SCIENCE TEACHERS' PEDAGOGICAL AND CONTENT KNOWLEDGE (TPACK) AS DETERMINANTS OF SECONDARY SCHOOL SCIENCE STUDENTS' PERFORMANCE IN MINNA, NIGER STATE

BY

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MTech/SSTE/FT/2018/8267

DEPARTMENT OF SCIENCE EDUCATION

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

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THESES SUBMITTED TO THE POST GRADUATE SCHOOL FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGERIA IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF TECHNOLOGY (MTECH) IN CHEMISTRY EDUCATION

APRIL, 2023.

DECLARATION

I EZE, Ifeanyi Emmanuel hereby declare that, the research work, Titled **"Science Teachers' Pedagogical And Content Knowledge (TPACK) As Determinants of Secondary School Science Students' Performance In Minna, Niger State."** is a collection of my original work and it has not been presented for any other qualification anywhere. Information from the works of other scholars (Published and unpublished) and their contributions here have been duly acknowledged.

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SIGNATURE & DATE

CERTIFICATION

This thesis titled: **“Science Teachers’ Pedagogical and Content Knowledge (TPACK) as Determinants of Secondary School Science Students’ Performance in Minna, Niger State.”** By EZE, Ifeanyi Emmanuel, (MTech/SSTE/FT/2018/8267) meets the regulations governing the award of the degree of Master of Technology in Science Education of the Federal University of Technology, Minna and it is approved for its contribution to scientific knowledge and literary presentation.

DEDICATION

This project is dedicated to my wife Mrs. Maria Eze and my mother Mrs. Roseline Nwamaka Eze.

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ABSTRACT

Teachers are part of the most important factors in students' learning, yet little is known about the specialized knowledge held by experienced teachers. In recent years, discourse on teachers' content knowledge (CK), pedagogy knowledge (PK), and pedagogical content knowledge (PCK) on students' learning outcomes have attracted increasing attention from several agents of change in the education industry. Conceptualizing teacher knowledge is a complex issue that involves understanding key underlying phenomena such as the process of teaching and learning, the concept of knowledge, as well as the way teachers' knowledge is put into action in the classroom. Empirical research shows that teacher quality is an important factor in determining gains in students' achievement. By inadequately explaining teachers' knowledge, existing educational production function research could be limited in its conclusions, not only by the magnitude of effects that teachers' knowledge has on students' learning but also about the kinds of teacher knowledge that matters most in producing students' learning outcomes. Teachers are expected to process and evaluate new knowledge relevant for their core professional practice and to regularly update their profession's knowledge base. This study used a correlational research design to investigate Science teachers' pedagogical and content knowledge as determinants of secondary school science students' academic performance in minna metropolis Niger state. Results from 253 respondents from the study population were analyzed using mean and standard deviation, scattered plot, linear regression, multiple regression and point biserial. According to the findings of research study it was revealed that science teachers' pedagogical knowledge, Content knowledge, Pedagogical and content knowledge and years of experience positively influences science student' academic performance. The findings also revealed that gender has no significant effect on science students' academic performance. Based on the findings, it was recommended that; government should formulate policies for continuous updating of knowledge of teachers through in-built professional development programs on a regular basis for science teachers in the States it also recommend that the Ministry of Education to promote Professional Development opportunities concerning pedagogy courses in order to define the metrics and standards of teachers as to achieve higher academic performance.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Education has gone beyond reading, writing, and the transfer of knowledge from one individual to another. This is because education is a continuous process of discovering new ideas, innovations, skills, and valuable information that will allow an individual to function effectively. Education, therefore, is seen as the easiest path to liberation and freedom. According to Veletsianos (2016), education is an enterprise of knowledge sharing and further stated that sharing of knowledge is the sole means by which education is achieved. This implies that there is no education if a teacher does not share what they know with students. Those educators who share their knowledge with the most significant proportion of their students are the ones referred to as the most successful educators. It is not enough to only acquire knowledge, certifications, and professional teaching qualifications but the ability to adequately, effectively, and efficiently transfer what the teacher knows to the students is necessary. There is no doubt that science teaching has a crucial role in shaping the future development of any society.

Science education therefore, has become an essential prerequisite for a thriving economy, especially with the emerging global economy. Many industrial nations seek to improve the quality of science education because of the vital role Science and Technology play in a nation's economy and in the standard of life. A new way of teaching and learning about science reflects how science itself is done because it emphasizes on inquiry to achieve knowledge and to understand the world. Teachers must have both theoretical and practical knowledge as well as the skills on learning and teaching science. The quality of science teacher \training and its relationship with improving the quality of the education systems generally have become critical issues of public concern across the world in recent years.

An important task of science education is making science more relevant to students, more easily learned and remembered, and more reflective of the actual practice of science. Therefore, training science teachers is an essential part of securing the future and improving the quality of science education. Nearly everyone now accepts the premise that teachers influence the quality of science education. The public also recognizes the importance of well-prepared teachers. Therefore, there is a strong belief that prospective science teachers need high-quality training and skills (Nezvalová, 2011)**.**Science is the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence. Science is divided into two significant branches of knowledge, namely Pure and applied science, which further comprises or embraces other branches like Chemistry, Physics, Biology, Agriculture and Biochemistry. There are also fields of study such as medicine, Engineering, Geochemistry, Computer Science and nursing (Bagley, 2017).

Furthermore, Science is of vital importance for practical living in any society. It is at the centre for producing resources necessary for socio-economic and technological advancement needed for any nation. Considering the branches of science, its fields of study and its importance in a nation's economic progress, it consequently becomes very requisite that efforts are made towards finding a lasting solution to science students' poor academic performance. Osborne (2021) reported that most science subjects are viewed by many as not easy to comprehend among other subjects and the level of academic performance is not always appealing compared to other subjects. Despite the popularity of science subjects, the failure rate has remained very high (Apu, 2020). Ekpen (2020) maintained that poor performance of students is mainly due to lack of motivation for teachers, poor infrastructural facilities and attitude of students to learning. Similarly, lack of opportunities for professional development of science teachers is also another factor affecting the pedagogical approach of science teachers. Other variables such as motivation, orientation, self–esteem, and learning approaches are important factors that influence academic performances. Motivation has gained more popularity amongst educational psychologists in leading other variables that could be manipulated to improve academic performance. Also, lack of interest by secondary school students in some science subjects has affected their academic performance in terminal and sessional examinations (Ntibi, 2017). Cornelius-Ukpepi (2020) further included that the availability of textbooks, laboratory apparatus, and other learning resources contributes significantly to students' performance in science sessional and terminal examinations and added that students with a positive attitude towards the subject often register better performances than those who have a negative attitude. Those with a positive attitude are motivated towards hard work and this is reflected in the good mark scored in the examination. According to Ibitham (2020) parental attitude is also very important in students' academic performances in science examinations. Parents have a significant influence on the academic performance of their wards. This is because the child from an educated family has many opportunities to study hard due to his/her access to the internet, newspaper, television e.t.c.

Furthermore, Teachers' pedagogical and content knowledge as well is imperative to the academic performance of science students. In fact, there is rich evidence that teachers take a critical role in student outcomes (Kunter *et al*, 2013). Students' performance is considered one of the main outcomes of instruction, a fact mirrored in international large scale studies on student achievement (such as PISA). Perhaps a productive path to travel is what Shulman (1986) has labeled teachers pedagogical and content knowledge

(TPACK). While Content Knowledge refers to one's understanding of the subject matter, pedagogical knowledge refers to one's knowledge of teaching and learning processes independent of subject matter, Teachers pedagogical and content knowledge refers to knowledge about the teaching and learning of particular subject matter that takes into account the specific learning demands inherent in the subject matter. Much has been written about the nature and development of TPACK and one of the main ideas is that TPACK is a personal construct, and a teacher's years of experience is predicted to be very important in the development of TPACK meaning that each teacher could develop their own TPACK over the years of teaching (Jacob, 2020). A teacher's pedagogical and content knowledge level determines how efficient he is in transferring knowledge in the best possible way that his students will understand. Therefore, TPACK is necessary for the effective achievement of educational goals because teachers are indispensable in the academic structure, for they are the life wire of education.

However, knowing the concepts and laws of science and the methods of scientific inquiry known as content knowledge (CK) is not just enough; teachers should be able to create learning environments in which students can master the concepts and the processes of science. In addition, teachers should know how people learn, how memory operates and how a brain develops with age. This knowledge is called general pedagogical knowledge or the knowledge of how people learn. Most importantly, teachers of a specific subject should possess particular understandings and abilities that integrate their knowledge of this subject's content and student learning of this content. This special knowledge, called Teacher Pedagogical and Content Knowledge (TPACK), distinguishes teachers' science knowledge from that of scientists. In the traditional path to becoming a teacher, teachers should develop their content knowledge of the discipline they will teach and pedagogical knowledge (general knowledge of how people learn and how schools work). Teachers learn the former while taking courses in the school. The latter knowledge is the domain of the schools of education. It includes the knowledge of psychology, general understanding of how people learn (such as how memory works), how they work in groups, etc. However, in the past 20 years many teachers concluded that the most important aspect of teachers' practical knowledge is their pedagogical and content knowledge which encompasses both the CK and the PK. Teachers content knowledge includes; Knowledge of science concepts, relationships among them and methods of developing new knowledge, Teachers pedagogical knowledge includes; Knowledge of brain development, Knowledge of cognitive science, knowledge of collaborative learning, Knowledge of classroom management and school laws while Pedagogical content knowledge includes; Orientation towards teaching, Knowledge of chemistry curriculum, knowledge of student ideas, knowledge of effective instructional strategies and knowledge of assessment methods.

Also, teachers' pedagogical knowledge includes all the required cognitive knowledge for creating effective teaching and learning environments and research suggests that this knowledge can be studied (Guerriero, 2014). Pedagogy is the science of teaching, instruction and training. Teaching is viewed as a knowledge-rich profession with teachers as 'learning specialists.' As professionals in their field, teachers can be expected to process and evaluate new knowledge relevant to their core professional practice and regularly update their knowledge base to improve their practice and meet new teaching demands (Guerriero, 2014).

Another variable to be considered is gender, the concept of gender has become an essential phenomenon for some psychologists on how students learn. Gender distinctions, gender bias, and gender issues remain very paramount in understanding achievement-related behaviors so as to make it predictable, and as such amenable to possible manipulations (Dee, 2006). The source of gender differences has long been a topic of heated debate. Though tests of general intelligence suggest on overall differences between men and women, there are large gender differences between men and women, there are larger gender differences in scores of cognitive tasks (Linda, 2006).

According to Goldman *et al*. (2020), performance means knowledge, skills, and understanding resulting from a particular school course. The author further said that these learning are not readily acquired without a specific school or out of school experiences with a particular subject matter. performance tests are designed to measure the outcome of the level of accomplishment in a specified area or occupation, which a student had undertaken in the recent past (Jacob *et al* 2020) also stated that, students' achievement scores determine academic performance and that academic performance measures the degree of success in performing specific tasks in a subject or area of study by students after a learning experience. The outcome of education indicates how well a student or class of students is/are doing academically. Cornelius-Ukpepi *et al.* (2020) defined students' academic performance as the extent to which students achieve their short or long-term educational goals.

Pedagogical Content Knowledge (PCK) plays a vital role in classroom instructions. It is an academic term that describes several interconnected domains of knowledge that are useful to the teacher teaching gin a school or in an out of school context. The most important domains are subject-specific content knowledge and knowledge of the pedagogy used in teaching a subject. A PCK involves teachers' competence in delivering the conceptual approach, relational understanding, and adaptive reasoning of the subject matter in the teaching and learning process. Without a full grasp of PCK, teachers may face difficulty in teaching the subject effectively, leading to either misconceptions or lack of understanding that will be evident in students' performance over time. Studies have shown that the development of pedagogical and content knowledge is critical for the educator. Teachers should be knowledgeable in the content areas and pedagogy for which they are responsible to teach, without this, the students may face difficulty in their learning. Furthermore, the study article has shown that improving teachers' PCK could improve teachers' instructional practices, and consequently, students' academic performance.

Therefore, based on the above reasons, science teachers' pedagogical and content knowledge can also determine science students' academic performance. Other factors which are responsible for continuous poor performance in science subjects include students' attitude towards the subjects, lack of resources such as textbooks and inadequate qualified teachers, regularity of the students to classes, (students-teachers relationship or teachers- students' relationship), Poor learning environment and school location. Therefore, this research work attempts to investigate how teachers' pedagogical content knowledge (TPACK) determines secondary school science students' academic performance in Minna metropolis, Niger State.

1.2 Statement of the Research Problem

Globally there is a quest for effective and meaningful learning in the classroom at all levels of education. However, there is growing concerns in the educational industry regarding the quality of teachers and students' performance. The success or failure in teaching and learning can be attributed to several factors (school, students, and teachers factors among others) and one of these factors is the pedagogical approach adopted by the teacher. For effective and meaningful instruction, the teacher must have good mastery of subject matter, pedagogical knowledge, good skills in communication, collaboration and proper knowledge of classroom management (Jacob *et al,* 2020). Therefore, the level of science teachers' TPACK could impact the quality of teaching and learning science. Consequently, teachers with high TPACK could influence effective learning while teachers with low TPACK could struggle to influence meaningful learning. Pedagogical Content Knowledge (PCK) plays a vital role in classroom instructions. PCK involves teachers' competence in delivering the conceptual approach, relational understanding, and adaptive reasoning of the subject matter in the teaching and learning process.

According to Ramos (2020) in his research on PCK and student's achievement in Chemistry concluded that teachers who possess high TPACK were able to produce students with high academic performance in Chemistry. Meanwhile, Jacob *et al.* (2020) investigated teachers' pedagogical and content knowledge as a determinant of academic performance in secondary schools and is results revealed that the teacher quality was high and there was an average level of students' academic performance in secondary schools. Therefore, teacher quality and academic qualification had no significant influence on students' academic performance. Furthermore, Science teachers' gender and years of experience could impact on teachers' pedagogical and content knowledge, therefore gender and years of experience are considered as moderating variables in this study.

Given the gap in literature and the inconclusiveness of findings on the relationship between science teachers' TPACK and science students' performance. Hence, this study investigates Science teachers' pedagogical and content knowledge as determinants of secondary school Science student's academic performance in Minna Niger state.

1.3 Aim and Objectives

This study investigated science Teachers' pedagogical and content knowledge as determinants of secondary school science students' performance in Minna Niger State. This aim would be fulfilled through the following specific objectives to:

1. Determine relationship between science teachers' Pedagogical Knowledge (PK) and science student' academic performance,
2. Identify the relationship between science teachers' Content Knowledge (CK) and science student' academic performance,
3. Determine the relationship between science teachers' Pedagogical and Content Knowledge (PCK) on science student' academic performance,
4. Ascertain the relationship between Science teachers' content knowledge, pedagogical knowledge and pedagogical and content knowledge on science students' academic performance,
5. Determine the relationship between teachers' gender and pedagogical and content knowledge,
6. Determine the relationship between teachers' years of experience and pedagogical and content knowledge.

1.4 Research Questions

The following research questions were raised to guide the study.

1. What is the relationship between science teachers' pedagogical knowledge and science student' academic performance in Minna, Niger state?
2. What is the relationship between science teachers' content knowledge and science student' academic performance in Minna, Niger state?

3. What is the relationship between science teachers' pedagogical and content knowledge and Science students' academic performance in Minna, Niger State?
4. What is the relationship between science teachers' Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical and Content Knowledge (PCK) and science students' academic performance in Minna, Niger State?
5. Is there any relationship between gender and pedagogical and content knowledge among Science teachers in Minna, Niger State?
6. Is there any relationship between teachers' years of experience and pedagogical and content knowledge among Science teachers in Minna, Niger State.

1.5 Research Hypothesis

The following null hypothesis was formulated to be tested at 0.05 level of significance.

HO1: There is no significant relationship between science teacher' pedagogical knowledge and Science students' performance.

HO2: There is no significant relationship between science teacher' content knowledge and Science students' performance.

HO3: There is no significant relationship between science teachers' pedagogical and content knowledge and Science students' performance.

HO4: There is no significant relationship between content knowledge, pedagogical knowledge, pedagogical and content knowledge and students' performance.

HO5: There is no significant the relationship between science teachers' gender and pedagogical and content knowledge.

HO_6: There is no significant relationship between teachers' years of experience of science teachers and pedagogical and content knowledge.

1.6 Significance of the Study

The findings of this study would contribute to knowledge and field of education. Specifically, the following group would benefit from the results of the study; teachers, science students, ministry of education, curriculum planners and parents/guardians.

It is expected that the findings of this study would help the science teachers on ways to improve on their PCK. In addition, this study will also go a long way to help the science teacher properly utilize time in teaching, use adequate and efficient teaching methods, and help in innovations and improvisation.

It is hoped that the findings of this study will help improve students' academic performance in science subjects that have been on decline for years now. It is expected that the results of this study would give the ministry of education insight into constantly improving teachers PCK by organizing seminars and workshops, to provide adequate materials and a conducive environment for learning. It should also provide sufficient reasons as to why the ministry should employ more qualified teachers and ensure that only well trained teachers are recruited and to ensure that all out of field teachers are either mandated to take adequate educational training courses or allowed to teach only subjects that they are trained for.

It is believed that the findings of this study will help curriculum planners to select or recommend appropriate learning experiences, knowledge and contents that would enhance effective teaching of science subjects and attainment of science education goals. It would serve as an enlightenment to parents and guardians in choosing schools they intend to send their wards to and to help analyse if there is a connection between the teacher and their wards.

1.7 Scope of the Study

The geographical scope of this study is Minna Niger State. The subject scope covered all the science teachers in the public secondary schools in Bosso and Chanchaga Local Government Areas Minna, Niger state. The variable scopes are pedagogical knowledge, content knowledge, pedagogical and content knowledge, and academic performance. The time scope for this research was six weeks.

1.8 Operational Definition of Terms

Academic Performance: students in secondary school academic performance in science subjects in Minna, Niger State

Content knowledge: refers to the facts, concepts, theories, and principles that are taught and learned in sciences, in other words is the teacher's knowledge of the subject matter in Secondary schools in Minna Niger State.

Pedagogical content knowledge: Pedagogical content knowledge integrates subject expertise and skilled teaching of science subjects in Secondary Schools in Minna Niger State.

Pedagogy: this is the method and practice of teaching in Secondary Schools in Minna, Niger State.

Science Teachers; I this study, this refers to teachers that educates science students on the core Science subjects namely Chemistry, Physics and Biology in Secondary schools in Minna, Niger state..

Science Students : These are learners who are being taught the core science subjects namely Chemistry, Physics and Biology in secondary schools in Minna, Niger state.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Conceptual Framework

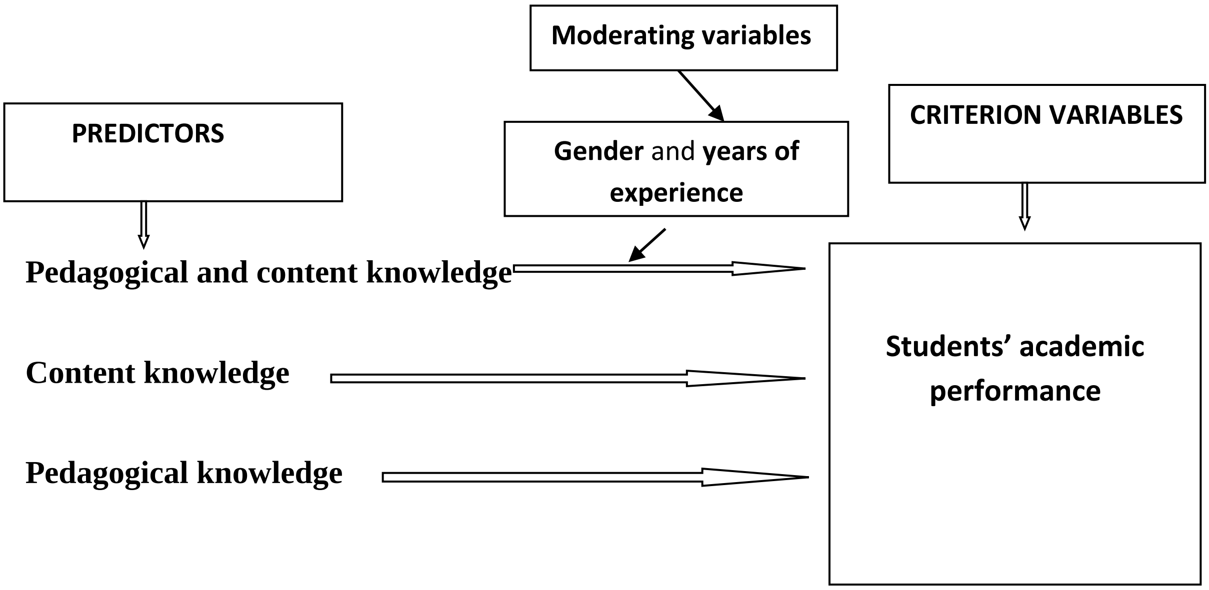

Figure 2.1: Conceptual Framework Using Author's Original Constructs

Figure 2.1 shows the independent variables TPACK, the moderating variables; Gender and Science students' performance and the criterion variables CK and PK. Fig 2.1 also reveals that both Content Knowledge and Pedagogical Knowledge of Science Teacher influence the practices of the teachers in the classroom as well as the academic performance of Science students in internal examinations. Finally, the figure shows that the practices of Science Teachers strongly influence the students' academic performance.

2.1.1 Pedagogical content knowledge

Teacher knowledge is one of the most critical factors affecting teachers' classroom behaviours and their students' success (Shulman, 1987). Arias *et al.* (2016) collected the types of knowledge the teacher should have to perform effective teaching under four titles: subject matter knowledge, general pedagogical knowledge, pedagogical content knowledge, and context knowledge. Accordingly, the most important qualifier of effective teaching is Pedagogical Content Knowledge (PCK). According to Kutluca, (2021) PCK which teachers develop and are a teacher-specific quality, is the subject-specific type of knowledge they have developed through time experiences. Furthermore, PCK is based on a mix of an understanding of the content that allows students to understand any subject and teacher pedagogy better. Therefore, PCK is subject matter-specific, title-specific, teacher-specific, and content-specific (Blömeke *et al*, 2017). Arya *et al.* (2020), who contextualized the PCK based on science teaching, suggested that a teacher should have the following components for qualified science teaching:

1. Orientations to teaching science (OTS): OTS reflects teachers' perspectives on science teaching.
2. Knowledge about students' understanding of science (KSU): KSU includes students' concepts on specific topics, learning difficulties, motivation, and diversity of talent, learning style, the field of interest, level of development, and knowledge of needs.
3. Knowledge of science curriculum (KSC): KSC represents the knowledge about the curriculum and curriculum materials.
4. Knowledge of instructional strategies for teaching science (KISR): KISR indicates how teachers benefit from instructional strategies and representation.

Shulman was of the view that content knowledge and pedagogic knowledge needed to be blended in ways that would be more powerfully meaningful for student learning (Shulman, 1987). PCK stood out as a distinct knowledge domain because it aimed to bring to the surface the understanding, reasoning, and underpinnings that a teacher develops in learning how to link content and pedagogy in meaningful ways in practice. In the absence of PCK (i.e., if the amalgam does not exist so that content and pedagogy are not linked), it could well be that the teacher just happens to have a good activity. The PCK-aware teacher sees a good activity and says, 'I know why that works'. Suppose the teacher cannot reason why they do something in a particular way for a particular reason in a particular content with a particular group of students. In that case, they are likely not utilising PCK. PCK therefore, is the individual and unique knowledge a teacher possesses that marries knowledge of content and pedagogy together in a way that enhances student learning (Haron *et al,* 2021). Therefore, this knowledge is 3 therefore often tacit and difficult to articulate, capture, and portray from science teachers because of its very personal construction. It is also difficult for teachers to share this knowledge amongst colleagues in any explicit manner (Blömeke *et al*, 2017). A framework for so doing then becomes an important goal if research into PCK is to progress, particularly in capturing and portraying concrete examples of PCK.

2.1.2 Content knowledge

Content knowledge (CK) is teachers' knowledge about the subject matter to be learned or taught. The content to be covered in middle school science or history is different from that in an undergraduate course on art appreciation or a graduate seminar on astrophysics. Knowledge of content is of critical importance for teachers. As Shulman (1987) noted that this knowledge would include knowledge of concepts, theories, ideas, organizational frameworks, knowledge of evidence and proof, as well as established practices and approaches toward developing such knowledge. Knowledge and the nature of inquiry differ greatly between fields, and teachers should understand the deeper knowledge fundamentals of the disciplines in which they teach. For example, in the case of science, this would include knowledge of scientific facts and theories, the scientific method, and evidence-based reasoning. In the case of art appreciation, such knowledge would include knowledge of art history, famous paintings, sculptures, artists and their historical contexts, as well as knowledge of aesthetic and psychological theories for evaluating art. The cost of not having a comprehensive base of content knowledge can be prohibitive; for example, students can receive incorrect information and develop misconceptions about the content area (Baki & Arslan, 2017). Yet content knowledge, in and of itself, is an ill-structured domain, and demonstrate, issues relating to curriculum content can be areas of significant contention and disagreement (Obielodan *et al*, 2020).

2.1.3 Pedagogical knowledge

Pedagogical knowledge (PK) is teachers' deep knowledge about the processes and practices or teaching and learning methods. They encompass, among other things, overall educational purposes, values, and aims. This generic form of knowledge applies to understanding how students learn, general classroom management skills, lesson planning, and student assessment. It includes knowledge about techniques or methods used in the classroom; the nature of the target audience; and strategies for evaluating student understanding. A teacher with deep pedagogical knowledge understands how students construct knowledge and acquire skills and how they develop habits of mind and positive dispositions toward learning. As such, pedagogical knowledge requires understanding cognitive, social, and developmental theories of learning and how they apply to students in the classroom. Pedagogical Content Knowledge PCK is consistent with and similar to Shulman's idea of knowledge of pedagogy that applies to teaching specific content. Central to Shulman's conceptualization of PCK is the notion of transforming the subject matter for teaching. Specifically, according to Shulman (1987), this transformation occurs as the teacher interprets the subject matter, finds multiple ways to represent it, and adapts and tailors the instructional materials to alternative conceptions and students' prior knowledge. PCK covers the core business of teaching, learning, curriculum, assessment and reporting, such as the conditions that promote learning and the links among curriculum, assessment, and pedagogy. An awareness of common misconceptions and ways of looking at them, the importance of forging connections among different content-based ideas, students' prior knowledge, alternative teaching strategies, and the flexibility that comes from exploring alternative ways of looking at the same idea or problem are all essential for effective teaching.

2.1.4 Teacher practice

Teachers' traditional and epistemological beliefs about classroom practices are typically teacher- centred. In such learning environment, passive learners adapt knowledge from the teacher who focuses mostly on the content. Contrarily, teachers' modern and constructivist beliefs about the classroom practices are student- centred. In the modern classroom, students can participate, choose from different options, work more independently, and have meaningful topics. (Haron *et al*, 2021) According to many studies, teachers' beliefs affect their practices (Kousa & Aksela, 2019). For example, teachers' positive beliefs are related to students' success in the classroom. However, examining teachers' beliefs might not be a straightforward process, because more than one belief has to be taken into account. In addition, teachers' beliefs and practices are not always similarly connected or recognized. Firstly, teachers' beliefs are often obstructing the successful implementation of their practices (Nopriyeni & Djukri, 2019). Secondly, both positive and negative beliefs tend to be stable (Mohammed *et al*, 2021). Therefore, it is important to examine teachers' beliefs to support their positive beliefs and successful teaching practices. Notably, teachers' negative beliefs tend to increase with the level of students' difficulties and differences. Especially chemistry teachers have more negative beliefs about teaching in diverse classes compared to other teachers.

Sometimes teachers' and students' negative beliefs can be a result of unsuitable teaching methods and materials. Additionally, teachers' lack of knowledge and misconceptions about learning disabilities can negatively influence students' achievement and future possibilities, for example, in their working lives. However, teachers who are used to teaching diverse classes or use differentiated instructions regularly, have more positive beliefs towards teaching and they are more optimistic about their abilities to teach diverse students (Chabalengula & Mumba, 2013). This is important because students' success in the classroom is teacher-dependent. It is stated, that student diversity can be dealt with three different ways: by ignoring it, taking most of students' needs into account or using diversity as a resource so that the whole class would benefit from it. It is essential, that the teaching methods respond to students' needs concerning their readiness, interests and learning profiles (Mumba *et al*, 2015). For example, hands-on activities and field trips can enhance diverse students' positive experiences and attitudes towards Chemistry (Kousa & Aksela, 2019) as well as inquiry-based activities (Mumba *at al*, 2015) and group work (Xu & Brown, 2016). In addition, much can also be done by using science, technology, society and environment (STSE) based issues which can increase students' positive attitudes, conceptual understanding and achievement. There is a relationship between teachers' beliefs about diversity and students' learning (Zion, & Mendelovici, 2012). However, teachers do not have enough knowledge or skills to handle diversity (Chabalengula & Mumba, 2013). There is also a shortage of suitable resources, teaching materials and methods. More time, assistants and possibilities to teach with a colleague are also needed as well as instructions on how to manage diverse classrooms and different behaviour. Consequently, more properly-planned training and support from the teacher education is needed because teachers find that the education in teacher training is inadequate. On the other hand, teacher educators need more research, training, and time to organize appropriate support and training for pre- and in-service teachers. Differentiated teaching aims for students' success.

The essential role is to adjust the teaching case-by-case to meet the needs of different students (Mohammed *et al*, 2021) rather than regularly individualizing the content and the amount of work (Obielodan *et al,* 2020) or avoiding difficult topics. In differentiated teaching, the various needs of students are considered by differentiating the "content, process, product, and learning environment" (Kousa & Aksela, 2019). A teacher can give differentiated instructions to an entire class, group, or individual (Xu & Brown, 2016). Curriculum material can be modified by supplementing, simplifying or altering the content. For example, low-achieving students can benefit from tiered material that has the same content and minimum concepts, but the depth of the content, activities and outcomes can be different depending on the student's skills. On the other hand, it is not necessarily efficient that students regularly follow certain "tracks", particularly in low levels.

2.1.5 Academic performance

Academic performance is the focus of an important study that measures the quality of education in all countries. Academic performance refers the efforts to measure of the extent to which students, teachers, or institutions have achieved educational goals. Although there is no general agreement in measuring academic performance, this has done measured through test scores, final exams, or national exams. Academic performance broadly includes achievement (measured by progress in school, graduation, and subsequent participation in higher education) and academic skills and knowledge. Academic performance is an important study topic in several countries globally, both developed and developing countries and underdeveloped countries. All this is related to the fact that academic performance is an important tool that can be used to evaluate the quality of education and how the quality of education is guaranteed (Indrahadi & Wardana, 2020). Research in the last few decade's shows that academic performance is one of the most widely studied aspects in education. The study focused on the causal relationships of several indicators on academic performance (Ayra & Kösterelioğlu, 2021).

Moreover, academic performance plays an important role in producing high-quality, best graduates who will become leaders and great human resources for the country so that they are responsible for the economic and social development of the country (Erdem & Kaya, 2020). High academic performance indicates different abilities between students (Castro *et al.,* 2015). Academic performance is an indicator of a student's academic success and a part of determining student graduation at school (Dịnçer, 2018). Therefore, it could be said that the study on students' academic achievement has become an aspect of improving student academic qualities in general senses. Currently, several internationally recognised institutions have measured yearly students' academic performance in various countries. In addition to measuring student academic restoration, learning, curriculum, school, and education system are considered four factors that influence student academic performance. Learner factors include the gender of students, the socioeconomic status of their family, motivation (interest in learning, level of participation, and self-confidence) and expectations for education.

Curriculum factors include teaching strategies, the class atmosphere felt by students, class size, teacher support for student learning and life, use of textbooks, etc. Factors at the school level include the type of school management (public or private), structure, quality of teaching staff, number of computers, culture (behaviour and ethics of students and teaching staff), and school management, class practices (classroom teaching activities, student evaluations, hours of study, classroom monitoring by the teacher) (Dotterer & Wehrspann, 2016).

Nevertheless, other studies had also measured the factors that affect academic performance, such as student factors, including demographic information such as gender and age of race, ethnicity, socioeconomic status (Cross *et al*, 2019). Factors related to learning, teacher factors including demographic details, teacher experience, student academic expectations, teacher support (Karadağ, 2017). School factors include demographic information such as school type, location, and school facilities. Then the last factor outside the school, including the educational environment at home, the use of time off. Most recent empirical studies use indicators commonly used in previous studies. Student academic performance is measured by several indicators such as socio-demographic factors, student factors, teacher factors, and school factors. While other studies grouped into personal variables, related to family, related to school, and social (Jeynes, 2017).

2.1.6 Instructional materials

The students who learn more through activity-based lessons with suitable and appropriate instructional material of Chemistry tend to be satisfied. Students' academic performance at whatever level of the education structure is largely dependent upon what the teacher possesses or does before, during, and after the teaching learning situations. Olayinka, (2016) carried out a study on the impact of instructional material utilization and the result shows that students taught with instructional materials performed better in Chemistry than students taught without instructional materials. Arcagok and Özbaşı (2020) defined dispositions as patterns of behaviour exhibited frequently and in the absence of coercion, and constituting a habit of mind under some conscious and voluntary control, and that is intentional and oriented to broad goals. Teachers' disposition also affects students' performance because some teachers do good things some of the time, and all good teachers do bad things some of the time. The differences among teachers lie not only in the delivery of subject matters but also in the internalization of the learning experiences by their students (Olokooba, 2021).

This is true because a teacher who is excited about the subject being taught and shows it by facial expression, voice inflexion, gesture and general movement is more likely to hold students' attention than one who does not exhibit these behaviours in them. Significantly, Abdu-Raheem and Oluwagbohunmi, (2015) opined that teachers' variables are the most important teacher-related factor influencing students' performance. Hence, the common saying that good teachers inspire students to learn and develop positive personalities through teachers' teaching traits, attributes and characteristics which might have been imitated and internalized. Teachers are a touchstone for students throughout their academic journey (Cabi & Ergün, 2016). They are a reliable and consistent presence in the daily school life of a student.

It should be noted that the total experiences acquired by students are functions of the teacher characteristics including gender, qualification, certification, experience, teachers' use of instructional materials and his disposition, is what usually reflects in the teacher effectiveness and by extension, students' academic performance, (Arcagok & Özbaşı, 2020). On pedagogical skills, people agree that good teachers are caring, supportive, concerned about the welfare of students, knowledgeable about their subject matter, and genuinely excited about the work they do and able to help students learn (Olokooba, 2021). Teacher's competence, ability, resourcefulness and ingenuity to efficiently utilize the appropriate language, methodology and available instructional materials to bring out the best from learners in terms of academic performance is what a pedagogical skill supposed to produce in a teacher. Contemporary issues in Nigeria education are quality and functional education that cultivate in learners innovation and creativity. However, the education system is facing with some challenges which hinder the realization of the educational goals.

The quality of the education offered in schools are associated with some factors. These factors include a shortage of well-trained teachers, inadequate teaching facilities, and inadequate funds to purchase necessary equipment, poor quality textbooks, overcrowded classrooms, poorly motivated teachers, and unequipped libraries. This is true because education is a compilation and product of many and different variables and factors but among these factors, teacher stand out as veritable tool in realizing the high standards that are being emphasized in schools. In other words, teachers' pedagogical skills, teachers' dispositions, gender, teachers' reflectivity and the teachers' ability to use instructional materials to teach any subject at whatever level of learning greatly determine the achievement or performance level of students in any matter. Given the fact that the quality of education of a nation is proportional to effective teaching and learning. A growing body of research which indicates that students' performance is more heavily influenced by teachers' characteristics or quality than the students' prior academic record, students' race or parents' level of educational attainment etc. Thus, Olokooba (2015) studied teacher characteristics and their effects on students' attitude. The study revealed that the class climate influenced by teacher has a major impact on students' motivation and attitude towards learning.

Arcagok and Özbaşı, (2020) examined the factors affecting quality of English Language teaching in secondary schools in Nigeria. He found out that English Language teachers do not frequently use modern instructional technologies and variety of teaching techniques in their English Language lessons. Cabi and Ergün, (2016) conducted a research on teachers' teaching experience and students' learning outcomes in secondary schools in Ondo State, Nigeria. He asserted that teachers' teaching experience was significant with students' learning outcomes measured by their performance in the Senior Secondary Certificate Examinations. Schools with more teachers with five years and above experience achieved better results than schools with fewer than five years of teaching experience.

Despite general agreement about the importance of high-quality teachers in relation to students' achievements, researchers have been unable to reach a consensus about what specific qualities and characteristics make a good teacher (Olayinka, 2016). Again, it is important to emphasize here that the various dispositions that teachers display at work greatly affect students' attitude towards learning generally and in particular, the learning of Chemistry and their subsequent performance in the subject. However, it seems that most of the studies highlighted above do not seek to capture the attention of learners hence, use of instructional materials become necessary. In addition to this, previous studies tend to focus more on teachers' characteristics and students' performance in mathematics, Biology, Economics and Christian Religious Knowledge. While much emphasis has been placed on some specific and common teacher' characteristics like Teacher' experience, certification, race, gender at the expense of other teacher' factors such as disposition. Closely related to the variables mentioned above, there is little research linking teachers' disposition and use of instructional materials.

2.2 Theoretical Framework

2.2.1 Shulman's pedagogical content knowledge theory

Shulman's model offered a way of viewing teaching as a profession which was analogous to that of other established professions, such as medicine and law. However, Shulman felt that the analyses of teachers' skills and competencies were incomplete (Shulman, 1986) unlike that defined in medicine and law. Of the research during the 1970s and early 1980s, he felt that crucial questions were not being asked about teaching (Shulman, 1986). He called this the "missing paradigm" of teacher knowledge research. What we miss are questions about the content of the lessons taught, the questions asked, and the explanations offered. From the perspectives of teacher development and teacher education, a host of questions arise. Where do teacher explanations come from? How do teachers decide what to teach, how to represent it, how to question students about it and how to deal with problems of misunderstanding? Research on teaching has tended to ignore those issues concerning teachers. His model proposed understanding the specialised knowledge for teaching that distinguished teachers from just being subject-matter specialists. Shulman wanted to categorise the domains of teacher's content knowledge, with particular attention to how their content knowledge related to their pedagogical knowledge: Teachers must not only be capable of defining the accepted truths in a domain for students. They must also be able to explain why a particular proposition is deemed warranted, why it is worth knowing, and how it relates to other propositions, both within the discipline and without, both in theory and practice. Shulman then, in 1986, offered the ten categories which he initially felt embodied teacher content knowledge. These are

i. Subject-matter content knowledge – referring to the “amount and organisation of knowledge per se in the mind of the teacher” about how to represent content knowledge;

ii. Pedagogical content knowledge – “the ways of representing and formulating the subject that make it comprehensible to others” for that subject matter; and,

iii. Curricular knowledge – knowledge of the curriculum and the use of teaching materials and tools available. A year later, Shulman had revisited these categories, and this time considered and proposed what a minimum ‘knowledge base’ of teacher knowledge might include.

iv. content knowledge;

v. General pedagogical knowledge, with special reference to those broad principles and strategies of classroom management and organisation that appear to transcend subject-matter;

vi. Curriculum knowledge, with particular grasp of the materials and programs that serve as ‘tools of the trade’ for teachers;

vii. pedagogical content knowledge, that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding;

viii. knowledge of learners and their characteristics;

ix. Knowledge of educational contexts, ranging from the workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures; and,

x. Knowledge of educational ends, purposes, and values, and their philosophical and historical grounds.

Shulman had now presented what he considered to be the seven fundamental areas of teacher knowledge. It was then that the term ‘pedagogical content knowledge (PCK) explicitly stood out as a construct of particular value. In the words of Shulman (1987), pedagogical content knowledge is of special interest because it identifies the distinctive bodies of knowledge for teaching. It represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organised, represented, and adapted to diverse interests and abilities of learners and presented for instruction. Pedagogical content knowledge is the category most likely to distinguish the understanding of the content specialist from that of the pedagogue. And to distinguish the knowledge base of teaching lies at the intersection of content and pedagogy, in the capacity of a teacher to transform the content knowledge he or she possesses into forms that are pedagogically powerful and yet adaptive to the variations in ability and background presented by the students.

Furthermore, Shulman (1987) reported that the most significant element of Shulman’s model was PCK: The central feature of this research program was the argument that excellent teachers transform their own content knowledge into pedagogical representations that connect with the prior knowledge and dispositions of the learner. From its conception, pedagogical content knowledge birthed much research and garnered much interest across all the subject disciplines of teacher knowledge research. It is clear that pedagogical content knowledge is a warranted and integral component of any teacher’s knowledge. More so, it can perhaps offer more specific focus for research within specific subject domains, particularly because the ‘distinctiveness of subjects’ added to the body of knowledge that is PCK.

2.2.2 Social Cognitive Theory (SCT)

Social Cognitive Theory (SCT), originally known as the Social Learning Theory (SLT), began in the 1960s through research done by Albert Bandura. The theory proposes that learning occurs in a social context. It considers the dynamic and reciprocal interaction of the person, environment, and their own behavior. Not all forms of learning are accounted for entirely by classical and operant conditioning. For example, imagine a child walking up to a group of children playing a game on the playground. The game looks fun, but it is new and unfamiliar. Rather than joining the game immediately, the child sits back and watches the other children play a round or two. Observing the others, the child takes note of how they behave while playing the game. By watching the behaviour of the other kids, the child can figure out the rules of the game and even some strategies for doing well at the game. This is called observational learning.

Observational learning is a component of Albert Bandura's Social Learning Theory (Bandura, 2005), which posits that individuals can learn novel responses via observing key others' behaviors. Observational learning does not necessarily require reinforcement but instead hinges on the presence of others, referred to as social models. Social models are normally of higher status or authority than the observer, examples of which include parents, teachers, and police officers. In the example above, the children who already know how to play the game could be considered authorities and are therefore social models even though they are the same age as the observer. By observing how the social models behave, an individual can learn how to act in a certain situation. Other examples of observational learning might include a child learning to place her napkin in her lap by watching her parents at the dinner table, or a customer learning where to find the ketchup and mustard after observing other customers at a hot dog stand.

Bandura theorizes that the observational learning process consists of four parts. The first is attention one must pay attention to what they are observing to learn. The second part is retention: to learn, one must retain the behavior they are keeping in memory. The third part of observational learning, initiation, acknowledges that the learner must be able to execute (or initiate) the learned behavior. Lastly, the observer must possess the motivation to engage in observational learning. In our vignette, the child must want to learn how to play the game to engage in observational learning properly.

In this experiment, Bandura (2005) had children individually observe an adult social model interact with a clown doll (Bobo). For one group of children, the adult interacted aggressively with Bobo: punching it, kicking it, throwing it, and even hitting it in the face with a toy mallet. Another group of children watched the adult interact with other toys, displaying no aggression toward Bobo. In both instances, the adult left and the children were allowed to interact with Bobo on their own. Bandura found that children exposed to the aggressive social model were significantly more likely to behave aggressively toward Bobo, hitting and kicking him than those exposed to the non-aggressive model. The researchers concluded that the children in the aggressive group used their observations of the adult social model's behavior to determine that aggressive behavior toward Bobo was acceptable.

While reinforcement was not required to elicit the children's behavior in Bandura's first experiment, it is important to acknowledge that consequences play a role in observational learning. A future adaptation of this study (Bandura, 2005) demonstrated that children in the aggression group showed less aggressive behavior if they witnessed the adult model receive punishment for aggressing against Bobo. Bandura referred to this process as vicarious reinforcement because the children did not experience the reinforcement or punishment directly yet were still influenced by observing it.

Bandura's (2005) findings suggest that there is the interplay between the environment and the individual. We are not just the product of our surroundings, rather we influence our surroundings. There is interplay between our personality and the way we interpret events and how they influence us. This concept is called reciprocal determinism. An example of this might be the interplay between parents and children. Parents not only influence their child's environment, perhaps intentionally through the use of reinforcement, etc., but children influence parents as well. Parents may respond differently to their first child than with their fourth. Perhaps they try to be the perfect parents with their firstborn, but by the time their last child comes along, they have very different expectations of themselves and their child. Our environment creates us and we create our environment. Today there are numerous other social influences, from TV, games, the Internet, i-pads, phones, social media, influencers, advertisements, etc.

2.3 Empirical Review

Badawi (2009) investigated the effectiveness of using blended learning model in developing EFL prospective teachers' pedagogical knowledge and students academic performance. The study sample included 38 EFL Saudi prospective teachers (fourth-year students) at the Faculty of Education & Arts, University of Tabuk, KSA. To collect the data required, a blended TEFL course, a pedagogical knowledge test, and a pedagogical performance scale were designed and implemented. During the first term of the academic year2008-2009, the participants were divided into two equal groups in terms of their number, accumulative grade point, and pedagogical knowledge. The first group studied four TEFL units using the traditional face-to-face model, while the second group studied the same four units using the suggested blended learning model. Results of the pedagogical knowledge test revealed that the mean scores of the EFL prospective teachers in the blended group surpassed the mean scores of those who were in the traditional face-to-face group. In addition, there were no significant differences between the two groups in terms of their mean scores on the pedagogical performance scale. The main conclusion was that blended learning model was more effective than face-to-face learning in developing EFL prospective teachers' pedagogical knowledge. However, both blended learning and face-to-face proved to have almost the same effectiveness in developing EFL prospective teachers' pedagogical performance.

The difference between the existing study and the current study is that the existing study investigates the effectiveness of using blended learning model in developing EFL prospective teachers' pedagogical knowledge (PK) and students academic performance. In contrast, the current study focuses on Chemistry students' performance in secondary schools in Niger State using TPACK as a determinant factor.

Cruz *et al.*, (2017) used mixed methods to examine an association between cognitive types of teachers' mathematical content knowledge and students' performance in lower secondary schools (grades 5 through 9). Teachers (*N* = 90) completed the Teacher Content Knowledge Survey (TCKS), which consisted of items measuring different cognitive types of teacher knowledge. The first cognitive type (T1) assessed participants' knowledge of basic facts and procedures. The second cognitive type (T2) measured teachers' understanding of concepts and connections. The third cognitive type (T3) gauged teachers' knowledge of mathematical models and generalizations. The study comprised two levels of quantitative data analysis. First, we explored each cognitive type of teachers' content knowledge and the overall TCKS score as they related to student performance. Second, we studied the correlation between each cognitive type of teacher content knowledge to deepen the understanding of content associations. Results of the study show a statistically significant correlation between cognitive types T1 and T2 of teacher content knowledge and student performance (p < .05). The correlation between cognitive type T3 and student performance was not significant (p = .0678). The most substantial finding was the correlation between teachers' total score on the TCKS and student performance (Pearson's r = .2903, p = .0055 < .01). These results suggest that teachers' content knowledge plays an important role in student performance at the lower secondary school. The qualitative phase included structured interviews with two of the teacher participants in order to further elaborate on the nature of the quantitative results of the study. The difference between the existing study and the current study is that existing study measures the uses of instructional materials using mixed method to examine an association between cognitive types of teachers' mathematical content knowledge and students' performance in lower secondary schools. In contrast, the current study focuses on Chemistry students performance in secondary schools in Niger State using TPACK as a determinant factor.

According to Odumosu and Olisama (2018) investigated teachers' content and pedagogical knowledge on students' achievement in algebra. The paper focuses on teachers' content and pedagogical content knowledge on students' performance in algebra. Using a test re-test quasi- experimental design with a 3x3x2x2 factorial matrix, the researchers purposively sampled 421 senior secondary school II students and 12mathematics teachers from eight (8) public and four (4) private schools in Education District 5 of Lagos State. The three instruments used are TCTA, OSTP and SATA. OSTP has Spearman' rho reliability coefficient of 0.77, while the TCTA and SATA produced reliabilities of 0.79 and 0.81 respectively using the Gutman' split half reliability method. The three instruments developed were validated and used for data collection. Data were analyzed using graphs and ANCOVA. The results F (2, 387) = 0.56; p = 0.67 revealed that all categories of the subject were equally affected by TCK in algebraic achievement after exposure to teacher' content knowledge. However, F (2, 387) = 12.91; p = 0.00 indicated that students were not equally affected by TPK in algebraic achievement test. On the other hand, F (1, 387) = 0.11; p = 0.90 indicated that gender has no significant effect on students' achievement in algebra after exposure to teachers' content and pedagogic knowledge. Furthermore, F (1, 387) = 0.21; p = 0.81 showed that school type has no significant effect on students' achievement in algebra after exposure to teacher' content and pedagogic knowledge. Also, F (1, 387) = 0.90; p = 0.34 revealed no significant interaction effect of content and pedagogical knowledge, gender and school type on students' achievement in algebra. In view of the findings, the study recommends that teachers of Mathematics, with in-depth knowledge of the subject and well groomed in teaching pedagogy should be allowed to teach algebra in schools.The similarity between the current study and the previous is that both measure the academic performance of secondary students; however, the current study used TPACK as a determinant factor for student academic performance in Chemistry as against the previous study which used CK and PK.

Gess-Newsome *et al.* (2019) attempted to measure potential changes in teacher knowledge and practice as a result of an intervention, as well as trace such changes through a theoretical path of influence that could inform a model of teacher professional knowledge. We created an instrument to measure pedagogical content knowledge (PCK), studied the impact of a two-year professional development intervention, explored the relationships among teacher variables to attempt to validate a model of teacher professional knowledge, and examined the relationship of teacher professional knowledge and classroom practice on student achievement. Teacher professional knowledge and skill was measured in terms of academic content knowledge (ACK), general pedagogical knowledge (GenPK), PCK and teacher practice. Our PCK instrument identified two factors within PCK: PCK-content knowledge and PCK-pedagogical knowledge. Teacher gains existed for all variables. Only GenPK had a significant relationship to teacher practice. ACK was the only variable that explained a substantial portion of student achievement. Our findings provide empirical evidence that we interpret through the lens of the model of teacher professional knowledge and skill, including PCK (Gess-Newsome, 2019). A model of teacher professional knowledge and skill including PCK: Results of the thinking from the PCK summit. In A. Berry, P. Friedrichsen, & J. Loughran (Eds.), *Re-examining pedagogical content knowledge in science education* (28–42). London: Routledge Press], highlighting the complexity of measuring teacher professional knowledge and skill. The difference between the current study and the current study is that existing study attempted to examine the relationship of teacher pedagogical knowledge, practice and student achievement. While the current study focuses on Chemistry student's performance in secondary schools in Niger State using TPACK as a determinant factor.

Ma'rufi *et al.,* (2020) aimed to explore pre-service mathematics teachers' PCK apased on gender and academic skills. To obtain rich and in-depth data, a qualitative approach was used. A total of 70 subjects aged between 19 – 21 years old participated in this study. There were two subjects selected based on their academic skills and gender. Using a grounded theory approach, we conducted a preliminary analysis; open coding, axial coding to obtain the three PCK components, namely Knowledge of Subject Matter (KSM), Knowledge of Pedagogy (KP), and Knowledge of Student (KS). Research findings revealed that the pre-service teachers' pedagogical content knowledge in terms of knowledge of subject matter was categorized as good in mathematics learning. As for their knowledge of pedagogy, the male subjects presented the concepts by employing the expository strategy, the female subjects with high skills used the guided discovery, and the female subjects with average skill also employed the strategy of expository. In the aspect of knowledge of students, the subjects with average skills overcame students' misconception by explaining the procedures and using the strategy of asking, but the subjects with high academic skills did not only implement the two previous strategies but also used their reasoning behind every procedure of problem-solving that they carried out. These findings can be used as recommendations for the development of mathematics learning. The difference between the existing study and the current study is that existing study aimed to explore pre-service mathematics teachers' PCK apased on gender and academic skills. To obtain rich and in-depth data, a qualitative approach was used, while the current study focuses on Chemistry students' performance in secondary schools in Niger State using TPACK as a determinant factor.

Wei and Hao Liu, (2018) examined an experienced chemistry teacher's pedagogical content knowledge (PCK) of teaching with practical work in China. Based on the well-known PCK model by Magnusson, Krajcik and Borko, (1999), Nature, sources, and development of pedagogical content knowledge for science teaching, in Gess-Newsome J. and Lederman N. G. (ed.), *Examining pedagogical content knowledge: the construct and its implications for science education*, Boston: Kluwer, pp. 95–132, we focused on how the participant's teaching orientations and relevant contextual factors shaped his practical knowledge of teaching with practical work. Data from multiple sources were collected and analysed over one semester (four months), including interviews, direct classroom observation, textbooks and lesson plans. Three conclusions were drawn from this study: (1) the participant held multidimensional and mixed science teaching orientations, (2) the participant's science teaching orientations shaped his knowledge and beliefs about students' learning and the instructional strategies related to practical work, and (3) contextual factors exerted great influence on his PCK. The difference between the existing study and the current study is that existing study examined experienced chemistry teacher's pedagogical content knowledge (PCK) of teaching with practical work in China, while the current study focuses on Chemistry students performance in secondary schools in Niger State using TPACK as a determinant factor.

Neumann *et al.,* (2018) aimed to present evidence about the relationships between content knowledge (CK), pedagogical knowledge (PK) and pedagogical content knowledge (PCK); the development of these types of knowledge in novice and experienced secondary science teachers; and how CK, PK and/or PCK impact students' learning. Since Shulman's introduction of PCK as the feature that distinguishes the teacher from the content expert, researchers have attempted to understand, delineate, assess and/or develop the construct in pre- and in-service teachers. Accordingly, empirical findings are presented that permit further discussion. Outcomes permit post-hoc examination of a recent, collectively described, 'consensus' model of PCK, identifying strengths and potential issues. As we will illustrate, the relationship between CK, PK and PCK is central to this; that is, probing the hypothesis of pedagogical content knowledge as an 'amalgam' of content and pedagogical knowledge. The difference between the existing study and the current study is that existing study measures the relationships between content knowledge (CK), pedagogical knowledge (PK) and pedagogical content knowledge (PCK); the development of these types of knowledge in novice and experienced secondary science teachers; and how CK, PK and/or PCK impact students' learning, while the current study focuses on Chemistry students achievement in secondary schools in Niger State using TPACK as a determinant factor.

2.5 Summary of Literatures Reviewed

The study has reviewed related information resources using journal articles, conference proceedings and newspapers. TPACK has been seen as Teachers Pedagogical and Content Knowledge in Chemistry in Secondary Schools as a determinant of students' academic performance. Pedagogical knowledge, Content Knowledge, Instructional materials, and students' academic achievement were also reviewed. The schematic representation of the constructs was also depicted. Similarly, TPACK and chemistry teachers' practices have been crucial to Chemistry students' academic performance.

In a quest to measure TPACK and student academic performance, the study adopted Schuman theory of TPACK and Social Cognitive Theory. The constructs used are pedagogical knowledge and content knowledge. The empirical review of existing studies on pedagogical knowledge, content knowledge, pedagogical and content knowledge, gender, years of experience and academic performance was done to identify the studies' gaps. From the reviewed literature, the following are the identified gaps in knowledge:

1. There is need to carryout research on the use of TPACK by Chemistry Teachers in Secondary schools
2. There is need to identify how TPACK influences the academic performance of Chemistry students in termly assessment.

This research will take into cognizance these gaps and will investigate teacher's pedagogical content knowledge as determinant of secondary school science students' performance in Minna Niger State.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Research Design

This study employed a survey design, specifically a correlational research design to establish the relationship between two or more variables. Seeram (2019) describes correlational research design as non-experimental research that facilitates prediction and explanation between variables. This design aids in obtaining information about teachers, content knowledge, pedagogical knowledge, pedagogical and content knowledge and students' performance.

3.2 Population of the Study

The study population comprised all science teachers and SS2 Science students in public senior secondary schools in Minna Niger State. There are two local government areas in Minna; Bosso and Chanchaga Local Governments with forty-one thousand, one hundred and eighty-three science students (41,183) and six hundred and ninety-two (692) science teachers.

Table 3.1 Illustrates the Population of Public Senior Secondary School Science Teachers in Bosso and Chanchaga Local Government Areas of Minna, Niger State.

Number	Subjects	Total
1	Biology	328
2	Chemistry	185
3	Physics	197
Total		**692**

Source: Planning Research and Statistics Niger State Ministry of Education Minna, 2021.

Table 3.2: Illustrates Population of Public Senior Secondary School teachers in Bosso Local Government Area of Niger State.

Nos	Schools in Bosso	Male	Female	Total
1	Abdullah-dada Secondary School Maikunkele	18	7	25
2	Bosso Secondary school Minna	34	39	73
3	Day Secondary School Gbada, Gidan Mangoro	18	13	31
4	Day Secondary School Chanchaga Minna B	16	17	33
5	Day Secondary School Garatu	12	1	13
6	Day Secondary School Maikunkele A	16	11	27
7	Day Secondary School Maitumbi Minna	27	51	78
8	Day Secondary School Pyata Bosso	11	6	17
9	Day Secondary School Shatta	8	3	11
10	Federal Government College Minna	146	74	220
11	Government Army Day Secondary School	49	42	91
12	Government Day Secondary School Beji	10		10
13	Government Science College Chanchaga	21	26	47
14	Government Senior Secondary School Kampala	10	2	12
15	Government Technical College Minna	67	50	117
16	Maryam Babangida Girls Science College Minna	34	54	88
17	Model Science College Tudun Fulani	29	24	53
18	Niger State School for Special Education Minna	13	3	16
19	Studies Tudun Fulani Minna	36	14	50
20	Hilltop Model Secondary School	29	31	60
	Total	**604**	**468**	**1072**

Table 3.3: Illustrates the Population of Public Senior Secondary School teachers In Chanchaga Local Government Area of Niger State.

Nos	Public Schools in Chanchaga Local Government Area	Male	Female	Total
1	Ahmadu Bahago Secondary School Minna	16	19	35
2	Day Secondary School Limawa Minna	24	16	40
3	Fr. O'Connell Science College Minna	37	55	92
4	Government Day Secondary School Bosso Road	31	31	62
5	Government Day Science College Tunga	40	161	201
6	Government Girls Secondary School Minna	26	47	73
7	Government Vocational Training Center	55	66	121
8	Women Day Secondary School	15	20	35
9	Zarumai Model School	33	48	81
	Total	277	463	740

Source: Niger State Ministry of Education Minna, 2021

3.3 Sample and Sampling Technique

The sample size for this study was derived using the Yamane formula (1967). The Yamane formula has long been heralded as a perfect fit for determining the appropriate sample size for a study whose population is known. Therefore the sample size for the study is 252 teachers and 252 students respectively; this is because the study applies a correlational design. The sampling technique for the study is the simple random sampling technique. The simple random sampling technique is used for probabilistic studies such that samples are been selected from the entire pool of population at random to allow for fairness and equality of each sample from the universal population having an equal chance of being selected or adopted for the study.

Considering that the current study examined teachers' pedagogical and content knowledge as a determinant for science student performance in Minna, the simple random sampling technique offers all subjects from the population equal chances of being selected for examination. And as such it is a perfect fit for the current study. To proceed, 253 respondents from the population having identified as the sample size will be randomly selected.

3.4 Research Instrument

The instrument used for data collection is a researcher-developed Questionnaire on Science teachers' Pedagogical and Content Knowledge as determinants of Secondary School Science Students' Performance in Minna metropolis, Niger state (QSTPACK).The questionnaire consists of five-point likert-type questions .In addition, the questionnaire comprises of six sections A to F.

Section A contains demographic information of the respondents such as gender, age of respondents, teaching area and years of experience, section B consists of questions on Pedagogical Knowledge (PK) amongst Science teachers, section C consists of questions on Content Knowledge (CK) amongst Science teachers and section D consists of questions on Pedagogical and Content Knowledge (PCK). The questionnaire is a 5-Likert point scale which is: Strongly Agree (SA), Agree (A), Undecided (UD), Disagree (DA), and Strongly Disagree (SD). The scores are: Strongly Agree (SA) = 5, Agree (A) = 4, Undecided (UD) = 3 , Disagree (DA) = 2 and Strongly Disagree (SD) =1.

3.5 Validation of Instruments

Validity is defined as the extent to which a concept is accurately measured in a quantitative study (Hale 2016). Two senior lecturers from the Federal University of Technology Minna's Science Education Departments and two experts from the Science Department of Government Model School Tudun Fulani Minna, Niger State validated the instrument. The instrument was validated in terms of content and face validity.

Content validity looks at whether the instrument adequately covers all the content that it should concerning the variable. In other words, does the instrument cover the entire domain related to the variable, or construct it was designed to measure? (Hale, 2016) While face validity is the extent to which a test is subjectively viewed as covering the concept it purports to measure (Hale, 2016). Furthermore, the experts were requested to examine the test instruments in terms of the appropriateness of the content, clarity and simplicity of the tools, its suitability for the category of teachers, and the extent to which the items cover areas they are meant to cover. Their corrections were incorporated into the final form of the instrument before administration as they reported that the instrument was valid.

3.6 Reliability of Research Instrument

Reliability is how a research instrument consistently has the same results if used in the same situation on repeated occasions (Hale 2016). Hence, to determine the reliability of the instrument, a pilot study was carried out among 25 Science teachers at St Clement Secondary School Gbaiko, Minna, Niger State, which will not take part in the actual research study but is within the study area and were collected back by the researcher using test re-test method. The sub-section of the instrument includes pedagogical Knowledge (PK), Content knowledge (CK), Pedagogical content knowledge (PCK). SPSS was used to analyze the reliability coefficient.

Table 3.4: Reliability of the Construct of the Instrument

SN	Construct	No of Items	Reliability coefficient
1	PK	20	0.76
2	CK	20	0.70
3	PCK	20	0.82

Table 3.4 shows the reliability coefficient scores of 0.76,0.70 and 0.82 for PK, CK and PCK, respectively. Sekaran and Bougie (2016) support this result, who reported that the reliability coefficient of 0.7 is considered acceptable. Reliability coefficient scores are considered ‘poor’ when the alpha coefficient is < 0.6, ‘moderate’ in the vicinity of 0.6 and 0.7, ‘good’ in the vicinity of 0.7 and 0.8, ‘great’ in the vicinity of 0.8 and 0.9, and ‘excellent’ when the Alpha coefficient is equivalent to or more than 0.9 (Hair, Black & Babin, 2019). Therefore, the reliability coefficient obtained for this instrument is considered acceptable for this research.

3.7 Method of Data Collection

The researcher collected a letter of introduction from Science Education Department of Federal University of Technology Minna and used the first and second week to visit the selected schools and examine the facilities and the science teachers. This was to determine their suitability for the research work and seek official permission and cooperation of the school management to use the schools and its facilities and results of the SS2 students from first to third term. The permission was granted in form of an approval letter. The researcher was then introduced to the science teachers from each of the sampled schools and the researcher informed them in due time and brought to speed on the study's objectives.

Table 3.5: Shows a Summary of the Weekly Activities of the Researcher at Various Schools.

S/N	Week number	Activity
1	Week 1	The researcher visited the selected schools to examine the facilities, the science teachers and to determine their suitability for the research work.
2	Week 2	The researcher sought official permission and cooperation of the school management to use the schools and its facilities.
3	Week 3	science teachers from each of the sampled schools were informed in due time and brought to speed on the objectives of the study.
4	Week 4	The researcher distributed the questionnaires among science teachers from the sampled schools.
5	Week 5	The questionnaires were collected from the teachers for data analysis.

3.8 Method of data Analysis

Samples were collected from sampled teachers and were analyzed using Mean and standard deviation supported by scatterplot to show the relationship. Finally, the null hypothesis were analyzed using linear regression and multiple regression at 0.05 level of significance.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Results

The study investigated science teachers' pedagogical and content knowledge as determinants of secondary school science students' performance in Minna Niger State. This chapter deals with data analysis and presentation of results and analysis based on the stated research questions and the formulated hypotheses as highlighted in chapter one. The chapter also deals with a summary of findings and a discussion of results. The findings from the data were presented in the following.

i. Research questions

ii. Testing hypotheses

4.1.1 Research Question 1.

What is the relationship between science teachers' pedagogical knowledge and science student' academic performance in Minna, Niger state? To answer this research question, scattered plot was used and the result is presented in Figure 4.1.

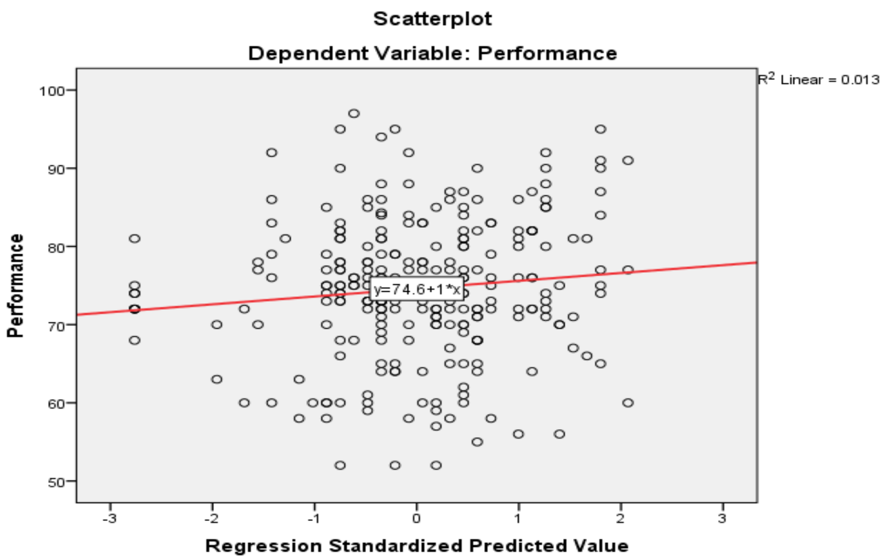

Figure 4.1: Scattered Plot of the Relationship Between Science Teachers' Pedagogical Knowledge and Student' Academic Performance in Secondary Schools Minna.

The scattered plot indicates that there is a positive relationship between science teachers' pedagogical knowledge and science student' academic performance in secondary schools in Minna as indicated by the regression line. This indicates that science teachers' pedagogical knowledge in this population influences science students' academic performance. Therefore, the mean and standard deviation of Pedagogical Knowledge and students' performance is as shown in Table 4.1

Table 4.1: Mean and Standard Deviation of Plot of the Relationship Between Science Teachers' Pedagogical Knowledge and Student' Academic Performance in Minna.

	N	Mean	Std. Deviation	Mean difference
Performance	252	74.60	8.93	10.30
Pedagogical knowledge	252	84.90	7.45	

Table 4.1 shows the mean and standard deviation of the science teachers' pedagogical knowledge and science student' academic performance. The findings show computed $\bar{x}$= 74.60 with SD = 8.93 for science students' academic performance and $\bar{x}$=84.90 with SD= 7.45 for science teachers' pedagogical knowledge. It indicated a mean difference of 10.30 between science teachers' pedagogical knowledge on science student' academic performance. This means that there is significant relationship between science teachers' pedagogical knowledge and students's academic performance.

4.1.2 Research question 2

What is the relationship between science teachers' content knowledge and science student' academic performance in Minna, Niger state? To answer this research question, scattered plot was used and the result is presented in Figure 4.2

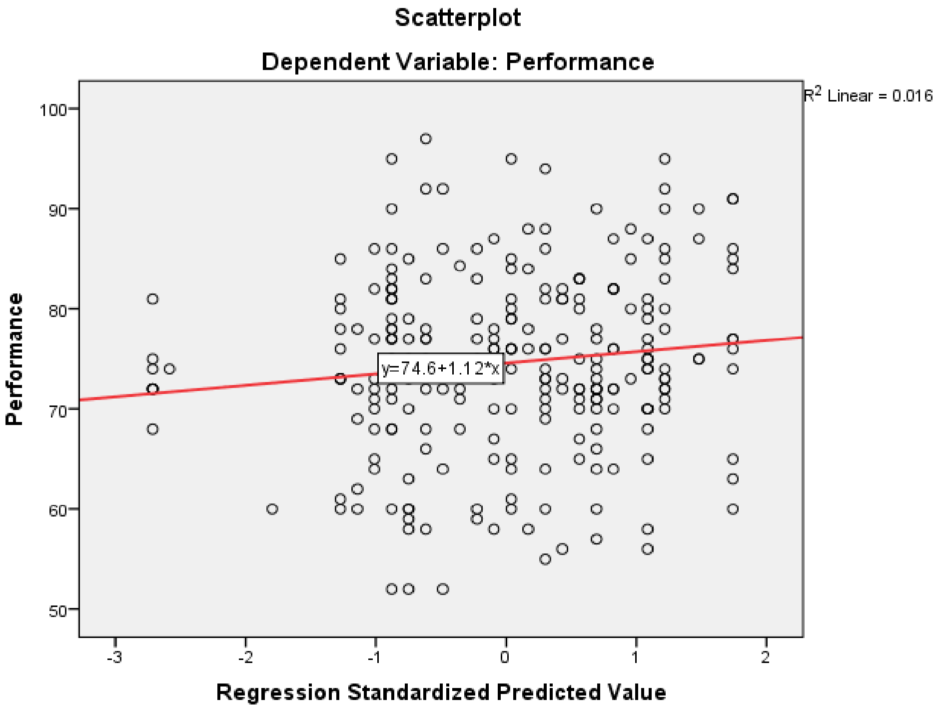

Figure 4.2 Scattered Plot of the Relationship between Science Teachers' Content Knowledge and Student' Academic Performance in Secondary Schools Minna.

The scattered plot indicates that there is a positive relationship between science teachers' content knowledge and science student' academic performance in secondary schools in Minna as indicated by the regression line. This indicates that science teachers' content knowledge in this population influences science student' academic performance. Therefore, the mean and standard deviation is shown in Table 4.2

Table 4.2: Mean and Standard Deviation of Plot of the Relationship between Science Teachers' Content Knowledge and Student' Academic Performance in Minna.

	N	Mean	Std. Deviation	Mean diff.
Performance	252	74.60	8.93	7.11
Content knowledge	252	81.71	7.63	

Table 4.2 shows the mean and standard deviation of the relationship between science teachers' content knowledge influence on science student' academic performance in Minna. The findings show computed $\bar{x}$= 74.60 with SD = 8.93 for science student' academic performance and $\bar{x}$=81.71 with SD= 7.63 for science teachers' content knowledge. It indicated a mean difference of 7.11 between science teachers' content knowledge and science student' academic performance. This means that there is significant relationship between science teachers' content knowledge and students's academic performance.

4.1.3 Research question 3

What is the relationship between science teachers' pedagogical and content knowledge and Science students' academic performance in Minna, Niger State. To answer this research question, scattered plot was used and the result is presented in Figure 4.3

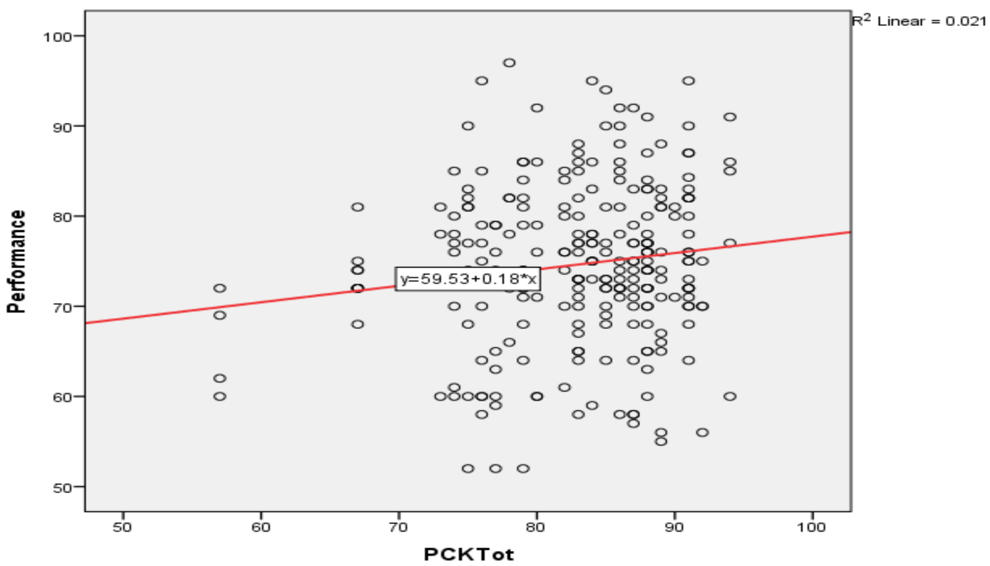

Figure 4.3: Scattered Plot of the Relationship between Science Teachers' Pedagogical and Content Knowledge and Student' Academic Performance in Secondary Schools Minna.

The scattered plot indicates that there is a positive relationship between science teachers' pedagogical and content knowledge and Science students' academic performance in secondary schools in Minna as indicated by the regression line. This indicates that science teachers' Pedagogical and content knowledge in this population influences science student' academic performance. Therefore, the mean and standard deviation is shown in Table 4.3

Table 4.3 Mean and Standard Deviation of Plot of the Relationship between Science Teachers' Pedagogical and Content Knowledge and Student' Academic Performance in Minna.

	N	Mean	Std. Deviation	Mean diff.
Performance	252	74.60	8.925	
Content knowledge	252	82.85	7.055	8.25

Table 4.3 shows mean and standard deviation of the relationship between science teachers' pedagogical and content knowledge influence on science student's academic performance in Minna. The findings show computed $\bar{x}$= 74.60 with SD = 8.93 for science student' academic performance and $\bar{x}$= 82.85 with SD= 7.06 for science teachers' pedagogical and content knowledge. It indicated a mean difference of 8.25 between science teachers' pedagogical and content knowledge and science student' academic performance. This means that there is significant relationship between science teachers' pedagogical and content knowledge and students's academic performance.

4.1.4 Research question 4

What is the relationship between science teachers' Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical and Content Knowledge (PCK) and Science students' academic performance in Minna, Niger state? To answer this research question, scattered plot was used and the result is presented in Figure 4.4

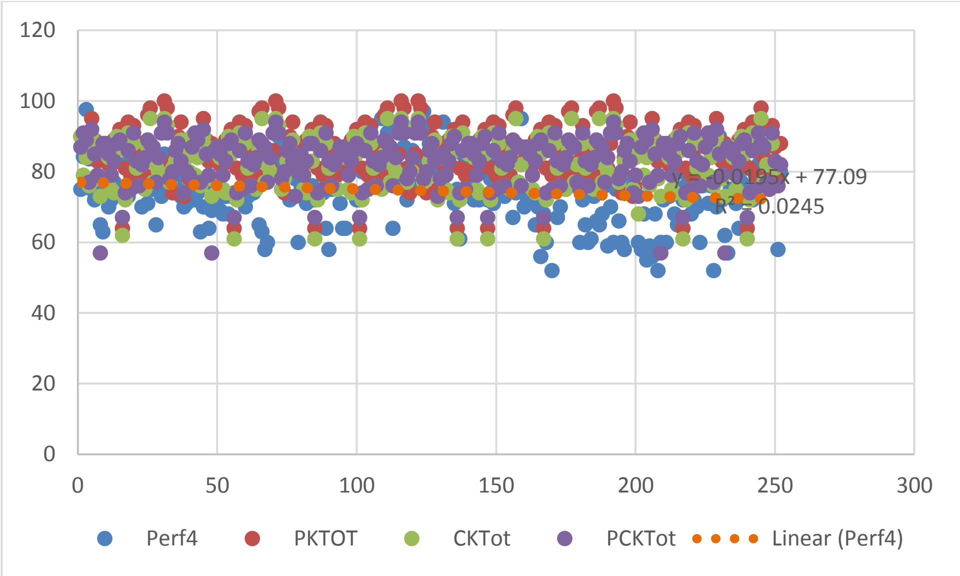

Figure 4.4: Scattered Plot of the Relationship between Science Teachers' Pedagogical knowledge, Content Knowledge, Pedagogical and Content Knowledge and students' academic performance in Secondary Schools in Minna.

The scattered plot indicates that there is a positive relationship between science teachers' pedagogical knowledge, content knowledge, pedagogical and content knowledge and Science students' academic performance in secondary schools in Minna as indicated by the regression line. This indicates that science teachers' pedagogical knowledge, Content knowledge and Pedagogical and content knowledge in this population influences science student' academic performance. Therefore, the mean and standard deviation is shown in Table 4.4

Table 4.4: Shows the Mean and Standard Deviation of Science Teachers' Pedagogical knowledge, Content Knowledge, Pedagogical and Content Knowledge and Science students' academic performance in Secondary Schools in Minna.

	N	Mean	Std. Deviation
Pedagogical knowledge	252	84.59	7.451
Content Knowledge	252	81.71	7.629
Pedagogical and content knowledge	252	82.85	7.055
performance	252	74.60	8.925

Table 4.4 shows mean and standard deviation of the relationship between science teachers' pedagogical knowledge, content knowledge, pedagogical and content knowledge and Science students' academic performance in Minna. The findings show computed $\bar{x}$= 84.59 with SD = 7.451 for science teachers' pedagogical knowledge,$\bar{x}$= 81.71 with SD = 7.629 for science teachers content knowledge, $\bar{x}$= 82.85 with SD = 7.055 for science teachers pedagogical and content knowledge and $\bar{x}$=74.60 with SD= 8.925 for science students' academic performance. This means that there is significant relationship between science teachers' pedagogical knowledge, content knowledge and pedagogical and content knowledge and students's academic performance.

4.1.5 Research question 5

What the relationship between science teachers' gender and Science teachers' pedagogical and content knowledge in Minna? To answer this research question, scattered plot was used and the result is presented in Figure 4.5

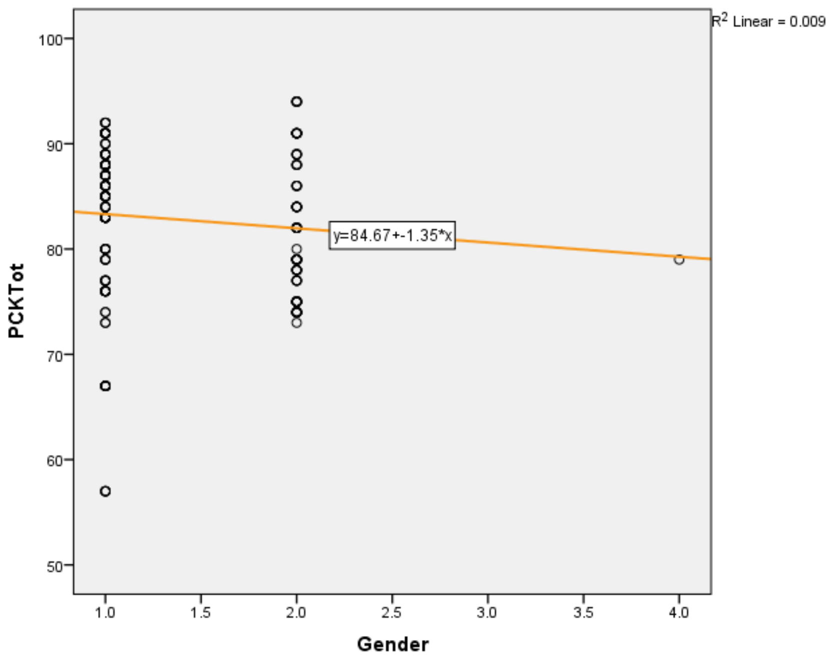

Figure 4.5: Scattered Plot of the Relationship between Science Teachers' Genders and Science Teachers' Pedagogical and Content Knowledge in Secondary Schools Minna.

The scattered plot indicates that there is a negative relationship between science teachers' gender and science teachers' pedagogical and content knowledge in secondary schools in Minna as indicated by the regression line. This indicates that science teachers' gender in this population does not influence their pedagogical and content knowledge. Therefore, the mean and standard deviation is as shown in Table 4.5

Table 4.5 shows the Mean and Standard Deviation Plot of the Relationship between Science Teachers' Gender and Science Teachers' Pedagogical and content Knowledge in Secondary Schools in Minna.

	N	Mean	Std. Deviation	Mean diff.
Pedagogical and Content Knowledge	252	72.85	7.055	71.50
Gender	252	1.35	.502	

Table 4.5 shows mean and standard deviation of the relationship on how science teachers' gender influences science Teachers' pedagogical and content knowledge in Minna. The findings show computed $\bar{x}$= 1.35 with SD = 0.502 for science teachers gender and $\bar{x}$=72.85 with SD= 7.055 for science teachers' pedagogical and content knowledge. It indicated a mean difference of 71.50 between gender of science teachers' and their pedagogical and content knowledge. This means that there is no significant relationship between science teachers' gender and students's academic performance.

4.1.6 Research question 6

6. What is the relationship between teachers' years of experience and pedagogical and content knowledge in secondary schools in Minna?. To answer this research question, scattered plot was used and the result is presented in Figure 4.6

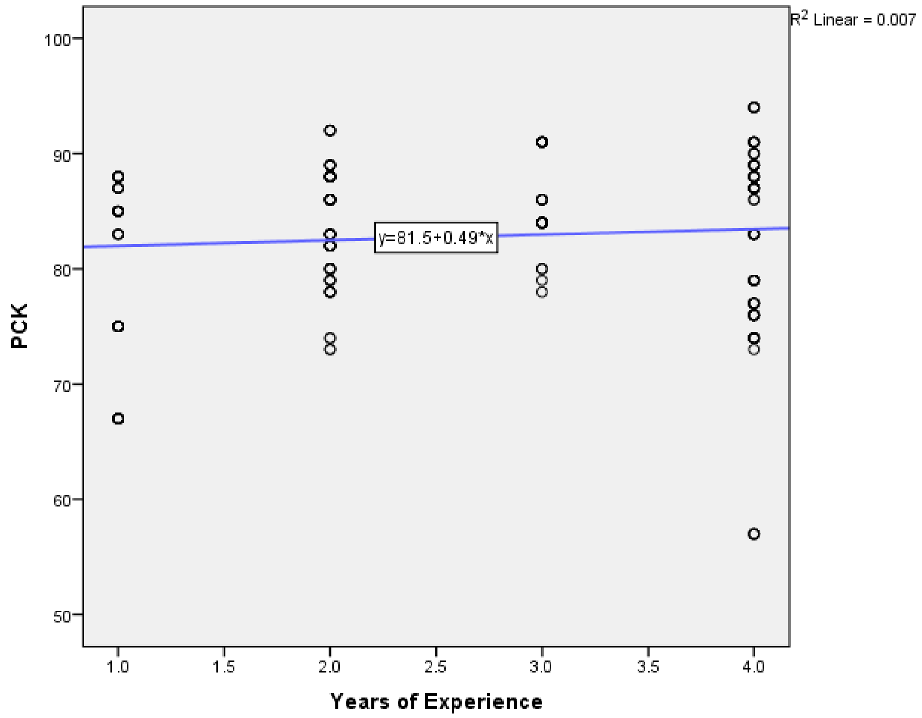

Figure 4.6: Scattered Plot of the Relationship between Science Teachers' Years of Experience and Science Teachers' Pedagogical and Content Knowledge in Secondary Schools Minna, Niger state.

The scattered plot indicates that there is a positive relationship between science teachers' years of experience and science teachers' pedagogical and content knowledge in secondary schools in Minna as indicated by the regression line. This indicates that science teachers' years of experience in this population influences their pedagogical and content knowledge. Therefore, the mean and standard deviation is shown in Table 4.6

Table 4.6: Shows the Mean and Standard Deviation plot of the Relationship between Science Teachers' Years of Experience and Science Teachers' Pedagogical and content Knowledge in Secondary Schools in Minna.

	N	Mean	Std. Deviation	Mean diff.
Pedagogical and Content Knowledge	252	72.85	7.055	70.10
Years of Experience	252	2.75	1.173	

Table 4.6 mean and standard deviation of the relationship between the influence of science teachers' years of experience on science Teachers' pedagogical and content knowledge in Minna. The findings show computed $\bar{x}$= 2.75 with SD = 1.173 for science teachers years of experience and $\bar{x}$=72.85 with SD= 7.055 for science teachers' pedagogical and content knowledge. It indicated a mean difference of 70.10 between years of experience of science teachers' and their pedagogical and content knowledge. This means that there is significant relationship between science teachers' years of experience and students's academic performance.

4.2 Testing of Null Hypotheses

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

4.2.1 Hypothesis one

HO_1: There is no significant relationship between science teacher' pedagogical knowledge and Science student' performance. To test this hypothesis, linear regression was used and the results presented in Table 4.7.

Table 4.7: Model Summary of the Relationship between science teacher' pedagogical knowledge and Science students' performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.112[a]	.013	.009	8.886

Predictors: (Constant), Pedagogical knowledge

Table 4.7a shows the regression coefficient for the independent (predictor) variable; pedagogical knowledge, while the dependent or criterion variable; Science students' performance. The result shows r (1,250) = .112, r^2 = .013. Indicating that only 1.3% of the variance in science students' performance is accounted by science teachers' pedagogical knowledge in secondary schools. The regression coefficient is presented in Table 4.7b

Table 4.7b: Regression coefficient for the constructs

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	**Std. Error**	**Beta**	**T**	**Sig.**
1 (Constant)	63.223	6.392		9.891	.075
PK	.135	0.075	.112	1.787	.001

a. Dependent variable: Performance

Table 4.7b shows the regression coefficient of science teachers' pedagogical knowledge. The result shows that there is a significant relationship between science teachers' pedagogical knowledge and science students' performance (B = 0 .08, t = 1.79, p (0.001) <0.05). The regression coefficient indicates that for any increase in one unit of science teachers pedagogical knowledge will predict an increase in 0.135 units of science students' performance when all other factors are constant in this population. This implies that increase in teachers PK will result in increase in students' performance.

4.2.2 Hypothesis two

HO_2: There is no significant relationship between science teacher' content knowledge and Science students' performance. To test this hypothesis, linear regression was used and the results presented in Table 4.8a

Table 4.8a: Model Summary of the Relationship between science teacher' content knowledge and Science students' performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.126[a]	.016	.012	8.872

Predictors: (Constant), content knowledge

Table 4.8a shows the regression coefficient for the independent (predictor) variable; content knowledge, while the dependent or criterion variable; Science students' performance. The result shows r (1,250) = .112, r^2 = .016. Indicating that only 2% of the variance in science students' performance is accounted for by science teachers' content knowledge in secondary schools. The regression coefficient is presented in Table 4.8b

Table 4.8b: Regression Coefficient for the Constructs

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	62.579	6.392		10.389	.000
	CK	.147	0.73	.126	2.005	.046

b. Dependent variable: Performance

Table 4.8b shows the regression coefficient of science teachers' content knowledge. The result shows that there is a significant relationship between science teachers' content knowledge and science students' performance (B = 0.147, t = 2.005, p 0.046 <0.05). The regression coefficient indicates that for any increase in one unit of science teachers content knowledge will cause an increase in 0.135 units of science students' performance when all other factors are constant in this population. This implies that increase in teachers CK will result in increase in students' performance.

4.2.3 Hypothesis three

HO3: There is no significant relationship between science teachers' pedagogical and content knowledge and Science students' performance. To test this hypothesis, linear regression was used and the results presented in Table 4.9a.

Table 4.9a: Model Summary of the Relationship between Science Teacher' Pedagogical and Content Knowledge and Science Students' Performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.144[a]	.021	.017	8.850

Predictors: (Constant), pedagogical and content knowledge

Table 4.9a shows the regression coefficient for the independent (predictor) variable; pedagogical and content knowledge, while the dependent or criterion variable; Science students' performance. The result shows r (1,250) = .144, r^2 = .021. Indicating that only 2.1 % of the variance in science students' performance is accounted for by science teachers' pedagogical and content knowledge in secondary schools. The regression coefficient is presented in Table 4.9b

Table 4.9b: Regression Coefficient for the Constructs

	Unstandardized Coefficients		Standardize Coefficients		
Model	B	Std. Error	Beta	T	Sig.
1 (Constant)	59.532	6.583		9.043	.000
PCK	.182	0.79	.144	2.298	.022

Dependent variable: Performance

Table 4.17b shows the regression coefficient of science teachers' pedagogical and content knowledge. The result shows that there is a significant relationship between science teachers' pedagogical and content knowledge and science students' performance (B = 0.182, t = 2.298, p (0.001) <0.05). The regression coefficient indicates that for any increase in one unit of science teachers pedagogical and content knowledge will cause an increase in 0.135 units of science students' performance when all other factors are constant in this population. This implies that increase in teachers PCK will result in increase in students' performance.

4.2.4 Hypothesis four

HO_4: There is no significant relationship between content knowledge, pedagogical knowledge, content knowledge, pedagogical and content knowledge and students' performance. To test this hypothesis, multiple regression was used and the results presented in Table 4.10a

Table 4.10a: Model Summary of the Relationship between Science Teacher' pedagogical knowledge, content Knowledge, Pedagogical and content knowledge and Science students' performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.147[a]	.022	.010	8.882

Predictors: (Constant), PK, CK and PCK

Table 4.10a shows the regression coefficient for the independent (predictor) variables; pedagogical knowledge, content knowledge and pedagogical and content knowledge while the dependent or criterion variable; Science students' performance. The result shows r (1,250) = .147, r^2 = .022. Indicating that only 2.2% of the variance in science students' performance is accounted by science teachers' pedagogical knowledge, content knowledge and pedagogical and content knowledge in secondary schools in Minna. The regression coefficient is presented in Table 4.10b

Table 4.10b: Regression Coefficient for the Constructs

Model	Unstandardized Coefficients		Standardize Coefficients		
	B	**Std. Error**	**Beta**	**T**	**Sig.**
1 (Constant)	58.206	7.213		8.070	.000
PK,	.040	0.109	.033	0.713	.713
CK	0.12	0.138	.010	.932	932
PCK	0.145	0.133	1.095	.275	275

Dependent variable: Performance

Table 4.10b shows the regression coefficient of science teachers' pedagogical knowledge, content knowledge and pedagogical and content knowledge. The result shows that there is a significant relationship between science teachers' pedagogical knowledge, content knowledge, pedagogical and content knowledge and science students' performance (B = 0.040 for PK, 0.12 for CK and 0.145 for PCK, while t = 0.713 for PK, 0.932 for CK and 0.275 for PCK, p (0.001) <0.05). The regression coefficient indicates that for any increase in one unit of science teachers' pedagogical knowledge, content knowledge and pedagogical and content knowledge will cause an increase in 0.135 units of science students' performance when all other factors are constant in this population. This implies that increase in teachers PK, CK and PCK will result in increase in students' performance.

4.2.5 Hypothesis five

HO_5: There is no significant the relationship between science teachers' gender and pedagogical and content knowledge. To test this hypothesis, point biserial was used and the results presented in Table 4.11

Table 4.11: Relationship between Science Teachers' Gender and Pedagogical and Content Knowledge in Secondary Schools in Minna.

Correlations			
		PCK	**Gender**
PCKTot	Rpb	1	-.096
	Sig. (2-tailed)		.00
	N	252	252
YrsofExpe	Rpb	-.096	1
	Sig. (2-tailed)	.128	
	N	252	252

**** Correlation is significant at the 0.01 level (2-tailed).**

Table 4.11b: revealed there is a significant negative relationship between gender and students' performance. The results show ɤpb=-0.096, p-value = 0.00, which means p<0.05, hence the null hypothesis five was rejected. The correlation coefficient (ɤpb = -.096) further shows that there is a negative relationship between years of experience of science teachers and pedagogical and content knowledge. This probability implies that science teachers, gender do not influence students academic performance.

4.2.6 Hypothesis six

HO_6: There is no significant relationship between years of experience of science teachers and pedagogical and content knowledge. To test this hypothesis, point biserial was used and the results presented in Table 4.12

Table 4.12: Relationship between Years of Experience of Science Teachers and Pedagogical and Content Knowledge in Secondary Schools in Minna.

Correlations			
		PCK	**Years of experience**
PCKTot	Rpb	1	-.081**
	Sig. (2-tailed)		.00
	N	252	252
YrsofExpe	Rpb	-.081*	1
	Sig. (2-tailed)	.197	
	N	252	252

**** Correlation is significant at the 0.01 level (2-tailed).**

Table 4.12: revealed there is a significant negative relationship between years of teaching experience and students' performance. The results show ɤpb= 0.081, p-value = 0.00, which means $p<0.05$, hence the null hypothesis five was accepted. The correlation coefficient (ɤpb = .081) further shows that there is a positive relationship between years of experience of science teachers and pedagogical and content knowledge. This probability implies that science teachers, years of experience influence students' academic performance.

4.3 Summary of Findings

From the analysis and the results obtained from this study, the findings were recorded and summarized as follows.

1. The respondents ascertained that science teachers' pedagogical knowledge has significant relationship with science students' academic performance.
2. The respondents indicated that science teachers' content knowledge has significant relationship with science student' academic performance.
3. The respondents believe that science teachers' Pedagogical and content knowledge has a very significant relationship on science student' academic performance.
4. Science teachers' pedagogical knowledge, content knowledge and pedagogical and content knowledge has significant relationship with science students' academic performance because of the relationship seen on the graph.
5. Gender has no significant relationship on science teachers' pedagogical and content knowledge.
6. The responses show that science teachers' years of experience influences their pedagogical and content knowledge.

4.4 Discussion of Findings on Science Teachers' Pedagogical and Content Knowledge as Determinants of Secondary School Science Students' achievement.

4.4.1 Quantitative research findings on research question one.

The result of this study as examined by the researcher reveals that respondents indicated that there is a significant relationship between science teachers' pedagogical knowledge and science students' academic performance in this population. It is important to highlight that more respondents in this population view pedagogical knowledge as a form of knowledge that makes science teachers rather than scientists. Teachers differ from scientists, not necessarily in the quality or quantity of their subject matter knowledge, but in how that knowledge is organized and used. In contrast, the standard deviation of the respondents to determine the relationship between science teachers' Pedagogical Knowledge (PK) and Science student' academic performance indicates no meaningful deviation in their responses. The finding was in line with the study of Ebenezer (2021) which revealed that there was a significant positive multiple correlation between the predictor pedagogical knowledge which includes (lesson preparation, teacher qualification, teacher assessment skills, classroom management, and lesson presentation) and science teachers' effectiveness in secondary schools in Niger State. This implied that teachers' pedagogical knowledge is a factor that can exert influence on science teachers' effectiveness in secondary schools in Niger State leading to improved academic performance.

4.4.2 Quantitative research findings on research question two.

The result of this study as examined by the researcher reveals that respondents indicated that there is a significant relationship between science teachers' content knowledge and science students' academic performance in this population. It is important to highlight that more respondents in this population agree that both teaching and learning depends on teachers therefore a teacher with a good content knowledge has been conceptualized as one who produces desired results in the course of his duty as a teacher. In contrast, the standard deviation of the respondents to determine the relationship between science teachers' content Knowledge (PK) and Science student' academic performance indicates no meaningful deviation in their responses the finding was in line with Ajayi (2017) that stated a positive correlation between science teachers' content knowledge and chemistry students performance in Otukpo local government area of Benue state.

4.4.3 Quantitative research findings on research question three.

The result of this study as examined by the researcher reveals that respondents indicated that there is a significant relationship between science teachers' pedagogical and content knowledge and science students' academic performance in this population. It is important to highlight that more respondents in this population agree that Pedagogical Content Knowledge (PCK) plays an important role in classroom instructions as an educational term that describes several interconnected domains of knowledge that are useful to the teacher teaching in a school or in an out of school context. In contrast, the standard deviation of the respondents to determine the relationship between science teachers' Pedagogical and content Knowledge (PCK) and Science student' academic performance indicates no meaningful deviation in their responses which is in contrast to the study of Joseph and Oluwatoyin (2017) who carried out a correlation research based on survey research design on pedagogical and content knowledge as a determinant of students performance in Edo state and reported that pedagogical and content knowledge had no significant influence on students' academic performance and recommended that that principals should ensure that the potentials of the teachers are well harnessed and utilized to reflect the true picture of their quality in the academic performance of students but was in line with the study of Hanna Hanna Yusuf who that teachers' with high Pedagogical and content knowledge has significant impact on students' performance.

This is also in line with the findings of Abe and Adu (2013) who found out that teachers' pedagogical and content knowledge contributed to the improvement of students' scores in their academic performance. This is an alteration to the fact that no one can give what he/she does not possess quality teachers constantly strive to possess all the requisite training and knowledge required to discharge their duties effectively and efficiently.

4.4.4 Quantitative research findings on research question four.

The result of this study as examined by the researcher reveals that respondents indicated that there is a significant relationship between science teachers' pedagogical knowledge, content knowledge, pedagogical and content knowledge and science students' academic performance in this population. This is in line with the study of Newman (2019) who probed the relationship between science teachers' content, pedagogical and pedagogical content knowledge and reported that CK, PCK and PK represent distinct but correlated knowledge bases for biology, chemistry and physics teachers. Further, Reinhold (2020) confirmed that pre-service physics teachers' CK, PCK and PK are distinct but strongly correlated knowledge bases. Thus, evidence emerges that CK and PCK interconnect in teachers' instructional practices with consequences for learning; this research suggest that when teachers' CK and PK are strong their PCK is more likely to help students learn than when CK and PK are poor. CK, PK and PCK begin to interconnect during pre-service (initial) teacher education, with subsequent changes occurring through classroom practice and professional development.

4.4.5 Quantitative research findings on research question five.

The result of this study as examined by the researcher reveals that respondents indicated that there is no significant relationship between science teachers' gender and science students' academic performance in this population this is in line with the findings of findings of Igberadja (2016) who carried out a research on the effects of teachers' gender and qualification on students academic performance and concluded that teachers' gender and qualification do not have significant effects on the academic performance of students. This implies that the rate of students' performance is the same when taught by male or female teachers.

4.4.6 Quantitative research findings on research question six.

The result of this study as examined by the researcher reveals that respondents indicated that there is a significant relationship between science teachers' years of experience and science students' academic performance in this population. This is contrast with the study of Ikumapayi *et al* (2021) which revealed that Biology teachers' years of experience did not significantly influence students' performance in Biology in public secondary schools in Ondo State and the study of Zuelke (2008) and Olofin (2020) who concluded that teachers' years of experience has no influence on students' academic performance while it was in line with the findings of Olaleye (2011) as they concluded that teachers' experience has significant influence on students' academic performance.

However, Ikumapayi *et al* (2020) also revealed that Chemistry teachers' years of experience significantly influenced students' performance in Chemistry in public secondary schools in Ondo State. The reason for this finding might be because experienced Chemistry teachers are considered to be more able to concentrate on the most appropriate way to teach particular topics that involved much technicalities to students. This finding is in consonance with the findings of Ewetan and Ewetan (2015) as they concluded that teachers' experience has significant influence on students' academic performance. Fatoba's study also revealed that Physics teachers' years of experience significantly influenced students' performance in Physics in public secondary schools in Ondo State and stated that this might be might be due to the fact that the more the teachers know about students, the better the teachers can connect with them and the more likely they will be able to benefit from the teachers' experience in reconstructing their world. The result is line with Adekola and Bamidele (2017) who found significant difference in the achievement of students taught by long time experienced teachers and short time experience teachers.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on the findings, the study concludes that; Teaching effectiveness of science teachers is anchored on their knowledge in terms of content, pedagogy, pedagogical content knowledge and years of experience. Growth and development of teacher pedagogical content knowledge is dependent on the teacher's constant practice of teaching over time. There is a significant relationship between science teachers' content, pedagogical and pedagogical content knowledge and students' academic performance. The pedagogical content knowledge required for effective teaching of science can be developed sustainably through several strategies. There is no significant relationship between science teachers' gender and students' academic performance while a significant difference exists between science teachers years of experience and students academic performance.

5.2 Recommendations

Based on the findings and conclusion drawn, the following recommendations were made;

1. Government should formulate policies for continuous updating of knowledge of teachers through in-built professional development programs on a regular basis for science teachers in the States.
2. The study recommends Ministry of Education to promote Professional Development opportunities concerning pedagogy courses in order to define the metrics and standards of teachers as to achieve higher academic performance. As this study focused on senior secondary, the researcher recommends other studies

of teacher quality and academic performance in higher levels of education because without this information poor performance could continue unchanged. Similarly, the researcher recommends investigating factors that affect students' performance but not investigated here.

3. School principals should organize seminars for science teachers on teaching methods periodically to further develop the science teachers pedagogical and content knowledge.
4. Principals should regularly visit the classroom during science lessons and follow up classroom visitation and observation with dialogue with the teachers so as to help correct those who do not recognize slow learners and cater for different categories of learners during lesson this will help in ensuring that all students are carried along during lessons.
5. Principals should ensure that they establish in-built formal school mentoring programs in their schools where newly employed science teachers will be under the guidance and supervision of older and more experienced teachers to help them grow in the teaching profession and develop adequate pedagogical, content and pedagogical content knowledge.

5.3 Suggestion for further studies

The following suggestions were made for further studies in this area;

1. While this study focused on investigating science teachers' pedagogical and content knowledge as determinants of secondary school science students academic performance, a similar study can be conducted on the effects of teachers' pedagogical and content knowledge on other arts related subjects.

2. This study was carried out in minna metropolis Niger state, a similar study can be carried out in other local government areas, geo political zone or other states of the federation.

5.4 Contribution to Knowledge

The study contributed the following to existing body of knowledge in science education;

1. The study proved empirically that science teachers in Minna, Niger state demonstrates good content knowledge during lesson in the classroom and this has a positive influence the students' academic performance.
2. The study established that science teachers in Minna, Niger state States demonstrated good pedagogical knowledge during lesson in the classroom and this has a positive influence the students' academic performance.
3. The study confirmed the efficacy of content and pedagogical knowledge of science teachers in enhancing their teaching effectiveness.
4. The study affirmed the association between pedagogical content knowledge and students' academic performance among science teachers' in Minna, Niger State.
5. It provided information on the various sources through which science teachers can update their pedagogical content knowledge for effective teaching of science subjects.

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APPENDIX A

Validation of Research Instrument

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA
DEPARTMENT OF SCIENCE EDUCATION

POSTGRADUATE INSTRUMENT VALIDATION FORM
(PIVAF)

NOTE: This form must be attached to the instrument and objectives/hypotheses of the study to the validator.

1. NAME OF THE VALIDATOR: Muhammed Ndako
2. SCHOOL/INSTITUTION/DEPARTMENT: Model Science College T.T. Science
3. TEL. PHONE NUMBER: 08064864493.
4. E-MAIL ADDRESS: ……
5. NAME OF THE CANDIDATE: Eze, Emmanuel Ifeanyi
6. MATRIC/ NO: Mtech/SSTE/2018/8267.
7. APPROVED THESIS TITLE: Science teachers' pedagogical and Content Knowledge (TPACK) as determinants of Secondary School Chemistry students' academic performance in Minna Metropolis
8. TITLE OF THE INSTRUMENT(s): Questionnaire on Science Teachers' Pedagogical and Content Knowledge as determinants of secondary school chemistry students academic performance in Minna metropolis (QSTPACK)

Instruction: Please, you are requested to make input or corrections where necessary.

S/No.	Categories	Appropriate	Not Appropriate
1	Is the outlook of the instrument appropriate to the respondents?	✓	
2	Are the word processing and layout of the instrument appropriate?		✓
3	Are the items generated in the instrument appropriate?	✓	
4	Are the items enough and appropriate to generate a valid conclusion on the construct to be observed?		✓
5	Are the items generated appropriate to the objectives of the study?		✓
6	Are the items generated appropriate to provide valid responses or answers to the research and hypotheses raised in the study?	✓	
7	Do you consider the whole instrument appropriate for the study?	✓	

9. GENERAL REMARK: Satisfactory
10. NAME AND SIGNATURE: Muhd Ndako [signature] 2.010

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA
DEPARTMENT OF SCIENCE EDUCATION

POSTGRADUATE INSTRUMENT VALIDATION FORM
(PIVAF)

NOTE: This form must be attached to the instrument and objectives/hypotheses of the study to the validator.

1. NAME OF THE VALIDATOR: Abubakar Adamu (1211)
2. SCHOOL/INSTITUTION/DEPARTMENT: Model Science College T/Fulani
3. TEL. PHONE NUMBER: 07037687765
4. E-MAIL ADDRESS: ....
5. NAME OF THE CANDIDATE: Eze, Emmanuel Ifeanyi
6. MATRIC/ NO: Mtech/SSTE/2018/8267
7. APPROVED THESIS TITLE: Science teachers' pedagogical and Content Knowledge (TPACK) as determinants of Secondary School Chemistry students' academic performance in Minna Metropolis
8. TITLE OF THE INSTRUMENT(s): Questionnaire on Science Teachers' Pedagogical and Content Knowledge as determinants of secondary School Chemistry Students academic performance in Minna metropolis (QSTPACK)

Instruction: Please, you are requested to make input or corrections where necessary.

S/No.	Categories	Appropriate	Not Appropriate
1	Is the outlook of the instrument appropriate to the respondents?	✓	
2	Are the word processing and layout of the instrument appropriate?	✓	
3	Are the items generated in the instrument appropriate?	✓	
4	Are the items enough and appropriate to generate a valid conclusion on the construct to be observed?	✓	
5	Are the items generated appropriate to the objectives of the study?	✓	
6	Are the items generated appropriate to provide valid responses or answers to the research and hypotheses raised in the study?	✓	
7	Do you consider the whole instrument appropriate for the study?	✓	

9. GENERAL REMARK: Satisfactory
10. NAME AND SIGNATURE: Abubakar Adamu [signature]

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA
DEPARTMENT OF SCIENCE EDUCATION

POSTGRADUATE INSTRUMENT VALIDATION FORM (PIVAF)

NOTE: This form must be attached to the instrument and objectives/hypotheses of the study to the validator.

1. NAME OF THE VALIDATOR: Dr. Bashir Yankuzo A. U.
2. SCHOOL/INSTITUTION/DEPARTMENT: SSTE / Science Education
3. TEL. PHONE NUMBER: 08086554262 5
4. E-MAIL ADDRESS: bashir.au@futminna.edu.ng
5. NAME OF THE CANDIDATE: Eze, Emmanuel Ifeanyi
6. MATRIC/ NO.: Mtech/SSTE/2018/8267
7. APPROVED THESIS TITLE: Science teachers' Pedagogical and Content Knowledge (TPACK) as determinants of Secondary School Chemistry Students' academic performance in Minna Metropolis
8. TITLE OF THE INSTRUMENT(s): Questionnaire on Science Teachers' pedagogical and Content Knowledge as Determinants of Secondary School Chemistry Students' academic Performance in Minna Metropolis

Instruction: Please, you are requested to make input or corrections where necessary.

S/No.	Categories	Appropriate	Not Appropriate
1	Is the outlook of the instrument appropriate to the respondents?	✓	
2	Are the word processing and layout of the instrument appropriate?	✓	
3	Are the items generated in the instrument appropriate?	✓	
4	Are the items enough and appropriate to generate a valid conclusion on the construct to be observed?	✓	
5	Are the items generated appropriate to the objectives of the study?	✓	
6	Are the items generated appropriate to provide valid responses or answers to the research and hypotheses raised in the study?	✓	
7	Do you consider the whole instrument appropriate for the study?	✓	

9. GENERAL REMARK: The instrument is okay, and will be better if Teaching Area of the science Teachers may be added.
10. NAME AND SIGNATURE: Dr. Bashir Yankuzo A. U. [signature] 18/11/2021

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA
DEPARTMENT OF SCIENCE EDUCATION

POSTGRADUATE INSTRUMENT VALIDATION FORM
(PIVAF)

NOTE: This form must be attached to the instrument and objectives/hypotheses of the study to the validator.

1. NAME OF THE VALIDATOR: Dr(Mrs) Gimba, R. W.
2. SCHOOL/INSTITUTION/DEPARTMENT: SSTE / FUT / SC. Edu.
3. TEL. PHONE NUMBER: 08032883603
4. E-MAIL ADDRESS: ramatu.gimba@futminna.edu.ng
5. NAME OF THE CANDIDATE: Eze, Emmanuel Ifeanyi
6. MATRIC NO.: Mtech/SSTE/2018/8267
7. APPROVED THESIS TITLE: Science teachers' pedagogical and Content Knowledge as determinants of Secondary School Chemistry Students' academic Performance in Minna Metropolis
8. TITLE OF THE INSTRUMENT(s): Questionnaire on Science Teachers' pedagogical and Content Knowledge (TPACK) as determinants of Secondary School Chemistry Students' Performance in Minna Metropolis (QSTPACK)

Instruction: Please, you are requested to make input or corrections where necessary.

S/No.	Categories	Appropriate	Not Appropriate
1	Is the outlook of the instrument appropriate to the respondents?	✓	
2	Are the word processing and layout of the instrument appropriate?	✓	
3	Are the items generated in the instrument appropriate?	✓	
4	Are the items enough and appropriate to generate a valid conclusion on the construct to be observed?	✓	
5	Are the items generated appropriate to the objectives of the study?	✓	
6	Are the items generated appropriate to provide valid responses or answers to the research and hypotheses raised in the study?	✓	
7	Do you consider the whole instrument appropriate for the study?	✓	

9. GENERAL REMARK: Satisfactory with Minor observation
10. NAME AND SIGNATURE: Dr(Mrs) Gimba, R.W. [signature] 16/11/21