RELATIONSHIP BETWEEN SUBJECT CONTENT KNOWLEDGE AND PEDAGOGICAL SKILLS OF NCE INTEGRATED SCIENCE STUDENTS IN NIGER STATE.

BY

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DECLARATION

I hereby declare that this thesis titled Relationship between Subject Content Knowledge and Pedagogical Skills of NCE Integrated Science Students in Niger State has been written by me and that it is a record of my own research work. It has not been presented partially or wholly in any previous application for a higher degree. All quotations and sources of information are duly acknowledged by means of references.

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CERTIFICATION

This thesis titled "Relationship between Subject Content Knowledge and Pedagogical Skills of NCE Integrated Science Students in Niger State" by ISAH Mohammed Fatima meets the regulations governing the award of Masters Degree M(Ed) in Science Education of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to my husband, Mohammed Kudu Isah, children of my Family, my mother, Hajiya Ramatu Chado and to my late father, Alhaji Mohammed Chado.

ACKNOWLEDGEMENT

In the name of Allah, the most Beneficent and the most Merciful. Honour is due to Almighty Allah alone, the Creator of the Universe who had spared my life, in good health and given me enough grace and perseverance to complete this work. Allah is the most great.

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ABBREVIATIONS

B. (Ed) - Bachelor of Education

COE - College of Education

ERC - Education Resource Centre

FCE - Federal College of Education

F.M.E - Federal Ministry of Education

ISPT - Integrated Science Performance Test

J.S.S. - Junior Secondary School

M. (Ed) - Master of Education

NCCE -National Commission for Colleges of Education

N.C.E - Nigeria Certificate in Education

NISP - Nigerian Integrated Science Project

NISTEP - Nigeria Integrated Science Teacher Education Project

NSTA - National Science Teachers' Association

P.C.K. - Pedagogical Content Knowledge

P.S.-Pedagogical Skills

S.C.K- Subject Content Knowledge

STAN - Science Teacher Association of Nigeria

STME - Science, Technology and Mathematics Education

TPAF - Teaching Practice Assessment Form

UNESCO - United Nations Educational Scientific and Cultural Organization

OPERATIONAL DEFINITION OF TERMS

Subject Content Knowledge:- This is the teachers' knowledge of the specific content they teach students including topics, facts and relationship within a subject. (Shulman, 1986)

Pedagogical Skills:- These are the actions and strategies of teaching, organization of classroom experiences, providing for diverse learner needs evaluation and implementation of learners' prior notions, and transformation of ideas into understandable pieces (National Science Teachers' Association, 1996).

ABSTRACT

This study investigated the relationship between Subject Content Knowledge and Pedagogical Skills of Nigeria Certificate in Education final year Integrated Science students of State College of Education, Minna and Federal College of Education, Kontagora. 100 (50 males and 50 females), study subjects of 300 level integrated science students were randomly selected using stratified random sampling from a population of 1000 students. Two instruments: Integrated Science Performance Test (ISPT) with r = 0. 75 and Students Teaching Practice Assessment Form (STPAF) were used for data collection. The ISPT was used to measure the subject content knowledge of the students while the STPAF was used to measure the pedagogical skills of the students. Five null hypotheses were tested at 0.05 level of significance. The data collected were subjected to Pearson Product-Moment Correlation Coefficient and t-test statistical tools for analyses. The major findings from the study were: Positive significant relationship exist between: NCE integrated science students' subject content knowledge and pedagogical skills, Male integrated science students' subject content knowledge and pedagogical skills. Female integrated science students' subject content knowledge and pedagogical skill. Also significant difference exists in the male and female integrated science students': subject content knowledge in favour of male students, and pedagogical skills in favour of female students. Based on the findings, recommendations were made among which are the need for inclusion of content mastery and pedagogical skills under a department. Similarly, teacher education programmes should re-organize their programmes towards preparation and professional development of teachers, and science teachers should give adequate orientation on micro-teaching to groom the teacher-trainees with adequate teaching skills with which they can relate to the contents taught.

TABLE OF CONTENTS

Title page - - - - - i

Declaration - - - - - ii

Certification - - - - - iii

Dedication - - - - - iv

Acknowledgement - - - - v

Abbreviations - - - - - vii

Operational Definition of Terms - - - viii

Abstract - - - - - ix

Table of Contents - - - - - x

List of Tables - - - - - xi

List of Figures - - - - - xii

List of Appendices - - - - xiii

CHAPTER ONE: The Problem

1.1 Introduction - - - - - 1

1.2 Statement of the Problem - - - - 8

1.3 Objectives of the Study - - - - 10

1.4 Research Questions - - - - 11

1.5 Hypothesis - - - - - 11

1.6 Significance of the Study - - - 12

1.7 Delimitation of the Study - - - 13

1.8 Basic Assumptions - - - - 13

CHAPTER TWO: Review of Related Literature

2.1 Introduction - - - - - 15

2.2 Concept of Integrated Science - - - 15

2.3 Philosophy and Objectives of Integrated Science - - 18

2.4 Nigeria Integrated Science Teacher Education Project (NISTEP)
Its Philosophy and Objectives for Teacher Trainers - 21

2.5 Nigeria Certificate in Education (Integrated Science Programme) 24

2.6 Subject Content Knowledge Mastery - - - 26
2.7 Pedagogical Skills - - - - 28
2.8 Science Teaching Methods - - - 30
2.9 Relationship Between Subject Content Knowledge and Pedagogical Skill - - - - 39
2.10 Gender and Achievement in Science - - - 43
2.11 Similar Studies on Subject Content Knowledge and Pedagogical Skills - - - - 46
2.12 Similar Studies on the Relationship Between Content Knowledge and Pedagogical Skills - - - - 54
2.13 Implications of the Literature Review to the Present Study - 55
CHAPTER THREE: Methodology
3.1 Introduction - - - - 61
3.2 Research Design - - - - 61
3.3 Population of the Study - - - - 62
3.4 Sample and Sampling Techniques - - - 63
3.5 Instrumentation - - - - 63
3.6 Data Collection Procedure - - - 69
3.7 Data Analysis - - - - 70
CHAPTER FOUR: Data Analysis Result and Discussions
4.1 Introduction - - - - 72
4.2 Data Analysis and Results - - - 72
4.3 Hypotheses Testing - - - - 72
4.4 Summary of Findings - - - - 77
4.5 Discussion of Results - - - - 77
CHAPTER FIVE: Summary, Conclusion and Recommendations
5.1 Introduction - - - - 81
5.2 Summary - - - - 81
5.3 Summary of Major Findings - - - 82

5.4	Conclusions	-	-	-	82
5.5	Recommendations	-	-	-	83
5.6	Limitation of the Study	-	-	-	84
5.7	Suggestions for Further Studies	-	-	-	84
	References	-	-	-	86
	Appendix A	-	-	-	94
	Appendix B	-	-	-	99
	Appendix C	-	-	-	101
	Appendix D	-	-	-	105
	Appendix E	-	-	-	107

LIST OF TABLES

PAGE

Table

3.1: Students in the Study Population - - - - 62

3.2: Sample Selected for the Study - - - - 63

3.3: Specification of the Instrument - - - - 65

4.1: Relationship between Students' Subject Content Knowledge and Pedagogical Skills in Integrated Science at NCE leve l 73

4.2: Relationship between Male Students' Content Knowledge and their Pedagogical Skills in Integrated Science at NCE Level 74

4.3: Relationship between Female Students' Content Knowledge And Pedagogical Skills in Integrated Science at NCE level - 75

4.4: Difference between Male and Female Students' Performance test in Integrated Science at NCE level 6 - - - - 76

4.5: Difference between Male and Female Students' (Pedagogical Skills) Teaching Practice in Integrated at NCE level- - - - 76

LIST OF FIGURES

FIGURE		PAGE
Figure 1:	Feyma's process of Scientific Inquiry - - -	37
Figure 2	Relationship between Subject Matter Content Knowledge and Pedagogical Skill - - - -	41

:

LIST OF APPENDICES

APPENDIX	PAGE
A: Integrated Science Performance Test (ISPT) - - -	94
B: Marking Scheme for ISPT - - - - - -	99
C: Student Teaching Practice Assessment Form - - -	101
D: Facility and Discrimination Indices - - - -	105
E: Integrated Science Course Codes, Titles and Topics - -	107
F: Letter of Introduction to Study Areas - - - -	110

CHAPTER ONE
THE PROBLEM

1.1 Introduction

Science plays a vital role in the development, progress, general well being and survival of any nation. The application of science and technology is important in all aspects of human existence such as agriculture, health, war-fare, communication, housing, even politics among others. Shaibu (2000) pointed out that education in science is so fundamental to any meaningful development of a country that a nation's effort might come to naught without a strong army of scientists and science literate citizenry. Expressing a similar view, Bichi (2002) described science as the universal vehicle for human progress and that nations should endeavour to give priority to science education.

In the context of the importance of science and technology education, Nigerian Government in the National Policy on Education (FME, 2004) and in National Policy on Science and Technology (FME, 2004) made provision for science and technology education in the educational system. These policies are aimed at promoting scientific and technological development to produce citizens with the needed scientific knowledge, skills, methods and attitude as well as the capacity to apply them to solve national problems. These policies have provided guidelines on science and technology education in Nigeria. In this respect several science curricular were developed and introduced into the school system.

One of such science curricular developed was the integrated science curriculum. The Core Nigerian Integrated Science Project (NISP) was the Series of Science Curriculum Project Developed by Science Teachers Association of Nigeria (STAN) in 1970. The integrated science curriculum drew its subject matter, methodology and philosophy from various aspects of science and related disciplines. It has also made conscious efforts to de-emphasize the artificial boundaries between different disciplines in the organization and presentation of instructional materials (Mejeha, 1992).

The introduction of integrated science programme was unique in that the course objectives were clearly spelt out in the National Curriculum for Junior Secondary School. However, after few years, researchers found that the objectives set out in the course were not being achieved and the main factor identified for this was inadequate for teacher preparation (Jegede, 1982, Bajah 1983, Shaibu 1986, Usman, 2000, Dogara, 2006). In such vein, it was felt that a specific pre-service training was required for teachers of integrated science for the Junior Secondary School (JSS) level. This training as envisaged could be provided at the National Certificate of Education (NCE) level by a double major integrated science programme. The above development gave rise to Nigerian Integrated Science Teacher Education Project (NISTEP) after the formal signing of a technical cooperation agreement between Nigeria and the Government of the United Kingdom in 1989.

The integrated approach to science teaching started in earnest as far back as the early 1960s all over the world as a result of curricula reforms. Integrated science is defined by Science Teachers' Association of Nigeria (STAN, 1972) as a course, which contains basic elements of the main branches of major concepts of sciences. It is a programme designed to teach the pupils the interwoven nature of the different branches of science and how the concepts of these branches are related to their everyday life. The aspect of integration in science could not be achieved if content knowledge and pedagogical knowledge skills are not given proper consideration by the teachers (Olorukooba. 2007).

Subject content knowledge (SCK) refers to the science knowledge a teacher should possess; it is a specific content knowledge that teachers teach students. Grossman (1994) defined subject content knowledge as the stuff of a discipline, factual information, organizing principles and central concepts of the subject. The content knowledge of a prospective science teacher is developed primarily in science courses taught by science department. Researches indicate that subject content knowledge influences instructional practices across subject area (Lee 1995). Without the essential base of subject content knowledge, teachers are simply unable to produce effective instruction (Shulman, 2008).

Subject Content Knowledge however, is "the first necessary, condition for effective instruction (Garnett & Tobin, 1990). Science and its language, on the other hand, implies the ways and manner teacher should teach in order to communicate the scientific concepts so as to cater for the learners interest and

for meaningful learning which calls for teachers Pedagogical Knowledge (PK) (Kemeny, 1995). Pedagogical knowledge comprises the theories, and principles of teaching and learning, knowledge of learners, and knowledge of principles and techniques of classroom behaviour and management (Sanders, 1993). It is a knowledge that a teacher uses to deal with everyday task of teaching and relating to students in the classroom. It is that kind of knowledge which the teacher use in order to make their students learning experiences valuable.

However, Shulman (2008) claimed that the emphasis on teacher subject content knowledge and pedagogical skills were treated as mutually exclusive domains. To address this dichotomy, he proposed to consider the necessary relationship between them by introducing the notion of Pedagogical Content Knowledge (PCK). Pedagogical Content Knowledge, according to Vistro -yu (2001) is the manner which subject content is transformed for teaching. This occurs when the teacher interprets the subject content and finds ways to represent it and makes it accessible to learners. For a science teacher to be effective in his teaching, he has to combine the subject content knowledge and the pedagogical skills in the teaching and learning process. Thus, the teacher is expected to exhibit skills in the use of analogies, illustrations, instructional materials, examples, explanation and variety of instructional strategies.

Infact, the teacher should note the:

- Use of different forms of representation of science ideas in a word.
- Ways of representing and formulating the subject that makes it comprehensible to others.
- Understanding of what makes learning of specific concepts easy or difficult.
- Preconception that students of different ages and background bring with them to the learning environment.
- Teaching of science requires science teachers" knowledge of their students" abilities, learning styles, their ages and developmental level, their attitudes, motivations, and prior knowledge of the concepts to be taught (Udogu, Amaechi & Njelita. 2007).

It is obvious that science curriculum consists of concepts, laws and theories which science teachers must be acquainted with to enable them transform valid knowledge of science effectively to their students. Their ability to impart scientific knowledge to learners must go beyond verbalization of the basic terms of science. Hence, Njelita (2005) contended that there is a difference between "studying science" and "understanding science". It implies that if what is taught in the classroom or laboratory is to reflect the true nature of science, it becomes obvious that those who teach the subject should possess its adequate knowledge. Therefore, teachers' understanding of content knowledge must tally with the pedagogical skills during classroom practice. In line with this

idea, this study aims at investigating the relationship between subject content mastery and pedagogical knowledge skills of NCE integrated science students to infer the results.

On the issue of gender-difference, research in science education indicates influence of gender on academic attainment. Researches on gender issues point to masculine image of science, the lack of participation of women in science subjects and how teachers influence gender-difference in science were investigated. Odetoyinbo (2004) and Usman (2010) noted that boys perform better than girls at activities that required manipulations. Another major factor which contributes to this higher science achievement among boys is the greater amount of teacher and resources interaction which boys appear to receive in classroom (James. 2000). In addition, investigation in some other part of the country researchers has found no gender-difference in achievement in science Yoloye (2004), Nworgu, (2005). They concluded that there are no gender differences between male and female's academic achievement in science. While Mustapha (2000) posited that female students teacher perform better in integrated science teaching practice than their male counterparts. The studies above did not look into subject content knowledge and pedagogical knowledge skills of integrated science teachers to see whether there is gender related difference especially at NCE level. In view of this concern, this study investigated the relationship between subject content knowledge and pedagogical knowledge skills of the male and female NCE integrated science students to see whether gender has any influence or not.

1.1.1 Theoretical Framework

Teaching effectiveness at any level of education is measured in terms of the knowledge of what to teach, how to teach, and when to teach (Odetoyinbo 2004). These are effectively functioned by pedagogical content knowledge. Pedagogical content knowledge was first proposed by Shulman (2008) and Gediss (1999) which they developed into broader perspective model for understanding teaching and learning. Their studies revealed how prospective teachers acquired new understandings of their content and how these understandings influenced their teaching. Shulman described pedagogical content knowledge as the knowledge formed by the synthesis of three knowledge bases: subject content knowledge, pedagogical skills and knowledge of context. Pedagogical content knowledge was unique to teachers and differentiates a science teacher from a scientist or a teacher from content specialist.

Teachers differ from biologists, historians, writers or educational researchers, not necessarily in the quantity or quality of their subject content knowledge but in how that knowledge is organized and used. For example, trained teachers' knowledge of science is structured from a teaching perspective and is used as a basis for helping students to understand specific concepts. A scientist's knowledge on the other hand, is structured from research perspective and is used as a basis for the construction of new knowledge in the field (Shulman, 2008).

Furthermore, Shulman (2008) stated that PCK includes those special attributes a teacher possessed that helped him/her guide a student to understand content in a manner that was personally meaningful. Shulman wrote that PCK included an understanding of how particular topics, problems, or issues are organized, presented, and adapted to the diverse interest and abilities of the learners, and presented for instruction. He then concluded that the key to identify the knowledge base of teaching lies at the intersection of content and pedagogy. That is the capacity of a teacher to transform the content knowledge he or she possesses into forms that are pedagogically powerful and adaptive to the variations and background presented by the students (Shulman, 2008).

Therefore, this study intends to investigate the relationship between subject content knowledge and pedagogical skills among final year N.C.E. integrated science students.

1.2 Statement of the Problem

Integrated science is a core-subject taught at the primary and secondary school levels. The integrated science philosophy demands that the teaching be relevant to pupils needs and experiences, stresses fundamental unity of science; it also lays adequate foundation for subsequent specialist studies; it adds cultural dimension to science education and skill development. the teaching strategies prescribe for attaining its objectives includes the use of discovery methods, problem solving activities and open ended laboratory activities. The

NCE integrated science students are trained to teach the subject effectively. Because, they are supposed to have both the subject matter content knowledge and pedagogical skills to teach the subject content. However, empirical evidences, enunciated by Jegede (1992) and Adetoyinbo (2004) supported that students of integrated science have the difficulties mastering the concepts and principles outlined in the National core curriculum for Junior Secondary School. These difficulties may emanate from a number of factors teachers were exposed to during their training in College of Education. They include, among others, poor teaching; deficient professional training; weak academic background while a number of them lack required experience.

Studies such as (Akale, 1992; Bajah, 1996; Maduabum, 1993; Jegede, 1992; Adetoyinbo, 2004;) showed that the integrated science teachers are not prepared for the job, because most of them were trained in separate disciplines. Even social studies teachers, religious studies teachers, et cetera, were asked to teach the subject, Obioma (1998), Williams, (2007). This may cause difficulties to the implementation of the programme.

Survey studies in various states of the federation have reported that incompetent teachers are handling integrated science teaching, and they are confronted with subject content knowledge and pedagogical difficulties as a result of their poor professional background and knowledge of the content(Akale 1992). In his review of teaching activities, Oke (2000) concluded that our laboratories were full of mess, with poor coordinated

students" activities posing threat to students.

Despite various training of in-service training for existing teacher for improving the training of integrated science teachers at colleges of education and universities there exists the persistent low performance of the teachers. The poor performance may be due to lack of integrating the content with specific effective methods of instruction while the teachers are in training (Abba, 1999).

Various studies carried out in the teaching and learning of integrated science have been on teaching methods, science process skills, academic achievement and practical activities effectiveness (Mari, 1995, Usman, 2000), among others. Studies on comparing the content knowledge mastery and pedagogical skills of NCE integrated science students is not much. The integrated science NCE curriculum is geared towards preparing students both for subject matter content knowledge and pedagogical skills. Therefore, there is the need to investigate relationship of these variables. Specifically, this study investigates the relationship (if any) between the content knowledge and pedagogical knowledge skills among final year NCE III integrated science students.

1.3 Objectives of the Study

The objectives of this study are to investigate the:-

- relationship between subject content knowledge and pedagogical skills among NCE integrated science students;

- relationship between subject content knowledge and pedagogical skills of male students;

- relationship between subject content knowledge and pedagogical knowledge skills of female students;

- difference between male and female students' content knowledge;
- difference between male and female students' pedagogical skills acquisition.

1.4 Research Questions

The following research questions were formulated to guide the study:

1. What is the relationship (if any) between subject content knowledge and pedagogical knowledge skills of integrated science students at NCE level?
2. What is the relationship between the performance of male students in the subject content knowledge and pedagogical skills?
3. What is the relationship in between the performance of female students in the subject content knowledge and their pedagogical skills?
4. What is the difference in male and female integrated science academic performance on subject content knowledge?
5. What is the difference in male and female integrated science academic performance on pedagogical skills?

1.5 Hypothesis

Based on the stated research questions, the following hypotheses are formulated for testing.

Ho_1: There is no significant relationship between NCE integrated science students' subject content knowledge and their pedagogical skills.

Ho_2: There is no significant relationship between subject content knowledge and pedagogical skills of male integrated science students.

Ho_3: There is no significant relationship between subject content knowledge and pedagogical skills of female integrated science students.

Ho_4:- There is no significant difference in male and female integrated science students' subject content knowledge mastery.

Ho_5: There is no significant difference in male and female integrated science students' pedagogical skills.

1.6 Significance of the Study

The purpose of this study is to investigate the relationship between subject content knowledge and pedagogical knowledge skills among the final year NCE integrated science students. It is hoped that the findings from this study would enable integrated science teachers to effectively relate content and pedagogical skill to the teaching and learning of integrated science.

- Secondly, it would enable the NCE students to identify appropriate teaching methods relevant to content area of integrated science as

proposed in the curriculum of integrated science.

- The curriculum planners will also benefit from this study by making adjustment in teacher education programmes in science in such a way that both content and pedagogical knowledge should be taught in relevant educational institutions.

- Researchers in science education will equally benefit from the findings of this study by using it as a stepping-stone for further studies in content knowledge and pedagogical skills and other related areas.
- It will enable teacher training programmes to reorient and reorganize their programmes towards a better preparation for professional development of would be teachers.

1.7 Delimitation of the Study

This study was limited to Colleges of Education in Niger State only. However, the result obtained here could serve as a base for innovation in other teaching Colleges of Education in the country.

The study was limited to integrated science students of 300 level only. This is because the students have already covered enough of the content and are well exposed to the science teaching methods which they have learnt throughout their course of three years study.

1.8 Basic Assumptions

In line with the purpose of study, the following assumptions were made:

Teachers have enough knowledge of content based on philosophy of integrated science at NCE level.

All students in 300 level of 09/10 session have been exposed to the same subject matter content knowledge.

Students are taught all the prescribed science education methodology courses necessary for understanding of the pedagogical knowledge of integrated science teaching.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter discusses the literature reviewed and is presented in the following subheadings;

- Concept of Integrated Science
- Philosophy and objectives
- Nigeria Integrated Science Teacher Education Project (NISTEP), its Philospohy and Objectives for Teacher Trainers
- Philosophy of Integrated Science in Nigerian Certificate in Education
- Nigerian Certificate in Education (Integrated Science Programme)
- Subject Content Knowledge
- Pedagogical Skills
- Science Teaching Methods
- Relationship between Subject Content Knowledge and Pedagogical Skills
- Gender and Achievement in Science
- Similar Studies on Subject Content Knowledge and Pedagogical Skills
- Similar Studies on the Relationship between Content Knowledge and Pedagogical Skills
- Implications of the Literature Review to the Present Study

2.2 Concept of Integrated Science

The integrated approach to leaching of science started in earnest as far back

as the early 1960s all over the world. There is much that remains confounding about the real meaning of integrated science. Integrated science .is defined by Science Teachers' Association of Nigeria (STAN, 1972) as "a course, which contains basic elements of the main branches of major concepts of sciences. It is a programme designed to teach the pupils the interwoven nature of the different branches of science and how the concepts of these branches are related to their everyday life. Dogara (2006) categorized the meaning of integrated science into four broad groups; namely:-

- as unity of all knowledge
- as the conceptual unity of science
- as unified process of scientific enquiry
- as inter disciplinary study
- While Ahmed (2003) defines integrated science as:

  i. the unity of all knowledge;

  ii. a unified process of scientific enquiry;

  iii. the conceptual unity of sciences;

  iv. the social relevance of science;

  v. interdisciplinary study.

Dogara (2006) opined that "learning science as unity is assumed to mean that science, as a human endeavour, is taken as the source of educational objectives and learning activities, and that traditional boundaries among the separate sciences are minimized considerably for these purpose". Akimade

(1992) reported that among sampled of Nigerian university and college of education pre-service teachers, the most popular meaning of integrated science was as the combination of physics, chemistry and biology", followed by a unified or uniform science; fused science elaborate science". The least popular definition among this sample was as an approach to science in which concept and principles are presented so as to express the fundamental unity of scientific thought.

Although there are many viewpoints concerning the definitions of integrated science, the one that forms the working definition for this study is that of UNESCO (1971) in which integrated science is defined as: approaches in which the concepts and principles of science are presented so as to express the fundamental unity of scientific thought and to avoid premature or undue stress on the distinction, between the various scientific fields.

In the present study, integrated science is defined as a way of teaching in which concept and principles of science are presented to the learners as a unity of all sciences and how the concept of these principles are related to everyday life..

From the foregoing integrated science is conceived as a science course which :-

- makes use of subject matter from various disciplines.
- de-emphasizes the boundaries in the organization and presentation of subject matter.
- consciously seeks to blend the subject matter from various

disciplines by organizing them into common themes/conceptual schemes/major concepts/science processes.

- provides opportunities for practicing the various science process skills including scientific approach to problem solving,
- promotes the application of scientific knowledge and skills to solve human problems.
- relates science to the environment and culture of the learner
- makes use relevant psychological theories of learning in the organization and presentation of subject matter and
- provides adequate foundations of further studies in the sciences.

The integrated science curriculum objectives emphasize both the content knowledge as well as the pedagogical skills of teaching science. Have these objectives been practiced in the teaching and learning of integrated science at NCE level? This is the main focus of this study.

Therefore, the study will investigate the relationship of subject content master and pedagogical knowledge skills of integrated science students at NCE level.

2.3 Philosophy and Objectives of Integrated Science

The concept of integrated discipline is based on the assumption that the universe has an inherent unity in which science attempt to provide knowledge for the understanding of this unity. This is the underlying philosophy of the integrated science programme. Nigeria Integrated Science Project (NISP) was the

first science curriculum to be designed by Science Teacher Association of Nigeria (STAN) in 1970. The essence of an integrated science course is to teach pupils what science is and how a scientist works. Therefore, integrating principles are intended to produce a course which:-

i. is relevant to the child's needs arid experiences
ii. stresses the fundamental unity of science
iii. lays adequate foundations for sub-sequent special study;
iv. adds a cultural dimension to science education

In other words, when the term "integration" is applied to science courses, it means that the course is devised and presented in such a way that the child:-

a. gains the concept of the fundamental unity of science;
b. gains the commonality of approach to problems of scientific nature;
c. is helped to gain an understanding of the role and function of science in everyday life and the world in which they live.

The Nigerian Integrated Science Project used the child-centered approach, making the learners to be involved in open ended laboratory activities to give them the feeling of being scientist. Dogara (2006) listed some objectives in line with the philosophy of Nigeria Integrated Science Project which are as follows:-

i. to actively involve the students in the learning process,
ii. to develop in students the motivation and ability to work and think in

an independent evil way.

iii. to develop in the students ability to recall information and experience.

iv. to develop in students the ability to devise schemes for solving problems.

v. to enable students use and classify information,

vi. to enable students interpret information showing evidence of judgment and assessment.

vii. to enable students to communication selectively and effectively,

viii. to enable students to relate their experiences in each area and also

ix. to other subject areas and to live in their society.

Dogara went ahead to mention some distinctive skills in science that integrated science students must learn. They are to:

i. Observe carefully and thoroughly,

ii. Report completely and accurately what they observed.

iii. Organize information acquired.

iv. Make generalization on the basis of acquired information.

v. Make predictions on the basis of the generalizations,

vi. Design experiments (including control where necessary) to check these predictions.

Efforts should be made by teachers to implement the philosophy and objectives of integrated science in order to create room for the effective

teaching and learning of the subject. This could not be achieved if the subject content knowledge is not related to pedagogical knowledge skills, which is what this study intends to investigate.

2.4 Nigeria Integrated Science Teacher Education Project (NISTEP) Its Philosophy and Objectives for Teacher Trainers

The Integrated Science programme in Nigeria was unique in that the course objectives were clearly spelt out, making evaluation of the programme attractive to researches for many years (Ahmed, 2003). After more than 18 years of integrated science teaching in Nigeria, researches and studies have shown that the objectives of integrated science are not being achieved. The main factor identified for this was lack of adequate trained and competent teachers of integrated science (Bajah 1996, Mustapha 2000). In fact, there was little or no teacher preparation since the assumption had been made that any science graduate could teach integrated science. This was shown to be a false assumption in most cases (Abba, 1999; Odetoyinbo, 2004). It was felt that specific pre-service training was required for the specific training of integrated science teachers at the junior secondary school level. The above development led to the establishment of "Nigerian Integrated Science Teacher Education Project (NISTEP)".

The aim of the project was the improvement of the quality of

integrated science teaching and learning at the JSS level. It was hoped that the above aim could be achieved through the following project objectives.

i. Establishing an NCE double major integrated science programme for use by Colleges of Education

ii. Making inputs into

   a. The B.Ed (Integrated Science) programme of the Faculty of Education, Ahmadu Bello University. Zaria.

   b. The M.Ed Programme of Faculty of Education. Ahmadu Bello University, Zaria.

   c. The in-service training of existing teachers through state Education Resource Centres (ERC).

2.4.1 Philosophy of Integrated Science in Nigeria Certificate in Education (NCE)

The philosophy of Nigeria Certificate in Education (NCE) integrated science is anchored on the following areas:-

   a. fundamental unit of science

   b. the use of scientific method as a common approach in solving problems of scientific nature

   c. the role and function of science in everyday life (NCCE, 2004).

i. enabling students gain the concept of fundamental unity of science

ii. installing a commonality of approach, to scientific nature i.e the

scientific methods;

iii. increasing students understanding of the role and functions of science in everyday life and the world in which he lives;

iv. making students well informed and gain scientific literature;

v. enabling students acquire and demonstrate the intellectual skills necessary to the teaching of integrated science in primary and junior secondary schools in conformity with national curriculum,

vi. developing in students the ability to impart and encourage in the pupils the spirit of inquiry into living things and non-living things in the environment,

vii. developing the ability and motivation in students to work and think in an independent manner, enabling students carryout scientific investigations and emphasizing cooperation,

viii. development of appropriate scientific processes and skills and improving their written and oral communication skills (NCCE Minimum Academic Standard, 2004).

The philosophy and objectives of integrated science will enable students to gain an insight into both principles of science and appreciation of the values of scientific enterprises, which has characterized the great scientific advances of the past. However, this philosophy could not be achieved if subject contents and pedagogical skills of integrated science are not related and used effectively by the teachers which is what this study intends to investigate.

2.5 Nigerian Certificate in Education (Integrated Science Programme)

The NCE Integrated Science Programme exists in two formats, namely, as a single major subject and double major subject. The major aims of teachers education in integrated science is to produce an all round scientists rather than single subject specialists. One of the major problems of integrated science as a single subject is in relation to the other major subjects. If Integrated Science is combined with any of the single science subject, this objective will not be achieved as an imbalance will be produced due to curriculum overlap. Thus:

i. Single major Integrated Science plus Biology would most likely produce a Biologist,

ii. Single major Integrated Science plus Chemistry would most probably produce a Chemist,

iii. Single major Integrated Science plus Physics would most probably produce a physicist.

The overlap between subject areas has consequences at the college level in both teaching and assessment, where certain combinations may be favoured and topics may be both taught twice and assessed twice in different subjects. For these reasons, Integrated science as a single major is not suitable to be taught in combination with the single science subject, sciences. Some other combinations, however, may be suitable, for example, in combination with mathematics. It should also be noted that a single major programme is deficient in science contents.

The double major programme eliminates most, if not all, the problems associated with Integrated Science as a minor subject or as a single major subject (Ahmed, 2003). The major objective of the double major Integrated Science programme is the production of effective teachers of science. The products of this programme can face the Integrated Science Syllabus at the JSS level squarely and teach it effectively because this is precisely what they have been trained to do.

The double major programme is made up of subject matters from various sciences and other related disciplines that are relevant to the students' environment and day to day activities. It thus enables the students to have a broad and balanced knowledge of science. In the past, the drawback to the double major programme was the absence of degree level opportunities. This is no longer the case with no less than thirteen degree awarding institutions having B.Ed. (Integrated Science) courses or its equivalence spread all over. The products are uniquely qualified to teach Integrated Science and their career progression in this field is ensured (Turton. 1994).

The NCE syllabus according to (Ahmed, 2003) is in a semester format based upon the Double Major Integrated Science Syllabus approved by the Board of studies, Institute of Education, Ahmadu Bello University, Zaria. Science courses form the major component of the programme in all the three parts of the NCE double major courses. The mathematics and methodology units form an integral part of the syllabus, and are covered in Parts I and II of the course. The programme emphasizes throughout the courses the processes

of scientific thinking, practical skills and the social relevance of the application of science.

Part I is seen as a foundation year in the basic sciences. Given the varied entry qualifications of candidates in terms of science content, a flexible approach is envisaged with a view to bringing all candidates to a common level of familiarity and understanding with the three major areas of science.

Parts II and III of the course are expansion of the content areas of the basic sciences. This is done with constant reference to unifying concepts such as energy, conservation, balance and cycles in nature, particle theory. It encompasses fields of study, such as health technology and ecology. It is this emphasis on the unity of the scientific worldview, which makes the programme different from a mere combination of the topics Physics, Chemistry and Biology (NCCE. 2004).

2.6 Subject Content Knowledge Mastery

Subject content knowledge refers to the stuff of a discipline: factual information, organizing principles, and central concepts of the subject (Grossman 1994). Similarly, Shulman (2008), defined subject content knowledge as "teachers' knowledge of the specific content they teach to students including topic, facts and relationship within a subject. Also, Olorukooba, (2007) defines subject content as the knowledge which the teacher has in any of the STM subject disciplines of either biology or physics or chemistry or integrated science or mathematics or geography.

Subject content knowledge of science teachers and students includes:-

- concepts and principles understood through science
- concepts and relationship unifying science domain
- process, of investigation in science disciplines
- application of mathematics in science research (National Science Teacher Association, 1998).

From the foregoing, subject content knowledge can therefore be defined as the teachers' knowledge which they teach their students and the content knowledge of the prospective science teacher is developed primarily in science courses taught by science department. National Science Teachers Association maintained that content knowledge provide the science teachers with adequate knowledge to make connections and see relationship between scientific concepts. Research on subject content indicates that teacher's knowledge of subject matter influences instructional practices across subject area at different levels (Lee, 1995). Heading that without the essential base of subject matter knowledge, teachers are simply unable to produce effective instruction.

Subject matter content knowledge is particularly an important issue in science education. Researches in science education indicate that teachers who possess subject matter content expertise and ability to represent subject matter to their students engage in those class activities that facilitate students' learning, such as free ranging class discussion of content (Anderson & Smith 2001). In contrast, teachers with weak subject matter knowledge rely heavily on

the textbook as the primary source of subject matter content (Olorukooba. 2007). During whole-class activities, teachers with weak subject matter knowledge tend to choose lecture or recitation, rather than solicit students questions or engage in class discussion. Also, these teachers tend to minimize students' participation in public forum (e.g. assigning individual seat work) in an effort not to display their inadequacy of subject matter knowledge (Lee, 1995). In line with the above statement this study intends to investigate the relationship of subject content mastery and pedagogical skills of integrated science students at NCE III level to see whether they are related or not.

2.7 Pedagogical Skills

Pedagogical knowledge in science is a knowledge that a teacher uses to deal with everyday task of teaching and relating to students in the classroom. It is that kind of knowledge that teachers hope to improve when they say they want to become better teachers because they realize that this is where they drew all the "tricks"' to make their students learning experiences valuable.

The National Science Teacher Association (1998) standard defined pedagogical knowledge skills as: actions and strategies of teaching, organization of classroom experiences, providing for diverse learner needs evaluation and implementation of learners' prior notions, and transformation of ideas into understandable pieces. Pedagogical knowledge is knowledge of principles and techniques of classroom behaviour and management (Sander, 1993).

Magnusson, (1999) opines that a general way of presenting science

teaching knowledge and belief is to guide the prospective science teachers on decisions about organization of activities, use of curricular materials, contents of students' assignment and evaluation of students learning through orientation. However, to get a realistic view of teaching prospective teacher must practice teaching in lessons in which they have to plan, implement and evaluate. They need to understand and be able to use the general principles of good classroom management from standardized routines. For instruction and get knowledge of pupils' attitudes, interest and problems that are essential for effective teaching. This can only be acquired through extended classroom experience. Initial practice should be provided in controlled forms as peer teachings, microteaching or some kind of case studies.

The prospective science teachers also need experience in classroom settings by observing experienced teachers and working with pupils individually and in small groups to develop the pedagogical knowledge skills. Pedagogical skills enable the teachers to have background knowledge of their students and to build on that. It also seek, to help science students to learn scientific problems (Geddis, 1993) while Magnusson (1999) stated that pedagogical skills guide the teacher to plan experiences for to their student to make inquiries. It also enables the teachers to elaborate on students' ideas and are able to link same to new contents. The pedagogical skills in this study refer to the skill of teaching with regards to classroom instruction of NCE III integrated science students.

2.8 Science Teaching Methods

The term 'method of teaching' refers to the totality of what a teacher does from the beginning to the end of the lesson. According to Atadoga and Onaolapo (2008), teaching refers to the general approaches of teachers as regards to the presentation of content. In most cases, the teaching method of a teacher is determined by this philosophical conviction of the goal for teaching integrated science and his own personal orientation. In general teaching methods refers to systematic ways in which teachers approach their instruction. Teaching methods advocated for integrated science are guided discovery problem solving and open ended laboratory activities.

Guided Discovery Method: This approach in science teaching was postulated by Brunner (1961). The approach enables pupils to get firsthand experience in getting facts, concepts and principles and processes by using mental process and manipulating scientific equipment and material. Brunner believes that a child who is exposed to the guided discoveries gets four (4) benefits. These are:

i. there will be increase in intellectual attainment.

ii. there is a shift from extrinsic to intrinsic motivation,

iii. the learning of the discoveries is valuable to student's investigation processes,

iv. discovery learning aid memory of the child.

Atadoga & Onaolapo (2008) sees it as mental assimilation by which the individual grasp a concept or principle resulting from physical and mental

activity. In this method, the teacher ensures that the students have a chance to form concepts by studying objects before leading the students to form the generalization. In guided discovery methods of teaching concept formation is the main purpose.

Guided discovery method has the following steps:

- the teacher describes the performance expected of the students after they have learned the concept.
- the teacher reduces the number of simpler concepts or attributes.
- the teacher provides positive and negative examples in close succession or simultaneously
- the teacher assesses the learning of the students

Guided discovery methods is applicable to virtually all areas of teaching. It is a methods of teaching that involves mental skills for learning by students to observing, measuring, classifying and so forth (James 2000, Usman 2010).

Problem Solving Method: Problem solving method is an instructional strategy in which problems (scientific in nature or related to the real world) are carefully formulated and presented to students (Bichi, 2002). In the process of problem solving students interact with one another, with the instructional materials and ultimately construct knowledge and acquire the process of science. Problem-solving method is a way of helping students to see the personal relevance and the applicability of the school science they learn (Atadoga & Onaolapo (2008)). It provides opportunities for students to

work as scientist, investigating phenomena in systematic way finding solutions to scientific problems (Bichi, 2002); promotes investigative thinking in children (Dass, 1999) and it enables the learner to experience new ideas. Problem solving process use to be interesting, challenging and therefore motivating (Oyedokun, 1998).

The following may serve as examples of problem solving method;

i. how do you get rid of a rat that causes damages to Daddy's farm products without killing the rat?

ii. a little spinach of salt accidentally drops into a drinking water in a cup and makes the water undrinkable. How can you make the water clean and drinkable?

Laboratory Activity Method:- This is an activity performed by an individual or group of students for the purpose of making personal observations or processes; products or event. It has been used in teaching science as:

i. a means of verifying principles, laws or theories.

ii. practicing one or more cognitive skills such as ability to observe, classify, measure, interpret data, et cetera.

iii. to determine the relationship between causes and effects (Pwol, 1995).

Laboratory exercise are activities carried out in order to provide practice in designing, operating and interpreting experiments. Laboratory activity makes

the students learn about the nature of science and technology thereby enhancing the students' interest and sharpening their understanding (Atadoga and Onaolapo 2008). They also has the following points as functions of developing pedagogical skills of science students.

- It enhances the ability of students skills to solve other problems
- It affords the students opportunity to develop manipulative skills through several attempts and trials in the laboratory.
- It has the potential of stimulating a lifetime interest in science in the students.
- It enable students develop scientific attitude and character such as: curiosity, open-mindedness, objectivity, honesty, tolerance and rationality.
- It gives students opportunities to gain exposure to scientific facts and phenomena which aid retention of information and translation such facts in another situations.
- Result from laboratory work sharpens the students mind and enhance the development of self confident needed by the teacher in the classroom during teaching and learning of science.
- It increases students ability for critical thinking, acquisition of improved understanding of basic concepts, principles and scientific facts.

  However, adequate planning and preparation in advance with proper

conduction of the activity makes the laboratory to become a centre for independent study, which is student-centred, activity oriented, and investigative in nature. Four stages of laboratory work have been identify by Gbamanja (1999) which are:

1. Pre-laboratory work learning stage involves gathering of all necessary materials and equipments by either the teacher alone or both the teacher and students.
2. Pre-Laboratory Discussion Stage: Students are made to know what the problems is, the objectives of the experiments, and safety precautions required.
3. The Laboratory Session Stage: The teacher outlines the procedures the students will follows and now withdraw to the background, young round to help and assist where necessary.
4. The Post Laboratory Work Stage: Reports made by individuals or groups are submitted for discussion, corrections are made, differences identified and explained.

Inquiry Based Method

The concept of inquiry-base science teaching was well articulated by Schweb during the 1960's (Atadoga and Onaolapo 2008). They defined inquiry method as a teaching approach whereby the students are allowed to formulate the problem, state the purpose, predict the result, identify procedures and perform the investigation. While Obeka (2010), describe inquiry method as a

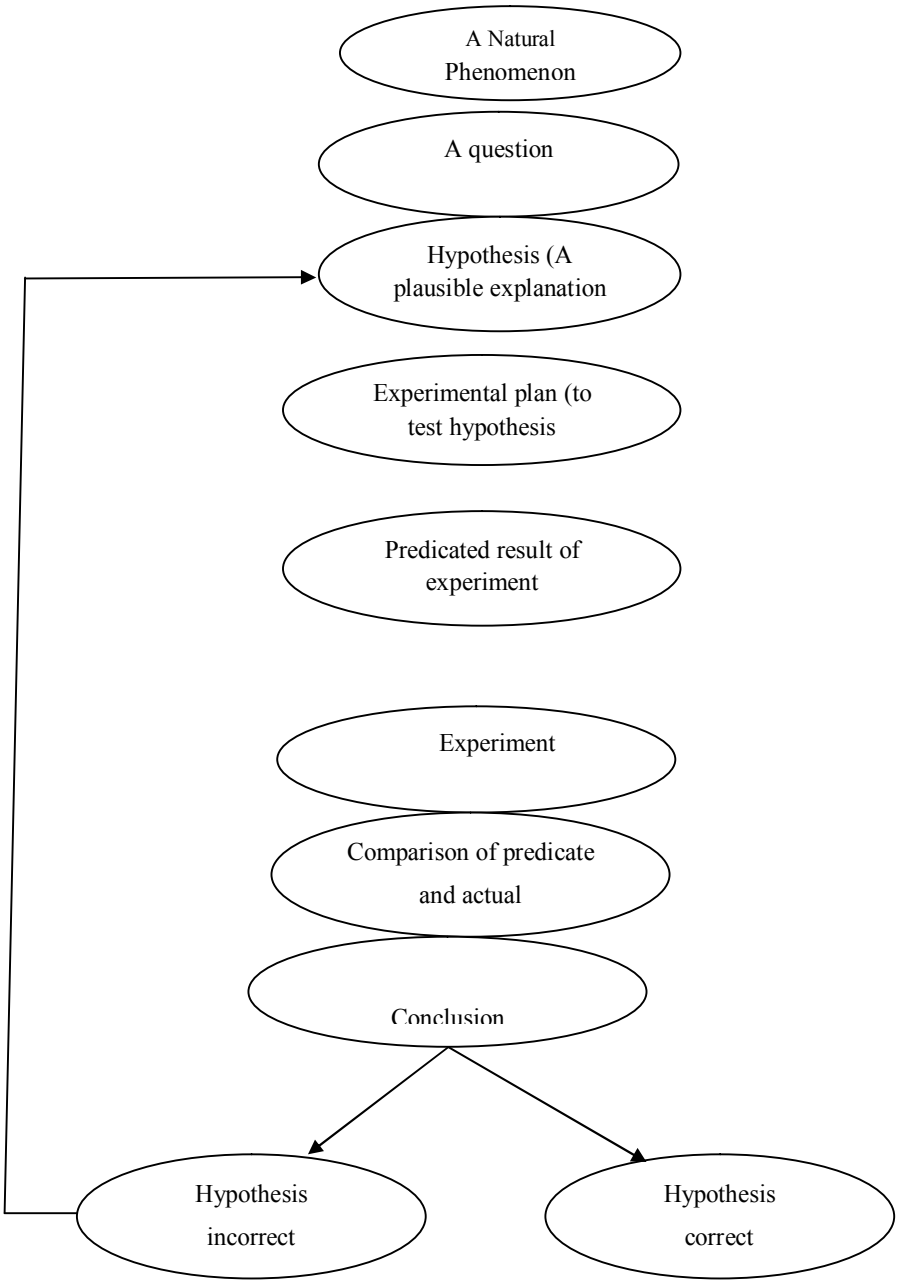
pseudo-experiment, where the teacher has the students reify already taught concepts. The parts of the lessons taught match the different components and are revised at each stage to allow for proven questions by the students. According to him, it is a highly interactive step by step approach which involve the students all levels of discussion to follow a systematic laid down principle set by the teacher for easy comprehension of the students.

However, inquiry method involves instructed exploration in which a student through their mental processes such as observing, measuring, classifying, analyzing, synthesizing and evaluating draw general conclusions from data which they have gathered. Hence, inquiry can either be guided or unguided. Guided inquiry would entail structuring of the initial lessons of the students that have not had any experience in learning through inquiry. First the problem will be posed by the teacher, then in order to help the students, the teacher bread down the problem into simpler questions to be answered and may even give advice about the steps which the students take to answer such questions. The amount of guidance in any situation depends on the grade level of the students, the problem and the teacher. In any event the students must come to an understanding of and a solution to the problem at the end of the time allow for inquiry.

Unguided inquiry occurs when students themselves formulate the problem to be solved, devise methods and techniques to solve a task, carryout an investigation and come to a conclusion. Unguided inquiry is suited to more

intellectually gifted children with a minimum amount of guidance from the teacher. This method has however been modified such that the process falls between guided inquiry and unguided inquiry. In this case the teacher provides the problem, and students are encouraged to attempt the problem individually or in groups. The teacher acts as a resource person giving title assistance so that they do not become frustrated and to help the students more forward in the investigation.

There is no simple recipe for doing science. The general method of scientific inquiry usually begins with a question, which is raised while observing some natural phenomenon. If there is no answer to the question posed, then one or more plausible hypothesis or explanations can be tested by means of a scientific experiment to answer each using a separate experiment. After planning the experiment, the scientist then predicts the result of the experiment assuming the hypothesis to be true. The key to designing successful experiment is the identification of all variables relevant to both the observed phenomenon and the questions posed ideally a scientific experimenter. As the experiment runs, only one variable is free to change, while all others are held constant. Feyman (2006) gave a method to represent the simplest form of inquiry process illustrated in figure 1.



Source: Feyman (2006)

Fig. 1: Feyman's Simplest and most basic scheme of reasoning and the process

of scientific inquiry.

Atadoga and Onaolapo (2008) listed some advantages of inquiry-based method to include:

- Development of students potentials and ability to work individually thereby gaining skills to deal effectively with their environment.
- Development of manipulative skills in students. Promote intellectual development of the students leading to high degree of assimilation and retention of scientific facts and ideas. All these aid pedagogical skills of science teacher to transform their content knowledge to the learners during the teaching and learning process.

The above mentioned integrated science method of teaching provides the prospective science teachers with necessary experiences in classroom setting to develop pedagogical skills. This pedagogical skill can chiefly be guided through students' teaching practice. Teaching practice is an indispensable component of a proper teacher education programme. Thus, teaching practice plays a vital role in the making of a professional teacher. The term "teaching practice" can therefore be described as a period of pre-certification .teaching that is intended to offer opportunities for the acquisition, development and refinement of necessary skills, knowledge, behaviours, attitudes and responsibilities that are basic for a successful teaching career (Adeniyi (2000). As a matter of fact, most educationists agree that the students' teaching practice is the most important component of his professional training (Adeniyi, 2000). Thus, the objectives of teaching practice in the NCE

teacher education programme include:

i. to help student-teachers develop positive attitude towards the teaching profession,
ii. to expose student-teachers to real life classroom experiences under the supervision of professional teachers.
iii. to enable student-teachers discover their own strengths and weaknesses in teaching and developing opportunities to overcome and consolidate them.
iv. to provide a forum for student-teachers to translate educational theories and principles into practice.
v. to familiarize student-teachers with school routines
vi. to expose student teachers to the total school environment,
vii. to provide student teachers with the necessary skills, competencies, personal characteristics and experiences for full time teaching after graduation; and
viii. to serve as a means of assessing the professional competence of student teachers (NCCE, 2004).

2.9 Relationship Between Subject Content Knowledge and Pedagogical Skill

It has now become clear that both teachers' pedagogical knowledge skills and subject content knowledge are crucial to good science teaching (Shulman, 2008. Similarly, the recent development of the National Science Education

Standards (NRC, 1996) and the Bench marks for science literacy (AAAS, 1993) further renewed emphasis on the importance of how pedagogical knowledge skills are related to science subject content. Subject content knowledge is the teachers' knowledge of the specific content they teach their students including topics, facts and relationship within a subject (Lee, 1995). The pedagogical skills are the actions and strategies of teaching organization of classroom experiences, providing for diverse learners needs, evaluation and implementation of learns' prior notions, and transformation of ideas into understandable pieces (National Science Teacher Association, 1996). While pedagogical content knowledge is the integration or synthesis of teachers pedagogical knowledge and the subject content knowledge (Lee, 1995).

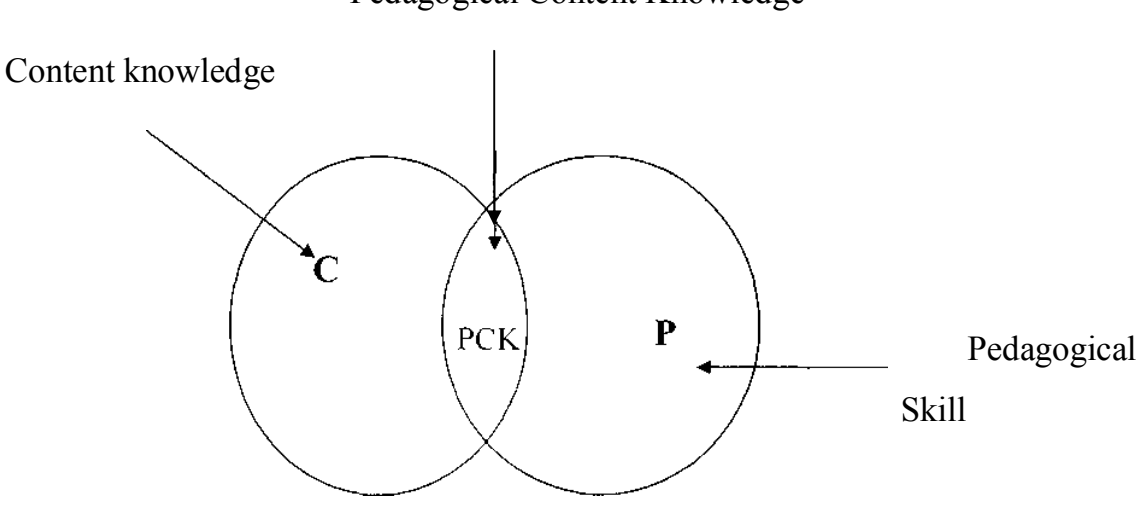
However, Shulman (2008) claimed that the emphasis on teacher subject matter content knowledge and pedagogy skills were treated as mutually exclusive domains. To address this dichotomy, he proposed to consider the necessary relationship between them by introducing the notion of Pedagogical Content Knowledge (PCK).

Shulman (2008) argued that having knowledge of subject and general pedagogical strategies, though necessary were not sufficient for capturing the knowledge of efficient science teacher. To characterize the complex ways in which teachers think about how particular content should be taught, he argued for pedagogical content knowledge as the teacher's base of knowledge that distinguishes a teacher from a subject specialist. If teachers were to be successful they would have to confront both issues (of content and pedagogy)

simultaneously by embodying "the aspect of content most germane to its teachability". The heart of PCK is the manner in which subject matter is transformed for teaching. This occurs when teachers interpret the subject content, find ways to represent it and make it accessible to learners.

Diagrammatically, Shulman's contribution to the scholarship of teachers" knowledge can be represented by connecting the two circles, so that their intersection represents pedagogical content knowledge as the interplay between pedagogy and content. In Shulman's words, this intersection contains within it, "the most regularly taught topic in ones subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, explanations in a word, the ways of representing the subject that make it comprehensible to others".

"Figure 2: Relationship between Subject Matter Content Knowledge and Pedagogical Skill.



Source: Shulman (2008)

Developing science literacy and the ability to transform this knowledge into learning opportunities require more than an understanding of content and pedagogy. It requires an understanding of the intersection. The content segment expects the teachers to be able to make connections and see relationship between concepts. On the other hand, the pedagogical segment seeks to help students learn about scientific problems. Making connections requires an understanding of the problems faced in learning science. Therefore, the content also expects science teachers to learn and teach about the process of inquiry, while the pedagogy expects teachers to plan experiences for their students to make inquiries. This presents the intersection in the learning and how to teach the process of inquiry. Making similar connections relies on the understanding of both the contents students are learning and how they learn. This is because the teacher knows about "organization of classroom experiences". However, to design such "organizations" requires a deep understanding of the content. This is what Shulman (2008) described as "The key to distinguishing the knowledge base of teaching lies at the intersection of content and pedagogy". Thinking about pedagogy and content enables teachers to identify the need of each student so that each learning experience can be matched to the current needs of the students. Applying notions of pedagogy to science content helps to reveal what might be problem for some groups. It also allows for greater flexibility within classroom based on the ability and interest of students.

This will enable teachers to modify learning goals and activities that are in line with educational curriculum.

Some critical amount of subject content knowledge seem to be necessary to develop the PCK required for teaching. Integration of knowledge domains is important to excellent teaching. Telling prospective teachers what to do does not enable them to put ideas into practice. They must have opportunities to learn in meaningful and supportive context. Integrating course content and field assignment are necessary to provide prospective teachers with integrated teaching knowledge (Magnusson, 1999).

PCK as the transformation of several types of knowledge for teaching is a core of science teacher education which includes the following elements:-

- The goals of science education and their relationship to teaching science (knowledge of orientation to teaching science, knowledge of science goals and objectives)
- instructional strategies that match particular orientations to teaching science (knowledge of subject-specific strategies, knowledge of specific science curricula).
- planning, conducting and reflecting upon teaching specific science topic, guided by considerations of students understandings (knowledge of students understanding, knowledge of science assessment) and the appropriateness/value of using particular instructional strategies (knowledge of topic specific strategies)
- planning and administration of assessment that are compatible with

ones orientation to science teaching and targeted goals and objectives (knowledge of science assessment. (Magnusson, 1999).

From all the foregoing, PCK includes knowing what teaching approaches fit the content and likewise knowing how element of the content can be arranged for better teaching. This knowledge is unique to teaching, and is based on the manner in which teachers relate their pedagogical knowledge (what they know about teaching) to their subject knowledge (what they know about what they teach). It is the integrated or the synthesis of teacher subject content knowledge and their pedagogical knowledge skills.

2.10 Gender and Achievement in Science

The issue of gender and academic achievement in science has been a major concern to science educators. A good number of researchers have been out to verify the influence of gender on academic achievement. A vast literature concerning gender difference favouring males in mathematics and science has arisen over the past decades in academic fields. For example Aigboman, (2002), Odetoyinbo (2004), and Usman (2010) reported significant gender difference in performance and achievement in science and science related tasks in favour of the males.

Recent analyses suggest that observed gaps in gender achievement tend to be stronger in physics and earth science than biology and life science or general science Ogunboyede (2003). Similarly, Nworgu (2005) points out that the enrolment of women in tertiary education has increased at a slower rate than male enrolment. They also observed that girls and women tend to enroll in humanities

and are found to be under represented in science subjects and mathematics, while male and men dominate. Perhaps this could be as a result of the fact that girls still have difficulty of understanding physical sciences notably physics as observed by Aigboman (2002), where they have been observed, a considerable effort has been expended in a variety of studies to explain science gender gaps. This trend was attributed by Milla (2004) to historical gender stereotyping of science as a "male realm" while to Sandoval (2005) the significant gender difference is due to content area interaction in science achievement, implying that males are more inclined to science than females.

Bennie (2001) claims that gender stereotyping which assigns science as male domain is a major cause of female low participation in science. On a similar note, Okeke (2001) agreed that, this may have also contributed to the poor enrolment and achievement of girls in science and technology in tertiary institution. This trend, he claims, traces back to history. It was formerly believed that certain subjects are not meant for women, this influences their attitudes towards certain subjects. Historically formal education system was established by the missionary churches and colonial government with a belief that boys would benefit from academic form of education (Ndirika, 2007). Girls generally remained illiterate and were encouraged to remain in the home (Aluko, 2005)

According to him, gender stereotyping permits the school system manifesting in both direct and subtle ways. Biological explanations have also been advanced suggesting that there are innate differences between the sexes that imply differential performance on assessments. However, the recent narrowing of

gender gaps suggests that biological differences are not important or can not be easily overcome by interventions.

Socialization and environmental factors receive more attention in the literatures. Popoola (2002) provides a useful summary of the individual, school and societal factors to explain differences in the way boys and girls participate and achieve in mathematics and science. While some researchers such as Mari (1999) and Bichi (2008) observed that females perform better than male in problem-solving activities. Supporting this view Mustapha (2009) contended that female students-teacher perform better in integrated science teaching practice than their male counterparts. Others on the contrary found out that sex (gender) plays, no significant role in science and technology (Yoloye 2004, and Nworgu, 2005). The issue of gender in science teaching seem to be a controversary. In this study, therefore, there is need to investigate the issue of gender difference on performance in integrated science using both content knowledge and pedagogical skill in the classroom at Junior Secondary School to which of them is gender friendly.

2.11 Similar Studies on Subject Content Knowledge and Pedagogical Skills

Several studies have been carried out on Subject Content Knowledge (SCK), Pedagogical Knowledge Skills (PKS) and Pedagogical Content Knowledge (PCK). Lee (1995) examined the relationship among three major components of classroom teaching: subject

content knowledge, classroom management and instructional practices. Two middle school science classes of different achievement levels were used as the subject of the study and were taught by the same female teacher. The teacher held an undergraduate degree with a major in social studies and a minor in mathematics and science from elementary teacher education programme. The findings from the study indicated that the teacher limited knowledge of science content and classroom order resulted in heavy dependence on the textbooks and students individual activities (e.g. seat work) and avoidance of whole class activities (e.g. discussion) in both classes.

Haider (1997) investigated the concept of atomic mass and balancing of chemical equations. 173 Junior and senior prospective chemistry teachers were the subject of his study. The results showed that the prospective teachers" understanding of most of the concepts range from a partial understanding with specific misconception to no understanding. Only on balancing chemical equations did the prospective teachers show good understanding. The findings indicate that most prospective teachers depended on mere memorization of the concepts without meaningful understanding. It also found that prospective teachers' knowledge about concept was fragmented. In other words, it seems they stored statement of concepts in their mind without integrating them in their knowledge structure. Furthermore, they failed to organize their knowledge and consequently deprived themselves of the ability to apply it

appropriately. Haider attributed the prospective teachers' misconceptions to defective instruction. It was therefore recommended that more effective teaching methods were needed to ensure a sound understanding of those concept.

Some studies in science education focused specifically on the role of content knowledge when teaching unfamiliar content. Sanders (1993) made a comparison between the teaching of experienced biology and physics teachers teaching both biology and physics topics. In a laboratory study involving stimulated recall and simulations, he showed that the teachers' knowledge of specific science content influenced their planning, their responses to students' questions and their lesson structure. He also describe the relationship of science teachers' knowledge to teachers' planning and described how teachers tended to choose instructional strategies relative to their familiarity with subject content. Sanders concluded that when teachers were familiar with the content, they choose conversationally risky classroom activities like discussion and when the content was unfamiliar they choose conversationally save activities like seat work. This view is greatly supported by the researcher because this is exactly what is being done by majority of our integrated science teachers. Therefore, there is the need to give students adequate contents knowledge as well as pedagogical skills which will make them to be competent in the use of appropriate teaching methods.

In another study, Millar (2006) examined teachers who were asked to teach physics, but were certified in another science area. He reported that the depth and extent of these teachers' background knowledge influenced their

confidence in being able to teach the new area. They anticipated much more difficulties they actually had. This point is also supported because many of the integrated science lecturers are graduates with single or double honours who were not professionally trained and are unfamiliar with the integrated science curriculum.

Shulman (2008) observed that a novice teacher was actually more successful teaching out of his area than another novice, teaching in his area. A science teacher and a teacher of English were both observed teaching English. The researchers revealed that the science teachers were actually more successful because of his intense motivation and interest, along with personal factors, such as his philosophy and interest in the students.

However, most students enter science classrooms with a set of conceptions about the world (Watson & Konicek 1990). For teacher to build on and challenge students" conceptions, it is necessary for teachers to have deep conceptual as well as pedagogical understanding. This application of pedagogical understanding to content understanding is a fundamental premise behind pedagogical content knowledge. Vistro-yu (2001) observed that content knowledge is useless without pedagogical knowledge; and without pedagogical knowledge teaching subject content is useless. Therefore, the two types of knowledge should be developed together to optimize learning. Geddis (1993) studied the transformation of pre-service science teachers subject content knowledge into "teachable content knowledge". According to Geddis, PCK plays a critical role in the transformation process. This conclusion was

based on students misconception (viz about electrical current) in comparison to their own view which appeared to promote the development of subject content representations and instructional strategies.

The transformation of subject-content knowledge in the context of pre-service science teacher education was also studied by Lederman (1992) in his study, the subject content structures of pre-service biology teacher were investigated. The knowledge structure appeared to be mainly derived from college science course work. More so, the structures were often vague and fragmented. On entering teacher education, they developed toward more coherent and integrated view during teacher education. Most important, it was observed that the translation of these subject content structures into classroom practice appeared to be complicated by classroom complexity. The authors suggested that until a teacher has gained experience and master basic classroom skills, it may be unrealistic to expect a reality accessible and useful translation of subject content knowledge into classroom practice.

Abba (1999) studied the pedagogical competence of junior secondary school integrated science teachers in Kotangora. His study adopted qualitative, interpretive methodology and a classroom observation schedule. The result indicated that integrated science teachers were not properly, professionally and academically prepared because of their weak subject content knowledge which also pose pedagogical difficulties of using chalk and talk method, accompanied by poorly framed question, and recall of memorized facts. It was also revealed that most integrated science classrooms, were dominated by instructional practices that

were inconsistent to promoted pupils development as individuals with intellectual and emotional needs. The study therefore recommended that the appointment of

integrated science teacher should be based on competences in both subject content knowledge and pedagogical skills which will facilitate use of appropriate strategies to enhance translation of science and implementation of integrated science as contained in the JSS curriculum.

Pedagogical skills in mathematics of secondary school teachers was investigate by Vistro-yu (2000). The teachers were selected based on their performance in mathematics test. They were interviewed, instructed to teach a beginning college algebra course, and were given questionnaire to complete. The interviews and actual teaching show that the teacher's pedagogical skills in mathematics were quite limited because the teachers had inadequate skills of preparation, planning and development of their lessons. The study also indicates that the teachers lack instructional strategies from their preparatory courses in dealing with the construction of question students understanding and evaluation.

It was therefore recommended that a more scientific approach to teach pedagogy and other related concepts in dealing with students and teaching material was required. Udogu, Ifeako & Njelita (2007) evaluate the pedagogical skills of science Technology and Mathematics Teachers (STM) in Secondary schools in Anambra State. The perceptions of 15 science teachers were sought and a modified classroom observation schedule was used to evaluate the level of the

usage of pedagogical skills. T-test statistics was used to analyse the data. The result of their study indicated that pedagogical skills were never used by the STM teachers adding that instructional practices of STM teachers appear to be didactic approach which leave the learners to learn by memorization of fact. Teachers were also observed not to be interested in adopting novel instructional strategies and classroom practices that enable learners to participate actively during the teaching and learning process. It was then recommended that STM teacher education programmes be reorganized to enable trainee teachers acquire appropriate pedagogical skills necessary for effective teaching; adding that the focus should be on novel instructional strategies and classroom practices that have been tried out and found to be effective in the teaching aid learning of STM subjects.

The above observations according to Njoku (2004) are true irrespective of the science subject concerned or the experiences of the teacher involved or the nature of science topic being handled. These characteristics of teachers who are seriously deficient in their understanding of the subject content knowledge teach the way they learned their content through the same ineffective traditional methods.

In another study of knowledge development, during teacher education, Lederman, et al (1994) investigated the self-reported changes in pre-service science teachers' conceptions of subject content and pedagogy. Although distinct changes in

both knowledge domains seem to take place mainly as a result of teaching experiences, pre-service teacher appear not to integrate these domains. The authors explained that this was as a result of lack of teaching experiences, and they therefore suggested that "with" the benefit of experience and continual use of ones subject content structure for purpose of teaching, the division between the pedagogical knowledge and subject content knowledge may become blurred" (Lederman et al; 1994).

Studies show that pedagogical content knowledge is highly specific to the concept being taught, than subject content knowledge alone, and develop over time as a result of teaching experiences. What is unique about the teaching process is that it requires teachers to "transform" their subject content knowledge for the purpose of teaching. (Shulman, 2008). This transformation occurs as the teacher critically reflects on and interprets the subject content; finds multiple ways to represent the information as analogies, metaphors, examples, problems, demonstrations and/or classroom activities; adapts the materials to student developmental level and abilities, gender, prior knowledge and misconceptions, and finally tailors the material to those specific individual or group of students to whom the information will be taught.

Cochran (1997) stated that this transformation process is a continual restructuring of subject content knowledge for the purpose of teaching. He then added that science teachers should maintain a fluid control or "flexible understanding" of their subject content knowledge. That means, they should be able to see a specific set of concepts from a variety of view points and at a variety

of levels, depending on the needs and abilities of the students.

The above studies focused mainly on physics, chemistry, biology, agric science, class management and instructional strategies at secondary school level. This type of study is required at NCE level most especially in integrated science to see whether or not there is any relationship between subject content knowledge and pedagogical skills of integrated science students in this subject at junior secondary schools level.

2.12 Similar Studies on the Relationship Between Content Knowledge and Pedagogical Skills

Correlation is the relationship between two or paired variables; that is two or more sets of data. The degree of relationship may be measured and represented by coefficient of correlation (Afolabi, 1998). The search of the literature revealed that enough studies have not been carried out on correlation of integrated science students' pedagogical content knowledge in Nigeria Colleges of Education.

Effect of investigative laboratory instruction on content knowledge and pedagogical skills across learning style was correlated by Brain and James (2005). They found that both male and female students showed significant relationship between content and pedagogical skills. Abba (1999) reported that application of pedagogical skills is effective for developing pedagogical content knowledge of integrated Science teachers' competence to teach at the junior secondary school level. On the other hand, Njelita (2005) studied the level of usage of pedagogical skills by science, technology and mathematics teachers in

secondary school and found that pedagogical skills were not appropriately used by STM teachers. Teacher who possess subject content knowledge expertise have ability to translate the subject content to their students and engage in class activities that facilitate free class discussion (Olorukooba, 2007).

Bent, (1996) correlated the organization of the knowledge among pre-service science teachers and untrained science teachers. It was found that pre-service science teachers had complex organization of subject content knowledge than the untrained science teachers. Shulman (2008) in studying teacher integration of subject content and pedagogy trainee teachers posited that teacher knowledge of teaching lies at the intersection of content and pedagogy adding that PCK support teacher education programmes that contain purposeful integrated courses in which teacher can develop the needed knowledge (content) and skills (pedagogy).

Developing Teacher pedagogical content knowledge (PCK) within the context of science teaching was investigated by Verloop and Wobble (1998). Their investigation identifies teaching experience as the major source of PCK while pedagogical skill may constitute a supporting framework for the development of PCK. Moreover, familiarity with specific topic in combination with teaching experience positively contributes to PCK.

2.13 Implications of the Literature Review to the Present Study

Teaching is a complex cognitive process in which an individual draw on knowledge from multiple domains in order to teach. What a teacher needs to

know and how that knowledge should be learnt and used to teach effectively has been a central theme for many educational researchers and philosophizers since the time of John Dewey. From a constructive point of view, it can be argued that teachers build conceptual structures to incorporate classroom events, instructional concepts, socially approved behaviours and explanatory patterns (Hewson, 1995).

The notion of a conception of teaching science has much in common with the picture of teachers' knowledge. It recognizes that the knowledge used in teaching is drawn from knowledge of the subject, the learner and instruction; and it is sensitive to the particular context in which the teacher uses it. Shulman (2008), presents a model of the component of professional knowledge based on teaching. These are knowledge of subject content, pedagogical knowledge skill, and pedagogical content knowledge. They suggested that these forms of knowledge are not isolated blocks of knowledge but are related to one another in different ways.

It is essential for any teacher of science or other subject to become acquainted with teaching methods that will help pupils achieve their learning objectives. This implies proper preparation in choosing relevant topics, appropriate methods and materials for the year work. Planning also provides for course continuity and gives one confidence as a teacher on what to teach and how to teach it.

The content knowledge influence planning in that it gives the teachers a sense of what is important in the content, what they wanted the students to know

and how to sequence the content presentation. Pedagogical Skills (PS) influence planning in that the teachers have the background knowledge of their students and build on that. The Pedagogical Content Knowledge (PCK) gives the teacher a sense of how to build the content by presenting the concept in a logical sequence and how much content to present at a time. Here, the teachers understand the interrelationship of the various parts of subjects content, recognize the need to transform the knowledge to the students.

Researchers have shown that the science teacher's knowledge of the subject content either enhances or limits students learning. Supporting this view, (Shulman, 2008) indicated that limited content knowledge resulted on heavy dependence on text books, avoidance of class activities. In students' questions, there is much talk, conventional safety activity like seat back and sometime both students and teacher end up in confusion. While teacher with essential content knowledge talk less, plan less risky instructional activities choose more risky settings such as discussion where students could ask questions, teachers can elaborate on students' ideas and are able to link ideas of the students to new content. However, without a firm grasp of subject content, the prospective teacher might not be able to exhibit their critical functions at the junior secondary school level for which their training is meant.

In addition to the essential content knowledge, effective instruction also requires teachers to transform and represent their knowledge in ways that the students can understand and appreciate. Teachers with familiar content knowledge tend to choose free ranging class activities such as discussion and

problem solving while teachers with weak content tend to choose lecture and recitation method. These methods do not enhance meaningful learning of science. Poor methodology resulting in bad teaching does not only frustrate the students but also minimizes their chances of success in the future. Therefore, if teacher education programmes are to prepare knowledgeable and competent practitioner and participants in educational institution, the programmes must be dynamic and current. That is, training of teachers should have the science content knowledge and methodology of imparting the knowledge.

The extent and depth of teacher's background knowledge enables him to follow the students' progress, adapt to different students' ability, use monitoring to proceed to the next topic or activity. Millar (2006) observed that teacher teaching out side their subject area had difficulties to link ideas of students to the new content.

Though integrated science curriculum has raised concern on some advantages for science instruction, these are guided discovery/inquiry (Atadoga & Onaolapo 2008) problem solving activities and open-ended laboratory work. The importance of using these methods as contained in the curriculum of integrated science cannot be overemphasized. Knowing what students learn through concepts and ideas will help them to choose their own present and future lifestyles. Brain and James (2005) indicated that investigatory approaches have higher content knowledge and science process

skill, than prescriptive laboratory approach.

Studies from Grossman (1990) and Shulman, (2008), revealed that knowledge of subject content and pedagogical skills though necessary, were not sufficient for capturing the knowledge of good teachers. They therefore, argued for "pedagogical content knowledge" as the knowledge that deals with teaching process, including the ways of representing and formulating of the subject that makes it comprehensive to others. Therefore, if our educational training institutions were to be successful they would have to confront both issues (of content and pedagogy) simultaneously, embodying "the aspect of content most game of its teachability. This is due to the fact that at the heart of PCK, it is the manner in which subject matter is transformed for teaching. This occurs when the teacher interprets the subject matter, finding different ways to represent it and make it accessible to learners.

Other studies have shown that teachers have incomplete or superficial level of pedagogical content knowledge and difficulty to articulate the relationships between pedagogical skills and subjects content concept (Abba, 1999). In addition, the pre-service and new teachers struggle with how to transform and represent the concepts and ideas in ways that make sense to the students they are teaching. Hence, the need to assess the relationship of subject content knowledge and pedagogical skills of prospective NCE integrated science students so that the effect might help to increase students competence and ability to teach effectively at the junior

secondary school level to the benefit of all. The literature has reviewed some teaching methods, subject content knowledge, pedagogical skills, pedagogical content knowledge and other areas that will be of benefit to the teacher and students at large. Studies from literature reviewed were on biology, chemistry, physics, agricultural science and English. Also study on subject content and pedagogical content knowledge in science is not enough in Nigeria. However, this study is unique to acquaint science educators and students with importance of pedagogical content knowledge (PCK) needed for effective teaching/learning of integrated science. This study therefore, aims at filling this gap by investigating relationship between content knowledge mastery and pedagogical study of integrated science teachers of J.S.S. levels.

CHAPTER THREE
METHODOLOGY

3.1 Introduction

This chapter discussed the research design, population of the study, sample and sampling techniques, treatment administration, instrumentation, pilot study, data collection, procedure and analysis. All these are discussed in the following order.

- Research Design
- Population of the Study
- Sample and Sampling Techniques
- Treatment Administration
- Instrumentation
- Pilot study
- Data Collection Procedure
- Data Analysis

3.2 Research Design

The research design used in this study is comparative and correlational, which involves collection of Integrated Science Performance Test (ISPT) results and Students Teaching Practice Assessment (STPA) scores from selected Colleges of Education on students subject content knowledge of integrated science and pedagogical skills in integrated science. The data were made up of Integrated Science Performance Test that was used to measure subject content

knowledge of the students and the Students' Teaching Practice Assessment Form (STPAF) was used to measure the pedagogical knowledge skills of the students. The two data were correlated to determine the relationship between them (if any).

3.3 Population of the Study

The population for this study comprise all the N.C.E. III integrated science students of 2009/2010 session in the two Colleges of Education located in Niger State. These Colleges are Federal College of Education, Kotangora and State College of Education, Minna. The colleges were purposively sampled because they were the only two Colleges of Education in the state during the time of study. There were 502 students in Federal College of Education, Kontagora and 498 students in Niger state College of Education, Minna, according to available records in the offices of Deans, students affairs. In the department of Integrated Science, there were 50 students (27 male and 23 female) in C.O.E, Minna while there were 50 students (27 male and 23 female) in F.C.E, Kontagora. The breakdown of the College of Education in the target population is presented in Table 3.1.

Table 3.1: Students in the Study Population

Institution	**Location**	NCE **III students' enrolment**	**Male**	**Female**	**Total**
F.C.E Kontagora	Kontagora	502	252	250	502
C.O.E Minna	Minna	498	250	248	498
	Total	**1000**	**502**	**498**	**1000**

Source: Examination Office.

3.4 Sample and Sampling Techniques

The sample used for this study was drawn from the population of the study. In order to have a manageable sample that is large enough for meaningful generalization, a total of 100 students was selected using purposeful random sampling techniques based on gender difference in which Fifty (50) students made up of 27 male and 23 female were selected from FCE Kontagora and fifty (50) students made up of 27 male and 23 females from COE, Minna. The 100(46 females and 54 male subjects constitute 10% of the study population of 1000. This is in line with recommendation of Tuckman (2003) that 10% of the study population is viable for correlational study. The summary of the sample selection is presented in Table 3.2

Table 3.2 Sample Selected for the Study.

Name of Institution	Location	Male	Female	Total
FCE Kontagora	Kotangora	27	23	50
Niger State College of Education	Minna	27	23	50
	Total	**54**	**46**	**100**

Source: Examination Office

3.5 Instrumentation

Two instruments were used for the purpose of data collection. These were Integrated Science Performance Test (ISPT) and Students' Teaching Practice Assessment Form (STPAF).

3.5.1 Integrated Science Performance Test (ISPT)

This instrument was used to determine the subject content knowledge of the students in integrated science. It was used to measure the academic Performance of the students in integrated science. The test consists of 30 multiple choice items developed by the researcher. The test items were obtained from 2007/2008 past questions of NCE examination papers. These questions were based on all 300 level courses the students were expected to have covered. A table of specification was used in preparing the items to ensure topics are evenly selected from all the first and second semester courses to ensure equal distribution of items.

The test items are in line with Bloom's (6) six level categories of cognitive domain, such as knowledge, comprehension, application, analysis, syntheses and evaluation. The details of the ISPT and the marking scheme are provided in appendix A and B.

3.5.2 Table of Specification

To achieve the educational objectives of students' content knowledge, there is the need to cover the cognitive domains of Bloom's taxonomy. These are knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. Bloom (1956) observed that, test items should measure performance objectives in this domain. Therefore test items were equally distributed across the six (6) levels of the cognitive domain. Summary of the analysis is presented in Table 3.4 below.

Table 3:3: Table of Specification of the Instrument (ISTP)

DOMAIN	TOTAL NUMBER	NUMBER OF ITEMS
Knowledge	5	1, 4, 9, 16, 20
Comprehension	5	5,6,10,22,27
Application	5	11,12,13, 14,23
Analysis	5	15, 18, 19,25,29
Synthesis	5	3,7,8,17,21,
Evaluation	5	2, 24, 26, 28, 30
Total	30	

3.5.3 Student Teaching Practice Assessment Form (STPAF)

Student Teaching Practice Assessment Form was used to measure students' competence in teaching skills. This instrument is used to determine pedagogical knowledge skills of the students in Integrated Science. The purpose of this assessment is to find out how individuals student can transform their subject content knowledge of integrated science to teach the Junior Secondary School integrated Science. The instrument was adopted from Adetula (1997). It consists of five section expected to measure the teaching or pedagogical skills of a teacher while he is teaching. The sections are:-

- Planning of the Lesson
- Teaching Procedure
- Class Management and Control

- Evaluation of Previous Work Done
- Teacher Personality

Each of these major sections have sub-sections which are clearly spelt out for easy scoring of any skill exhibited by the student teacher. The maximum mark required for each section is assigned on the form and each sub-section has a maximum of 5 marks. (See **Appendix** C). Since the instrument **(STPAF)** was adopted from Adetula **(1997),** it was subjected to validity and reliability test in which r = 0.75 was observed, meaning that the instrument is reliable and was used for data collection in this study. (NCCE minimum standard 2001 reviewed version)

3.5.4 Pilot Testing

The instrument for the study i.e. Integrated Science Performance Test (ISPT) was pilot-tested using 2008/09 NCE III integrated science students, of FCE, Zaria. This set of students, 30 in number, was used for pilot study since they have covered subject content and have been exposed to science teaching methodology and micro teaching. These sets of students were also ready for their teaching practice training. Hence, they were equivalent to the target study sample for this study.

The pilot testing was to:-

i. Find out the characteristics of (ISPT) items through item analysis
ii. Determine the appropriateness of the wording of the Integrated Science Performance Test.

3.5.5 Validity of the Instrument

Integrated Science Performance Test (ISPT) and corresponding marking scheme were validated by a panel of four (4) science education lecturers. The panel consisted of two senior lecturers of science education ABU, Zaria and two lecturers from C.O.E., Minna. These experts were required to examine the instrument for the purpose of:-

(a) Content Validity

(b) Appropriate use of the items in terms of difficulty for the groups in the study.

(c) Clarity of the statement in the instrument

(d) Check possible errors in the proposed answers.

The instrument was revised on the bases of the corrections and recommendations. Out of forty (40) items; thirty (30) test items were selected in agreement with recommendations of the panel members. In addition, a second panel consisting of four integrated science lecturers from Federal College of Education, Kontagora and College of Education, Minna were given the Teaching Practice Assessment Score Forms to validate. The validators were requested to examine the content of the items in the test (ISPT) and to provide necessary corrections and observation to judge whether or not they could be understood by the NCE III students offering integrated science.

The result of the validation exercise indicated that, the content of the items of the test meet the characteristics of the research instrument.

3.5.6 Reliability of the Instrument

The reliability of the Integrated Science Performance Test was done using test-retest method in which items were administered to 30 students twice with interval of 2 weeks as proposed by Tuckman (2003). Pearson Product Moment Correlation Coefficient statistics was used and the reliability coefficient of the instrument was found to be 0.75.

3.5.7 Item Analysis

Items analyses were carried out on the score from the pilot study and to determine the facility or difficulty (fi) and discriminate on indices (Di).

3.5.8 Facility Index

Facility index of each item for the test was calculated. Each item facility index calculation was based on the formula given by Sambo (2005)

$$P = \frac{R}{T}$$

P=Facility Index

R = Number of students who answer the questions correctly

T = Total number of student tested

According to Sambo (2005) if 30% - 70% can answer correctly items then such items are recommended for use. The facility index of the test (ISPT) was 48.00% (see Appendix D).

3.5.9 Discrimination Index Di

The discrimination index of a test is the ability to discriminate between high and low achievers among students in the sample. This gives room for ranking of students in a given test. The formula given by Sambo (2005) is

$$D = \frac{Ru - RL}{N}$$

D = Discrimination Index

Ru = Number among upper 27% who responded correctly to the item

RL = Number among the lower 27% who responded correctly to the item

N = The Number of respondents in the upper and lower 27%

From the result of the pilot study, the average discrimination index for whole test was 0.49. Thirty (30) items of the test got between 0.30 -0.70 indices and the remaining ten items are below 0.30 indices. In view of these results, the ten test items with less than 0.30 indices were rejected for not possessing appropriate discrimination power and excluded from the items to be used for the final test in the test. The discrimination indexes of items for this study are present in appendix D.

3.6 Data Collection Procedure

For the purpose of this study, two instruments were used for data collection. These instruments were Integrated Science Performance Test (ISPT) and Student Teaching Practice Assessment Form (STPAF). The ISPT test was administered to student a week to their second semester examination to

measures their subject content knowledge in integrated science. The test was written under the duration of 45 minute and students were supervised by the researcher and the research assistant (examination officers). The scripts were marked and scores were also recorded for all students. Total scores for the test was sixty percent 60%.

Students' continuous Assessment scores were collected from the integrated science departmental examination officers and were added to their test scores to give a total of 100 marks. This was done to all study subjects.

The student pedagogical skill was determined using Students Teaching Practice Assessment Form (STPAF). The study subjects were supervised 3 times by the researcher and research assistants and the average of their scores were taken during the teaching practice exercise was used for data analysis. All Scores obtain from ISPT and STPASF were subjected to data analysis.

3.7 Data Analysis

The data collected from the study were used to test hypotheses stated in chapter one. Each of the hypotheses is restated below along with the statistical tools used for testing them.

Ho_1: There is no significant relationship between NCE integrated science students' subject content knowledge and pedagogical skills.

Ho_2: There is no significant relationship between subject content knowledge and pedagogical skills of male integrated science.

Ho_3: There is no significant relationship between subject content

knowledge and pedagogical skills of female integrated science students

To test each of these three hypotheses Pearson Product-Moment Correlation Coefficient (PPMCC) was used.

Ho_4:-There is no significant difference between male and female integrated science students subject content knowledge.

Ho_5:There is no significant difference between male and female integrated science student pedagogical skills.

To test Ho_4 and Ho_5 t- test statistics was used.

CHAPTER FOUR

Data Analysis Result and Discussions

4.1 Introduction

This chapter discusses the data analysis, result presentation, summary of findings and discussion of results.

4.2 Data Analysis and Results

Two types of instruments were analyzed. They are

(i) Integrated Science Performance Test Scores.

(ii) Student Teaching Practice Assessment Scores.

These data were used in testing the five stated hypotheses and were analyzed using Pearson's product-moment correction coefficient and t-test statistics. The probability level of retaining or rejecting the hypotheses was P $\leq$0.05.

4.3 Hypotheses Testing

Null Hypothesis 1:

Ho_1: There is no significant relationship between NCE integrated Science Students' subject content knowledge and pedagogical skills.

To test this hypothesis, the scores of the students in ISTP in Integrated Science Performance Test and their corresponding pedagogical skills results in teaching practice were subjected to Pearson's Product-Moment Correlation Coefficient statistics. Summary of the analysis is presented in Table 4.1.

Table 4.1 Relationship between Students' Subject Content Knowledge and Pedagogical Skills in Integrated Science at NCE level.

Variable	N	Df	r-cal	P	Remark
Content Knowledge	100				
Pedagogical Skills	100	98	0.84	0.001	Sig

- **Significant at P < 0.05**

Table 4.1 shows the calculated r-value of 0.84 with degree of freedom 98 at P< 0.05 level of significance. Also the P value of 0.00 1 obtained is less than 0.05. Therefore there is significant relationship between NCE Integrated Science subject content knowledge and pedagogical skills. The stated null hypothesis was therefore rejected. This means the knowledge base of Integrated Science students lies at the intersection of content and pedagogy for effective teaching of Integrated Science.

Null Hypothesis 2:

Ho_2: There is no significant relationship between male integrated Science Students' content knowledge and their pedagogical skills.

To test this hypothesis, Male Students' content knowledge result in integrated Science performance test and their corresponding pedagogical skills result in teaching practice were subjected to Pearson's Product-Moment Correlation Coefficient Statistics. Summary of the analysis is presented in table 4.2

Table 4.2: Relationship between Male Students' Subject Content Knowledge and pedagogical Skills in Integrated Science at NCE level.

Variable	N	Df	r-cal	P	Remark
"Male	50				
		48	070	0.001	S
Male	50				

*** Significant at P< 0.05**

Table 4.2 shows the calculated r-value of 0.70 with degree of freedom 48 at P< 0.05 level of significance. Also the P-value of 0.001 obtained is less than 0.05. Therefore there is significant relationship between male student subject content knowledge and pedagogical skills. Thus, me null hypothesis was rejected. This means familiarity of content knowledge with teaching method enable teacher to be successful on their job by embodying the aspect of content and pedagogy simultaneously.

4.3.3 Null Hypothesis 3:

Ho_3: There is no significant relationship between Female Integrated Science Student's subject content knowledge and pedagogical skills

To test this hypothesis, female student's subject content knowledge result in integrated science performance test and their corresponding pedagogical skill result in teaching practice were subjected to Pearson's Product-Moment Correlation Coefficient Statistics. Summary of the analysis is presented in Table 4.3.

Table 4.3: Relationship between Female Student Subject Content Knowledge and Pedagogical Skills in Integrated Science at NCE level.

Variable	N	Df	r-cal	P	Remark
Female	50				
		48	0.64	0.001	S
Female	50				

Significant at P<0.05

Table 4.3 shows the calculated r-value of 0.64 with degree of freedom 48 at P<0.05 level of significance. Also, the P value of 0.001 is less than 0.05. Therefore, there is significant relationship between female student subject content knowledge and pedagogical skills. Thus the stated null hypothesis was therefore rejected. This means familiarity of content knowledge with teaching method enable teacher to be successful on their job by embodying the aspect of content and pedagogy simultaneously.

Null Hypothesis 4:

Ho_4: There is no significant difference between Male and Female Integrated Science students' content knowledge.

To test this hypothesis, Male and Female Students' content knowledge test results in integrated science performance test were subject to t-test statistics. Summary of the test of significant difference is presented in Table 4.4.

Table 4.4: t-test Analysis of Male and Female Students' Performance Test mean scores in Integrated Science at NCE level

Variable	N	Mean	Df	t-cal	P	Remark
Male	50	65.64				
			98	2.39	0.01	Sig
Female	50	61.54				

* **Significant at P< 0.05**

Table 4.4 shows the calculated t - value of 2.39 with degree of freedom of 98, at P< 0.05 level of significance. Also the P value of .019 is less than 0.05, showing that there is significant difference between male and female students' content knowledge in integrated science performance test in favour of male students. The null hypothesis is therefore rejected.

Null Hypothesis 5:

Ho_5: There is no significant difference between male and female integrated science students' pedagogical skills.

To test this hypothesis scores from teaching practice were subjected to t- test statistics. Summary of the test of significant difference is presented in table 4.5.

Table 4.5 t-test Analysis of Male and Female Students' (Pedagogical Skills) Teaching Practice mean scores in Integrated Science at NCE level

Variable	N	Mean	Df	t-cal	P	Remark
Male Content	50	52.84				
			98	**3.62**	**0.00**	**Sig**
Female content	**50**	58.86				

* **Significant at P< 0.05**

Table 5.5 shows the calculated t - value of 3.62 with degree of freedom of 98 at P< 0.05 level of significance. Also the P - value of 0.000 is less than the 0.05 level of significance. The null hypothesis was therefore rejected that is there is significant difference between male and female pedagogical skills in integrated science in favour of male students as observed in their mean scores.

4.4 Summary of Findings

The findings of the study are outlined below.

- That there is a significant relationship between NCE integrated science student subject content knowledge and their pedagogical skills.
- There is a significant relationship between Male students' subject content knowledge in integrated science and their pedagogical skills.
- There is significant relationship between Female students' subject content knowledge in integrated science and their pedagogical skills.
- There is significant difference between Male and Female students' content knowledge of Integrated Science in favour of male students.
- There is significant difference between male and female students' pedagogical skills in integrated science students in favour of male students.

4.5 Discussion of Results

This study investigated the relationship between subject content knowledge and pedagogical skills of NCE integrated science students in Niger State. The students integrated science performance test result and their corresponding teaching practice results were used for data analyses.

The result from null hypothesis one Table 4.1 shows that significant relationship exists between NCE integrated science students' content knowledge and their pedagogical skills. Correlation coefficient obtained at probability level of 0.05 was 0.84 which was positive and significant as shown in Table 4.1. The null hypothesis which states that there is no significant relationship between NCE Integrated Science students' content knowledge and the pedagogical skills was rejected.

The significant relationship observed between students' content knowledge and pedagogical skills may be likely due to orientation through microteaching and students' emulation of their teachers using specific content with effective teaching strategies during teacher training. The finding is in line with Shulman (2008) where it was noted that knowledge of teaching lies at the insertion of content and pedagogy.

The result of the second hypothesis indicated that there is significant relationship between male Integrated Science students' content knowledge and their pedagogical skills. The correlation coefficient obtained at $P< 0.05$ was 0.70 which was positive and significant as shown in Table 4.2 above. Also the result of the third hypothesis revealed that there is significant relationship between female students' content knowledge and their pedagogical skills. The correlation coefficient obtained at $P< 0.05$ was 0.64 which was significant and positively correlated as shown from Table 4.3 above.

These significant relationship observed is due to male and female students familiarity of Integrated Science content specific topic with science teaching methods and use of instructional materials. This finding is in line with James (2000) where significant relationship exist between content knowledge and pedagogical skills. Therefore, if male and female students have effective content knowledge and pedagogical skills they can handle teaching and learning activity of Integrated Science effectively at Junior Secondary School level.

The result of the fourth hypothesis showed that there is significant difference between male and female Integrated Science students' content knowledge at NCE level. The result of the t-test indicated that the t-value obtained at $P< 0.05$ was 2.39 as shown from table 4.4 above. The result revealed that male students perform better academically in content knowledge than their female counterpart. This finding is in line with Aigboman, 2002; Odoetoyinbo 2004; and Usman 2010. They posited that male students are academically superior to the female counterparts on science. This result may be due to the fact that the societal set up gives males the opportunity to exploit the environment which is pre-requisite to science. The boys are left free to move about exploring the environment.

The result of the fifth hypothesis revealed that there is significant difference between male and female integrated science students' pedagogical skills. The result of the t-test statistics showed that t-value obtained at $P< 0.05$ was

3.62 as shown from table 4.5. The Table revealed that female student performance in content knowledge (ISPT) affects their pedagogical skills positively. This means the content knowledge obtained enable them to apply actions and strategies of teaching, classroom experiences and transformation of ideas into learners understanding. This finding is in line with Olorukooba (2007) who reported that teachers that possess essential subject content knowledge engage in class activities that facilitate free class discussion. This result may be due to the experiences obtained from orientation of micro-teaching in the school while on training. This also conforms with Mustapha (2000) who posited that female students teacher perform better in integrated science teaching practice than their male counterparts performance academically.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter discusses the summary, conclusions, and recommendations emanating from the study. Specifically, the chapter is discussed under the following sub-headings;

- Summary
- Summary of the Major Findings
- Conclusions
- Recommendations

5.2 Summary

The purpose of this study is to investigate the relationship between subject content knowledge and pedagogical skills among NCE integrated science students in Niger State.

There are two Colleges of Education in Niger State. The sample study comprised of a 100 students drawn from the population of 1000 students in Federal College of Education Kontagora and State College of Education Minna. They were selected by stratified sampling technique.

Integrated Science Performance Test scores and Teaching Practice scores were used as data for the study. Pearson's Product-Moment Correlation Coefficient and t - test statistics were used to determine the correlation coefficient and differences at 0.05 probability level. From the results, there are positive

significant relationship between content knowledge and pedagogical skills. Gender differences was also observed between male and female content knowledge and pedagogical skills.

5.3 Summary of Major Findings

The study has the following major findings:

- That there is a significant relationship between NCE integrated science student subject content knowledge and their pedagogical skills.
- There is a significant relationship between Male students' subject content knowledge in integrated science and their pedagogical skills.
- There is significant relationship between Female students' subject content knowledge in integrated science and their pedagogical skills.
- There is significant difference between Male and Female students' content knowledge of Integrated Science in favour of male students.
- There is significant difference between male and female students pedagogical skills in integrated science students in favour of male students.

5.4 Conclusions

From the findings of the study, it was observed that content knowledge and pedagogical skills are significantly related. This implies that the knowledge base lies at the intersection of content and pedagogy. The study

therefore, review that there is a need for content knowledge to be thought together with pedagogical skill in order to enhance the teaching and learning of integrated science appropriately.

However, teacher at the higher institutions such as colleges of education need to take cognizance of the importance of pedagogical content knowledge (PCK) which has the potentiality of content been related positively with pedagogical skills as shown in this study. If teachers should teach integrated science concept in line with the pedagogical required, there is possibility of uplifting the teaching and learning of integrated science and basic sciences generally.

5.5 Recommendations

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

1. Teacher education programmes should reorganize and orient their programmes toward preparation and professional development of teachers. This can effectively be done through studying of the content mastery and pedagogical skills under one department so that trainee teachers can effectively identify how to relate the content taught with specific science teaching methods.
2. The government (State and Federal) should encourage in-service training programmes for teachers of Integrated Science working force to update their knowledge and to improve on the classroom practices. Such programmes should be focused toward linking the subject content with

pedagogy to enable the trainee acquire appropriate technical skills necessary for effective Integrated Science teaching.

3. Lecturers teaching at colleges of education should organize yearly orientation on micro-teaching to enable trainee teachers identify effective classroom teaching strategies which they can use when they go back to teach at JSS level.
4. Science educators should always diagnose their teaching methods to enable them to cater for the mixed ability groups found among their learners.
5. In this study, it was observed that male students obtained high pedagogical skills than their female counterparts. This tend to show that male teachers can teach Integrated Science better at Junior Secondary School level than female teachers. This calls for regular orientation (microteaching) where students can be groomed with good class management, teaching skills, use of specific instructional materials and teacher comportment.

5.6 Limitation of the Study

This study has some limitations, which include the following:

- The study was carried out in only Colleges of Education in Niger State, which made the scope to be fairly narrow.

5.7 Suggestions for Further Studies

The study was carried out in only Colleges of Education in Niger State. However, it is the view of the researcher that it has become absolutely necessary to make the following suggestions that:

- There is the need to conduct similar research in other states in Nigeria to see if the result would be the same or different.
- There is the need to conduct similar studies in other basic sciences and other science related courses to see whether pedagogical content knowledge is actually an interplay between content and pedagogy.
- There is the need to evaluate the level of usage of the pedagogical skills of NCE lecturers at Colleges of Education. This is to ascertain whether the trainee teachers have been imparting the pedagogical skills in relations to the subject content knowledge

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APPENDICES

APPENDIX A

INTEGRATED SCIENCE PERFORMANCE TEST (ISPT)

SEX: | M | F | **Time Allowed: 45 Minutes**

This test is being administered to collect data for research purpose only. It is not to be used to assesses your personal performance or that of your teacher.

Instruction: Answer All Questions

Each question is followed by four (4) options; tick the correct option you consider to be the correct answer.

Organic compound question 1-3

(1) Organic chemistry originally applies only to the study of
   (a) Plant origin
   (b) Animal origin
   (c) Non-carbon compounds
   (d) Plants and Animal origin

(2) Hydrocarbon with a double covalent carbon-carbon bond are called
   (a) Alkanes
   (b) Alkenes
   (c) Alkynes
   (d) None of the above

(3) An alkene with 4 carbon atom would have how many hydrogen atom.
   (a) 4
   (b) 8
   (c) 10
   (d) 18

(4) Fertilization takes place in the upper part of
   (a) Oviduct
   (b) Uterus
   (c) Vagina
   (d) Test

(5) Which of the following parts produces sperm and hormones
   (a) Testis
   (b) Penic
   (c) Vagina
   (d) Ovary

(6) Plantation of zygote takes place in
   (a) Uthera
   (b) Oviduct
   (c) Uterus
   (d) Fallopian tube

(7) All are advantages of science and technology except
(a) Machines
(b) GSM Mobile phone
(c) Coloring
(d) Hybridization.

(8) Through application of science and technology the following are obtained except
(a) Refrigerator
(b) Soil
(c) Radio
(d) Air condition

(9) Technology is
(a) A body of organized knowledge and a proces of inquiry
(b) A knowledge that is concerned with finding out about things in the environment
(c) The practice application of scientific knowledge using the resources of matter, energy and natural phenomena to solve human problems and making life easier.
(d) The basic ideas, methods and objectives of teaching science.

(10) Which of the following substances is not deter mined in qualitative analysis ?
(a) Anions
(b) gases
(c) Cations
(d) Plastics

(11) Calculate the number of Male of NaOH 500cm of 0.2 mol^{-1} dm^3
(a) 0.1 moles
(b) 20 moles
(c) 500 moles
(d) 0.2 moles

(12) The oxidation number of sulphur in tetraoxosulphate (VI) is
(a) -6
(b) -2
(c) +6
(d) +4

(13) A way of stating relative number of Male and Female is known as.
(a) Population
(b) Maternity
(c) Mortanity
(d) Sex ratio

(14) Increasing a population is food supply may directly increase
(a) Environmental resistance on the population
(b) The carrying capacity of the population

(c) The population's mortality
(d) The population pressure

(15) Which one of the following is an example of an exponential increase?
(a) 100, 200, 300, 400,500.
(b) 1,2,3,4,5.
(c) 2, 4, 8, 16, 32.
(d) 5,10,15,20,25.

(16) The first chemistry to investigate the effect of different factors on equilibrium is
(a) le- chartelier,
(b) Hess
(c) Arrhenius
(d) Robert Hook

(17) For a chemical reaction to occur there must be ..... between reacting particles
(a) Disintegration
(b) disruption
(c) confusion
(d) Collision

(18) Catalyst increase the rate of a chemical reaction by lowering .... energy
(a) Kinetic
(b) Activation
(c) Light
(d) Potential

(19) The sex of the offspring is determined by.....
(a) The Male
(b) The Female
(c) Both Male and Female
(d) None of the above

(20) The following are signs of puberty in Female except
(a) Breast development
(b) Deepened voice
(c) Pubic and under arm hair
(d) Fat is added to the buttocks and thighs

(21) The sex of an individual is set
(a) At conception
(b) At birth
(c) At puberty
(d) During pregnancy.

(22) A point on a stationary wave where there is no movement of the medium is called
   (a) Antinodes
   (b) Node
   (c) Amplitude
   (d) Period
(23) The maximum displacement of the particles from their mean, or rest position could be called ..... ……..
   (a) Amplitude
   (b) Period
   (c) Frequency
   (d) Velocity
(24) Tranverse mechanical wave will move only through
   (a) Solids
   (b) Liquid
   (c) Gases
   (d) All of the above
(25) The R in ROH represents..... -.....- .....
   (a) A functional group
   (b) A hydrogen group with a name ending with yl
   (c) An atom of inorganic element
   (d) Polyatomic ion that does not contain carbon
(26) Amines are derivatives of..... ……..
   (a) Acid
   (b) Ammonia
   (c) Hydroxyl
   (d) Alkaneals
(27) The C = is called..... ..... Group
   (a) Carboxyl
   (b) Carbonyl
   (c) Hydroxyl
   (d) Amino
(28) Which of the green house gases, contribute most to global warming
   (a) Sulphur (IV) oxide
   (b) Carbon (IV) oxide
   (c) Nitrogen (IV) oxide
   (d) Lead oxide
(29) Ozone is able to protect the earth from harmful amount of ultraviolet radiation by
   (a) Reflecting it back to space
   (b) absorbing it and decomposing, then reforming.
   (c) refracting it to a lower attitude
   (d) All of the above

(30) The green house effect result in increase temperature near the surface because

(a) Clouds trapintrad radiation back toward the surface
(b) Some of the energy is reradiated back toward the surface
(c) Carbon dioxide molecule does not permit radiation
(d) Carbon dioxide and water vapour both trap intrad radiation.

APPENDIX B

MARKING SCHEME

Items	Correct Options
1.	D
2.	B
3.	C
4.	A
5.	A
6.	C
7.	C
8.	B
9.	C
10.	D
11.	A
12.	C
13.	D
14.	B
15.	C
16.	A
17.	D
18.	C
19.	A
20.	B
21.	C
22.	A
23.	A
24.	A

25. A
26. C
27. C
28. A
29. B
30. B

APPENDIX C STUDENT TEACHING PRACTICE ASSESSMENT **FORM (STPF)**

This assessment instrument contains specific items or skills which are used to assess the performance of the student - teacher. The criteria against which student-teacher could be assessed have been categorized into planning of the lesson, teaching procedure, class management and control, evaluation of the previous work done and teacher's personality. Each of these major categories with the sub-categories are outlined below for easy scoring of any skill exhibited. The maximum mark required for each section is assigned on the form and the Sub-categories should be rated in order of their magnitude as provided in the form.

NAME OF STUDENT:.....……

SCHOOL:..... ……

MAJOR SUBJECT:..... SUBJECT TAUGHT:……..

TOPIC OF LESSON:.....……....

CLASS TAUGHT: ..... NO. PRESENT: .....,……...

1. PLANNING OF THE LESSON (25)

a. Objectives (behaviourally stated specific appropriate and clear

b. Arrangement of lesson (Logicality and sequence)

c. teaching aids (variety, suitability and adequacy)

d. Facts (adequacy and adequacy)

e. Comprehensiveness and adequacy

0	**1**	**2**	**3**	**4**	**5**

2. TEACHING PROCEDURE (50)	**0**	**1**	**2**	**3**	**4**	**5**
a. Introduction (Relevance, degree of motivation						
b. Subject content (mastery, adequacy, accuracy)						
c. presentation of lesson content (logical and flow)						
d. Use of chalkboard (neatness, legibility, orderliness)						
e. Questioning techniques (Relevance, variety, appropriateness, distribution)						
f. Use of Teaching Aids (effectiveness, efficiency)						
g. Command of language (Simplicity clarity, accuracy and pace						
h. Time management (coverage of lesson as planned						
i. Evaluation of the lesson taught (Quantity and quality)						
j. Conclusion of lesson (Smoothness, briskness)						

3. CLASS MANAGEMENT AND CONTROL (10)

a. Teaching – student relationship alertness to problems, proper handling of class, maintenance of control through out the lesson, recognition of safety precautions)

b. Classroom environment (neatness and conduciveness)

0	1	2	3	4	5

4. EVALUATION OF PREVIOUS WORK DONE (10)

a. Quantity and quality (adequacy, relevance, clarity)

b. Quantity of Correction

0	1	2	3	4	5

5. TEACHING'S PERSONALITY (5) (Activity, enthusiasm, neatness composure)

0	1	2	3	4	5

6. GENERAL COMMENTS

……

Total marks and grade

……

Date

……

Name and Signature of Supervisor

0	Cannot be assessed	Grades	Cores	Interpretations
1	Poor	A	70 – 100	Distinction
2	Average	B	60 - 69	Credit
3	Above Average	C	50 - 59	Merit
4	Good	D	40-49	Pass
5	Excellent	E	Below 40	Fail

APPENDIX D

Item analysis of pilot test scores

Item	Facility Index (%)	Discrimination Index
1	40	0.50
2	35	0.46
3	48	0.50
4	46	0.50
5	35	0.48
6	34	0.35
7	46	0.45
8	50	0.55
9	48	0,55
10	55	0.60
11	54	0.56
12	48	0.50
13	52	0.48
14	45	0.36
15	36	0.36
16	60	0.60
17	36	0.36
18	60	0.65
19	50	0.55
20	55	0.60
21	45	0.54
22	55	0.60
23	48	0.50
24	45	0.46

25	55	0.65
26	46	0.48
27	48	0.50
28	55	0.45
29	60	0.60
30	48	0.55
Average	48.00	0.49

APPENDIX E

Integrated SCIENCE 300 Level Course Codes, Titles and Topics Selected

COURSES CODE	COURSE TITLE	SELECTED TOPICS	ITEM OF QUESTIONS
ISC311	Carbon Compound I	Organic Compounds	1,2,3
ISC 321	Transport control & Development	Reproduction	4,5,6
ISC 313	Global Ecology	Influence of Science and Technology on the Society	7,8,9
ISC 314	Quantitative & Qualitative Analysis	Volumetric Analysis	10,11,12
ISC 321	Environment and Population	Human population	13,14,15
ISC 323	Chemical Energetic	Rate of Reaction	16,17,18
ISC 324	Genetics, Growth & Development	Genetics	19,20,21
ISC 325	Field and Waves	Wave Motion	22,23,24
ISC 326	Carbon Compound II	Alkanols	25,26,27
ISC 327	Global Ecology II	Environmental Changes	28,29,30