Education, Journal of Education and Practice ISSN 2222-1735 (Paper) ISSN 2222-288X (Online) Vol.8, No.12, 2017. Faculty of Education, Canakkale Onsekiz Mart University, 17000, Canakkale, Turkey.

Sánchez Solarte, A. C. (2019). Classroom Management and Novice Language Teachers: Friend or Foe? *HOW*, *26*(1), 177–199. https://doi.org/10.19183/how.26.1.463

Santos, J. M., & Castro, R. D. (2021). Technological Pedagogical content knowledge (TPACK) in action: Application of learning in the classroom by pre-service teachers (PST). *Social Sciences & Humanities Open*, *3*(1), 100110.

Schlebusch, G, Bhebhe, S and Schlebusch, L. (2024) "Technology Integration in Teacher Education Practices in Two Southern African Universities" *Open Education Studies*, vol. 6, no. 1, 2024, pp. 20220223. https://doi.org/10.1515/edu-2022-0223

Schleicher, A. (ed.) (2012). "Preparing teachers to deliver 21st-century skills", in Preparing Teachers and Developing School Leaders for the 21st Century: Lessons from around the World, OECD Publishing. Paris.

Schleicher, A. (2014). 21st Century Education for Student Success and Economic Development. Transforming Education for the Next Generation a Practical Guide to Learning and Teaching with Technology: 1–10.

Schooner, P., Nordlöf, C., Klasander, C., & Hallström, J. (2017). Design, System, Value: The Role of Problem-Solving and Critical Thinking Capabilities in Technology Education, as Perceived by Teachers. Design and Technology Education, 22(3), n3.

Seechaliao T. (2017). Instructional Strategies to Support Creativity and Innovation in Education. *Journal of Education and Learning; Canadian Center of Science and Education*. 6(4)201

Serdyukov, P. (2017). Innovation in Education: What Works, What Doesn't, and What to Do about It? Journal of Research in Innovative Teaching & Learning, 10, 4-33. https://doi.org/10.1108/JRIT-10-2016-0007

Shabani, K., Khatib, M., & Ebadi, S. (2010). Vygotsky's zone of proximal development: Instructional implications and teachers' professional development. *English language teaching*, *3*(4), 237-248.

Shah, R. (2019) Effective Constructivist Teaching Learning in the Classroom. Shanlax International Journal of Education, vol. 7, no. 4, 2019, pp. 1–13.

Shaikh, Z. A., & Khoja, S. A. (2012). Role of Teacher in Personal Learning Environments. Digital Education Review, 21, 23-32.

Shaikh, Z. A., & Khoja, S. A. (2014). Personal learning environments and university teacher roles explored using Delphi. *Australasian Journal of Educational Technology*, *30*(2).

Sharma, G. (2017). Pros and Cons of Different Sampling Techniques. International Journal of Applied Research, 3, 749-752.

Shin, M. H. (2018). Effects of Project-Based Learning on Students' Motivation and Self-Efficacy. English teaching, 73(1), 95-114.

Shulman, L.S. (1987). Knowledge and teaching: foundations of the new reform.pdf. *Harvard Educational Review*, 57: 1–21.

Simmons, C. (2010). Teacher skills for the 21st century eHow. http://www.ehow.com/list_6593189_teacher-skills-21st-century.html

Singh-Pillay, A. Exploring Science and Technology Teachers' Experiences with Integrating Simulation-Based Learning. Educ. Sci. 2024, 14, 803. https://doi.org/ 10.3390/educsci14080803

Singh-Pillay A. (2023) Pre-Service Teachers' Experience of Learning about Sustainability in Technology Education in South Africa. *Sustainability.* 15(3):2149. https://doi.org/10.3390/su15032149

Singh-Pillay, A. & Ohemeng-Appiah, F. (2016) Interconnectedness of technology teachers' perceptions of the design process to learner creativity, *Perspectives in Education,* 34(2), 70–82.

Singh-Pillay, A., & Samuel, M. A. (2017). Life sciences teachers negotiating professional development agency in changing curriculum times. *Eurasia Journal of Mathematics, Science and Technology Education*, 13(6), 1749-1763.

Smith, B. (2018). Generalizability in qualitative research: misunderstandings, opportunities and recommendations for the sport and exercise sciences. *Qualitative Research in Sport, Exercise and Health*, *10*(1), 137–149. https://doi.org/10.1080/2159676X.2017.1393221

Sotsaka Douglas & Asheena Singh-Pillay (2020). Meeting the challenges first-year engineering graphic design pre-service teachers' encounter when they read and interpret assembly drawings. *Journal of Education,* (80)73-84 http://journals.ukzn.ac.za/index.php/joe

Stauffer, B. (2020). What Are 21st Century Skills? March 19, 2020, 1–17. www.aeseducation.com

Steyn, G.M. (2017). Transformative learning through teacher collaboration : a case study. Koers- Bulletin for Christian Scholarship, 82(1): 1–15 Steyn, G.M. 2017. Transformative learning through teacher collaboration : a case study. *Koers- Bulletin for Christian Scholarship*, 82(1): 1–15.

Stigler, J.W. & Hiebert, J. (2016). Lesson study, improvement, and the importing of cultural routines. ZDM - Mathematics Education, 48(4): 581–587.

Stokes-Beverley, C., & Simoy, I. (2016). Advancing Educational Technology in Teacher Preparation: Policy Brief. *Office of Educational Technology, US Department of Education*.

Straus SE, Johnson MO, Marquez C, Feldman MD. Characteristics of successful and failed mentoring relationships: a qualitative study across two academic health centers. Acad Med. 2013 Jan; 88(1):82-9. doi: 10.1097/ACM.0b013e31827647a0. PMID: 23165266; PMCID: PMC3665769.

Sultan, U.N., Axell, C. and Hallström, J. (2018) Girls' Engagement in Technology Education: A Systematic Review of the Literature. The 36th Pupils' Attitudes towards Technology Conference. Ireland

Summak, M. (2011). Assessment of technology integration in vocational education and training schools. *International Journal of Education and Development using ICT*, *7*(1), 68-85.

Taber, K. S. (2018). Masterclass in science education: Transforming teaching and learning. Bloomsbury Publishing.

Thaanyane, M., & Jita, T. (2024). Pre-Service Teachers' Professional Competence in Integrating ICT in Business Education in Lesotho: A Systematic Literature Review. *International Journal of Learning, Teaching and Educational Research*, *23*(4), 462- 475.

Thomas, J. (2000). A review of research on project-based learning. Bob Pearlman. http://www.bobpearlman.org/BestPractices/PBL_Research.pdf

Tiantong, M. & Teemuangsai, S. (2013). The four scaffolding modules for collaborative problem-based learning through the computer network on moodle lms for the computer programming course. *International Education Studies*, 6(5): 47–55.

Tiba, C.A. (2018). The Ability of Newly Qualified Teachers to Integrate Technology into their Pedagogical Practice. Cape Peninsula University of Technology.

Timotheou, S., Miliou, O., Dimitriadis, Y., Sobrino, S. V., Giannoutsou, N., Cachia, R., & Ioannou, A. (2023). Impacts of digital technologies on education and factors influencing schools' digital capacity and transformation: A literature review. Education and information technologies, 28(6), 6695-6726.

Tondeur, J., Pareja Roblin, N., van Braak, J., Voogt, J. & Prestridge, S. (2017). Preparing beginning teachers for technology integration in education: ready for take-off? *Technology, Pedagogy and Education,* 26(2): 157–177. http://dx.doi.org/10.1080/1475939X.2016.1193556.

Tondeur, J., Scherer, R., Baran, E., Siddiq, F., Valtonen, T. & Sointu, E. (2019). Teacher educators as gatekeepers: Preparing the next generation of teachers for technology integration in education. *British Journal of Educational Technology*, 50(3): 1189–1209.

Tondeur, J., Van Braak, J., Sang, G., Voogt, J., Fisser, P. & Ottenbreit-Leftwich, A. (2012). Preparing pre- service teachers to integrate technology in education: A synthesis of qualitative evidence. In *Computers and Education*. 134–144.

Toro, W. X. (2019). 21st century learning skills in education and employability. St. John's University (New York). ProQuest Dissertations & Theses, 2019. 27666017.

Trilling, B., & Fadel, C. (2009). 21st Century Skills: Learning for Life in Our Times. San Francisco, CA: John Wiley & Sons.

Tunjera, N., Mukabeta, T., Ramirez, I. & Zinyeka, G. (2014). Using a Mobile Application to Increase Interaction amongst Students in an Open and Distance Learning Programme in Zimbabwe : A Cultural Historical Activity Learning. Educational Technology Research & Development. *Journal of Education and Human Development.* 3(1): 573–592.

Uerz, D., Volman, M. & Kral, M. (2018). Teacher educators' competences in fostering student teachers' proficiency in teaching and learning with technology: An overview of relevant research literature. *Teaching and Teacher Education*, 70(2): 12–23. https://doi.org/10.1016/j.tate.2017.11.005.

Umeh-Idika, A. & Okpala, J. (2022) Strategies for improving maintenance of laboratories equipment for effective service delivery in universities in Abia State. *Nigeria Journal of Home Economics (ISSN: 2782-8131)*, *10*(7), 324-332. https://doi.org/10.61868/njhe.v10i7.168

Umugiraneza, O., Bansilal, S., & North, D. (2018). Exploring teachers' use of technology in teaching and learning mathematics in KwaZulu-Natal schools. *Pythagoras,* 39(1), 1-13.

UNESCO (2015). 21st-century goals and objectives: 21st -century learning. https://sites.google.com/.../21stcentury-goals-objectives.Retrieved 04/04/2018

UNESCO (2010). Educating for a Sustainable Future a Transdisciplinary Vision for Concerted Action. UNESCO Teaching and Learning for a Sustainable Future. www.unesco.org/education/tlsf/mods/theme_a/.../mod01t05s01.htm 24 April 2014.

United Nations (2020) The Impact of Digital Technologies. United Nations Publications.

United Nations Educational, Scientific and Cultural Organization, UNESCO. (2018). ICT Competency Framework for Teachers. Paris: UNESCO. ISBN 978-92-3-100285-4

Upadhye, Vaishali and Madhe, Swati, (2022) Demo-Based Learning: An Effective Teaching-Learning Pedagogy in STEM Education (January 31, 2022). Proceedings of the International Conference on Best Innovative Teaching Strategies (ICON-BITS 2021), Available at SSRN: https://ssrn.com/abstract=4022481 or http://dx.doi.org/10.2139/ssrn.4022481

Uzorka, A., Namara, S. & Olaniyan, A.O. (2023) Modern technology adoption and professional development of lecturers. *Educ Inf Technol* 28, 14693–14719 (2023). https://doi.org/10.1007/s10639-023-11790-w

Valli Jayanthi, S. & Balakrishnan, Santhi & Lim, Angela & Latiff, Noor & Nasirudeen, A. M A. (2014). Factors Contributing to Academic Performance of Students in a Tertiary Institution in Singapore. *American Journal of Educational Research*. 2. 752-758. 10.12691/education-2-9-8.

Van der Merwe, D. (2022) 'Preparing pre-service teachers to guide and support learning in South African schools', *South African Journal of Childhood Education* 12(1), a1163. **https://doi.org/10.4102/sajce.v12i1.1163**

Von Glasersfeld E. (1995). A constructivist approach to teaching. In: Steffe L. P. & Gale J. (eds.) Constructivism in education. Erlbaum, Hillsdale: 3–15. http://www.vonglasersfeld.com/172

Voogt, J., Fisser, P., ParejaRoblin, N., Tondeur, J. & van Braak, J. (2013), Technological pedagogical content knowledge – a review of the literature. *Journal of Computer Assisted Learning*, 29: 109 -121.

Vygotsky, L. (1978). Interaction between Learning and Development. In M. Gauvain & M. Cole, eds. Mind and Society. Cambridge: Harvard University Press: 79–91.

Wang, MT., Degol, J.L. (2017) Gender Gap in Science, Technology, Engineering, and Mathematics (STEM): Current Knowledge, Implications for Practice, Policy, and Future Directions. *Educ Psychol Rev* **29**, 119–140. https://doi.org/10.1007/s10648-015-9355-x

Wang, Y. (2023) Exploring Chinese EFL pre-service teachers' perceptions of self-directed professional development: The benefits and challenges disclosed. Porta Linguarum Issue 2023c, DOI: https://doi.org/10.30827/portalin.vi2023c.29623 ISSN paper edition: 1697-7467, ISSN digital edition: 2695-8244

Warren, E., Trigueros, M., & Sonia, U. (2016). Research on the learning and teaching of algebra. In Á. Gutiérrez, G. C. Leder, & P. Boero, Eds. *The Second Handbook of Research on the Psychology of Mathematics Education: The Journey Continues*. (pp. 73–108). SENSE PUBLISHERS: https://doi.org/10.1007/978-94-6300-561-6_3.

Westbrook, J., Durrani, N., Brown, R., Orr, D., Pryor, J., Boddy, J. & Salvi, F. (2013). Pedagogy, curriculum, teaching practices and teacher education in developing countries. Education rigorous literature review. Sussex. http://r4d.dfid.gov.uk/Output/195891/Default.aspx.

World Economic Forum (2018) The Future of Jobs Report, https://doi.org/10.1177/1946756712473437. Geneva.

Wylie, J. (2016) mobile Learning Technologies for 21st Century Classroom. https//www.scholastic.com. Retrieved 22/5/19

Yaman, İ. (2014). EFL Students' Attitudes towards the Development of Speaking Skills via Project-Based Learning: an Omnipresent Learning Perspective. GAZİ UNIVERSITY.

Yang, R. (2008). Transnational higher education in China: Contexts, characteristics and concerns. *Australian Journal of Education*, 52(3), 272-286.

Yildirim, S. (2007). Current utilization of ICT in Turkish basic education schools: A review of teacher's ICT use and barriers to integration. *International journal of instructional media, 34(2), 171.*

Yin, R. (2013). How to Start Your Analysis, Your Analytic Choices, and How They Work. Case Study Research: *Design and Methods*: 127–164

Yin, R. K. (2017). Case Study Research and Applications: Design and Methods. Washington DC: Sage Publications.

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

APPENDIX 1: Ethical Clearance from University of KwaZulu-Natal

10 January 2023

Fatai Oladotun Dahunsi (220112291)
School of Education
Edgewood Campus

Dear FO Dahunsi,

Protocol reference number: HSSREC/00005076/2022

Original title: Exploring Technology lecturers' instructional strategies to prepare Basic technology pre-service teachers for twenty-first century teaching
Revised title: Exploring Technology lecturers' instructional strategies to prepare basic technology pre-serviceteachers for twenty-first century teaching
Degree: PhD

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 08 November 2022 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries,please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid until 10 January 2024.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out reportto be submitted when study is finished.

HSSREC is registered with the South African National Research Ethics Council (REC-040414-040).Yours sincerely,

Appendix 2: Approval to conduct from AB University

LAGOS STATE UNIVERSITY OF EDUCATION, OTO/UANIKIN

with a campus @ Noforija, Epe

PROF. LAFIAJI-OKUNEVE, BIDEMI BILKIS(Ph.D.)
Ag. Via! Qancrll«

O PEOLUWA AKINFEf'v1.IWA: ***Ag. !f gbtrar***

REF:LASUED/REG/037/VOL.I/01 17th October, 2022

•.

DAHUNSl ,Fatai Oladotun
, Department of Technology Education,
School of Education,
College of Humanities,
University of Kwa Zulu, Natal,
Edgewood Campus,
South Africa.

RE- ?i:RM!SSION TO CONDUCT RESEARCH

Please r fer to your letter dated 11th October 2022 on the above subject matter.

I write to convey the approv r of the Acting Vice Chancellor of your request to carry out research in the Lagos State University of Education for your PhD programme.

You are therefore to liaise with the Dean, College of Information and Technology Education for further information.

Than·k·you for theinter'est shown in our University.

Best wishes

[redacted]

Ipe tuwa AkinfernivJa
Acting Registrar

Appendix 3: Informed consent

Dept. of Technology Education,

School of Education,
College of Humanities,
University of KwaZulu-Natal,

Edgewood Campus.

The Vice-Chancellor,
Lagos State University of Education,
Lagos, Nigeria.

Madam,

Permission to conduct research

My name is Dahunsi, Fatai Oladotun. I am a PhD, Technology Education candidate studying at the University of KwaZulu-Natal, Edgewood campus, South Africa. I am interested in learning more about the Technology Lecturers' Instructional Strategies in preparing Basic Technology pre-service teachers for 21st-century teaching. To gather the information, I need your consent to conduct this study at your institution. I will also need access to Basic Technology lecturers, in the Department of Electrical/Electronic Technology, College of Information and Technology Education.

To gather data I will need to observe Basic Technology lectures for a duration of a week and thereafter conduct an interview with the lecturers. The duration of the interview is 30 minutes. The interviews will be scheduled during non-lecturing times. The findings of the research will not be used for any purpose other than the doctoral dissertation. The data will be stored by my supervisor and disposed of at the end of the research. Pseudonyms will be used to protect the identity of your university and the identity of the Basic Technology lecturers in this study. All information disclosed will be kept in confidence. Participation in this research is voluntary and should you find that you wish to withdraw or terminate your permission for the research, you may do so without any negative consequences. Informed consent will also be sought from the Basic Technology lecturers.

- If you are willing to grant me access to your school please indicate (by ticking as applicable)

	Granted	Not granted
Access		

I can be contacted at: Tel. Number: +27 63 989 6605 or +234 802 323 4250

E-mail:dotdahunsi@gmail.com

My supervisor is: Prof. A. Singh-Pillay. She is located at the School of Education, Science and Technology cluster, Edgewood campus, University of KwaZulu-Natal. South Africa.
Contact details: email: pillaya5@ukzn.ac.za Phone number: 031-26053672

Thank you for your contribution to this research.

_____ _____

Signature Date

APPENDIX 4: Informed Consent Letter: Participants

School of Education, College of Humanities,

University of KwaZulu-Natal,

Edgewood Campus,

Dear Participant

INFORMED CONSENT LETTER

My name is Dahunsi, Fatai Oladotun. I am a PhD candidate studying at the University of KwaZulu-Natal, Edgewood campus, South Africa. I am interested in exploring Technology Lecturers instructional strategies used in preparing Basic Technology pre-service teachers for 21st century teaching at Lagos State University of Education, Lagos. Nigeria.

To gather the information, I will need to observe Basic Technology lectures for a duration of a week and thereafter conduct an interview with the lecturers. The duration of the interview is 30 minutes. The interviews will be scheduled during non-lecturing times. The findings of the research will not be used for any purpose other than the doctoral dissertation. Basic Technology lecturers will also be involved in collage making and concept mapping which will last about 30 minutes. These two activities will also be conducted afters lecturing hours. The findings of the research will not be used for any purpose other than the doctoral dissertation. Pseudonyms will be used to protect the identity of your university, as well as the identity of the Basic Technology lecturers in this study. All information disclosed will be kept in confidence. Participation in this research is voluntary and should you find that you wish to withdraw or terminate your permission for the research, you may do so without any negative consequences.

In addition, I also require permission to audio record the meetings.

Please note that:

. Your confidentiality is guaranteed as your inputs will not be attributed to you in person, but reported only as a population member opinion.

- Lecture will be observed for one week
- The interview may last for about 30 minutes.
- Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only.
- Data will be stored in secure storage and destroyed after 5 years.
- You have a choice to participate, not participate or stop participating in the research. You will not be penalized for taking such an action.
- You have the right to withdrawal from the research at any time without any negative consequences

- Your involvement is purely for academic purposes only, and there are no financial benefits involved.
- If you are willing to have your lectures observed, be interviewed and participate in a focus group interview all of which will be audio recorded please indicate (by ticking as applicable) whether or not you are willing to allow the recording by the following equipment:

	Willing	Not willing
Audio equipment		

Yours truly,

Mr. Dahunsi, Fatai Oladotun

I can be contacted at: Tel. Number: +27 63 989 6605

E-mail:dotdahunsi@gmail.com

My supervisor is: Prof. A. Singh-Pillay. She is located at the School of Education, Science and Technology cluster, Edgewood campus, University of KwaZulu-Natal. South Africa.

Contact details: email: pillaya5@ukzn.ac.za Phone number: 031-26053672

If I have any questions or concerns about any aspect of the study or the researchers, then you may contact:

Humanities & Social Sciences Research Ethics Administration,

Westville Campus.

HSSREC@ukzn.ac.za

DECLARATION

I…… (Full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project and I am aware that I have the right to withdrawal without any negative consequences

_____ _____

Signature Date

APPENDIX 5: Post-observation interview questions:

Interview (Questions)

1. What instructional strategies do use in preparing the Basic technology pre-service teacher for twenty-first century teaching?
2. Which of these instructional strategies do you use in your lecture?
3. How frequently are these instructional strategies used?
4. When do you use these instructional strategies?
5. How confident are you in using these instructional strategies in your teaching?
6. What type of training did you receive for the instructional strategies you use and those needed to prepare pre-service teachers for the twenty-first century?
7. How competent do you perceive yourself to select and use various instructional strategies to support teaching and learning?
8. How do you implement these instructional strategies across the curriculum?
9. When you decide to use instructional strategies in your teaching, what informs your decision?
10. Have you been trained to use the instructional strategies? For how long? What type of training did you receive?
11. Does the use of instructional strategies enhance teaching /learning in your lesson and the training of pre-service teachers?
12. What are your views on the use of instructional strategies in the Basic technology lecture room?
13. Do you collaborate with colleagues when planning your teaching strategy? Please elaborate
14. What kind /type of support is available at this institution to support your preparation of pre-service teachers for the twenty-first century?
15. How has your pedagogy changed since preparing pre-service teachers for the twenty-first century?

APPENDIX 6: Observation Scheduler

Factor observed

1. Orientation to teaching Basic technology
2. Process
3. Rigour
4. Pre-service teacher activities
5. Lecture venue
6. Objectives/learning outcome for lesson
7. What Instructional strategies were used
8. To what extent do the Instructional strategies used support lesson objectives?
9. Frequency of use
10. How are they linked to content?
11. When are they used?
12. Why are they used in this way?
13. What scheme was employed to assessing learning in terms of the use of Instructional strategies?
14. How effective is the Instructional strategies at achieving the main lesson objective(s)?
15. How good is the instructional strategies used at encouraging creativity and collaborative learning?
16. Does the activity fit within the timetable?
    To what extent does it support problem-solving/critical thinking?
17. How appropriate are the explanations for the level of your intended group?
18. Knowledge of curriculum (Vertical or Horizontal)
19. Knowledge of Basic technology pre-service teachers
    Misconception
    Learning difficulties
    Learning styles
    Motivation
    Needs
    Background
20. Assessments: types of assessment
21. Materials and resources.

APPENDIX 7: Lesson Plan (P1)

Appendix 7: Lesson plan.

The following schedule was used during the observation of the enactment of the Technology Education curriculum at a Nigerian university:

Contextual Information	
Practising lecturer	Participant 1 (P1)
Date	22/08/23
Course Title	Technical Drawing 1 (TCD 121)
Topic	Construction of lines, angles, triangles
Location	AB University, Lagos. Nigeria.

Factor observed	Researcher comment
Orientation to teaching Technical Drawing Process Rigor Strategies used activities	The orientation to teaching basic technology was focused on providing students with the skills and knowledge necessary to understand and apply basic technology concepts and principles. This includes developing students' problem-solving and critical-thinking skills, as well as their ability to work collaboratively and creatively. The content was challenging and not too difficult for the learners to understand. The learners were provided with scaffolding which enabled them to start learning by breaking down the lesson into smaller units from the complex concepts. In the teaching of the triangle, for example, the teacher first introduced the basic definition, then provided practice of constructing triangles, and then allowed the learners to solve problems that involve the construction of angles and triangles. The lecturer employed a combination of lecture, questioning, brainstorming, demonstration methods, and hands-on activities, and cooperative learning as instructional strategies.
Objectives/learning outcome for the lesson: How do these relate to the intended curriculum?	At the end of the lesson, the learners should be able to: 1. Construct different angles (90, 60, 45, 30, 120, etc.) using a compass 2. Construct different triangles (scalene, isosceles, equilateral, etc.) using a compass 3. State the characteristics of different triangles 4. Construct a circle given a radius 5. Construct a circle inside the triangle 6. Construct a circle outside the triangle. The skills and competencies in the objectives are foundational in geometry. They are highly relevant to the Technology education curriculum in Nigerian universities as these geometric constructions form the basis for more complex technology concepts that students will encounter in their studies.

	Practical demonstration
Content: type of content? Elaboration of content Topic Depth of topic beyond the intended curriculum goals? Breath beyond intended goals	Construction of lines, angles, triangles Exploring the depth of these geometric constructions beyond the intended curriculum goals leads to a richer understanding and application in various advanced fields such as building drawing, Engineering Graphics and Drawing (EGD), etc. By delving deeper into these topics, students can develop a more comprehensive skill set that prepares them for cutting-edge research and innovation in Technology Education. This approach enhances their technical abilities but, fosters critical thinking and problem-solving skills.
Instructional strategy used	The lecturer employed a combination of lecture, questioning, brainstorming, demonstration methods, and using hands-on activities and cooperative learning as instructional strategies
Knowledge of curriculum Vertical Horizontal	The knowledge of the curriculum for the construction of lines, angles, triangles, and triangles in a circle is primarily horizontal. The curriculum focuses on teaching students the specific skills and knowledge needed to construct these shapes. This includes understanding the concepts of lines, angles, and triangles, and being able to apply these concepts to construct shapes. There is also some vertical knowledge, in that students need to have a basic understanding of geometry to understand the topic. However, the overall focus is on horizontal knowledge and skills development.
Knowledge of subject Learning difficulties Learning styles Motivation Needs Background	In constructing angles and triangles in Technical Drawing you can measure the angles straightaway is one of the major misconceptions in constructing lines and angles. Learners experienced difficulty in understanding the different types of triangles, such as equilateral, isosceles, and scalene triangles and the relationship between angles and lines. There were varieties of different learning styles that were used. The visual-spatial learning style which involves using images, pictures, and diagrams to represent the concepts. Another learning style used was the auditory-sequential, which involves learning through listening to and repeating information. Another learning style was tactile-kinesthetic, which involves learning through hands-on activities and movement. Finally, there was the use of the intrapersonal learning style, which involves learning through reflection and introspection. The lecturer used recognition for achievement during the delivery of instruction to motivate the learners. Learners needed appropriate scaffolding, clear and concise explanations so that students can understand the concepts being taught and adequate practice, so that students can master the concepts.

	The lecturer introduced the topics by providing some background knowledge and understanding explaining the basic geometry concepts such as points, lines, angles, and shapes.
Assessments: types of assessment	The formative assessment was used to identify areas of confusion and address misconceptions. This was done through questioning, observation, or other methods. Secondly, the summative assessment will be used to evaluate the student's learning after they had completed the unit. These assessments will take the form of tests, projects, or other activities.
Materials and resources what is available and used	-Ruler - Pencils - Compass - Whiteboard and Markers - Chart paper or poster board **Books:** "Technical Drawing for School Certificate and GCE" – by G.N. Green. "Engineering Drawing with worked examples" – by Parker, M.A., and Pickup, F.

Appendix 8: Lesson plan

The following schedule was used during the observation of the enactment of the Technology Education curriculum at a Nigerian university:

Contextual Information	
Practising lecturer	Participant 2 (P2)
Date	22/08/23
Course title	Industrial Safety: ITE 121
Topic	Introduction Industrial Safety
Location	AB University, Lagos. Nigeria.

Factor observed	Researcher comment
Orientation to teaching Introduction Industrial Safety Process Rigor Strategies used activities	This subject is to equip students with the knowledge and skills they need to work with machines and equipment safely. With that in mind, the orientation focuses on safety and how to stay safe while working with machines. - Identify the learning objectives for the lesson. - Select appropriate instructional strategies and materials. - Plan activities and assessments that align with the objectives. - Execute the lesson and assess student understanding. - Evaluate the effectiveness of the lesson and make adjustments as needed. The rigor was high enough to challenge and engage students. The lecturer struck a balance between making the material too easy or too difficult and adjusting the rigor as needed based on student performance. The instructional strategies used by the lecturer were the Lecture method, questioning, and blended learning.
Objectives/learning outcome for the lesson: How do these relate to the intended curriculum?	At the end of the course, students will be able to: 1. Define industrial safety, 2. State the importance of industrial safety in the workplace, 3. State its impact on workers, organisation & community, 4. State the different safety hazards and how to avoid them The learning objectives on industrial safety are highly relevant to the Electrical/Electronics curriculum in Nigerian universities. They ensure students understand the critical importance of safety in preventing accidents and protecting workers. By defining industrial safety, recognizing its significance in the workplace, and understanding its impact on workers, organizations, and communities, students are better prepared to foster a safe working environment. Additionally, identifying various safety hazards and learning how to avoid them equips students with the necessary

	skills to handle electrical and electronic systems safely, ultimately enhancing their technical proficiency and professional readiness.
Content: type of content? Elaboration of content Topic Depth of topic beyond the intended curriculum goals? Breath beyond intended goals	Notes/Practical demonstration Introduction Industrial Safety Exploring the depth of these geometric constructions beyond the intended curriculum goals leads to a richer understanding and application in various advanced fields such as building drawing, Engineering Graphics and Drawing (EGD), etc. Exploring industrial safety in greater depth within the Electrical/Electronic curriculum can involve advanced topics such as risk assessment methodologies, safety management systems, and the integration of safety engineering principles. Students could delve into case studies of industrial accidents to understand root causes and preventive measures. Additionally, they could learn about the latest safety technologies and innovations, such as smart sensors and automation systems that enhance workplace safety. Broadening the scope of industrial safety includes: Interdisciplinary approaches, such as the impact of safety practices on environmental sustainability and public health. Students could explore the legal and regulatory frameworks governing industrial safety globally, comparing them with local standards. Another area could be the economic implications of safety investments, analyzing cost-benefit scenarios. Furthermore, incorporating soft skills like communication and leadership in safety training can prepare students to advocate for and implement safety practices effectively in diverse workplace settings.
Instructional strategy used	The instructional strategies used by the lecturer were the Lecture method, questioning, and blended learning.
Knowledge of curriculum Vertical Horizontal	There is both horizontal and vertical knowledge of the curriculum that is needed. The horizontal knowledge includes an understanding of the basics of safety, such as the importance of following safety procedures, how to identify and assess hazards, and how to respond to emergencies. The vertical knowledge includes specific knowledge about the hazards that occur in an industrial setting and how to prevent and mitigate them. Both types of knowledge are important for a comprehensive understanding of industrial safety.
Knowledge of the subject Learning difficulties Learning styles Motivation Needs Background	A few misconceptions arose when teaching introduction to industrial safety. One misconception is that safety is only important in high-risk industries. In reality, all workplaces have some level of risk and all employees should be aware of basic safety practices. Another misconception is that safety is only about physical safety. In reality, safety also includes psychological, emotional, and social well-being. Some learning difficulties arose during the teaching. One difficulty was that the concepts were abstract and difficult to understand. Another difficulty was that many students lacked prior experience with workplace safety, so they may not be able to relate the concepts to their own lives. The students had a hard time staying engaged.

	The main learning styles that were used include visual and auditory. Visual learners learn best by seeing information, such as through charts, diagrams, and other images. Auditory learners learn best by hearing information, such as through lectures or discussions. These styles were incorporated into the course to ensure that all students have the opportunity to learn in the way that works best for them. The lecturer used rewards or recognition for achievement during the delivery of instruction to motivate the learners. These include physical needs, such as a comfortable learning environment and adequate resources. There are also cognitive needs, such as clear and understandable instruction. Finally, there are affective needs, such as a sense of belonging and positive reinforcement. The lecturer was able to fulfill these needs while delivering his teachings. The lecturer provided background notes for industrial safety, important context and information about the topic. They included a brief history of safety practices in the workplace, an overview of current safety regulations and standards, and an explanation of common hazards and risks. Additionally, the background notes contained case studies of past incidents and accidents, and information about how to prevent similar incidents from occurring in the future.
Assessments: types of assessment	The lecturer used various assessment methods to gauge the students' comprehension of the material. These include quizzes and questions. Additionally, the lecturer used observation and questioning to assess the student's understanding of the material. The assessment was designed to measure the student's understanding of the key concepts and to identify any areas that need further instruction. Summative assessments at the end of the lesson were also given, such as tests, essays, and projects.
Materials and resources what is available and used	Textbooks: i) "Introduction to Safety Engineering" by S.O. Agunbiade, published by the Federal Institute of Industrial Research Oshodi (FIIRO). ii) "Industrial Safety" by H.I. Amaku, published by Spectrum Books Limited. Videos, 2. Videos 11. Handouts, 12. Worksheets, 13. Case studies 14. Safety data sheets, and 15. Safety equipment.

Appendix 9: Lesson plan

The following schedule was used during the observation of the enactment of the Technology Education curriculum at a Nigerian university:

Contextual Information	
Practising lecturer	Participant 3 (P3)
Date	23/08/23
Course Title	Workshop Practice
Topic	Safety in the Workshop
Location	AB University, Lagos. Nigeria.

Factor observed	Researcher comment
Orientation to teaching Introduction Industrial Safety Process Rigor Strategies used activities	By teaching students about safety in the workshop, they will be better equipped to handle the challenges and risks that come with working with technology. -identifies the learning objectives for the lesson. -creates a lesson plan that incorporates different teaching methods and strategies. -delivers the lesson and engages with students. -assesses the student's understanding and provides feedback. The lecturer has a strong knowledge of the safety protocols that are in place to mitigate these hazards and he communicates these clearly and effectively to students. The instructional strategies used include the lecture method, questioning, and blended learning.
Objectives/learning outcome for the lesson: How do these relate to the intended curriculum?	At the end of the lesson, students should be able to: 1. Define safety, 2. State the causes of accidents in the workshop, 3. Describe a good workshop planning & layout. 4. State the importance of safety in the workplace, 5. Identify potential safety hazards 6. State proper safety procedures when using equipment in a workshop. These learning objectives are crucial for Electrical/Electronics students in Nigerian universities, as they emphasize the importance of safety in the workshop. By defining safety, identifying causes of accidents, and understanding good workshop planning and layout, students can create a safer working environment. Recognizing potential hazards and adhering to proper safety procedures when using equipment ensures that students are well-prepared to handle electrical and electronic systems safely, ultimately enhancing their technical skills and fostering a strong safety culture in their professional careers.

Content: type of content? Elaboration of content Topic Depth of topic beyond the intended curriculum goals? Breath beyond intended goals	Notes/Practical demonstration Safety in the Workshop Exploring safety in the workshop more deeply can involve advanced topics such as ergonomic design principles, which aim to reduce strain and injury. Students could study detailed risk assessment techniques and learn to develop comprehensive safety management plans. Additionally, they could investigate the latest safety technologies, such as automated safety systems and IoT-based monitoring, which enhance workshop safety. Analyzing real-world case studies of workshop accidents can provide insights into the root causes and effective preventive measures. Broadening the scope of workshop safety can include interdisciplinary approaches, such as the environmental impact of safety practices and the role of safety in sustainable development. Students could explore global safety standards and compare them with local regulations, gaining a broader perspective on safety practices. Another area could be the economic implications of safety investments, examining how safety improvements can lead to cost savings and increased productivity. Incorporating soft skills like teamwork and communication in safety training can also prepare students to effectively promote and implement safety measures in diverse workplace settings.
Instructional strategy used	The instructional strategies used include the lecture method, questioning, and blended learning.
Knowledge of curriculum Vertical Horizontal	It's important to have both vertical and horizontal knowledge. Students need to have a broad understanding of the different aspects of safety, and they also need to have a deep understanding of the specific safety procedures that are relevant to the workshop environment. So, to effectively teach safety in the workshop, it's important to have a curriculum that incorporates both vertical and horizontal knowledge.
Knowledge of the subject Learning difficulties Learning styles Motivation Needs Background	Common misconceptions about safety can include thinking that safety procedures are not important, or that safety is only necessary for certain types of equipment. Misconceptions can lead to dangerous situations in the workshop, so it's important to address them early on. To address these misconceptions, teachers can use a variety of strategies, such as discussion, role-playing, and hands-on activities. To address the learning difficulties, lecturers use a variety of techniques, such as breaking down tasks into smaller steps, providing frequent feedback, and using visual aids. Learning difficulties may include a lack of focus, difficulty following instructions, and trouble comprehending abstract concepts. The learning styles utilized during classroom instruction include: visual, auditory, and reading/writing. The lecturer used the following motivation: setting clear goals, providing meaningful feedback, and using positive reinforcement during questioning and answering sessions.

	One need is to understand the importance of safety and how it relates to learners' safety and the safety of others in the workshop. Another need is to understand how to follow safety procedures and use safety equipment correctly. Finally, students need to have the confidence to speak up if they see something unsafe happening in the workshop. This background includes understanding the history of workplace safety, the evolution of safety laws and regulations, and the impact of safety on the economy and society. With this background knowledge, students can understand the importance of safety and how it relates to their lives.
Assessments: types of assessment	Several types of assessments are used in the classroom when teaching safety in the workshop. For example, observational assessments are used to observe students' behavior and actions while working in the workshop. In addition, short tests were used to assess students' understanding of safety concepts.
Materials and resources what is available and used	- Fire extinguishers - First aid kits - Safety signs - Whiteboard & marker.

Appendix 10: Lesson plan (P4)

The following schedule was used during the observation of the enactment of the Technology Education curriculum at a Nigerian university:

Contextual Information	
Practising lecturer	Participant 4 (P4)
Date	28/08/23
Course Title	Building Technology (BUT 121)
Topic	Principle of design and Foundation
Location	AB University, Lagos. Nigeria.

Factor observed	Researcher comment
Orientation to teaching Principle of design and Foundation Process Rigor Strategies used activities	This topic, principle of design & foundation is aligned with the overall goal of basic technology, which is to provide students with an understanding of the fundamental principles and concepts of technology. To achieve this goal, it is necessary to cover topics such as design, materials, manufacturing processes, and quality control. This particular topic falls under the umbrella of design, which is a critical aspect of technology education. -introducing students to the basic concepts and principles of design. It also involves providing them with opportunities to apply these concepts in real-world situations. The lecturer introduced the topic by stating the practical stages involved in the construction of a building: Clearing of plants, Recce survey (first visit to the site), mapping out the site, discussion with the client, sketching the building plan (based on the client's needs), -Providing opportunities for students to reflect on their learning and receive feedback from the teacher. This process can be broken down into several smaller steps, such as introducing the topic, providing examples, and facilitating discussion. The lecturer provides students with a thorough understanding of the principles of design. This includes the theoretical understanding and how these principles can be applied in real-world situations. The topic is challenging enough to engage students and encourage them to think critically. The lecturer used demonstration, lecture methods, questioning and project-based learning in teaching the students
Objectives/learning outcome for the lesson: How do these relate to the intended curriculum?	At the end of the lecture, students should be able to: - i. State the process of design & foundation, ii. Explain the difference between form and function in design. iii. Define concrete & mortar. iv. Explain the constituents & properties of concrete. v. State the difference between mortal & concrete. vi. Design a task that uses project-based learning These learning objectives are essential for students in the Basic Technology curriculum, as they provide a solid foundation in

	construction and materials science. By understanding the process of design and foundation, students can apply these principles to electrical installations and infrastructure projects. Explaining the difference between form and function in design helps them appreciate the balance between aesthetics and practicality. Defining concrete and mortar, along with their constituents and properties, equips students with the knowledge to select appropriate materials for various applications. Finally, distinguishing between mortar and concrete ensures they can choose the right material for specific construction tasks, enhancing their technical proficiency and practical skills. This is a practical course, competency must be developed in the lessons, to have demonstrations and hands-on activities. Also, to know how to set up, maintain, and ensure safety in the workshop and site.
Content: type of content? Elaboration of content Topic Depth of topic beyond the intended curriculum goals? Breath beyond intended goals	Notes/Practical demonstration Principle of design and Foundation Delving deeper into the topics of design and materials can involve advanced concepts such as structural analysis and the principles of sustainable design. Students could explore the latest innovations in construction materials, such as high-performance concrete and eco-friendly alternatives. Additionally, they could study the impact of different environmental conditions on the properties and durability of concrete and mortar. Advanced topics might also include the use of computer-aided design (CAD) software for creating detailed construction plans and simulations. Broadening the scope can include interdisciplinary approaches, such as the integration of electrical systems within building designs and the role of materials in energy efficiency. Students could explore global construction standards and practices, comparing them with local regulations to gain a broader perspective. Another area could be the economic and environmental implications of material choices, examining how sustainable materials can reduce costs and environmental impact. Incorporating project management and teamwork skills in the curriculum can also prepare students to effectively collaborate on complex construction projects.
Instructional strategy used	The lecturer used demonstration, lecture methods, questioning and project-based learning in teaching the students
Knowledge of curriculum Vertical Horizontal	In the Basic Technology curriculum, vertical knowledge include progressing from basic electrical principles to more complex topics like circuit design, power systems, and advanced electronics. Basic Technology curriculum, horizontal knowledge include understanding how electrical principles apply to other fields such as mechanical engineering, computer science, and industrial safety. This interdisciplinary approach helps students see the connections between different areas of study and apply their knowledge in diverse contexts.

Knowledge of the subject Learning difficulties Learning styles Motivation Needs Background	-The belief that design is only about aesthetics - The belief that technology is only about using computer - The belief that design and technology are separate subjects. One potential difficulty is the practical nature of the subject. This means that students may struggle to grasp the concepts and make connections with real-world experience. Another potential difficulty is the technical nature of the subject. This means that students may struggle to understand the technical language and concepts used in the curriculum The learning styles employed for this teaching included: - Visual learning: This involves using images, charts, and diagrams to teach the material. - Kinesthetic learning: This involves hands-on activities and experiments to teach the material. - Auditory learning: This involves listening to and discussing the material. - Reading/writing learning: This involves reading texts and writing about the material. - Provided positive reinforcement and feedback. - Gave them opportunities to be creative and innovative. - Encouraged collaboration and discussion. Understanding the historical and cultural context of the subject. - Learning about the different types of design and technology. - Developing problem-solving skills. The lecturer made the subject relevant to the learners' lives and future careers. - Used examples and applications that are interesting and meaningful to them. The lecturer gave us some notes about the topic being discussed. The historical background of building construction
Assessments: types of assessment	- Observation: This involves observing students as they work on projects and complete assignments. - Tests and quizzes: These were given during the lesson as formative assessments and used to measure student knowledge. - Self-assessment: This involves having students.
Materials and resources what is available and used	- Books and articles on design and technology. - Physical materials, building materials: cement, sand & coarse aggregate (granite or gravel). - Project-based materials, such as materials for building models or prototypes. - Real-world examples and case studies.

Appendix 11: Lesson plan (P5)

The following schedule was used during the observation of the enactment of the Technology Education curriculum at a Nigerian university:

Contextual Information	
Practising lecturer	Participant 5 (P5)
Date	
Course Title	Introduction to Vocational and Technical Education
Topic	Characteristics of Vocational & Technical Education
Location	AB University, Lagos. Nigeria.

Factor observed	Researcher comment
Orientation to teaching Principle of design and Foundation Process Rigor Strategies used activities	The orientation of the topic "characteristics of vocational education" to basic technology is primarily in the context of the importance of technical skills and knowledge in vocational education. Basic technology includes a wide range of skills and knowledge that are necessary for success in vocational education, such as computer literacy, basic math and science skills, and hands-on learning. - identify the learning objectives for the lesson. -Identification of learning objectives - Development of instructional materials - Implementation of instruction - Evaluation of learning The "rigour" involved in teaching "characteristics of vocational education" is primarily related to the depth and breadth of the knowledge and skills that are required for success in vocational education. This means that students need to have a thorough understanding of the material, and be able to apply it in real-world situations. In addition, they need to be able to demonstrate proficiency in a variety of skills and techniques that are relevant to the field. The instructional strategies used by the lecturer includes lecture, brainstorming, and cooperative learning in her teaching
Objectives/learning outcome for the lesson: How do these relate to the intended curriculum?	At the end of the lecture, the students should be able to: i. define vocational education and vocational training, ii. state the differences between vocational education & vocational training: iii. Differentiate between vocational education and technical education. iv. Identifying the components of vocational education. v. Explaining the role of vocational education in society. These learning objectives are essential for students to understand the nuances of vocational education and training. By defining vocational education and vocational training, students can grasp the

	foundational concepts. Differentiating between vocational education and technical education helps clarify the focus of each type of education—vocational education emphasizes hands-on skills for specific jobs, while technical education delves into the scientific principles behind those jobs1. Identifying the components of vocational education and explaining its role in society highlights its importance in workforce development and economic growth. Evaluating the effectiveness of specific vocational education programs enables students to assess and improve these programs, ensuring they meet industry needs and standards.
Content: type of content? Elaboration of content Topic Depth of topic beyond the intended curriculum goals? Breath beyond intended goals	Notes Characteristics of Vocational & Technical Education Exploring vocational education and training in greater depth can involve advanced topics such as the development of competency-based education frameworks and the integration of industry standards into curriculum design. Students could study the impact of technological advancements on vocational training, such as the use of virtual reality for skill development. Additionally, they could analyze the effectiveness of different pedagogical approaches in vocational education, such as project-based learning and apprenticeships. Evaluating the long-term career outcomes of vocational education graduates can provide insights into the effectiveness of these programs. Broadening the scope can include interdisciplinary approaches, such as the role of vocational education in addressing social issues like unemployment and economic inequality. Students could explore global trends in vocational education and compare different models of vocational training across countries. Another area could be the integration of soft skills training, such as communication and teamwork, into vocational programs to enhance employability. Examining the relationship between vocational education and lifelong learning can also provide a broader perspective on how vocational training supports continuous professional development.
Instructional strategy used	The instructional strategies used by the lecturer includes lecture, brainstorming, and cooperative learning in her teaching
Knowledge of curriculum Vertical Horizontal	In studying vocational education, vertical knowledge would start with basic definitions and differences between vocational education and training, then move on to more detailed studies of curriculum design, pedagogical approaches, and program evaluation. In studying vocational education, horizontal knowledge might include understanding its role in society, the economic impact of vocational training, and the integration of soft skills like communication and teamwork. This interdisciplinary approach helps students see the connections between different fields and apply their knowledge in diverse contexts.

Knowledge of the subject Learning difficulties Learning styles Motivation Needs Background	Some possible misconceptions include the idea that vocational education is only for people who are not academically inclined, or that it is only for people who want to learn a specific trade. Other misconceptions may include the idea that vocational education is not as rigorous as traditional education, or that it does not lead to well-paying jobs One possible difficulty is that the concepts and terminology used in this subject can be complex and challenging to grasp. Some of the different learning styles used by the lecturer include visual, auditory, and kinesthetic learning styles. - Recognition from peers or teachers. - Rewards. One need is for clear and concise information, as this can help to ensure that students understand the concepts being taught. Another need is for practical and hands-on learning opportunities, as this can help to reinforce the concepts being taught and make them more meaningful. Finally, pre-service teachers may need support and feedback from instructors, as this can help to guide their learning and ensure that they are on the right track Vocational education focuses on the acquisition of practical skills and knowledge that can be applied in a workplace. It can be acquired both in a non- traditional settings such as a trade school or apprenticeship program. It also focuses on specific occupations or industries.
Assessments: types of assessment	- True/False quiz - A short answer/ Essay question - A group activity or discussion - Self-reflection.
Materials and resources what is available and used	**Textbooks:** - "Vocational Education: Principles and Practice" by J.O. Onyema, published by Lagos State University Press. - "Vocational Education and Training in Nigeria" by K.O. Odimegwu, published by University Press Plc. - "Foundations of Vocational Education" by S.J. Olasanmi, published by Associated Press of Nigeria Limited. - "A Critical Analysis of Vocational Education in Nigeria" by I.A. Adeboye

Appendix 12: Lesson plan (P6)

The following schedule was used during the observation of the enactment of the Technology Education curriculum at a Nigerian university:

Contextual Information	
Practising lecturer	Participant 6 (P6)
Date	14/08/23
Course Title	Woodwork
Topic	Defects in timber
Location	AB University, Lagos. Nigeria.

Factor observed	Researcher comment
Orientation to teaching Principle of design and Foundation Process Rigor Strategies used activities	This topic is oriented towards basic technology in a few ways. Firstly, the topic involves understanding the different types of defects that can occur in timber, and how these defects can affect the strength and durability of the timber. Secondly, the topic involves understanding the methods used to detect and diagnose timber defects, as well as the methods used to prevent or correct them. This all falls under the umbrella of basic technology, as it relates to the understanding and use of tools and methods for working with wood. Introduce students to the different types of defects that can occur in timber, and the different causes of these defects. - explain how defects can affect the strength and durability of timber and the potential consequences of leaving these defects unaddressed. -explain how to detect and diagnose defects in timber, and how to correct or prevent them - ask questions and get feedback This topic requires a good deal of rigour. However, the lecturer was able to adjust the rigor to the level of the students. Given that different defects can occur in timber and a range of methods for addressing them. Students need to have a solid understanding of the different types of defects, as well as the methods for identifying and correcting them. In addition, this topic requires students to have a good understanding of the science behind the defects. Students need to be able to identify and diagnose different types of defects, such as checks, shakes, splits, knots, and decay. They also need to be able to determine the severity of each type of defect, and whether or not the defect needs to be corrected. In addition, students need to be able to understand and apply the various methods for correcting defects, including filling, patching, trimming, and sealing. The lecturer used lecture methods, questioning demonstration, project-based learning and blended learning to prepare Basic technology pre-service teachers.
Objectives/learning outcome for the lesson: How do these relate to the intended curriculum?	At the end of the lesson, the students should be able to: i. State the meaning of defects in timber, ii. Differentiate natural and artificial defects iii. Explain the conversion of timber. iv. Identify and describe the different types of defects in timber.

	v. Explain the causes of defects in timber. These learning objectives are essential for students in the Technology Education, as they provide a solid foundation in understanding materials and their properties. By defining defects in timber and differentiating between natural and artificial defects, students can better assess the quality and suitability of materials for various applications. Explaining the conversion of timber, helps them understand the processes involved in preparing timber for use. Identifying and describing different types of defects, along with their causes, equips students with the knowledge to prevent and address these issues, ensuring the integrity and durability of their projects. Also, build confidence, create an environment for support, critique and learning skills like classroom management, timing the pace of the lesson, and thinking about how the content could be taught differently, lesson planning is about creativity and problem-solving.
Content: type of content? Elaboration of content Topic Depth of topic beyond the intended curriculum goals? Breath beyond intended goals	Notes/Practical demonstration Defects in timber Exploring timber defects in greater depth can involve advanced topics such as the microscopic analysis of wood structure to understand how defects impact mechanical properties. Students could study the effects of various environmental conditions on timber defects, such as humidity, temperature, and exposure to chemicals. Additionally, they could learn about advanced techniques for detecting and repairing defects, including the use of non-destructive testing methods and modern repair materials. Broadening the scope can include interdisciplinary approaches, such as the environmental impact of timber harvesting and processing, and the role of sustainable forestry practices in reducing defects. Students could explore global standards and practices for timber quality, comparing them with local regulations. Another area could be the economic implications of timber defects, examining how defects affect the cost and availability of timber products. Incorporating project management and teamwork skills in the curriculum can also prepare students to effectively collaborate on projects that involve timber and other materials.
Instructional strategy used	The lecturer used demonstration, lecture methods, questioning and project-based learning in teaching the students
Knowledge of curriculum Vertical Horizontal	In the context of timber defects, vertical knowledge would start with basic definitions and types of defects, then move on to more detailed studies of causes, detection methods, and advanced repair techniques. In studying timber defects, horizontal knowledge might include understanding the environmental impact of timber harvesting, the economic implications of defects, and the role of sustainable forestry practices. This interdisciplinary approach helps students see the connections between different fields and apply their knowledge in diverse contexts.

Knowledge of the subject Learning difficulties Learning styles Motivation Needs Background	i. All timbers are the same ii. All timbers have the same defects iii. All defects are bad and should be avoided. One difficulty may be the abstract nature of some aspects of this topic. Some students cannot visualize and understand concepts like cell structure, moisture content, and drying rates. Another difficulty may be the technical nature of the terminology used to describe defects, such as "compression wood" and "cross-grain. - Visual learning: This involves using images, charts, and diagrams to teach. - Kinesthetic learning: This involves hands-on activities and experiments to teach the material. - Auditory learning: This involves listening to and discussing the material. - Reading/writing learning: This involves reading texts and writing about the material One thing that motivated the students was the real-world relevance of this topic. Another motivating factor was the hands-on nature of this topic. Students can learn by doing, which can make the learning process more engaging and meaningful. Some students may need adaptations related to their physical ability, such as modifications to equipment or materials. Others may need adaptations related to their cognitive ability, such as visual aids or alternative explanations. It's important for teachers to be aware of the needs of their students and to make appropriate adaptations to help them learn effectively. The background of the topic "defects in timber" includes the history of timber use, the biology of trees, and the different types of defects that can occur in timber. Knowing this background information helps students to better understand the topic and to make connections between different concepts.
Assessments: types of assessment	**Assessments: types of assessment** Both formal and informal assessments were used. Formal assessments include tests that measure students' knowledge and understanding of specific concepts. Informal assessments included discussions and observations of students as they work.
Materials and resources what is available and used	- Images and photographs of different types of defects - Samples of wood with different defects - A video that shows the formation of defects in timber - A timeline of the history of timber use - Worksheets and activities that allow students to identify and classify defects - Resource books and websites that provide information on the topic.

Appendix 13: Lesson plan (P7)

The following schedule was used during the observation of the enactment of the Technology Education curriculum at a Nigerian university:

Contextual Information	
Practising lecturer	Participant 7 (P7)
Date	21/08/23
Course Title	Automobile Technology
Topic	Fundamentals of Automobile Transmission Systems
Location	AB University, Lagos. Nigeria.

Factor observed	Researcher comment
Orientation to teaching Principle of design and Foundation Process Rigor Strategies used activities	This course is designed to equip students with the knowledge and skills they need to work in the automobile industry or to teach automobile technology in schools. The orientation was on the importance of transmission systems in automobiles. -identify the learning objectives for the lesson. - create a lesson plan that incorporates different teaching methods and strategies. - deliver the lesson and engage with students. - assess the students' understanding and provide feedback. To make sure the material is sufficiently rigorous, the lecturer considers the prior knowledge and abilities of their students, the learning objectives of the lesson, and the resources available. Then plan the lesson accordingly, providing opportunities for students to engage with the material at an appropriate level of challenge. The lecturer made use of lecture methods, questioning, blended learning, demonstration, and project-based learning in his teaching.
Objectives/learning outcome for the lesson: How do these relate to the intended curriculum?	At the end of the lesson, the students should be able to: - Understand the working principles of transmission systems. - Explain the design of modern automobile transmission systems. - Describe different types of transmission systems. - Demonstrate how you would teach transmission systems and control using brainstorming as an instructional strategy. These learning objectives are crucial for students studying automobile engineering or related fields. They ensure a comprehensive understanding of transmission systems, which are vital components of modern vehicles. By understanding the working principles of transmission systems, students can grasp how power is transferred from the engine to the wheels. Explaining the design of modern automobile transmission systems helps them appreciate the advancements and innovations in the field. Describing different types of transmission systems, such as manual, automatic, and continuously variable transmissions (CVT), equips students with the

	knowledge to identify and work with various systems in real-world applications.
Content: type of content? Elaboration of content Topic Depth of topic beyond the intended curriculum goals? Breath beyond intended goals	Notes Fundamentals of Automobile Transmission Systems Exploring transmission systems in greater depth can involve advanced topics such as the detailed mechanics of gear ratios, torque converters, and dual-clutch systems. Students could study the impact of different materials and manufacturing processes on the performance and durability of transmission components. Additionally, they could delve into the integration of electronic control systems in modern transmissions, including the role of sensors and actuators in optimizing performance and efficiency. Analyzing case studies of innovative transmission designs and their real-world applications can provide deeper insights into the field. Broadening the scope can include interdisciplinary approaches, such as the environmental impact of different transmission technologies and their role in improving fuel efficiency and reducing emissions. Students could explore the economic aspects of transmission system design, including cost-benefit analyses of various technologies. Another area could be the comparison of global standards and practices in transmission system design and manufacturing. Incorporating soft skills like project management and teamwork can also prepare students to effectively collaborate on complex automotive projects that involve transmission systems.
Instructional strategy used	The lecturer made use of lecture methods, questioning, blended learning, demonstration, and project-based learning in his teaching.
Knowledge of curriculum Vertical Horizontal	In studying transmission systems, vertical knowledge would start with basic principles of how transmissions work, then move on to detailed mechanics, design innovations, and advanced control systems. In studying transmission systems, horizontal knowledge might include understanding the environmental impact of different transmission technologies, the economic aspects of their design and manufacturing, and the role of electronic control systems. This interdisciplinary approach helps students see the connections between different fields and apply their knowledge in diverse contexts.
Knowledge of the subject Learning difficulties Learning styles Motivation Needs Background	There are several common misconceptions that pre-service teachers might have about this topic. One is that all transmission systems work in the same way, regardless of the type of vehicle or engine. Another misconception is that there is only one type of transmission system There are a few potential learning difficulties. One is the amount of technical terminology that was used in this topic. Another difficulty was the abstract nature of some concepts, such as the relationship between gears and speed. In addition, pre-service teachers might have difficulty understanding the physical processes involved in the functioning of the transmission system.

	- Visual learners learn best through images, diagrams, and charts. - Auditory learners learn best through listening and speaking. - Kinesthetic learners learn best through hands-on activities and movement. - Read/write learners learn best through reading and writing. -Grades and performance feedback. - Recognition from peers or teachers. - Rewards and incentives, such as extra credit or special privileges. - Intrinsic motivations, on the other hand, are those that come from within the learner. Some examples include: - Interest in the subject matter. - A sense of accomplishment or satisfaction in understanding the material. - A desire to share what they've learned with others. - An appreciation for the challenges and complex. First, they need access to materials and resources that are accurate, relevant, and up-to-date. This includes textbooks, websites, and online resources. Also, they need a safe and supportive learning environment that encourages collaboration and hands-on learning. Third, they need opportunities to practice and apply what they are learning through activities like problem-solving and project-based learning. Lastly, they need feedback and assessment that is accurate and constructive The background knowledge that is required to teach the Fundamentals of automobile transmission systems effectively includes a solid understanding of basic physics and mathematics, as well as an understanding of basic automotive mechanics. Pre-service teachers should also have some experience working with tools and equipment, as well as some understanding of computer systems and technology. Additionally, they should have a basic understanding of how the transmission system is connected to other systems within the vehicle.
Assessments: types of assessment	- A quiz or worksheet. - A performance assessment that involved a hands-on demonstration of the material. - A self-reflection would be a good way for the students to reflect on what they learned in the lecture. - A peer review was a good way to get feedback from classmates about the lecture. - Lastly, a Teacher observation allows for assessing students' understanding.

Materials and resources what is available and used	- A textbook or other reference materials on the topic. - A computer or other device with internet access for research. - A projector and screen for presentations - A whiteboard for writing and drawing. - Pens, pencils, and paper for note-taking and sketching. - Tools and equipment for hands-on activities. - A classroom or space for group work.

APPENDIX 14: Focus Group Interview Questions

Focus Group Interview questions

1. To what extent did you employ instructional strategies to enhance teaching and learning in the lessons you taught this semester?
2. Does the use of instructional strategies increase/impede student interactions?
3. Does the use of instructional strategies positively impact student learning and achievement?
4. Will most of your students be able to employ instructional strategies at an appropriate level?
5. Are you able to employ the instructional strategies with the pre-service teacher curriculum in terms of content and pedagogy?
6. Is your teaching more student-centred when instructional strategies were employed into the lessons?
7. Has implementing instructional strategies changed the way you teach? Please explain.
8. Has integrating instructional strategies changed your content knowledge and pedagogy?
9. Is there support for lecturers when it comes to employing instructional strategies? - please elaborate
10. How would you rate your level of knowledge about Instructional strategies
11. How was this knowledge developed?
12. How confident are you about using these strategies in your teaching?
13. What factors promote/impinge the use of instructional strategies in the Basic technology lecture room?
14. What factors promote/impinge teaching and learning in the Basic technology lecture room? How confident are you in your use of instructional strategies in your teaching?
15. How competent do you perceive yourself to select and use various instructional strategies to support teaching and learning?
16. To what extent can you employ instructional strategies across the curriculum?
17. How capable are you of determining why, when, and how to employ instructional strategies in education?
18. Have you been trained to use the instructional strategies? For how long? What type of training did you receive?
19. Do the use of instructional strategies enhance teaching /learning in your lesson?

20. What are your view on the use of instructional strategies in Basic technology lecture?
21. How likely is the instructional strategies to appeal to your students and engage / motivate them? How likely is the instructional strategies to appeal both genders? How likely will the task be accomplished within the attention span of the intended students?

APPENDIX 15: Interview responses.

Post-Observation Interviews responses

P1)

1. **What instructional strategies do you use in preparing the Basic technology pre-service teacher for twenty-first century teaching?**

It is the combination of lecture method, questioning, brainstorming, and demonstration because of the course content.

2. **Which of these instructional strategies do you use in your lecture?**

I use the strategies mentioned above in my lectures: lecture method, questioning, brainstorming & demonstration.

3. **How frequently are these instructional strategies used?**

I used these instructional strategies every time in my lectures, to prepare my mind before entering the class. When I teach (during lectures) I apply the one suitable for our students' capacity building. Sometimes, I combine the instructional strategies to elicit if the students are getting what they are being taught.

4. **When do you use these instructional strategies?**

Most times, I present the content to the students first (brainstorming (critical thinking) at the beginning of the lesson to know the level of previous knowledge, so that I can know what to build on.

5. **How confident are you in your use of these instructional strategies in your teaching?**

With the background experience of a constructivist approach to teaching, which emphasizes activism (ask students to recollect what I have taught them so that they can retain it better and apply it to a new situation).

6. **What type of training did you receive for the instructional strategies you use and those needed to prepare pre-service teachers for the twenty-first century?**

I received training in strategies for teaching students, during my doctoral studies, focusing on active learning, constructivism, critical thinking, and collaborative work environments. This experience has helped me learn when and how to combine these strategies effectively to elicit the desired responses from students.

7. **How competent do you perceive yourself to select and use various instructional strategies to support teaching and learning?**

   The experience will help in when and how to combine the strategies (to elicit the responses that you want). I have been trained to have experience with these strategies. So, my competency is high.

8. **How do you implement these instructional strategies across the curriculum?**

It depends on the course sometimes, you need to know the previous knowledge of the students before you introduce the strategies and observe the students. Also, I used the demonstration method and allowed them to extrapolate, from their own experience and guide them. Then, I assess the process, as I teach, whether you need to introduce another strategy. From the responses, you will know what strategy to use.

9. **When you decide to use instructional strategies in your teaching, what informs your decision?**

What informed my decision on the strategies to use is the students. Practical activity involves the content and nature of the practical, the thinking skills that are required. The definitions, as a lecturer, you need to define some content for the students.

The thinking skills of the lecturer should be abreast of time. The nature of work is changing, so you don't present obsolete things. So as a lecturer, I always carry out my research first, before entering the class to teach the students. By the time I enter the class, the readiness is there. Readiness is about getting the students ready to listen to the lecturer. When you teach, the students' attention must be captured, and from there you move forward, presenting the topics. No particular strategy is the best. It's the combination of strategies that brings out the best in students, especially in technology education.

10. **Have you been trained to use instructional strategies? For how long? What type of training did you receive?**

I have some training in strategies and experience on the job. However, there is a need for constant Professional development in 21st-century teaching. It is about capacity building because you can't give what you don't know.

11. **Does the use of instructional strategies enhance teaching /learning in your lesson and the training of pre-service teachers?**

Steps affect teaching when you skip steps. You teach technology courses step by step. If you skip a step, there is always a problem.

Instructional Strategies enhance the teaching and learning of the students. It glad your heart when you get positive feedback from your students, especially those in the industry or practicing. Teaching technology courses is about the application of the theory.

12. **What are your views on the use of instructional strategies in the Basic technology lecture room?**

My view is technology education is a dynamic area of study. Technology changes daily, therefore we need to upgrade the facilities and also the instructional strategies. That is, the lecturers should develop themselves (skills). I am getting innovative, and upgrading ourselves.

13. **Do you collaborate with colleagues when planning your teaching strategy? Please elaborate.**

I collaborate with my colleagues in technology education, this is because we specialize in a unit. For example, in the automobile technology unit, we have those that handle the electrical parts, Air conditioning, etc.

14. **What kind/type of support is available at this institution to support your preparation of pre-service teachers for the 21st century?**

The institution's support for the lecturers is inadequate. There is a need for upgrading and in-service training, capacity building, and training the trainers. You cannot give what you don't have. Tell me the quality of the students and I will tell you the quality of the teachers. The quality of the teacher determines the output of the students—constant upgrading of the staff and the facilities.

15. **How has your pedagogy changed since preparing pre-service teachers for the 21st century?**

My pedagogy (method of teaching) has changed. It changes due to the experience and quality of the students. When the students are challenging the lecturers, the lecturer will have to prepare himself and his pedagogy will improve. I check the internet, and textbook and collaborates with other colleagues, even outside the states.

P2)

16. **What instructional strategies do you use in preparing the Basic technology pre-service teacher for 21st-century teaching?**

The Instructional Strategies that I used to prepare Basic Technology pre-service teachers for 21st-century teaching are problem-solving, lecture method, questioning, and blended learning.

17. **Which of these instructional strategies do you use in your lecture?**

Problem Solving, lecture method, questioning, and blended learning are the Instructional Strategies that I use in my lectures.

18. **How frequently are these instructional strategies used?**

I always use these instructional strategies in all my lectures.

19. **When do you use these instructional strategies?**

These strategies are used in the beginning and during the lectures.

20. **How confident are you in your use of these instructional strategies in your teaching?**

I am confident in using these instructional strategies because it has been yielding a very practical output – in terms of the performance of the students.

21. **What type of training did you receive for the instructional strategies you use and those needed to prepare pre-service teachers for the 21st century?**

I have received some training. But I need more training in twenty-first century teaching. The institution should arrange workshops for lecturers on twenty-first century teaching to enhance our teaching performance.

22. **How competent do you perceive yourself to select and use various instructional strategies to support teaching and learning?**

My level of competency is good in the application of these strategies, based on the experience acquired.

23. **How do you implement these instructional strategies across the curriculum?**

In the curriculum, there is a course outline for each course in which I use the strategies to teach. If well utilized, it will bring a good outcome of brilliance from the students' performance.

24. **When you decide to use instructional strategies in your teaching, what informs your decision?**

What informed my decision to use the Instructional strategies is how to impact the knowledge of students. Also, for students to gain experience outside the domain, for example in the industry (university and industry collaboration) will help students to see how a machine works, and other relevant knowledge.

25. **Have you been trained to use instructional strategies? For how long? What type of training did you receive?**

Although I have received some training, it did not include instructional strategies focused on preparing Basic Technology pre-service teachers for the demands of the twenty-first century.

26. **Does the use of instructional strategies enhance teaching/learning in your lesson and the training of pre-service teachers?**

Yes. It enhances teaching and learning it makes teaching and learning more effective compared to the traditional method used before.

12. What are your views on the use of instructional strategies in the Basic technology lecture room?

Instructional strategies enhance the efficiency and performance of the learners and teachers. Secondly, it enhances the critical thinking ability of the students and encourages creativity. Hence, the instructional strategies enhance the development of a nation.

13. **Do you collaborate with colleagues when planning your teaching strategy? Please elaborate.**

Yes, I collaborate with my colleagues when planning my teaching strategy. In the course I took this semester. I collaborated with lecturers in other units in the technology education department, viz-a-viz electrical/electronics, metal work, building & woodwork, to know the areas relevant to industrial safety and shared ideas on how best to deliver the lectures.

14. **What kind/type of support is available at this institution to support your preparation of pre-service teachers for the 21st century?**

The university system has workshops, equipment, tools, and materials. However, the institution should provide modern equipment and tools, which will enable students to have sound practical knowledge. Industrial visits should be a regular exercise for the students, to have real practical experience.

15. **How has your pedagogy changed since preparing pre-service teachers for the twenty-first century?**

My pedagogy has improved now. I am now better prepared to teach the students effectively. The design process emphasises all teaching in technology subjects and emphasizes problem-solving, critical thinking, evaluation, and creativity, essential twenty-first century skills. So, it is natural for us to promote these skills in pre-service technology teachers. This is a part and parcel of technology education and an integral part of our pedagogy.

P3)

1. **What instructional strategies do you use in preparing the Basic technology pre-service teacher for twenty-first century teaching?**

From our curriculum, the Instructional strategies I mostly employed to prepare Basic technology pre-service teachers for twenty-first century teaching include lecture method, questioning, blended learning, and demonstration.

2. **Which of these instructional strategies do you use in your lecture?**

Blended learning, brainstorming and lecture methods are the ones I used mostly, due to my experience with students and their performance. Also, I use the questioning and demonstration methods.

3. **How frequently are these instructional strategies used?**

In almost all the lectures. I use them frequently in my teaching and practice.

4. **When do you use these instructional strategies?**

Firstly, I use the instructional strategies at the beginning of the class, to test their entry behavior, and previous knowledge, and also at the end of the class. Occasionally, I throw it in during the lesson.

5. **How confident are you in your use of these instructional strategies in your teaching?**

I am confident in myself in the use of instructional strategies. I am very good at using them.

6. **What type of training did you receive for the instructional strategies you use and those needed to prepare pre-service teachers for the 21st century?**

My training involves self-development primarily. I believe it would be beneficial to provide additional training (e.g., in-service training) for all educators at the university, particularly within our department (Technology Education), to equip prospective technology teachers with essential skills for the twenty-first century.

7. **How competent do you perceive yourself to select and use various instructional strategies to support teaching and learning?**

I am confident in selecting the strategies to use, at any point in time.

8. **How do you implement these instructional strategies across the curriculum?**

In implementation, I would like to throw more light on this because the content we are taking, and the curriculum will determine the way we start the class, and which of the strategies we need to use. So, this is according to the curriculum, according to what we are teaching, at a particular time in the class. That allows us to know which of the strategies we need to utilise first, or the one to come last or which one should come in the middle. So, the content or the curriculum determines the strategy that we will apply.

9. **When you decide to use instructional strategies in your teaching, what informs your decision?**

The content of the lesson I am taking will determine which of the instructional strategies to use (apply) in a particular class. So, looking at it, we can use the same strategy all through for all the classes, and all the content for the curriculum that we are taking. The type of class we are taking, the topic, and the curriculum determine the strategy we are going to use.

10. **Have you been trained to use instructional strategies? For how long? What type of training did you receive?**

My training is mainly, self-development. However, the management needs to arrange special training in twenty-first century teaching for the lecturers.

11. **Does the use of instructional strategies enhance teaching/learning in your lesson and the training of pre-service teachers?**

Yes, It enhances the assimilation, how the students learn, how they produce practical works and teach, as well.

12. **What are your views on the use of instructional strategies in the Basic technology lecture room?**

Okay, regarding that, using these strategies is very helpful, and I will ask the institution to organize training for the lecturers on how to teach in the twenty-first century. Our students today are "digital natives."

13. **Do you collaborate with colleagues when planning your teaching strategy? Please elaborate**

Yes, I collaborate with them to know their views and use their ideas and views to add to what we know. This makes planning and teaching more effective.

14. **What kind/type of support is available at this institution to support your preparation of pre-service teachers for the twenty-first century?**

The institution needs to enhance support by providing better training for lecturers and improving the availability of equipment and instructional materials for teaching and learning in the twenty-first century.

15. **How has your pedagogy changed since preparing pre-service teachers for the twenty-first century?**

Yes, it has changed a lot, teaching and learning have changed using these strategies, on both sides (i.e. the teachers/instructors and also the students). Seeing what it is yielding, to our students, the type of students we are producing, and graduating each year, so, we can see the reward of using the instructional strategies in teaching.

P4)

1. **What instructional strategies do you use in preparing the Basic technology pre-service teacher for twenty-first century teaching?**

Most of the time I use real objects, demonstration, and project-based learning to disseminate information to students and to show them what we mean by most of these basic things in Basic Technology. I can cater to the instructional strategy. I use it in teaching the Basic Technology pre- service teachers about critical thinking and creativity. Most times, for instance, I want to teach concrete (Building Technology) i.e. production of concrete), I come to the workshop with coarse aggregate (granite or gravel), fine appreciate (send), wax (cement), and some volume of water. I will carry out the mixing, practically in the presence of the students. These are things they have been seeing but they may not know the technical terms (used for) these materials. Showing them all these and how they can be mixed to form concrete. This makes them understand faster than just disseminating the information. Showing them all these real things brings them home faster than lecturing alone.

2. **Which of these instructional strategies do you use in your lecture?**

Basic technologies have to do with the psychomotor domain, whereby you use your head, and your hand to demonstrate to the students. In my lectures, I use demonstration, lecture methods, and questioning.

3. **How frequently are these instructional strategies used?**

I use these instructional strategies frequently.

4. **When do you use these instructional strategies?**

Before I move into the lecture hall, my behavioural objectives have to be well stated. I need to use the appropriate instructional strategies at the beginning of the lecture and during the lecture to demonstrate and arouse the interest of the students.

5. **How confident are you in your use of these instructional strategies in your teaching?**

I am confident, because showing them the real object and explaining it to them, makes the students understand the concept faster than expected.

6. **What type of training did you receive for the instructional strategies you use and those needed to prepare pre-service teachers for the 21st century?**

I have been visiting the site since my time in technical college, where I was introduced to these concepts. After grasping them, I utilized these skills to convey information to my students, helping them understand the material more quickly due to my exposure to both theoretical and practical aspects.

7. **How competent do you perceive yourself to select and use various instructional strategies to support teaching and learning?**

I am competent in selecting the appropriate instructional strategies to support my teaching. I do mingle with them and they do teach me and those things couple together and with what I have taught in the classroom and on the site, I bring them together to teach the students.

8. **How do you implement these instructional strategies across the curriculum?**

When you look at the curriculum, it varies from one course to another, but you have to set goals, and the activities that are expected, because of the students that will receive the curriculum. The values have to be inculcated into the teachings so that the aim of the curriculum will not be defeated.

9. **When you decide to use instructional strategies in your teaching, what informs your decision?**

What informed my decision to use instructional strategies is the students. How to teach them effectively.

10. **Have you been trained to use instructional strategies? For how long? What type of training did you receive?**

My training is self-development. During my self-development training, I received instruction in the building industry, which prepared me for using demonstration and project-based learning methods. I also studied as a draughtsman before obtaining my first degree in Building Technology. I had the opportunity to apply what I learned in real-life situations by going to various construction sites. This hands-on experience has given me an advantage in effectively and efficiently teaching my students.

11. **Does the use of instructional strategies enhance teaching/learning in your lesson and the training of pre-service teachers?**

Very, well. The use of Instructional strategies enhances teaching and learning.

12. **What are your views on the use of instructional strategies in the Basic technology lecture room?**

My view is this, with the advancement of technology nowadays, Basic technology lecturers should develop their knowledge of instructional strategies and how to use them effectively and efficiently.

13. **Do you collaborate with colleagues when planning your teaching strategy? Please elaborate**

Yes. I collaborate with my colleagues when planning the teaching strategies for my lessons. In some areas, even if I am good in such areas, I will still want to learn from another person and my superior, to tap into their idea and add to my own.

14. **What kind/type of support is available at this institution to support your preparation of pre-service teachers for the twenty-first century?**

When we look around this institution we will discover that we have some equipment and tools, but we need the latest type. By utilising modern equipment to teach the students, they can learn faster and better, than ordinary lectures, hence, preparing the pre-service teachers for the twenty-first century.

15. **How has your pedagogy changed since preparing pre-service teachers for the twenty-first century?**

Going over the lectures and the use of instructional strategies over the years has prepared me to teach the students very well.

P5)

1. **What instructional strategies do you use in preparing the Basic technology pre-service teacher for 21st-century teaching?**

In preparing Basic technology pre-service teachers, I used mostly problem-solving, demonstration, and lecture methods. These strategies enable me to teach the students theories and practicals. Also, I referred them to the internet when it comes to assignments, to enhance their teaching and enable them to see what they have been taught.

2. **Which of these instructional strategies do you use in your lecture?**

It depends on what the topic is saying. Most of the time, I use lectures, demonstrations, and problem-solving approaches. However, the students are referred to digital technology when it comes to assignments, to enhance their teaching and enable them to see the object (diagrams, photos, videos, etc) of what they have been taught.

3. **How frequently are these instructional strategies used?**

I use the instructional strategies frequently because it is just like an enhancer, which assists in teaching the pre-service students.

4. **When do you use these instructional strategies?**

I use the instructional strategies as the lesson dictates, according to the topic at hand (that will be taught in the class). The topic will determine when, what, and how to use strategies. if the students need to solve problems, collaborate, etc. since lessons are practically based. When it comes to practicals, you have to explain the process to the students and demonstrate the practical aspect. So that they can comprehend what you have been teaching in the class (theory).

5. **How confident are you in your use of these instructional strategies in your teaching?**

I have been using these strategies for so many years. It has assisted me so I have confidence in using the instructional strategies.

6. **What type of training did you receive for the instructional strategies you use and those needed to prepare pre-service teachers for the 21st century?**

The university has not trained us in 21st-century teaching. There is an urgent need for the institution to train his/her staff to be able to meet up with new ways/methods of teaching.

7. **How competent do you perceive yourself to select and use various instructional strategies to support teaching and learning?**

It is the result that justifies the competency (means). When you see the students at the end of the class they can answer questions, be able to use their skills (the application of skills they have been taught), they can manipulate and put it down both in practical and theoretical aspects of it.

8. **How do you implement these instructional strategies across the curriculum?**

The curriculum dictates the kind of strategies that would be used for a particular topic.

9. **When you decide to use instructional strategies in your teaching, what informs your decision?**

We have the theoretical aspects and practical aspects of the lesson, when you teach the theoretical aspect, you must be able to link it to the practical aspect. Teach them and let them be able to solve the problem.

For example: block laying in building technology unit. You will tell them the tools that will be used. The ability to use the tools, even if they are not perfect in performing the practical. But when they are allowed to perform the practical again, there will be an improvement. The aspect of the course (lesson) will determine the I.S. that will be used.

10. **Have you been trained to use instructional strategies? For how long? What type of training did you receive?**

Not really. I have experience in using instructional strategies and have developed myself through the years. However, I recognize the need for training in 21st-century teaching methods.

11. **Does the use of instructional strategies enhance teaching/learning in your lesson and the training of pre-service teachers?**

Yes, the use of instructional strategies enhances teaching and learning in my lesson and pre-service teachers' training.

12. **What are your views on the use of instructional strategies in the Basic technology lecture room?**

Instructional Strategies assist lecturers in teaching effectively and the students comprehend what they have been taught.

13. **Do you collaborate with colleagues when planning your teaching strategy? Please elaborate**

Yes, we collaborate and share ideas, to get new ways, ideas, and methods of doing things (teaching and preparing the students).

14. **What kind/type of support is available at this institution to support your preparation of pre-service teachers for the 21st century?**

There are workshops and equipment, but they are inadequate to prepare the students for the twenty-first century. Also, the institution should provide a constant power supply to operate the machine.

15. **How has your pedagogy changed since preparing pre-service teachers for the twenty-first century?**

Yes, pedagogy has to change, because we are moving with the trend of things. As a technology lecturer, you must be informed, so that you will not be left behind. You follow the latest information on ideas and methods on the best way to teach. But if one is stagnant, one will not have new ideas or ways of doing things (teaching and preparing students).

P6)

1. **What instructional strategies do you use in preparing the Basic technology pre-service teacher for 21st-century teaching?**

I used **demonstration**, **project-based learning**, **questioning**, and **lecture** methods to prepare Basic technology pre-service teachers because basic technology is more or less a technological-oriented subject. Using the problem-solving, demonstration, and project-based will bring out the needed interest in them. Occasionally, I do use **blended learning** because some of the students go back to the use of their phones, laptops, and the internet to search for some information. For example, if you are teaching students the classification of tools that have geometrical tools, cutting tools, etc, you can ask them to

search diagrams relating to these sub-headings. By the time they type “diagrams of geometrical tools”, it will show them photographs/diagrams/figures of geometrical tools like compass, dividers, etc.

2. **Which of these instructional strategies do you use in your lecture?**

I will say as I have explained in the first question, I can use the Instructional strategies mentioned. Mostly in our context, it is the **lecture**, **demonstration**, and **project-based learning** that we use.

3. **How frequently are these instructional strategies used?**

I will say it depends on the nature of the lecture/lesson that I want to teach. If I have a theoretical lesson, I can use **questioning** and **lecture methods.** But, if it involves students looking at how objects are constructed, then I will use **demonstrations** and **project-based learning**. Also, most of these things are available on the internet. So, I will direct them to the appropriate link to see how some of these machines and tools are used. Technology regulates students' thinking mostly in solving problems.

4. **When do you use these instructional strategies?**

It depends on the nature of the lesson. In Basic Science/Technology, we have the theory aspect and practical aspect. It depends on what you are trying to teach the students, whether it is only the theoretical which is the background of the main course, or practical.

5. **How confident are you in your use of these instructional strategies in your teaching?**

Based on the experience and the lesson will determine how confident I will be able to apply the strategies.

6. **What type of training did you receive for the instructional strategies you use and those needed to prepare pre-service teachers for the 21st century?**

Some of the strategies are what we have learnt many years ago. So, along the line as a trained teacher, I have been gathering experiences (training) along the way. However, the institution should organise regular staff training for lecturers on twenty-first century teaching.

7. **How competent do you perceive yourself to select and use various instructional strategies to support teaching and learning?**

Having been teaching for a long period (i.e. over 30 years), invariably I come across new things, which I disseminate to students. With knowledge and confidence, I can do that. It requires determining when to use these instruments, sometimes, it comes naturally, based on experience.

8. **How do you implement these instructional strategies across the curriculum?**

The curriculum has two main motives: teaching the theoretical aspect of a particular field or teaching the practical aspects.

Sometimes, I need to do the theoretical work before going to the practical aspect. Based on that, the Instructional strategies will vary from the theoretical aspect to how you teach the manipulative skills in the practical.

9. **When you decide to use instructional strategies in your teaching, what informs your decision?**

The nature of the lesson will inform my decision. Whether via teaching them the theoretical aspect or manipulative aspect (practical). So, the nature of the lesson will determine which of the instructional strategies to use.

10. **Have you been trained to use instructional strategies? For how long? What type of training did you receive?**

My years of experience in teaching have been incredibly valuable. In teaching practicals, you have to bring out the creativity of the students, in the act of manipulating, demonstrating, and project-based learning. Basic technology has to do with the manipulation of the tools and the creative thinking of the student. The students' minds must be constantly motivated to create ideas that are new (novel).

11. **Does the use of instructional strategies enhance teaching/learning in your lesson and the training of pre-service teachers?**

Sure, because without instructional strategies how do you get yourself accustomed to the students/how do you motivate them? How will you know exactly what you want to imbibe into their lesson? Instructional strategies enhance creativity.

12. **What are your views on the use of instructional strategies in the Basic technology lecture room?**

We cannot rule out the use of instructional strategies. They are the impacting techniques of teaching students any form of curriculum, even if it is History. If you cannot do things that will make the students remember, there is no way you can effectively conduct the lesson.

13. **Do you collaborate with colleagues when planning your teaching strategy? Please elaborate**

We need collaboration among ourselves, as teachers. *We do not have much support at an institutional level, due to insufficient funds. But as technology lecturers, we collaborate to improve our skills and share best practice.* Everybody will come up with new things. There is a need for the exchange of ideas. Collaboration is very essential.

14. **What kind/type of support is available at this institution to support your preparation of pre-service teachers for the twenty-first century?**

In Basic Technology, we have workshops for various units; with equipment and tools for teaching, but the equipment are not the modern ones. Also, there is a need for professional development *for us to prepare pre-service teachers to teach in the twenty-first century.*

15. **How has your pedagogy changed since preparing pre-service teachers for the twenty-first century?**

Teaching in the previous decades was centered on **lecturing**, but things are now improving. People are now imbibing new teaching strategies that will promote effective teaching and learning.

P7)

1. **What instructional strategies do you use in preparing the Basic technology pre-service teacher for twenty-first century teaching?**

I make use of lecture methods, questioning, blended learning, demonstration, and project-based learning**.**

2. **Which of these instructional strategies do you use in your lecture?**

I use the aforementioned instructional strategies for my teachings and practicals.

3. **How frequently are these instructional strategies used?**

Most times, when I am teaching the students.

4. **When do you use these instructional strategies?**

I make use of these instructional strategies during my lectures and practicals.

5. **How confident are you in your use of these instructional strategies in your teaching?**

I am confident in the use of instructional strategies since I have experience in the use of teaching strategies and techniques.

6. **What type of training did you receive for the instructional strategies you use and those needed to prepare pre-service teachers for the twenty-first century?**

I have not received training on twenty-first century teaching. The institution is encouraged to arrange staff development training for lecturers focusing on instructional strategies tailored to twenty-first-century teaching. The knowledge and skills acquired during these sessions can be effectively applied in the classroom to enhance student learning.

7. **How competent do you perceive yourself to select and use various instructional strategies to support teaching and learning?**

I am competent in the use of instructional strategies, due to my experience in the teaching profession.

8. **How do you implement these instructional strategies across the curriculum?**

To implement these strategies, especially digital technologies, there is a need for a power supply, to operate the equipment and gadgets. During practicals, utilize creativity (demonstration) and critical thinking.

9. **When you decide to use instructional strategies in your teaching, what informs your decision?**

What informed my decision is how I can teach and impart the students with appropriate and adequate knowledge.

10. **Have you been trained to use instructional strategies? For how long? What type of training did you receive?**

My teaching experience has taught me to use instructional strategies in my teaching. The institution should organize regular staff professional development on twenty-first century teaching.

11. **Does the use of instructional strategies enhance teaching/learning in your lesson and the training of pre-service teachers?**

Yes, Instructional strategies enhance the teaching and learning in my lesson and the training of pre-service teachers.

12. **What are your views on the use of instructional strategies in the Basic technology lecture room?**

My view is that instructional strategies permit the students to understand the lessons adequately. Also, allows the students to know how to carry out practical and teach, effectively.

13. **Do you collaborate with colleagues when planning your teaching strategy? Please elaborate.**

Yes, I collaborate with my colleagues when planning my teaching strategy. Teaching basic technology students requires the lecturers to cooperate and achieve the objectives of Basic technology curriculum.

14. **What kind/type of support is available at this institution to support your preparation of pre-service teachers for the 21st century?**

The institution needs to send the lecturers for regular staff development training to update their knowledge of the latest instructional strategies and effective teaching methods to prepare the pre-service teachers for the twenty-first century.

15. **How has your pedagogy changed since preparing pre-service teachers for the 21st century?**

My pedagogy has improved. As stated previously, regular training for lecturers in twenty-first century teaching is essential.

APPENDIX 16: Focus Group Interview Responses

Question 1: To what extent did you employ instructional strategies to enhance teaching and learning in the lessons you taught this semester?

P1: I employ various instructional strategies to enhance teaching and learning in courses I taught, to a large extent. Many of these strategies were used, which included the lecture technique, questioning, brainstorming, and demonstration. Occasionally, I might employ one or more strategies to increase teaching effectiveness.

P2: To a great extent, I employed instructional strategies to enhance teaching and learning in the lessons I taught this semester, these strategies were utilized especially when necessary.

P3 I used all the strategies in all the lessons, throughout the semester. Students must be able to think critically and solve real problems in daily life; they must transfer knowledge from technology, for example, to fix a leaking tap and design and make their cupboard. This is the nature of all technical subjects.

P4: I always utilize instructional strategies to disseminate my lectures. For me, it is graphical communication. Being able to make and read visual representations is how we communicate in building technology.

P5: To a large extent, I have been using the strategies in my lectures, sometimes I combined the strategies, both in theory classes and practical.

P6: The nature of instructional strategies used is determined by theory and practice issues in the lesson objectives. Design thinking is critical in technology, which I emphasise in my classes. We know that the design process drives technology. You cannot have technology without design, so for me, it is about design, problem-solving, generating innovative ideas, trying them, evaluating them, and coming up with the best solution or product.

P7: I make use of the instructional strategies to teach the students regularly this semester. For instance, Hands-on, and manipulative skills are important in automobile technology, for example, filter and fluid replacement, stripping a gearbox and reassembling it.

2. Does the use of Instructional strategies increase/impede students' interactions?

P1: Instructional strategies increase their interactions, and their active learning, especially their collaboration. By incorporating collaborative activities, such as group discussions or projects, instructors foster interaction among students.

P2: Instructional strategies increase the students' interaction and enhance their performance as well. This increased interaction positively impacts their overall performance. Strategies like formative assessments, case studies, and debates contribute to a deeper understanding of the subject matter.

P3: Instructional strategies increase their interactions, during the classes and after classes. Beyond the classroom, instructional strategies continue to influence student interactions. Instructional strategies create opportunities for students to engage with the content and their peers beyond scheduled class time.

P4: Instructional strategies increase their interactions and their learning abilities. By implementing a variety of teaching techniques, instructors empower students to develop critical thinking skills, problem-solving abilities, and a deeper grasp of the material. These interactions contribute to their overall learning experience.

P5: Instructional strategies make the students discover new things about learning and it allows teamwork. Students actively seek out information, collaborate with classmates, and uncover new insights. Teamwork becomes an essential component, fostering a supportive learning environment.

P6: Instructional strategies enable students to know more about the lesson, and the situation surrounding the topic. It increases their interactions. Whether through case studies, simulations, or real-world examples, these approaches provide context and encourage students to engage deeply with the subject matter.

P7: Instructional strategies increase the students' interaction and understanding. By promoting interaction, active learning, and critical thinking, instructors create an environment where students can grasp complex concepts more effectively.

3. Does the use of Instructional Strategy positively impact students learning and achievement?

P1: Definitely, it impacts students learning positively as these strategies contribute significantly to enhancing the learning experience.

P2: It positively impacts students learning and achievement. Instructional strategies not only improve understanding but also lead to successful outcomes, such as improved grades or mastery of learning objectives.

P3: It impacts their learning and achievements positively, compared to what happened in the past. Instructional strategies are seen as an improvement over previous methods, suggesting that they yield better results for students.

P4: It impacts the students' learning and achievements a lot as instructional strategies play a crucial role in shaping students' learning experiences and overall achievement.

P5: It highly impacts on the students learning and achievement and this impactful nature of instructional strategies underscores the significant impact of instructional strategies. Students benefit greatly from these approaches, leading to improved learning outcomes.

P6: It impacts students learning and has a great effect on learning ability and achievement. Not only do they enhance learning, but they also strengthen students' abilities and contribute to their overall achievement.

P7: Yes, it impacts students learning positively and they can achieve the aims at the end of the lesson. Students can meet their goals and objectives through effective implementation of these instructional strategies.

4. Will most of your students be able to employ Instructional strategies at an appropriate level?

P1: Yes, they will be able to employ the strategies because they were part of the learning.

They participated effectively, hence they must have acquired that skill; what they acquired they can do.

P2: Utilization of the instructional strategies in the class enhances their performance. So, they will be able to utilize the strategies at the appropriate level, as they were being taught.

P3: I believe they will be able to utilize the strategies because they are part of the instructions. Given that instructional strategies are part of the instructions, students should be able to utilize them effectively.

P4: Since they were actively involved in the class, they would be able to employ the strategies at an appropriate level.

P5: Yes, they would be able to, because it is what they see and do, that will help them to employ the strategies at an appropriate level.

P6: They should be able to, because of their interaction with the teacher. Through imitation, they should be able to employ the strategies at an appropriate level.

P7: Yes, most of the students will be able to employ the instructional strategies at an appropriate level, once they have been taught. They can easily make use of the instructional strategies at an appropriate level.

5. Are you able to employ the Instructional Strategies with the pre-service teacher curriculum in terms of content and pedagogy?

P1: Yes, I can employ the Instructional strategies with the pre-service teacher curriculum in terms of content and pedagogy, it is with the content that is in the curriculum that we teach. Except you want to enhance the curriculum. The curriculum has been the minimum standard. It is the curriculum that guides teaching.

P2: I can utilize the instructional strategies with the pre-service teacher curriculum in terms of content and pedagogy.

P3: Yes, I can employ the instructional strategies with the curriculum, in terms of content and pedagogy. Staying within the curriculum's boundaries is crucial. Effective teaching doesn't require going beyond the established framework.

P4: Yes, the curriculum spelled out the details of the content. So, I can employ the strategies with the teaching curriculum. Having a clear roadmap ensures that the instructional strategies enhance teaching and learning experiences.

P5: Yes, I can employ the strategies with the pre-service teacher curriculum, because the curriculum serves as the guide. One should not go out of the curriculum to enhance effective teaching.

P6: I can employ the strategies, according to the curriculum, in terms of content and pedagogy. Adhering to the curriculum ensures consistency and coherence. By applying strategies in line with content and pedagogy, you create a robust learning environment for pre-service teachers.

P7: Yes, I can employ the use of instructional strategies with teachers' curriculum, within the content and pedagogy. The curriculum serves as a valuable guide. By weaving instructional strategies seamlessly into the content and pedagogical context, you empower future teachers to excel.

6. Is your teaching more student-centered when instructional strategies are employed in the lessons?

P1: Yes, it is student-centered. When instructional strategies are employed, the focus shifts to the students. Their needs, interests, and active participation become central to the teaching process.

P2: Yes, it is student-centered, because they need the knowledge most. By using instructional strategies, you ensure that their learning experiences are at the forefront.

P3: Yes, my teaching has been student-centered now, due to the application of the strategies and interaction of the students. Students are more involved during the classes.

P4: Yes, it is student-centered. Student-centered teaching prioritizes learners' needs, preferences, and active involvement. Instructional strategies facilitate this shift.

P5: Yes, it is student-centered because the students are the purpose of the teaching, so, they should be able to interact freely, not the teacher being the only one talking, but the students should be (involved) able to interact freely.

P6: Yes, my teaching has been student-centered because they are the core, the main thing in the curriculum.

P7: Yes, the teaching is more student-centered, when the instructional strategies are used, the students can understand what I teach and comprehend the lesson.

7. Has implementing instructional strategies changed the way you teach?

P1: Yes, as I utilized the instructional strategies, it enhanced my teaching capabilities. These strategies empower educators to engage students effectively and promote deeper understanding.

P2: Yes, the strategies have changed the way I teach. It makes me to impact more knowledge. The strategies indeed change the teaching landscape, allowing you to impart more knowledge and create meaningful learning experiences

P3: Yes, the use of the strategies has increased assimilation and the delivery of the lessons in the class. By using strategies, you enhance lesson delivery and increase student assimilation. It's a win-win for both educators and learners

P4: Yes. The use of instructional strategies to teach propels one to teach better and more. Also, it makes the students learn faster than when instructional strategies were not utilized.

P5: Yes, the end product is visible. These visible outcomes—whether improved student performance or increased engagement—underscore the effectiveness of these strategies.

P6: Yes, it motivates the students. It makes the students to see the real thing. Without instructional strategies, they may not be able to comprehend. Motivation and comprehension go hand in hand. Strategies provide that bridge, making learning more tangible and real for students.

P7: Yes. The implementation of the instructional strategies has changed the way I teach the students. I always observe the students, they understand what I teach them. Observing students and ensuring their understanding is a key shift. Instructional strategies facilitate this student-centered approach.

8. Has integrating instructional strategies changed your content knowledge and pedagogy?

P1: Yes, it has changed. It improved my content knowledge and pedagogy. Integrating instructional strategies not only changes the way we teach but also deepens our understanding of the content. As educators, we continually learn and adapt, enhancing both our knowledge base and teaching practices

P2: Yes. It has enhanced my content knowledge and pedagogy. The use of instructional strategies enriches our content knowledge and pedagogical approaches. It's a dynamic process that benefits both teachers and students.

P3: Yes, it has helped my content knowledge and pedagogy in teaching and learning. Applying strategies improves our grasp of content and enhances our teaching methods. It's a symbiotic relationship—our teaching informs our understanding, and vice versa.

P4: Yes, it has tremendously helped in imparting knowledge as it contributes significantly to imparting knowledge effectively. As we employ them, our expertise grows, benefiting our students.

P5: Yes, it is effective, as when properly used, instructional strategies empower us to teach more effectively, bridging theory and practice.

P6: Yes, it increases student's rate of learning because it accelerates student learning, which, in turn, deepens understanding. It's a virtuous cycle.

P7: Yes, it has changed the content knowledge and pedagogy. The interplay between content knowledge and instructional strategies enriches our pedagogy. It's an ongoing journey of growth.

9. Is there support for lecturers when it comes to employing Instructional Strategies? Please elaborate.

P1: Yes, there is support, but the support may not be enough as expected. As educators, we often need to supplement existing resources with our own creativity and adaptability.

P2: Actually, there is support, but we must be resourceful in areas where gaps exist; in those areas where there are lapses, one needs to improvise to meet diverse teaching needs.

P3: Yes, there is support for lecturers from the management provision through the laboratory, workshop, equipment, machines and other gadgets we use in teaching the students. However, continuous training and professional development are crucial.

P4: Yes, there is support from the management as they play a crucial role in supporting instructional strategies. Yet, ongoing training and collaboration can further enhance our teaching practices.

P5: Yes, there is support for lecturers. However, there is room for more training and support for enhanced skill development.

P6: The management provides some support for lecturers, but there is a need for professional development for us to prepare pre-service teachers to teach in the twenty-first century. However, I took it upon myself to read about twenty-first century teaching and integrate these skills in my teaching and design of lessons and assessments.

P7: Yes, there is some level of support from the management, but there is a need for training on twenty-first century teaching.

10. How will you rate your level of knowledge about instructional strategies?

P1: Very high percentage because I know the strategies. Also, I did some work on collaborative teaching. Collaborative teaching can be a powerful strategy, allowing students to learn from each other and fostering a cooperative learning environment.

P2: My level of knowledge about instructional strategies is very high. My investment in professional development related to instructional strategies reflects my commitment to growth. Continuous learning ensures that I stay abreast of evolving educational practices.

P3: I will rate my level of knowledge in instructional strategies as above average, because I have a strong grasp of instructional strategies which undoubtedly enhance teaching and learning outcomes.

P4: I will rate myself as average. My familiarity with instructional strategies, including collaborative teaching, places me at an advanced level. Collaborative teaching indeed empowers my students to learn from one another and cultivates a cooperative learning environment.

P5: Average. My expertise in instructional strategies positions me to create engaging learning experiences for my students. Adaptability and continuous learning are key to staying effective in the ever-evolving educational landscape, hence, my quest for continuous on the job training.

P6: I will say based on experience, it is high as my practical experience contributes significantly to my understanding and real-world application they say, often reinforces theoretical knowledge; making it more effective.

P7: In terms of percentage rating, I will say 70% as I have invested time and effort in professional development related to instructional strategies.

11. How was the knowledge developed?

P1: My level of knowledge about instructional strategy was developed through experience and training and liaising with industry and colleagues from other institutions to ensure that our teaching and assessments are pitched appropriately so that our pre-service teachers are well-equipped to teach technology at their future schools.

P2: I developed the knowledge through experience, seminars, and workshops. Practical exposure and professional development contribute significantly to your expertise.

P3: I developed the knowledge through previous knowledge and training on instructional strategies. Building on previous knowledge and targeted training ensures a well-rounded understanding of instructional strategies. It's a continuous learning journey.

P4: The blend of formal training, on-the-job programs, and interaction with senior colleagues has shaped my expertise in use of instructional strategies over the years. Learning from peers is invaluable.

P5: The knowledge was developed through training (training the trainers) and experience.

P6: Through my lecturers who impacted the knowledge, in-training programme, collaborative effort among colleagues, and personal development

P7: The knowledge was developed through training and re-training, workshops, seminars, Conferences, etc.

12. How confident are you about using these strategies in your teaching?

P1: I am very confident about using the strategies in my teaching, through experience, practice made perfect. My confidence in using instructional strategies stems from practical experience. Over time, practice has honed my ability to effectively incorporate these strategies into teaching.

P2: My confidence in using the strategies is high, when it comes to implementing instructional strategies. They've become an integral part of my teaching toolkit.

P3: I can say that I am confident in using instructional strategies. Their impact on student learning and engagement reinforces this confidence.

P4: I am confident in my ability to apply these strategies. Their positive influence on teaching outcomes motivates me to use them consistently.

P5: My confidence extends to the successful integration of instructional strategies in my teaching. They enhance student understanding and participation.

P6: My confidence is unwavering. Having used strategies extensively over a long period, I've seen their transformative effects on student learning.

P7: Experience has bolstered my confidence in using instructional strategies. I'm well-prepared to create dynamic and engaging learning experiences through my professional training and self- development.

13. What factors promote/impinge the use of Instructional Strategies in the Basic technology lecture room?

P1: The basic factor could be time, for you to cover the content, you have to choose the instructional strategies to be able to meet up with the content you want to teach. So, time is a factor.

P2: In Basic technology, you need to have enough time, because it is a practical-oriented programme. So, one needs to utilize time appropriately. Time utilization is very essential.

P3: Instructional materials affect the use of strategies. Also, the electronic gadgets for the visual aid rooms and students' interest. If the students are interested in the instructional strategy being used by the lecturer.

P4: Improper planning on the side of the lecturers can hinder the effective utilization of instructional strategies for effective teaching and learning.

P5: Funding, can promote/impinge on the use of instructional strategies in the lecture room. When we don't have enough consumables (materials, tools to use in teaching the basic technology effectively)

P6: In some cases, the time factor, inadequate power supply for the equipment, instruments, electronic gadgets, and ICT equipment.

P7: Availability of electricity supply, training devices, and equipment promotes the use of instructional strategies in the Basic Technology lecture room.

14. What factors promote/impinge teaching and learning in the Basic Technology Lecture room?

P1: The factors that promote/impinge teaching and learning are: preparation of the lecturer

(How prepared) and power supply.

P2: Time management is an important factor that promotes/impinges teaching and learning in Basic Technology lectures.

P3: Most of the factors have been mentioned in previous answers; electricity supply to power the equipment to use. Also, the student's interest.

P4: Teachers' preparation and time management are factors that promote/impinge teaching and learning in Basic technology lectures.

P5: Purchasing of modern equipment and training of the craftsmen, and technologists on these equipment.

P6: An important factor that promotes/impinges teaching and learning in the Basic technology lecture room is funding. The latest equipment/tools should be purchased to prepare the students for the digital age.

P7: The factors that promote teaching and learning are equipment, machines, tools and other technology devices.

15. How confident are you in your use of Instructional Strategies in your teaching?

P1: I am very confident in my use of the instructional strategies in my teaching. This is due to my experience in teaching and the use of instructional strategies.

P2: Highly confident in the use of instructional strategy. High confidence is essential for effective teaching. Instructional strategies play a crucial role in creating engaging learning experiences.

P3: Very confident in the use of instructional strategy because it has become integral to teaching and learning processes. Familiarity with instructional strategies enhances the confidence.

P4: I am confident in the use of instructional strategy in my teaching. This mindset of mine ensures successful implementation of instructional strategies in your teaching practice.

P5: I am very confident in the use of instructional strategy in my teaching and this aligns with their positive impact on student engagement and understanding.

P6: I am very confident in my use of instructional strategy to teach the students. This is based on my experience in the field. In my field, you must be a master of the craft.

P7: I am very confident in the use of instructional strategy in my teaching. This is because I have been using instructional strategies for many years.

16. How competent do you perceive yourself in selecting and using various instructional strategies to support teaching and learning?

P1: Very competent as I possess a deep understanding of how instructional strategies impact student engagement and learning outcomes.

P2: ompetent. The consistent use of instructional strategies to engage students reinforces my high level of competence. It's a powerful approach.

P3: Competent, because it has been part of what engaged the students in every class

P4: Fairly competent. My competence aligns with the positive effects of instructional strategies. They enhance my teaching effectiveness and student success.

P5: My competence is above average. My experience and regular application of strategies contribute to my high competence level. Mastery comes from practice.

P6: Highly competent. This reflects my expertise in tailoring instructional strategies to meet diverse learning needs of my learners.

P7: I am competent in selecting and using various instructional strategy to support teaching and learning. This is because of the regular use of these strategies on a regular basis.

17. To what extent can you employ instructional strategies across the curriculum?

P1: To a high extent as the deliberate use of strategies enhances student engagement, understanding, and overall learning outcomes.

P2: To a very reasonable extent because balancing various teaching approaches ensures effective instruction while considering the unique needs of each topic or subject.

P3: To a large extent. From the beginning of the class, I have been using the strategies. Use the strategies from the beginning to the end and throughout the session. So, it's an extensive use of the strategies.

P4: I employ instructional strategies to a good extent. This is because recognizing the impact of strategies; I integrate them extensively to create an enriched learning environment.

P5: I utilize instructional strategies well. I ensure that the instructional strategies I use align with curriculum goals and foster active engagement.

P6: To a good extent, because there is no aspect of instructions that I cannot use instructional strategies for.

P7: I employ instructional strategies across the curriculum, as the need arises and the flexibility allows me to address varying learning objectives, student backgrounds, and subject-specific challenges.

18. How capable are you of determining why, when, and how to employ instructional strategies in education?

P1: I possess a high level of proficiency in defining the appropriate timing, rationale, and methodology for implementing instructional strategies in the field of education, stemming from my teaching experience.

P2: My experience has given me the ability to understand the why, when, and how of using instructional tactics in the classroom.

P3: I am capable of why, when, and how to apply the instructional strategies during my lectures because I have been using them for a long time.

P4: My confidence reflects a solid understanding of strategy selection and implementation. Also, my awareness of context and student needs allows me to choose the right strategies at the right time.

P5: My capability aligns with the importance of strategic choices in education. It's essential for impactful teaching. My ability to adapt strategies to diverse situations enhances student learning outcomes.

P6: I am highly capable. My intuitive grasp of when and how to use instructional strategies enhances student learning. My experience over the years has fine-tuned my decision-making process, ensuring effective teaching practices.

P7: I always make use of these instructional strategies. My adaptability allows me to tailor strategies to specific contexts and learning objectives. So, I am very capable of using it.

19. Have you been trained to use the instructional strategies? For how long? What type of training did you receive?

P1: I have been trained in various teaching strategies, but there is a need for professional development in twenty-first century teaching.

P2: I have undergone training on strategies since I started teaching. The training of staff on the application of twenty-first century skills should be given priority.

P3: I have been trained in the use of instructional strategies, but the lecturers need modern training on the pre-service teachers' preparation for the Fourth Industrial Revolution (4IR).

P4: I have been trained on strategies to teach the students, practically and theoretically. However, this does not include how to prepare pre-service teachers for twenty-first century teaching.

P5: My experience with instructional strategies spans over a decade, but there is always room for further professional development.

P6: My experience with instructional strategies began years ago as a teacher in secondary schools and continues in this institution. Even though there was no professional development for us to prepare pre-service teachers to teach in the twenty-first century, I took it upon myself to read about twenty-first century teaching and integrate these skills in my teaching and design of lessons and assessments.

P7: I have received various forms of training on instructional strategies since I was employed as a lecturer.

20. Does the use of instructional strategies enhance teaching/learning in your lesson?

P1: Yes, it enhances teaching/learning in my lesson. These strategies create dynamic and engaging experiences for students, fostering deeper understanding, active participation, and meaningful connections to the content. I ensure a more effective and impactful educational environment

P2: Yes, it enhances it. Whether through active learning techniques, formative assessments, or collaborative activities, these strategies create an enriched classroom experience.

P3: Absolutely, it enhances teaching/learning. The deliberate use of instructional strategies enhances both teaching and learning. It creates an environment where students actively engage with the material. This engagement leads to better comprehension and retention

P4: Yes, instructional strategies have an enormous impact on teaching and learning. They transform passive listening into active participation, making lessons more memorable and meaningful.

P5: Yes, it amplifies teaching and learning. From scaffolding complex concepts to promoting critical thinking, these strategies create a dynamic classroom and foster deeper understanding.

P6: Yes, it serves as a catalyst for increased teaching and learning. By intentionally selecting strategies, it creates an environment where students actively construct knowledge which leads to better outcomes.

P7: Yes, the consistent use of instructional strategies enhance teaching and learning in my lesson. These strategies create a vibrant and effective educational experience.

21. What are your views on the use of instructional strategies in Basic technology lectures?

P1: My view is that it enhances teaching/learning. Also, it encourages students to participate actively in class.

P2: It enhances one to dissipate the knowledge acquired so far in the area of specialization or his teaching area.

P3: It gives room for students to be more involved in teaching and learning. By incorporating instructional strategies, we empower students to take an active role in their learning journey. Their involvement leads to better retention and application of knowledge.

P4: Instructional strategies allow the students to participate creatively. It provides a canvas for student creativity.

P5: It gives room for teamwork among the students. Also, creativity and new ideas will spring up during the lectures.

P6: It promotes active learning and outcome-based learning. Most especially, when you are talking about practical-oriented courses.

P7: It makes the students concentrate (focus) on the teachings. It improves the performance of the students.

22. How likely are the instructional strategies to appeal to your students and engage/motivate them?

P1: Most likely, the instructional strategies will appeal to the students and engage them. These strategies create a dynamic learning environment, making lessons more interesting and relevant.

P2: Most likely, because they become engaged and motivated, it becomes easier for them to acquire more knowledge.

P3: It engages the students because they are involved in the teaching and learning, and using the strategies, gets the students involved.

P4: Instructional strategies arouse and pique students' interest. Whether through interactive discussions, or hands-on activities these strategies make learning more exciting.

P5: It gives room for more ideas and creativity. Students contribute their ideas, fostering a vibrant and collaborative classroom.

P6: It actively engages them in the learning process and keeps them motivated. Instructional strategies provide opportunities for exploration, critical thinking, and meaningful participation.

P7: It always helps students stay focused, appealing to and enjoying their lessons.

23. How likely are the instructional strategies to appeal to both genders?

P1: Very likely, to appeal to both genders. Although, not in all cases it's essential to recognize that individual preferences may vary. Not all instructional strategies will resonate equally with everyone.

P2: It will appeal to both genders if well utilized. It enhances the interest in the course because effective utilization of instructional materials enhances interest across genders.

P3: It will appeal to both genders because the strategies are not gender-based as Instructional strategies transcend gender biases. They focus on effective teaching and learning, ensuring that all students benefit, regardless of their gender

P4: The instructional strategies are not gender biased, and all the students are actively involved, therefore, it will appeal to both genders.

P5: There is no disparity in gender when it comes to instructional strategies as their purpose is to facilitate learning for everyone.

P6: Instructional strategies do not discriminate about sex, because all the students are involved in teaching and learning, therefore instructional strategy will appeal to both genders.

P7: Instructional strategy is not gender biased, because the students can see and be involved in the lessons.

24. How likely will the task be accomplished within the attention span of the intended students?

P1: It depends on the number of instructional strategies combined within a lesson/class/lecture. If the number of instructional strategies employed is one or two, the task will be accomplished within the attention span of the students.

P2: The task can be accomplished within the stipulated time if the lecturer taking the course is time-conscious, the tasks will be completed within the stipulated time frame.

P3: It can be accomplished. It is based on the instruction the lecturer gave to the students and the timeframe. These will determine the accomplishment of the task.

P4: Time frame is the determinant. The allocated time significantly impacts task completion. Shorter tasks are more likely to fit within students' attention spans.

P5: When the instructional strategies are properly utilized, they will most likely accomplish the task within the attention span of the intended students.

P6: Using the appropriate instructional strategy will determine how to accomplish the task within the attention span of the students.

P7: The task can be accomplished within the attention span of the students through effective time management.

APPENDIX 17 OBSERVATION SCHEDULE

Contextual Information	
Practising lecturer	Participant 1 (P1)
Date	22/08/23
Course Title	Technical Drawing 1 (TCD 121)
Topic	Construction of lines, angles, triangles
Location	AB University, Lagos. Nigeria.

Orientation to teaching Basic technology: The orientation to teaching basic technology was focused on providing students with the skills and knowledge necessary to understand and apply basic technology concepts and principles. This includes developing students' problem-solving and critical-thinking skills, as well as their ability to work collaboratively and creatively
Process: The process of teaching was first broken down into manageable steps, with a focus on engaging students. - Understanding the concepts. - Selection of appropriate instructional strategy and materials. - Good lesson plan with clearly stated objectives, teaching strategies, and assessment methods - Delivering the lesson - Evaluating the effectiveness of the instruction.
Riquor: The content was challenging and not too difficult for the learners to understand. The learners were provided with scaffolding which enabled them to start learning by breaking down the lesson into smaller units from the complex concepts. In the teaching of the concept of a triangle, for example, the teacher first introduced the basic definition, then provided practice of constructing triangles, and then allowed the learners to solve problems that involve the construction of angles and triangles.
Pre-service teacher activities: Pre-service teachers engaged in activities that helped the students to understand the content. -answering questions and brainstorming, -engaging in discussions with peers and the lecturer. -involved in the practice of construction of angles and triangles, as demonstrated by the lecturers.
Lecture venue: The lecture was held in the automobile workshop. There were distractions during the lecture. The appropriate place for this lecture is the drawing room.
Objectives/learning outcome for the lesson: At the end of the lesson the learners should be able to: 7. Construct different angles (90, 60, 45, 30, 120, etc.) using a compass 8. Construct different triangles (scalene, isosceles, equilateral, etc.) using a compass 9. State the characteristics of different triangles 10. Construct a circle given a radius 11. Construct a circle inside the triangle 12. *Plan a discussion on different triangles drawings.*
What instructional strategies were used? The lecturer employed a combination of lecture, questioning, brainstorming, demonstration methods, and using hands-on activities and cooperative learning as instructional strategies.
To what extent are the instructional strategies used to support lesson objectives? The combination of these instructional strategies provided a very effective approach to support the lesson objectives.
Frequency of use: The lecturer consistently used these instructional strategies in his lectures.

How are they linked to content? All the instructional strategies used by the lecturers are linked to the content as they all provide opportunities to explore, understand, and apply the concepts taught. The lecture method was used to explain the main ideas of the topic while the questioning method was used to clarify points and deepen understanding. The brainstorming was used to generate ideas and discussion and the demonstration method was used to complete some tasks in the content. Cooperative learning was used to reinforce the concepts in the content and allow for practice and application.
When are they used? These instructional strategies were used at various points throughout the lesson. The lecture method was used at the beginning of the lesson to introduce the concepts. The questioning and brainstorming methods were used throughout the lesson to check for understanding and encourage discussion. The demonstration method was used at the end of the lecture to reinforce the key points. The cooperative learning activities were also used as a culminating activity at the end of the lesson, or as a formative assessment during the lesson.
Why are they used in this way? The instructional strategies were used in these ways because they are evidence-based and are effective in supporting student learning. The lecture method is a direct way to present new information, while the questioning and brainstorming methods allow for student interaction and discussion. The demonstration method provides a concrete example of the concepts, and the cooperative learning activities promote collaboration and teamwork. By using these strategies in these ways, the lecturer was able to meet the needs of all students and help them to achieve the learning objectives. The lecture, questioning, brainstorming, and demonstration methods are all used because they align with the principles of cognitive learning theory. This theory suggests that learning is an active process that involves the construction of knowledge and that different students have different learning styles.
What scheme was employed to assess learning in terms of the use of Instructional strategies? To assess instructional strategies' effectiveness, the lecturer employed various assessment methods. One method used was formative assessments: asking questions during the lecture and giving quick quizzes throughout the lesson. Additionally, observation was used to assess student engagement and understanding during the lesson.
How effective are the Instructional strategies at achieving the main lesson objective(s)? The instructional strategies used above are very effective at achieving the main lesson objectives. The lecture method is effective at providing a basic understanding of the concepts. The questioning and brainstorming methods are effective at promoting critical thinking and encouraging students to engage with the material. The demonstration method is effective at showing how the concepts can be applied in real-world situations. Finally, cooperative learning activities are effective at promoting teamwork and collaboration. These instructional strategies work together to provide a comprehensive learning experience that meets the stated objectives.
How good are the instructional strategies used at encouraging creativity and collaborative learning? The instructional strategies employed are very effective at encouraging creativity and collaborative learning. The lecture, questioning, and brainstorming methods all encourage students to think creatively and come up with their ideas. *Demonstration method is well suited as an instructional strategy for technical subjects to promote spatial visualisation, identification and graphic communication.* The cooperative learning activities promote active collaboration and teamwork. These strategies provide opportunities for students to be creative and work together, which is very important for learning and success in the real world.
Does the activity fit within the timetable? Yes, the lecture duration was two (2) hours. So, the activity fits within the allotted period

To what extent does it support problem-solving/critical thinking? The above instructional strategies provided a great deal of support for problem-solving and critical thinking. The lecture method introduces the problem and provides some information and context. The questioning method encourages students to think critically about the problem and come up with possible solutions. The brainstorming method provides an opportunity for students to generate ideas and solutions. And the demonstration method provides a model for how to approach and solve the problem. These strategies work together to enhance problem-solving and critical-thinking skills in various ways.
How appropriate are the explanations for the level of your intended group? The explanations utilized by the lecturer were very appropriate for the intended students. The explanations were clear, concise, and easy to understand. They were also supported by examples, demonstrations, and opportunities for practice. The explanations are at a level that is appropriate for the student's prior knowledge and understanding.
Knowledge of curriculum (Vertical or Horizontal): The knowledge of the curriculum for the topic construction of lines, angles, triangles, and triangles in a circle is primarily horizontal. The curriculum focuses on teaching students the specific skills and knowledge needed to construct these shapes. This includes understanding the concepts of lines, angles, and triangles, and being able to apply these concepts to construct shapes. There is also some vertical knowledge, in that students need to have a basic understanding of geometry to understand the topic. However, the overall focus is on horizontal knowledge and skills development.
Knowledge of Basic technology pre-service teachers: The knowledge of the basic technology pre-service teachers for this topic, is a combination of both vertical and horizontal knowledge. On the vertical side, pre-service teachers need to have a solid foundation in basic mathematics. This includes understanding concepts such as angles, lines, and triangles. On the horizontal side, the pre-service teachers need to know how to use the compass to construct these shapes. They also need to understand the importance of accuracy and precision when constructing these shapes.
Misconception: There are a few common misconceptions that students often have about the construction of angles and triangles. First, in constructing angles and triangles in Technical Drawing you can measure the angles straightaway. This is not so. Only the compass should be employed for the construction. This misconception can be corrected by providing students with accurate information and by allowing them to explore and experiment with these shapes.
Learning difficulties: There were a few common learning difficulties that students experienced. One difficulty was the inability to first understand the different types of triangles, such as equilateral, isosceles, and scalene triangles. Some students also had difficulty understanding the relationship between angles and lines. Additionally, students found it difficult to make an arch with a compass and visualize the construction of these shapes.
Learning styles: There were varieties of different learning styles that were used. The visual-spatial learning style which involves using images, pictures, and diagrams to represent the concepts. Another learning style used was the auditory-sequential, which involves learning through listening to and repeating information. Another learning style was tactile-kinesthetic, which involves learning through hands-on activities and movement. Finally, there was the use of the intrapersonal learning style, which involves learning through reflection and introspection.
Motivation: There are a few different motivations that were used to encourage the students to learn. One motivation was curiosity, which was fostered by asking questions and encouraging exploration. Another motivation was relevance, which was fostered by explaining how the concepts can be applied in the real world. Another motivation was competition, which was fostered by using quick quizzes as challenges to teach the concepts. Finally, there was recognition, which was

fostered by providing positive feedback and recognition for achievement during the delivery of instruction.
Needs: There are a few different needs that need to be considered. -appropriate scaffolding: providing support and guidance as students learn new concepts. -various and engaging activities, which help to keep students interested and engaged. -clear and concise explanations so that students can understand the concepts being taught. -adequate practice, so that students can master the concepts.
Background: The lecturer introduced the topics by providing some background knowledge and understanding. First, he explained the basic geometry concepts such as points, lines, angles, and shapes. Without this background knowledge, It can be challenging for students to comprehend the principles of construction in technical drawing.
Assessments: types of assessment: There are a few types of assessment that were used to evaluate the class's understanding of the construction of lines, angles, triangles, and triangles in a circle. The formative assessment was used to identify areas of confusion and address misconceptions. This was done through questioning, observation, or other methods. Secondly, the summative assessment was used to evaluate the student's learning after they had completed the unit. These assessments can take the form of tests, projects, or other activities.
Materials and resources: Ruler - Pencils - Compass - Whiteboard and Markers - Chart paper or poster board **Books:** "Technical Drawing for School Certificate and GCE" – by G.N. Green. "Engineering Drawing with worked examples" – by Parker, M.A., and Pickup, F.

APPENDIX 18: OBSERVATION SCHEDULE (P2)

Contextual Information	
Practising lecturer	Participant 2 (P2)
Date	22/08/23
Course title	Industrial Safety: ITE 121
Topic	Introduction Industrial Safety
Location	AB University, Lagos. Nigeria.

Orientation to teaching Basic technology: This subject is to equip students with the knowledge and skills they need to safely work with machines and equipment. With that in mind, the orientation focuses on the importance of safety and how to stay safe while working with machines.
Process: - Identify the learning objectives for the lesson. - Select appropriate instructional strategies and materials. - Plan activities and assessments that align with the objectives. - Execute the lesson and assess student understanding. - Evaluate the effectiveness of the lesson and make adjustments as needed.
Riguor: The rigor was high enough to challenge and engage students. The lecturer struck a balance between making the material too easy or too difficult and adjusting the rigor as needed based on student performance.
Pre-service teacher activities: - Observing the lecturer while teaching in the classroom. - answering questions during classroom - discussing with peers - asking the lecturer questions during the lecture - Reflecting on teaching experiences.
Lecture venue: The lecture took place in Technology Education Hall 1. The hall was well-illuminated and ventilated. The chairs and tables were well arranged.
Objectives/learning outcome for the lecture: At the end of the course, students will be able to: 5. Define industrial safety, 6. State the importance of industrial safety in the workplace, 7. State its impact on workers, organisation & community, 8. State the different safety hazards and how to avoid them.
What instructional strategies were used? The instructional strategies used by the lecturer were the Lecture method, questioning, and blended learning.
To what extent are the instructional strategies used to support lesson objectives? The instructional strategies were employed appropriately to support the teaching objectives of industrial safety. The lecture method provides a clear and structured way to introduce new concepts, while the questioning method encourages students to engage with the material and think critically about it. Blended learning allows students to do part of their learning in an independent digital environment, and part of it in a face-to-face classroom setting.
Frequency of use: He used these instructional strategies consistently in all of his lectures.
How are they linked to content? The lecture method was used to introduce new concepts, while the questioning method encouraged students to engage with the material and think critically about it. Blended learning combines the best of both worlds, providing a structured way to learn the material

while also allowing for critical thinking. This means that the methods are closely linked to the content of the course, as they allow students to understand and apply the concepts in a meaningful way.
When are they used? The different instructional methods are used at different points throughout the teaching process. The lecture method was used at the beginning of the lesson, to introduce the main concepts. The questioning method was used throughout the lesson, to check for understanding and promote critical thinking.
Why are they used in this way? Each instructional method was used in this way for a specific reason. The lecture method provides a clear and concise introduction to the concepts. The questioning method and blended learning were used to keep students engaged and provide opportunities for feedback.
What scheme was employed to assess learning in terms of the use of Instructional strategies? To assess the effectiveness of these instructional strategies, the lecturer used formative assessment, such as questions, quick quizzes, or reflections, throughout the teaching process to track student progress and identify any areas of difficulty. This helps to ensure that the instructional strategies are effective.
How effective are the Instructional strategies at achieving the main lesson objective(s)? These instructional strategies were highly effective at helping students to achieve the main objectives of a lesson. The lecture method helped to establish a basic understanding of the concepts. The questioning method promotes higher-level thinking and deepens understanding. And the blended learning method reinforces the concepts and helps to make them meaningful and relevant. By using all of these strategies together, students were more likely to retain and apply the information they had learned.
How good are the instructional strategies used at encouraging creativity and collaborative learning? These instructional strategies are very good at encouraging creativity and collaborative learning. The lecture method provided a framework for discussion and exploration. The questioning method encouraged students to think outside the box and generate new ideas. The blended learning method helped opportunities for collaboration and group. This led to a more creative and collaborative learning experience.
Does the activity fit within the timetable? Yes, the activity fit within the time-table. The duration on the time-table is two (2) hours.
To what extent does it support problem-solving/critical thinking? The lecture, questioning and blended learning provided a high level of support for problem-solving and critical thinking. The lecture method provided the foundational knowledge needed to understand the problem. The questioning method promoted the use of problem-solving skills and critical thinking. The blended learning method allows for hands-on practice and the application of problem-solving skills. Together, these strategies provided a well-rounded approach to support students in becoming skilled problem solvers and critical thinkers.
How appropriate are the explanations for the level of your intended group? The explanations are highly appropriate for the intended group. The explanations were clear and concise. Also, provided enough detail to be meaningful. The terminology used is relevant to the group's background and level of understanding. Overall, the explanations are very well-suited to the intended group.
Knowledge of curriculum (Vertical or Horizontal): There is both horizontal and vertical knowledge of the curriculum that is needed. The horizontal knowledge includes an understanding of the basics of safety, such as the importance of following safety procedures, how to identify and assess hazards, and how to respond to emergencies. The vertical knowledge includes specific knowledge about the hazards that occur in an industrial setting and how to prevent and mitigate them. Both types of knowledge are important for a comprehensive understanding of industrial safety.
Knowledge of Basic technology pre-service teachers: For basic technology pre-service teachers, horizontal knowledge includes an understanding of the basics of safety, such as the importance of workplace safety, the role of government agencies in regulating safety, and how to create a safe workplace. The vertical knowledge includes a deeper understanding of specific safety topics, such as

emergency preparedness, and environmental safety. Pre-service teachers need to have both horizontal and vertical knowledge of the curriculum, so they can effectively teach their future students about industrial safety.

Misconception: A few misconceptions arose when teaching introduction to industrial safety. One misconception is that safety is only important in high-risk industries. In reality, all workplaces have some level of risk and all employees should be aware of basic safety practices. Another misconception is that safety is only about physical safety. In reality, safety also includes psychological, emotional, and social well-being.

Learning difficulties: Some learning difficulties arose during the teaching. One difficulty was that the concepts were abstract and difficult to understand. Another difficulty was that many students lacked prior experience with workplace safety, so they may not be able to relate the concepts to their own lives. The students had a hard time staying engaged.

Learning styles: The main learning styles that were used include visual and auditory. Visual learners learn best by seeing information, such as through charts, diagrams, and other images. Auditory learners learn best by hearing information, such as through lectures or discussions. These styles were incorporated into the course to ensure that all students have the opportunity to learn in the way that works best for them.

Motivation: Common motivations used are rewards or recognition. Collaboration with other students also gave social motivation to the learners, as the desire to belong or feel connected to others increased their interest in the classroom. Combining these motivations effectively encouraged students to learn the material in a meaningful way.

Needs: These include physical needs, such as a comfortable learning environment and adequate resources. There are also cognitive needs, such as clear and understandable instruction. Finally, there are affective needs, such as a sense of belonging and positive reinforcement. The lecturer was able to fulfill these needs while delivering his teachings.

Background: The lecturer provided background notes for industrial safety, important context and information about the topic. They included a brief history of safety practices in the workplace, an overview of current safety regulations and standards, and an explanation of common hazards and risks. Additionally, the background notes contained case studies of past incidents and accidents, and information about how to prevent similar incidents from occurring in the future.

Assessments: types of assessment:
The lecturer used various assessment methods to gauge the students' comprehension of the material. These include quizzes and questions. Additionally, the lecturer used observation and questioning to assess the student's understanding of the material. The assessment was designed to measure the student's understanding of the key concepts and to identify any areas that need further instruction. Summative assessments at the end of the lesson were also given, such as tests, essays, and projects.

Materials and resources:

16. Textbooks,
    I) "Introduction to Safety Engineering" by S.O. Agunbiade, published by the Federal Institute of Industrial Research Oshodi (FIIRO).
    II) "Industrial Safety" by H.I. Amaku, published by Spectrum Books Limited.
17. Videos,
18. Handouts,
19. Worksheets,
20. Case studies
21. Safety data sheets, and
22. Safety equipment.

APPENDIX 19: OBSERVATION SCHEDULE Participants 3

Contextual Information	
Practising lecturer	Participant 3 (P3)
Date	23/08/23
Course Title	Workshop Practice
Topic	Safety in the Workshop
Location	AB University, Lagos. Nigeria.

Orientation to teaching Basic technology: By teaching students about safety in the workshop, they will be better equipped to handle the challenges and risks that come with working with technology.
Process: First, the lecturer identifies the learning objectives for the lesson. Second, the lecturer creates a lesson plan that incorporates different teaching methods and strategies. Third, the lecturer delivers the lesson and engages with students. Fourth, the lecturer assesses the student's understanding and provides feedback. Also, emphasise the need to plan for teaching, be guided by the curriculum, and check what content must be covered before designing the lesson and planning activities, but all this depends on the student's content knowledge.
Rigour: The lecturer has a strong knowledge of the safety protocols that are in place to mitigate these hazards and he communicates these clearly and effectively to students.
Pre-service teacher activities: - Reading and discussing a case study about a workplace accident - Listening to the explanation and observing the lecturer. - Participating in a safety quiz.
Lecture venue: The lecture took place in the Technology Education Hall 1. The hall was well-lit and well-ventilated, creating a conducive environment for learning.
Objectives/learning outcome for the lesson: At the end of the lesson, students should be able to: 1. Define safety, 2. State the causes of accidents in the workshop, 3. Describe a good workshop planning & layout. 4. State the importance of safety in the workplace, 5. Identify potential safety hazards 6. State proper safety procedures when using equipment in a workshop.
What instructional strategies were used? The instructional strategies used include the lecture method, questioning, and blended learning.
To what extent are the instructional strategies used to support lesson objectives? The instructional strategies were used to support lesson objectives to a large extent. The lecture method provides the learners with a clear and precise explanation of the lesson objectives while also introducing new ideas and concepts. The questioning technique was used to test the students' understanding of the concept and also to encourage critical thinking while the demonstration showed the learners how to apply the concept in real-world situations. Finally, blended learning provided a more interactive and remain experience that helped the learners to understand better and retain taught concepts.
Frequency of use: The lecturer consistently employed instructional strategies in his teaching.
How are they linked to content? These methods were linked to the content of the lesson differently. The lecture method was used to introduce new concepts, while questioning allows students to explore and expand on those concepts. The demonstration method was used to complete some tasks in the content and blended learning helps to apply those concepts to real-world situations.
When are they used? These methods were used during the lecture and at the end of the lesson to convey the key concepts, summarize the concepts, reinforce the key points, and engage the learning experience.
Why are they used in this way? The lecture method allows students to hear new ideas and concepts, which can spark their creativity and give them new ideas to explore. Questioning

encourages students to think creatively and critically about the material, and The demonstration method provides a concrete example of the demonstration method provides a concrete example of the concepts. In blended learning, students can work together to complete tasks and solve problems, which promotes collaboration and teamwork.
What scheme was employed to assess learning in terms of the use of Instructional strategies? The lecturer gave the learners a quiz that included questions about workplace safety. The learners were also asked to develop a plan to improve workplace safety in their workshop. Assessing the results of learning through these methods is known as "learning outcomes assessment".
How effective are the Instructional strategies at achieving the main lesson objective(s)? The main lesson objective was successfully achieved through the combination of these instructional strategies, as shown by the response of the learners during the short quiz, as well as the questions and answer segment at the end of the lesson.
How good are the instructional strategies used at encouraging creativity and collaborative learning? The lecture method encouraged creativity by presenting new and interesting information that sparks new ideas. Questioning encouraged creativity by requiring students to think critically and come up with new solutions.
Does the activity fit within the timetable? Yes. The activity was scheduled appropriately in the time-table."
To what extent does it support problem-solving/critical thinking? Lectures support problem-solving by providing information and examples that were applied to real-world problems. Questioning supports critical thinking by requiring students to evaluate and analyze information to come up with answers. This allows students to explore multiple perspectives and approaches to problem-solving.
How appropriate are the explanations for the level of your intended group? The lecture was effective in promoting knowledge acquisition, and questioning was effective in promoting critical thinking.
Knowledge of curriculum (Vertical or Horizontal): It's important to have both vertical and horizontal knowledge. Students need to have a broad understanding of the different aspects of safety, and they also need to have a deep understanding of the specific safety procedures that are relevant to the workshop environment. So, to effectively teach safety in the workshop, it's important to have a curriculum that incorporates both vertical and horizontal knowledge.
Knowledge of Basic technology pre-service teachers: Pre-service teachers are students who are in the process of becoming certified teachers. They may have some knowledge of safety, but, their knowledge is still developing.
Misconception: Common misconceptions about safety can include thinking that safety procedures are not important, or that safety is only necessary for certain types of equipment. Misconceptions can lead to dangerous situations in the workshop, so it's important to address them early on. To address these misconceptions, teachers can use a variety of strategies, such as discussion, role-playing, and hands-on activities.
Learning difficulties: To address the learning difficulties, lecturers use a variety of techniques, such as breaking down tasks into smaller steps, providing frequent feedback, and using visual aids. Learning difficulties may include a lack of focus, difficulty following instructions, and trouble comprehending abstract concepts.
Learning styles: The learning styles utilized during classroom instruction include: visual, auditory, and reading/writing.
Motivation: The lecturer used the following motivation: setting clear goals, providing meaningful feedback, and using positive reinforcement during questioning and answering sessions.
Needs: One need is to understand the importance of safety and how it relates to learners' safety and the safety of others in the workshop. Another need is to understand how to follow safety procedures and use safety equipment correctly. Finally, students need to have the confidence to speak up if they see something unsafe happening in the workshop.
Background: This background includes understanding the history of workplace safety, the evolution of safety laws and regulations, and the impact of safety on the economy and society. With this background knowledge, students can understand the importance of safety and how it relates to their lives.

Assessments: types of assessment: Several types of assessments are used in the classroom when teaching safety in the workshop. For example, observational assessments are used to observe students' behavior and actions while working in the workshop. In addition, short tests were used to assess students' understanding of safety concepts.
Materials and resources: Fire extinguishers**,** First aid kits**,** Safety signs**,** Whiteboard & marker.

APPENDIX 20: OBSERVATION SCHEDULE (P4)

Contextual Information	
Practising lecturer	Participant 4 (P4)
Date	28/08/23
Course Title	Building Technology (BUT 121)
Topic	Principle of design and Foundation
Location	AB University, Lagos. Nigeria.

Orientation to teaching Basic technology
This topic, principle of design & foundation is aligned with the overall goal of basic technology, which is to provide students with an understanding of the fundamental principles and concepts of technology. To achieve this goal, it is necessary to cover topics such as design, materials, manufacturing processes, and quality control. This particular topic falls under the umbrella of design, which is a critical aspect of technology education.

Process This process involves introducing students to the basic concepts and principles of design. It also involves providing them with opportunities to apply these concepts in real-world situations. The lecturer introduced the topic by stating the practical stages involved in the construction of a building: Clearing of plants, Recce survey (first visit to the site), mapping out the site, discussion with the client, sketching the building plan (based on the client's needs), etc.
The process includes opportunities for students to reflect on their learning and receive feedback from the teacher. This process can be broken down into several smaller steps, such as introducing the topic, providing examples, and facilitating discussion.

Rigour: The lecturer provides students with a thorough understanding of the principles of design. This includes the theoretical understanding and how these principles can be applied in real-world situations. The topic is challenging enough to engage students and encourage them to think critically.

Pre-service teacher activities:
- Observing the lecturer while teaching in the classroom
- asking the lecturer questions during the lecture
- Brainstorming exercises
- Team projects
- Case studies

Lecture venue: The lecture was held in Technology Education Hall 1. The hall was well-lit and well-ventilated, creating a conducive environment for learning.

Objectives/learning outcome for the lesson: At the end of the lecture, students should be able to:
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vii. State the process of design & foundation,
viii. Explain the difference between form and function in design.
ix. Define concrete & mortar.
x. Explain the constituents & properties of concrete.
xi. State the difference between mortal & concrete.

What instructional strategies were used? The lecturer used demonstration, lecture methods, guided discovery, discussion and project-based learning in teaching the students.

To what extent are the instructional strategies used to support lesson objectives?
The lecturer used to a great extent, all the instructional strategies. They all have a role to play in helping students reach their learning objectives

Frequency of use: The lecturer used these instructional strategies oftentimes, in his teaching.

How are they linked to content?
The instructional strategies were all linked to the content in a meaningful and relevant way. For example, the demonstration was used to show how the concepts are applied in the real world, lecture method was used to explain the concepts in detail, questioning was used to assess and reinforce understanding of the concepts, and project-based learning was used to apply the concepts to a real-world situation. Guided discovery is an instructional strategy that caters to learner diversity in technology classrooms in terms of levels of cognition and gender. The teacher is the guide who only scaffolds learning, but the learner does the thinking and problem-solving.

When are they used?
The different instructional methods were used at different points throughout the teaching process. The lecture method was used at the beginning of the lesson, to introduce the main concepts. The questioning method was used throughout the lesson, to check for understanding and promote critical thinking. The demonstration and project-based learning were used at the end of the lesson.

Why are they used in this way?
First, these methods are all evidence-based and are effective in promoting learning. Second, they are all suited to the learning objectives of teaching principles of design & foundation. Demonstration is a good way to show clearly the concepts being taught, the lecture method provides clear and concise explanations, questioning allows for discussion and interaction, and project-based learning allows for hands-on application of the concepts. Also, drawing from the curriculum content and aligning the assessment with the objectives so those objectives are achieved, choosing the correct teaching strategy, providing feedback and allowing them to reflect.

What scheme was employed to assess learning in terms of the use of Instructional strategies?
This scheme is called the "assessment triangle." The assessment triangle consists of three elements: performance assessment, feedback, and student reflection. Performance assessment is used to measure student learning, while feedback is used to provide information about student performance. Student reflection is used to encourage students to think about their learning process and make connections between what they have learned and their own experiences. All three elements of the assessment triangle are important for effective learning and assessment and were employed by the lecturer.

How effective are the Instructional strategies at achieving the main lesson objective(s)? The combination of the instructional strategies used was very effective. The positive feedback showed that the combination was very effective in achieving the stated behavioral objectives.

How good are the instructional strategies used at encouraging creativity and collaborative learning? Very good as the combination of instructional strategies encouraged creativity and collaborative learning in the following ways:
- Encourage students to ask questions, experiment, and make mistakes
- Promote discussion and collaboration among students
- Provide opportunities for students to explore their interests and passions
- Allow students to work on projects independently or in small groups
- Foster an environment of curiosity, creativity, and innovation
- Use real-world problems and scenarios as the basis for learning activities

Does the activity fit within the timetable? Yes, the activity fits within the time-table.

To what extent does it support problem-solving/critical thinking?
The instructional strategies were used in several ways to encourage these skills:
- Encouraging students to think critically and reflect on their learning
- Providing opportunities for students to problem solve and make decisions
- Challenging students to consider multiple perspectives and find creative solutions
- Helping students to break down complex problems into smaller, more manageable tasks

How appropriate are the explanations for the level of your intended group?
These instructional strategies are effective at encouraging problem-solving and critical thinking by providing a visual representation of the problem and solution. It also allows students to ask questions and receive feedback in real-time. Additionally, students were encouraged to ask questions and make connections to their own experiences.

Knowledge of curriculum (Vertical or Horizontal):
There is both horizontal and vertical knowledge of the curriculum that is needed.
Vertical knowledge refers to the progression of concepts and skills from one grade level to the next. This means that the curriculum was designed so that students build on their knowledge and skills from one grade level to the next. Horizontal knowledge refers to the connections between different subjects and concepts within the curriculum.

Knowledge of Basic technology pre-service teachers. They need to have a basic understanding of the principles of design and technology. This includes understanding the role of design and technology in society, the different types of design, and the different types of technology.

Misconception
- The belief that design is only about aesthetics
- The belief that technology is only about using computer
- The belief that design and technology are separate subjects.

Learning difficulties One potential difficulty is the practical nature of the subject. This means that students may struggle to grasp the concepts and make connections with real-world experience.
Another potential difficulty is the technical nature of the subject. This means that students may struggle to understand the technical language and concepts used in the curriculum

Learning styles The learning styles employed for this teaching included:
- Visual learning: This involves using images, charts, and diagrams to teach the material.
- Kinesthetic learning: This involves hands-on activities and experiments to teach the material.
- Auditory learning: This involves listening to and discussing the material.
- Reading/writing learning: This involves reading texts and writing about the material.

Motivation:
The lecturer made the subject relevant to the learners' lives and future careers.
- Used examples and applications that are interesting and meaningful to them.
- Provided positive reinforcement and feedback.
- Gave them opportunities to be creative and innovative.
- Encouraged collaboration and discussion.

Needs:
- Understanding the historical and cultural context of the subject.
- Learning about the different types of design and technology.
- Developing problem-solving skills.
- Learning how to use technology effectively.
- Developing critical thinking skills.

Background:
The lecturer gave us some notes about the topic being discussed - the historical background of building construction.

Assessments: types of assessment
- Observation: This involves observing students working on projects and completing assignments.
- Tests and quizzes: These were given during the lesson as formative assessments and used to measure student knowledge.

Classwork:

Design a task that uses project-based learning.
Materials and resources - Books and articles on design and technology. - Physical materials, building materials: cement, sand & coarse aggregate (granite or gravel). - Project-based materials, such as materials for building models or prototypes. - Real-world examples and case studies.

APPENDIX 21: OBSERVATION SCHEDULE (P5)

Contextual Information	
Practising lecturer	Participant 5 (P5)
Date	
Course Title	Introduction to Vocational and Technical Education
Topic	Characteristics of Vocational & Technical Education
Location	AB University, Lagos. Nigeria.

Orientation to teaching Basic technology The orientation of the topic "characteristics of vocational education" to basic technology is primarily in the context of the importance of technical skills and knowledge in vocational education. Basic technology includes a wide range of skills and knowledge that are necessary for success in vocational education, such as computer literacy, basic math and science skills, and hands-on learning.
Process - Identification of learning objectives - Development of instructional materials - Implementation of instruction - Evaluation of learning
Rigour: The "rigour" involved in teaching "characteristics of vocational education" is primarily related to the depth and breadth of the knowledge and skills that are required for success in vocational education. This means that students need to have a thorough understanding of the material, and be able to apply it in real-world situations. In addition, they need to be able to demonstrate proficiency in a variety of skills and techniques that are relevant to the field.
Pre-service teacher activities: - Reading and analyzing relevant materials. - Engaging in class discussions. - Reflecting on personal experiences. - Researching and collecting information. - Collaborating with peers. - Practicing skills and techniques. - Observing and analyzing real-world examples.
Lecture venue: The lecture was held in Vocational Education Hall 3
Objectives/learning outcome for lesson: At the end of the lecture, the students should be able to: i. Define vocational education and vocational training ii State the differences between vocational education & vocational training iii Differentiate between vocational education and technical education. iv Identifying the components of vocational education. v Explaining the role of vocational education in society. vi Evaluating the effectiveness of specific vocational education programs.
What instructional strategies were used? The instructional strategies used by the lecturer includes lecture, brainstorming, and cooperative learning in her teaching.
To what extent are the instructional strategies used to support lesson objectives? Lecture method is a good match for the objective of providing a comprehensive overview, as it allows the instructor to present a lot of information in a structured way. Brainstorming is a good match for the objective of generating new ideas, as it encourages creative thinking and problem-solving. Cooperative learning is a good match for the objective of promoting collaboration, as it requires students to work together to complete tasks.
Frequency of use: The instructional strategies were used intermittently during the lectures.
How are they linked to content?

- Lecture provides an overview of the subject, which helps students to understand the basic concepts and ideas. - Brainstorming allows students to explore and expand on the information learned through lecture. - Cooperative learning provides an opportunity for students to apply the information from lecture and brainstorming in a real-world context.
When are they used? The lecture method was used to introduce the topic to the learners which provided an overview. The brainstorming activity was used in the middle of the class to get the learners thinking creatively about the topic while the creative learning was used at the end of the class to help the students apply what they have learnt and consolidate their knowledge.
Why are they used in this way? The above instructional strategies are used in the way they are because they each have their own unique benefits. Lecture is used to present a lot of information in a clear and concise way, while brainstorming is used to generate new ideas and creative solutions. Cooperative learning is used to foster teamwork and collaboration, which can help students to learn from each other and improve their communication skills.
What scheme was employed to assess learning in terms of the use of Instructional strategies? The assessment scheme for "characteristics of vocational education" included a variety of different assessments, such as: - Written exams that test students' knowledge of the subject. - Presentations that give students the opportunity to demonstrate their understanding of the subject. - Self-assessment activities that encourage students to reflect on their learning.
How effective are the Instructional strategies at achieving the main lesson objective(s)? They are highly effective when used together. For example, lecture provided the necessary background information for students, while brainstorming helped to generate new ideas and solutions. Cooperative learning was used to put these ideas into practice, and assess how well they work. This approach was particularly effective in achieving the lesson objectives, as it allows students to learn from each other and build on their understanding of the taught topic.
How good are the instructional strategies used at encouraging creativity and collaborative learning? The combination of the instructional strategies proved to be very effective at encouraging both creativity and collaboration. For example, brainstorming has shown to promote creative thinking, as it allows for the free flow of ideas without judgment. Cooperative learning has also shown to encourage collaboration, as it requires students to work together to complete tasks and achieve goals. So, it seems that these strategies can be very effective in promoting creativity and collaboration.
Does the activity fit within the timetable? Yes
To what extent does it support problem-solving/critical thinking? Both lecture and cooperative learning are highly effective at supporting these skills. lecture can provided students with the information and knowledge they need to solve problems. Cooperative learning then allowed the students to practice problem solving in a real-world context, as they work together to find solutions. This combination of lecture and cooperative learning was very effective in supporting problem solving and critical thinking.
How appropriate are the explanations for the level of your intended group? This class evaluation suggests that lecture, brainstorming, and cooperative learning can all be very effective for pre-service teachers. This is because these strategies can help to provide a strong foundation of knowledge and skills, which is important for new teachers. They can also help to develop teamwork and communication skills, which are essential for working with students and colleagues.
Knowledge of curriculum (Vertical or Horizontal)
Knowledge of Basic technology pre-service teachers: The pre-service teachers may have some knowledge of the characteristics that distinguish vocational education from other types of education. For example, they may know that vocational education is focused on developing practical skills that can be used in the workforce. They may also know that vocational education often takes place in a different setting than traditional education, such as in a workshop or laboratory.

Misconception: Some possible misconceptions include the idea that vocational education is only for people who are not academically inclined, or that it is only for people who want to learn a specific trade. Other misconceptions may include the idea that vocational education is not as rigorous as traditional education, or that it does not lead to well-paying jobs.
Learning difficulties: One possible difficulty is that the concepts and terminology used in this subject can be complex and challenging to grasp.
Learning styles: some of the different learning styles used by the lecturer include visual, auditory, and kinesthetic learning styles.
Motivation:
Needs: One need is for clear and concise information, as this can help to ensure that students understand the concepts being taught. Another need is for practical and hands-on learning opportunities, as this can help to reinforce the concepts being taught and make them more meaningful. Finally, pre-service teachers may need support and feedback from instructors, as this can help to guide their learning and ensure that they are on the right track
Background: Vocational education focuses on the acquisition of practical skills and knowledge that can be applied in a workplace. It can be acquired both in a non- traditional settings such as a trade school or apprenticeship program. It also focuses on specific occupations or industries.
Assessments: types of assessment: - True/False quiz - A short answer/ Essay question - A group activity or discussion - Self-reflection.
Materials and resources: **Materials** **Textbooks:** - "Vocational Education: Principles and Practice" by J.O. Onyema, published by Lagos State University Press. - "Vocational Education and Training in Nigeria" by K.O. Odimegwu, published by University Press Plc. - "Foundations of Vocational Education" by S.J. Olasanmi, published by Associated Press of Nigeria Limited. - "A Critical Analysis of Vocational Education in Nigeria" by I.A. Adeboye

APPENDIX 22: OBSERVATION SCHEDULE (P6)

Contextual Information	
Practising lecturer	Participant 6 (P6)
Date	14/08/23
Course Title	Woodwork
Topic	Defects in timber
Location	AB University, Lagos. Nigeria.

Orientation to teaching Basic technology:
This topic is oriented towards basic technology in a few ways. Firstly, the topic involves understanding the different types of defects that can occur in timber, and how these defects can affect the strength and durability of the timber. Secondly, the topic involves understanding the methods used to detect and diagnose timber defects, as well as the methods used to prevent or correct them. This all falls under the umbrella of basic technology, as it relates to the understanding and use of tools and methods for working with wood.

Process:
-Introduce students to the different types of defects that can occur in timber, and the different causes of these defects.
- explain how defects can affect the strength and durability of timber and the potential consequences of leaving these defects unaddressed.
-explain how to detect and diagnose defects in timber, and how to correct or prevent them
- ask questions and get feedback

Rigour :
This topic requires a good deal of rigour. However, the lecturer was able to adjust the rigor to the level of the students. Given that different defects can occur in timber and a range of methods for addressing them. Students need to have a solid understanding of the different types of defects, as well as the methods for identifying and correcting them. In addition, this topic requires students to have a good understanding of the science behind the defects. Students need to be able to identify and diagnose different types of defects, such as checks, shakes, splits, knots, and decay. They also need to be able to determine the severity of each type of defect, and whether or not the defect needs to be corrected. In addition, students need to be able to understand and apply the various methods for correcting defects, including filling, patching, trimming, and sealing.

Pre-service teacher activities:
-Students participated in hands-on activities such as examining different types of wood for defects.
-They also researched using their smartphones on the different types of defects, their causes, and how to correct them.
-Students worked in groups to analyze real-world examples of timber defects and discuss how they could be addressed.

Lecture venue: The lectures took place in the Woodwork Technology workshop. It is the appropriate venue for this course, with all necessary equipment, tools, instruments, workbenches, and materials.

Objectives/learning outcome for the lesson: At the end of the lesson, the students should be able to:

vi. State the meaning of defects in timber,
vii. Differentiate natural and artificial defects
viii. Explain the conversion of timber.
ix. Identify and describe the different types of defects in timber.
x. Explain the causes of defects in timber.

What instructional strategies were used? The lecturer used lecture methods, brainstorm, questioning, demonstration, project-based learning and blended learning to prepare Basic technology pre-service teachers.

To what extent are the instructional strategies used to support lesson objectives?
The lecture method was effective in achieving learning outcomes by providing students with a broad overview of the topic. Questioning was used to achieve learning outcomes by testing students'

understanding of the topic and allowing them to demonstrate their knowledge in a structured way. The demonstration method helped to reinforce the knowledge that students have gained from lectures and readings. The Project-based method was used to achieve learning outcomes by allowing students to apply the knowledge they have gained from lectures and readings to real-world problems. Blended learning was effective at achieving learning outcomes because it combines multiple instructional strategies into a single approach. This allowed the students to learn in a variety of ways, and to benefit from the advantages of each strategy.

Frequency of use: The lecturer used the instructional strategies in his teaching, constantly.

How are they linked to content:
The lecture method was used to introduce the topic to give an overview, and the questioning technique was used to ask some questions about the materials to check learners' understanding after the different types of defects on timber were demonstrated through pictures and videos, then the learners where grouped into different groups to identify and classify the different defects as project work in the class and blended learning was used to reinforce the topic taught by asking the students to research more information of defects of timber.

When are they used?
The lecture method was used at the beginning of the lesson, then the questioning technique was used throughout the lesson to ask some questions to check learners understanding, the demonstration was used in the middle of the class by showing the learners pictures and videos of defects of timbers then the project-based was used at the end of the class, while blended learning was used throughout the class like the questioning technique.

Why are they used in this way?
The lecture method was used at the beginning of the lesson because it's an efficient way to cover a lot of material within a short time. The questioning technique was used throughout the lesson to keep the learners engaged and to ensure proper understanding while the demonstration method was used in the middle of the class as it provided a more concrete understanding of the taught concept and made learning more engaging, by showing the learners pictures and videos of defects of timbers then the project-based was used at the end of the class because it allowed the learners to apply the learned knowledge practically. Blended learning was used throughout the class because it allowed for flexible and personalized learning and made learning more engaging with pictures and videos which made the class more interesting to the learners.

What scheme was employed to assess learning in terms of the use of Instructional strategies?
This scheme is called the "assessment triangle." The assessment triangle consists of three elements: performance assessment, feedback, and student reflection. Performance assessment is used to measure student learning, while feedback is used to provide information about student performance. Student reflection is used to encourage students to think about their learning process and make connections between what they have learned and their own experiences. All three elements of the assessment triangle are important for effective learning and assessment and were employed by the lecturer.

How effective are the Instructional strategies at achieving the main lesson objective(s)?
Demonstration is very effective in achieving the stated objectives because it allows students to see a skill or concept in action. Project-based learning is effective because it allows students to apply what they have learned practically. Questioning is effective because it encourages students to think critically and to apply what they have learned. Blended learning is effective because it allows students to learn in a variety of ways, which can help to reinforce their understanding. The lecture method is effective because it can be used to provide students with a lot of information in a short period. This makes it especially useful for covering a lot of material in a short time.

How good are the instructional strategies used at encouraging creativity and collaborative learning? Demonstration encouraged creativity by allowing students to see a skill or concept being applied creatively. Project-based learning encourages creativity by allowing students to come up with their solutions to a problem. Questioning encouraged creativity by allowing students to come up with their questions and explore new ideas. Blended learning encourages creativity by combining a variety of teaching methods, which allows for more creativity in the learning process. Blended learning also encouraged collaboration by providing opportunities for students to work together on projects and tasks. Questioning also encouraged collaboration by allowing students to work together to find answers to questions. Guided discovery is an instructional strategy that caters to learner diversity in

technology classrooms. The teacher is the guide who only scaffolds learning, but the learner does the thinking and problem-solving.

Does the activity fit within the timetable? Yes, the activity fit within the timetable.

To what extent does it support problem-solving/critical thinking? The Lecture method helps to introduce new concepts and ideas, which stimulate students' interest and encourage them to think critically about the material. Questioning encourages problem-solving by allowing students to analyze and evaluate information and data. It also encourages critical thinking, by prompting students to consider different perspectives and viewpoints. Blended learning supports problem-solving and critical thinking by providing a variety of approaches and resources for students to draw from.

How appropriate are the explanations for the level of your intended group?
All of the instructional methods of demonstration, brainstorm, project-based learning, questioning, blended learning and lecture are appropriate for teaching defects in timber to the intended group of students. Each method has its strengths and can help to engage students and ensure that they are learning the material. The lecturer used a combination of these methods, thereby creating a well-rounded and effective learning experience for their students.

Knowledge of curriculum (Vertical or Horizontal): The lecturer thoroughly explained every aspect of the topic and several connections were made between this topic and other topics within the curriculum. There are connections between defects in timber and other topics within the wood course. These include topics such as wood properties and wood preservation. There are also connections between defects in timber and other topics within the larger technology curriculum, such as material and manufacturing.

Knowledge of Basic technology pre-service teachers: This knowledge includes both subject-specific knowledge, such as knowledge of the different types of defects and how they are caused, and pedagogical knowledge, such as knowledge of effective teaching strategies for this topic. Teachers need to have a strong understanding of both types of knowledge to effectively teach this topic. The lecturer has a good understanding of the different types of defects that occur in timber, such as knots, splits, and checks. He also understands how these defects are caused, such as by poor growing conditions, defects in the tree, or improper drying or storage. Pedagogical knowledge includes understanding how to effectively teach students about these defects, such as through hands-on activities, demonstrations, and discussion. These were taught effectively, by the lecturer.

Misconception:

iv. All timbers are the same
v. All timbers have the same defects
vi. All defects are bad and should be avoided.

Learning difficulties: One difficulty may be the abstract nature of some aspects of this topic. Some students cannot visualize and understand concepts like cell structure, moisture content, and drying rates. Another difficulty may be the technical nature of the terminology used to describe defects, such as "compression wood" and "cross-grain.

Learning styles:
- Visual learning: This involves using images, charts, and diagrams to teach.
- Kinesthetic learning: This involves hands-on activities and experiments to teach the material.
- Auditory learning: This involves listening to and discussing the material.
- Reading/writing learning: This involves reading texts and writing about the material

Motivation
One thing that motivated the students was the real-world relevance of this topic. Another motivating factor was the hands-on nature of this topic. Students can learn by doing, which can make the learning process more engaging and meaningful.

Needs: Some students may need adaptations related to their physical ability, such as modifications to equipment or materials. Others may need adaptations related to their cognitive ability, such as visual aids or alternative explanations. It's important for teachers to be aware of the needs of their students and to make appropriate adaptations to help them learn effectively.

Background: The background of the topic "defects in timber" includes the history of timber use, the biology of trees, and the different types of defects that can occur in timber. Knowing this background information helps students to better understand the topic and to make connections between different concepts.

Assessments: types of assessment

Both formal and informal assessments were used. Formal assessments include tests that measure students' knowledge and understanding of specific concepts. Informal assessments included discussions and observations of students as they work.

Assignment:

Brainstorm how you would address the defects encountered at some schools regarding the desks and chairs.

In your project design, indicate what measures are taken to troubleshoot, problem solve, critique and evaluate the design and what is innovative or creative about your design. Use local materials to present your project.

Materials and resources:

- Images and photographs of different types of defects
- Samples of wood with different defects
- A video that shows the formation of defects in timber
- A timeline of the history of timber use
- Worksheets and activities that allow students to identify and classify defects
- Resource books and websites that provide information on the topic.

APPENDIX 23: OBSERVATION SCHEDULE (P7)

Contextual Information	
Practising lecturer	Participant 7 (P7)
Date	21/08/23
Course Title	Automobile Technology
Topic	Fundamentals of Automobile Transmission Systems
Location	AB University, Lagos. Nigeria.

Orientation to teaching Basic Technology: This course is designed to equip students with the knowledge and skills they need to work in the automobile industry or to teach automobile technology in schools. The orientation was on the importance of transmission systems in automobiles.

Process:
- identify the learning objectives for the lesson.
- create a lesson plan that incorporates different teaching methods and strategies.
- deliver the lesson and engage with students.
- assess the students' understanding and provide feedback.

Rigour: To make sure the material is sufficiently rigorous, the lecturer considers the prior knowledge and abilities of their students, the learning objectives of the lesson, and the resources available. Then plan the lesson accordingly, providing opportunities for students to engage with the material at an appropriate level of challenge.

Pre-service teacher activities:
- Learners observed and listened attentively.
- Learners took notes,
- Answer questions orally.
- Students participate in group discussions & work in teams to solve problems.
- Learners complete online assignments,
- Participate in online discussions, or give presentations.
- Learners plan, carry out, and present their projects.

Lecture venue: The lecture was held in the Automobile workshop. It is the appropriate place for teaching the course, with easy access to equipment, tools, machines, spare parts, etc.

Objectives/learning outcome for the lesson:
At the end of the lesson, the students should be able to:
- Understand the working principles of transmission systems.
- Explain the design of modern automobile transmission systems.
- Describe different types of transmission systems.

What instructional strategies were used? The lecturer made use of lecture methods, questioning, blended learning, demonstration, and project-based learning in his teaching.

To what extent are the instructional strategies used to support lesson objectives?
The lecture method was used to introduce the main concepts of the lesson which helps to support the objective of understanding the concept. Questioning was used to check for understanding and to make sure that the students were on the right track which also supported the objectives and blended learning was used to reinforce the material and to help students apply their knowledge. Demonstration was used to provide a concrete example of the material which also supported the lesson objectives. Project-based learning was used to assess if the learners have truly mastered the concept taught which also supported the lesson objectives. Each of these methods helps to ensure that the content is presented in a way that is engaging and effective.

Frequency of use: The lecturer used these instructional strategies, recurrently.

How are they linked to content? The lecture method was linked to the content by creating a clear and logical structure for the material. Questioning was linked to the content by asking specific questions about the material. Blended learning was reinforced by using various media to supplement the course content. Demonstration was linked to the content by choosing an example that is relevant and meaningful.

When are they used? The lecture method was used to provide information and to introduce new concepts. Questioning helps to engage students and to assess their understanding. Blended learning

allows for a variety of learning styles to be accommodated. The demonstration provides a real-world example of the material. And project-based learning allows students to apply what they've learned practically.

Why are they used in this way? Lecture method was used to introduce new concepts or to provide an overview of a topic. Questioning and blended learning were used to reinforce the material and to help students apply their knowledge. Demonstration was used to provide a concrete example of the material. And project-based learning was used to give students a real-world application of the material. Each of these methods helps to ensure that the content is presented in a way that is engaging and effective.

What scheme was employed to assess learning in terms of the use of Instructional strategies? The scheme that was developed for assessment was based on the learning objectives and the needs of the learners. It also considers the different methods that were used in the course unit. The lecture method was assessed through tests and quizzes. Questioning was assessed through discussion and written responses. Blended learning was assessed through online activities and projects. Demonstration was assessed through observation. And project-based learning was assessed through projects in the class.

How effective are the Instructional strategies at achieving the main lesson objective(s)?
The lecture method was effective at introducing new concepts and providing a broad overview of the material. Questioning was effective at encouraging critical thinking and developing problem-solving skills. Blended learning was effective at providing a variety of learning experiences and engaging different types of learners. The demonstration strategy was effective at showing real-world applications of the material. And project-based learning was effective at promoting deeper understanding.

How good are the instructional strategies used at encouraging creativity and collaborative learning? Lecture method encourages creativity by providing opportunities for students to ask questions and share ideas. Questioning encourages creativity by allowing students to think and solve problems. Blended learning also encourages both creativity and collaborative learning by providing a variety of resources and activities. Demonstration encourages creativity by showing students how to approach problems in new ways. And project-based learning can encourage both creativity and collaborative learning by requiring students to come up with their solutions to complex problems.

Does the activity fit within the timetable? Yes, the activity fit within the time allotted for the course.

To what extent does it support problem-solving/critical thinking?
Lecture methods can support problem-solving and critical thinking by providing clear explanations and real-world examples. Questioning can support these skills by prompting students to think about problems in new ways and come up with creative solutions. Blended learning can support these skills by providing a variety of resources and activities that challenge students to think critically. Demonstration can support these skills by showing students how to apply problem-solving strategies in real-world situations. And project-based learning can support these skills by requiring students to identify and solve complex problems.

How appropriate are the explanations for the level of your intended group?
All of the explanations were appropriate for pre-service teachers of basic technology. The lecturer used simple and easy-to-understand language for the level of the students.

Knowledge of curriculum (Vertical or Horizontal): In the context of Fundamentals of Automobile Transmission Systems, horizontal knowledge includes topics such as the history of automobile transmission, the different types of transmission systems, and the advantages and disadvantages of different types of systems. Vertical knowledge includes the specific parts of a transmission system, the functions of those parts, and the relationships between the parts. Students need to understand both types of knowledge to comprehend the topic and to apply their knowledge in real-world situations.

Knowledge of Basic technology pre-service teachers:
Pre-service teachers may have some general knowledge about the topic, such as the basic function of a transmission system or the general components of a vehicle. However, they may not have specific knowledge about the Fundamentals of automobile transmission systems, such as the detailed function of each component or the history of the transmission system.

Misconception: There are several common misconceptions that pre-service teachers might have about this topic. One is that all transmission systems work in the same way, regardless of the type of vehicle or engine. Another misconception is that there is only one type of transmission system

Learning difficulties: There are a few potential learning difficulties. One is the amount of technical terminology that was used in this topic. Another difficulty was the abstract nature of some concepts, such as the relationship between gears and speed. In addition, pre-service teachers might have difficulty understanding the physical processes involved in the functioning of the transmission system.

Learning styles:
- Visual learners learn best through images, diagrams, and charts.
- Auditory learners learn best through listening and speaking.
- Kinesthetic learners learn best through hands-on activities and movement.
- Read/write learners learn best through reading and writing.

Motivation:
- Grades and performance feedback.
- Recognition from peers or teachers.
- Rewards and incentives, such as extra credit or special privileges.
- Intrinsic motivations, on the other hand, are those that come from within the learner. Some examples include:
- Interest in the subject matter.
- A sense of accomplishment or satisfaction in understanding the material.
- A desire to share what they've learned with others.
- An appreciation for the challenges and complex

Needs: First, they need access to materials and resources that are accurate, relevant, and up-to-date. This includes textbooks, websites, and online resources.
Also, they need a safe and supportive learning environment that encourages collaboration and hands-on learning.
Third, they need opportunities to practice and apply what they are learning through activities like problem-solving and project-based learning.
Lastly, they need feedback and assessment that is accurate and constructive.

Background: The background knowledge that is required to teach the Fundamentals of automobile transmission systems effectively includes a solid understanding of basic physics and mathematics, as well as an understanding of basic automotive mechanics. Pre-service teachers should also have some experience working with tools and equipment, as well as some understanding of computer systems and technology. Additionally, they should have a basic understanding of how the transmission system is connected to other systems within the vehicle.

Assessments: types of assessment
- A quiz or worksheet.
- A performance assessment that involved a hands-on demonstration of the material.
- A self-reflection would be a good way for the students to reflect on what they learned in the lecture.
- A peer review was a good way to get feedback from classmates about the lecture.
- Lastly, a Teacher observation allows for assessing students' understanding.

Materials and resources:
- A textbook or other reference materials on the topic.
- A computer or other device with internet access for research.
- A projector and screen for presentations
- A whiteboard for writing and drawing.
- Pens, pencils, and paper for note-taking and sketching.
- Tools and equipment for hands-on activities.
- A classroom or space for group work.

APPENDIX 24: Editing Certificate

8A ADENIYI OLISE CLOSE, AGEGE, LAGOS

[redacted]

30th July, 2024

To Whom It May Concern

Dear Sir/Madam,

EDITOR'S REPORT ON MR. FATAI OLADOTUN DAHUNSI'S DOCTORAL THESIS

This letter confirms that the Doctoral Thesis with the title ***Exploring Technology Lecturers Instructional Strategies to Prepare Basic Technology Pre-Service Teachers for Twenty-First Century Teaching*** by Fatai Oladotun Dahunsi was edited by a professional English-language editing expert.

The thesis has been edited for most of the standard things like grammar/syntax, punctuation, spelling, paragraphing, sentence structure, word choice, capitalization, and organization. Furthermore, I have checked the thesis for relevant aspects of consistent, albeit eclectic style: numbers, italics, bold, lists, reference list entries, spacing, indentation, wordiness, redundancy, clarity, conciseness, use of abbreviations and acronyms, format, and parallel structure.

Suggestions were made where observed, on the most appropriate punctuation mark depending on the context of the sentence. The structural recommendations made were related to paragraphing, the use of upper or lower case, and a few citation/referencing errors.

I trust that the editing work that has been done, enhances the overall quality of the Thesis.

Sincerely yours,

[redacted]

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