EFFECTS OF GUIDED INQUIRY TEACHING METHOD ON SELF-EFFICACY AND ACADEMIC ACHIEVEMENT OF NIGERIA CERTIFICATE IN EDUCATION INTEGRATED SCIENCE STUDENTS IN NORTH-WEST, NIGERIA

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MARCH, 2014

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DEPARTMENT OF SCIENCE EDUCATION,

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MARCH, 2014

DECLARATION

I declare that the thesis entitled "Effects of Guided Inquiry Teaching Method on Self-efficacy and Academic Achievement of Nigeria Certificate in Education (NCE) Integrated Science Students in North-West, Nigeria" has been carried out by me in the department of Science Education. The information derived from the literature has been duly acknowledged in the text and list of references provided. No part of this thesis was previously presented for another degree or diploma at this or any other Institution.

Ibrahim Justice Duwan, ABDULLAHI		3/04/2014
(Name of Student)	Signature	Date

DEDICATION

The work is dedicated to my late parents Abdulrashid Abubakar and Ramatu Abdullahi, and my wives Hussaina Adamu Duwan, Ramatu Isma'il Yandoma and Jamila Abdul'aziz Duwan as well as my children Abduljalal, A'isha, Muhammad and Musa among others for their patience and moral support throughout the period of this study.

CERTIFICATION

This thesis entitled "Effects of Guided Inquiry Teaching Method on Self-Efficacy and Academic Achievement of Nigeria Certificate in Education (NCE) Integrated Science Students in North-West, Nigeria" by Ibrahim Justice Duwan ABDULLAHI meets the regulations governing the award of the degree of Master of Science Education of Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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TABLE OF CONTENTS

Page

Title Page---------- ii

Declaration---------- iii

Dedication---------- iv

Certification---------- v

Acknowledgements---------- vi

Table of Contents---------- viii

List of Tables---------- xii

List of Figures---------- xiii

List of Appendices---------- xiv

List of Abbreviations---------- xv

Operational Definition of Terms---------- xvii

Abstract---------- xviii

CHAPTER ONE: THE PROBLEM

1.1 Background of the Study---------- 1

1.1.1 Theoretical Framework---------- 12

1.2 Statement of the Problem---------- 15

1.3 Objectives of the Study---------- 16

1.4 Research Questions---------- 17

1.5 Hypotheses---------- 17

1.6 Significance of the Study---------- 18

1.7 Basic Assumptions---------- 19

1.8 Scope of the Study---------- 19

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction---------- 21

2.2 Historical Development of Integrated Science---------- 21

2.2.1 Philosophy and Objectives of Integrated Science---------- 28

2.2.2 Importance of Teaching Integrated Science---------- 32

2.2.3 General Problems in the Teaching of Integrated Science---------- 33

2.3 NCE Integrated Science Programme---------- 35

2.4 Teaching and Learning of Science as Inquiry---------- 39

2.5 Lecture or 'Talk-chalk' Method---------- 40

2.6. Concept of Self-efficacy---------- 43

2.6.1 Mastery experience---------- 45

2.6.2 Vicarious Experience/Social Modeling---------- 46

2.6.3 Social/Verbal Persuasion---------- 47

2.6.4 Psychological Responses/Somatic and Emotional Sates---------- 47

2.7 Self-efficacy and Academic Achievement in Science---------- 48

2.8 Gender and Self-Efficacy---------- 50

2.9 Gender and Academic Achievement in Science---------- 52

2.10 Overview of Similar Studies---------- 55

2.11 Implication of Literature Reviewed on the Present Study---------- 59

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 Selection of Topics for the Study---------- 64

3.6 Instrumentation---------- 65

3.6.1 NCE Students' Self-efficacy Questionnaire (NSSQ) ---------- 66

3.6.1.1 Validation of the Instrument (NSSQ) ---------- 66

3.6.2 Integrated Science Achievement Test (ISAT) ---------- 67

3.6.2.1 Validation of the Instrument (ISAT) ---------- 67

3.7 Pilot Study---------- 68

3.7.1 Reliability of NSSQ---------- 69

3.7.2 Reliability of ISAT---------- 70

3.8 Treatment Administration---------- 70

3.9. Data Collection Procedure---------- 71

3.10. Data Analysis---------- 71

CHAPTER FOUR: DATA ANALYSIS, RESULTS AND DICUSSION

4.1 Introduction---------- 73

4.2 Analysis and Results Presentation---------- 73

4.3 Summary of Findings---------- 79

4.4 Discussion of the Results---------- 80

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATONS

5.1 Introduction---------- 86

2.2 Summary---------- 86

5.3 Summary of Major Findings---------- 87

5.4 Conclusion---------- 88

5.5 Recommendations---------- 89

5.6 Contribution to Knowledge---------- 91

5.7 Limitation of the Study---------- 91

5.8 Suggestions for Further Studies---------- 92

References---------- 94

Appendices---------- 108

LIST OF TABLES

Table **Page**

3.1 Population of the Study---------- 63

3.2 Samples for the Study---------- 64

3.3 Students' Average Performance from 2005/2006 to 2009/2010 Session---------- 65

3.4 Items Specification Based on Content Areas---------- 68

3.5 Items Specification Based on Bloom's Taxonomy of Cognitive Level---------- 68

4.1a Mean Scores and Standard Deviation in NSSQ of the Experimental and Control Groups---------- 73

4.1b t-test of the Posttest Mean Scores of the Experimental and Control Groups On Self-efficacy Questionnaire---------- 74

4.2a Mean Scores and Standard Deviation in NSSQ of Males and Females in the Experimental Group---------- 75

4.2b t-test of the Posttest Means Scores of Males and Females in the Experimental Group on Self-efficacy Questionnaire---------- 76

4.3a Mean Scores and Standard Deviation in ISAT of the Experimental and Control Groups---------- 77

4.3b t-test of the Posttest Mean Scores of the Experimental and Control Groups on Integrated Science Achievement Test (ISAT) ---------- 77

4.4a Mean Scores and Standard Deviation in NSSQ of Males and Females in the Experimental Group---------- 78

4.4b t-test of the Posttest Mean Scores of Males and Females in the Experimental Group on Integrated Science Achievement Test (ISAT) ---------- 79

LIST OF FIGURES

Figure **Page**

3.1 Research Design Illustration---------- 62

LIST OF APPENDICES

Appendix **Page**

Appendix A: Pretest Mean Scores Used for Sample Selection---------- 108

Appendix B: Lesson Notes for Experimental Group---------- 129

Appendix C: Lesson Notes for Control Group---------- 145

Appendix D: NCE Students' Self-efficacy Questionnaire (NSSQ)---------- 151

Appendix E: Integrated Science Achievement Test (ISAT) ---------- 153

Appendix F: ISAT Marking Scheme---------- 159

Appendix G: Item Analysis and Discrimination Indices---------- 160

LIST OF ABBREVIATIONS

In the course of this study, some words have been abbreviated and frequently used in the text. The abbreviated words are outlined as follows:

NPE — National Policy on Education

FRN — Federal Republic of Nigeria

STAN — Science Teachers Association of Nigeria

NCE — Nigeria Certificate in Education

STEBI — Science Teaching Efficacy Belief Instrument

NTI — National Teachers Institute

FCE —Federal College of Education

FME— Federal Ministry of Education

COE — College of Education

NCCE — National Commission for Colleges of Education

USA — United States of America

AAAS — American Association for the Advancement of Science

SAPA — Science-A-Process Approach

CBA —Chemical Bond Approach

UK — United Kingdom

SISP —Scottish Integrated Science Program

PSSC — Physical Science Study Committee

BSCS — Biological Science Curriculum Study

WAEC — West African Examination Council

NISP — Nigerian Integrated Science Project

NISTEP — Nigerian Integrated Science Teacher Education Project

ABU — Ahmadu Bello University

ODA — Oversees Development Administration

PSI —Problem Solving Inquiry

NRC — National Research Council

NSSQ — NCE Students' Self-efficacy Questionnaire

ISAT — Integrated Science Achievement Test

PPMCC — Pearson Product-Moment Correlation Coefficient

OPERATIONAL DEFINITION OF TERMS

Self-Efficacy: Is the one's capability and readiness to perform a given task or teach students effectively and confidently in such a way that students are able to understand the content/concepts taught to them so that they too will be able to deliver effectively and confidently to others.

Academic Achievement: Is an individual's capability to demonstrate successfully his or her cognitive, affective, and or psychomotor abilities in an educational setting in relation to a given/accepted standard.

Guided Inquiry Teaching Method: Is a set of activities of students guided and supervised by the teacher requiring the performance of mental process such as observing, measuring, describing, etc and that help students to develop their individual responsibility, problem- solving and understanding of skills.

Lecture Method: Is a one-way instructional process of presenting ideas, concepts, generalization, and facts orally that is employed in our schools in which the students' need for interaction with the instructor and instructional materials is not addressed adequately.

ABSTRACT

This study investigated the effects of guided inquiry teaching method on self-efficacy and academic Achievement of Nigeria Certificate in Education (NCE) Integrated Science students in North-West geopolitical zone of Nigeria. All the NCE II Integrated Science students of the eleven (11) Colleges of Education in the area under study; totaling one thousand, two hundred and seven (1,207) were used as the population of the study. Two out of the eleven Colleges of Education in the area with their total number of 200 students were selected as the sample of the study using simple random sampling technique involving fish bowl method. The Colleges were labeled as experimental (i.e. FCE, Katsina) and control (i.e. IKCOE, Dutsin-ma) groups; and intact classes of the two Colleges were used. The experimental group was taught using guided inquiry teaching method while the control group was taught by lecture method. The instruments used for the study were NCE Students' Self-efficacy Questionnaire (NSSQ) with the reliability value of 0.96 and Integrated Science Achievement Test (ISAT) which has the reliability value of 0.69. Four research questions were stated; such as what is the effect of guided inquiry teaching method on the self-efficacy of NCE Integrated Science students?, and four corresponding hypotheses such as there is no significant difference in the mean academic achievement of NCE Integrated Science students exposed to guided inquiry teaching method and those exposed to lecture method were formulated and tested at 0.05 level of significance. The data collected were analyzed using t-test statistics at $P < 0.05$. The findings of the study showed that the guided inquiry teaching method used for the study has improved the self-efficacy and academic achievement of NCE Integrated Science students. However, neither male nor female NCE Integrated Science students performed significantly better than the other after their exposure to the method. One of the major recommendations made based on the findings of the study is that NCE teachers should undergo training through seminars/workshops and that activity-based teaching methods such as guided inquiry should be used in training/teaching them so that they can also be confident and efficient in using the methods when in class with their students.

CHAPTER ONE

THE PROBLEM

1.1 Background of the Study

One of the national education goals is "the acquisition of appropriate skills and the development of mental, physical and social abilities and competencies as equipment for the individual to live in and contribute to the development of his society" (FRN, 2005). Also, the essence of teaching in science education is to enable students acquire the process skills and the product of science, and be able to apply them in their everyday life to enable them achieve the national education goals. To achieve these goals as desired, it is highly needed for teachers at all levels to have high sense of self-efficacy for the enhancement of teaching and learning of scientific concepts and principles that can lead to positive scientific and technological development. Having high sense of self-efficacy (strong confidence) in the subject matter and a better understanding of what to teach students enable teachers to discharge their duty of imparting sound knowledge to such students successfully. This is because teachers' low sense of self-efficacy as reported by Harlen and Holroyd (1997); Appleton and Kindt (1999) results into ineffective teaching of the subject. This ineffective teaching of the subject contributes to the students' low interest in science and its teaching. This in turn affects students' achievement in the subject.

In order to develop confidence and high achievement in science teaching and learning, the Science Teachers Association of Nigeria (STAN, 1970 & 1971) and Ogunniyi (1986) recommended that in teaching of Integrated Science, teachers should adopt a child-centred approach, stressing three basic strategies:

a) Use of inquiry teaching tactics.

b) The inclusion of problem-solving activities.

c) The involvement of students in open-ended laboratory exercise.

In view of STAN's (1970 & 1971) and Ogunniyi's (1986) recommendations, Kadcef (2000) observed that science unlike other subjects cannot be learned and understood by rote learning but can only be learned by using investigation and experimental methods of instruction which are more practical, clear and permanent.

In training teachers, these three practices as outlined should be used to teach them during their training years. These strategies if adhered to strictly may likely increase the self-efficacy and academic achievement of such Integrated Science teachers. Therefore, in this study guided inquiry teaching method was used to teach the Nigeria Certificate in Education (NCE) students to see if it would increase their self-efficacy and academic achievement. NCE students were chosen because NCE is considered as the minimum qualification for teaching in Nigeria. Again, such teachers are at the end expected to teach in primary and probably junior secondary schools, where sound scientific background is supposed to be properly laid. Besides, since teachers mostly teach the way they were taught during their training period as reported by Vanzee and Robert (2001), if they were not trained using an activity-based approach, they may find it difficult to lay the expected foundation of science in such lower levels of education. This may eventually affect their subsequent scientific study, confidence in science teaching and academic achievement as well.

Many teachers lack sense of science self-efficacy which is crucial to the success of teaching and performance in classrooms (Tosun, 2000 & Palmer, 2006). This problem might emanate during training in schools as a result of using inappropriate approach/method(s) of teaching. Vanzee and Robert (2001) also reported that teachers may teach in ways similar to their

own learning experiences (i.e. the way they were taught) as they may not have the knowledge and confidence to use pedagogically sound strategies in their classrooms. Hence the essence of selecting NCE students with a view to improving the situation using guided inquiry teaching method in training them

The term "self-efficacy" has been defined differently by different authors. For instance, Bandura (1981) in his theory of social learning defined individual's self-efficacy as that person's judgments about how well one can organize and perform an action that has unpredictable and stressful components. Bandura (1986) also defined self-efficacy as the "judgment of one's capacity to accomplish a certain level of performance. Again, Bandura (1995) described self-efficacy as the belief in one's capability to organize and execute the courses of action required to manage prospective situations. Self-efficacy seems to imply a degree of preparedness by virtue of training, experience, or talent (Housego, 1992). According to Salamah, Wahl, and Abrian (2003) self-efficacy is the confidence that one has in carrying out specific behaviours. In this context, self-efficacy is viewed as the teachers' capability and readiness to convey the message to or teach students effectively and confidently in such a way that they are able to understand the content/concepts that they were taught so that they too would in turn deliver effectively and confidently. In other words, it is a person's belief in his or her ability to achieve a goal or an outcome or to succeed in a particular situation. Bandura (1977) described two critical components of self-efficacy. The first component is "efficacy expectation", which represents the belief in one's ability to successfully perform the behavior. The second component of self-efficacy is "response-outcome expectancy", which is the belief that the performance of the behavior will have a desirable outcome.

Self-efficacy of teachers has been the focus of many studies (Palmer, 2001; Morrell, & Carroll, 2003). This is mainly due to the expected effect this might have on teachers' behavior in classroom teaching. Harlen and Holroyd (1997) and Appleton and Kindt (1999) reported that low self-efficacy beliefs could negatively affects students' achievement and attitudes towards science and teaching. In teacher education programmes, the perception that a performance has been successful raises efficacy beliefs (Pajares, 2002). Such successful models of teaching can contribute to the expectation that teacher performs as competently as possible. If the success is attributed to internal effort, then self-efficacy is enhanced. But if success is attributed to luck or the intervention of others, then self-efficacy may not be strengthened (Pintrich & Schunk, 1996). An individual may have a high self-efficacy for one task but have a low self-efficacy for another. Implementing this view with teachers and the areas of specialty indicate that a teacher may have a high or low level of personal efficacy in a science domain. Ramey- Gassert, Shroyer, and Staver (1996) used the Science Teaching Efficacy Belief Instrument (STEBI) to examine factors related to science teaching self-efficacy in elementary teachers. Three categories were outlined as factors that relate to science teaching self-efficacy: antecedent, internal and external. Antecedent factors included science-related experiences in and out of school, teacher preparation, and science teaching experiences. Internal factors included attitudes towards science and interest in science. External factors affecting science teaching self-efficacy included the school work place, environment, student variables, and community variables. The aim of this research is to find out if the use of guided inquiry approach to teach teachers in training will improve their self-efficacy in science teaching and thus enhancing their ability to deliver when they get to the field.

Science teaching is very complex and involving many activities and concepts. In the classroom therefore, teaching methods and techniques have to be mixed with real life situation (Atadoga and Onaolapo, 2008). One important rule which facilitates the selection of appropriate and adequate approaches of imparting knowledge or developing a particular skill to students at any level is to consider the pupil's age, prior knowledge on the topic and the general ability (Atadoga & Onaolapo, 2008). Martins and Oyebanji (2000) stated that "more than anything else, teaching methods affect the response of students and determine whether they are interested, motivated and involved in the lessons in such a way as to be engaged in good learning". His statement further emphasizes the key role of the teacher in the teaching-learning process and indicates possible roles the teachers' instructional strategies may play as a measure of teaching effectiveness.

Lecture method is one in which the teacher is the initiator of knowledge while students are passive recipient of knowledge. According to Dieye and Gbamanja (1990) lecture method is a detriment to students learning, but many academics have accepted it as proper way of imparting a body of knowledge due to the pressure to cover the syllabus, since our educational system puts so much emphasis on paper qualifications which are earned through public/external examination. Ruyle (1995) describes the lecture method simply as an oral presentation of instructional materials. McIntoch (1996) defined lecture method as frequently a one-way process unaccompanied by discussion, questioning, or immediate practice, which makes it a poor teaching method. In the context of this study, lecture method is conceived as a one-way instructional process of presenting ideas, concepts, generalization, and facts orally that is employed in our schools in which the students' need for interaction with the instructor and instructional materials is not addressed. Using the traditional chalk-talk method of teaching,

though does not promote meaningful learning of science as it appeals to only the sense of hearing and as such the learners easily lose interest after some time (National Teachers Institute(NTI, 2007; Atadoga & Onaolapo, 2008), is the easiest way for teachers to cover the syllabus. In this study lecture method was used as a control.

On the other hand, inquiry method involves not only the sense of hearing but also the senses of sight and touch. As a result, at all levels of education instructional materials are very important in the attainment of desired goals and objectives as they enhance understanding and retention (NTI, 2007). Many educational studies such as (Furtak, 2006) explored the effectiveness of scientific inquiry teaching on learner performance. Schwarz and Gwekwerere (2006); Nugent, Kunz, Levy, Harwood and Calson (2008); Akerson, Hanson, and Cullen (2007) stated that inquiry practices are very important in terms of forming scientific knowledge. They found that pre-service teachers who experienced guided inquiry as part of instructional framework improved their prior ideas of science teaching and felt that this had increased their knowledge and confidence on how to teach science. In his longitudinal studies, Palmer (2006) worked with pre-service teachers in Turkey and looked at the effectiveness of a guided inquiry teaching method on their self-efficacy beliefs and performance in their student teaching with students (micro-teaching). He found that the method had increased pre-service teachers' beliefs about their ability to perform teaching behavior after their exposure to the instruction. Palmer (2006) also interviewed his students and reported that there were strong positive changes in self-efficacy as a result of using the approach. Ozdilek, and Bulunuz (2009) conducted similar study still in Turkey and reported that teachers improved their scores after exposure to guided inquiry in the science laboratory course and that their self-efficacy beliefs could be improved by appropriate teaching approaches such as guided inquiry. The researcher intended to carry out

similar study in North-West Zone, Nigeria and see if the findings/results of the study would agree with Palmer's (2006), and Ozdilek and Bulunuz's (2009) despite the differences that might exist in the aspects of cultural background, socio-economic status, geographical location, level of educational awareness/development, and understanding of the language of communication (i.e. English) of the two areas.

Inquiry method as defined by Martin (1997) is a learning-by-doing model where the teacher sets the direction and suggests open-ended activities, which children pursue to find out what they can discover and inquire into what they don't understand. It is a student-centered and activity-based teaching strategy where a teacher uses a variety of instructional materials to help students discover possible and testable solutions to their defined scientific investigation (Nwagbo, 2006). Kulthau, Moniotes and Caspari (2007) defined guided inquiry as careful planning, close supervision, ongoing assessment and targeted intervention by teacher(s) through the inquiry processes that gradually leads students towards independent learning. According to Australian Library and Information Association (ALIA) and Australian School Library Association (ASLA, (2009)) guided inquiry is a method which allows students to seek and engage in a variety of ideas to increase their understanding in pursuit of knowledge and greater awareness. The associations further described guided inquiry as an approach or methodology to learning which provides a means by which teachers are able to tailor learning experiences and opportunities, resources and processes to the needs and abilities of each student according to intended curriculum learning outcomes. In this study, guided inquiry is considered as a set of activities of students guided and supervised by the teacher requiring the performance of mental process such as observing, measuring and describing among others. Through these activities the students will be able to develop their individual responsibility, problem- solving and

understanding of skills. The activities offer an opportunity to engage students' interest in scientific investigation and sharpen their critical-thinking skills.

Exline (2004) said in the workshop he organized on Inquiry-based learning that, an old adage states: "Tell me and I forget, show me and I remember, involve me and I understand". He explained that inquiry implies involvement that leads to understanding. Furthermore, involvement in learning implies possessing skills and attitudes that permit you to seek answers/solutions to questions and issues while you construct new knowledge. Looking at educational practices, the Chinese said that:

"I hear, I forget

I see, I remember

I do, I understand".

In the NTI (2007) manual for re-training primary school teachers, it is clearly stated that people generally remember

10% of what they read,

20% of what they hear,

30% of what they see,

50% of what they hear and see,

70% of what they say and

90% of what they say as they do a thing.

From what is discussed so far, it is observed that there are several studies that provide evidence as to varied benefit of using guided inquiry approach in pre-service instruction. Those benefits may either be offset or augmented by the effect that guided inquiry has on pre-service teachers' science teaching self-efficacy and achievement. This study investigated if guided

inquiry teaching method does affect them (i.e. NCE students) in North-West geopolitical zone of Nigeria. This is because, what is true of Palmer's (2006), Ozdilek and Blunuz's (2009) findings might not be true with the zone; probably due to some of the differences such as geographical location and level of educational awareness/development of the two areas among others as earlier mentioned elsewhere in this work.

Gender differences may exist in many different areas of education; from performance to attitude, from classroom activities and course enrolments to perceptions in careers. Oraifo (1990) and Nworgu (2005) stated that presently in our schools, there exist gender differences in science achievement and these have attracted some debates. For example, David and Stanley (2002); Ariigbabu and Mji (2004); Bilesanmi -Awoderu (2006) reported that there is no gender differences in the cognitive, affective and psychomotor skill achievements of students. Other researchers such as Onekutu and Onekutu (2002), Eriba and Sesugh (2006) have reported differently on this issue. They found that boys outperformed in science and mathematics achievements. In a study on trends in students' achievement in Integrated Science, Njoku (2003) in Nworgu (2005) also observed that male students performed significantly better than female students. Some other studies such as Alkhateeb (2001), Bleuer and Waltz (2002) and Omoniyi (2006) reported that males are becoming the disadvantaged gender in schools and that fewer males are interested in science. The differences between males and females achievements as reported by Baber and Leary (1995) and Nworgu (2005) are linked to the way science is being taught in our schools.

The term academic achievement can be described to mean the successful outcome of accomplished activities or tasks in educational measurement in relation to accepted standards. Tests are conducted to know the rate of achievements of students in stated objectives (Raji,

1994). Owoyemi (2000) described academic achievement as the scholastic standing of a student at a given moment. It refers to how an individual is able to demonstrate his or her intellectual abilities. This scholastic standing could be explained as the grades obtained in a course or groups of courses taken.

Science education in Nigeria has been under the pressure of numerous problems/criticisms. Ajeyalemi and Bajah (1994) in Akinsola (2013) listed such criticisms as in the areas of poor performance in science, poor quality teaching, and inadequate instruction al and infrastructural facilities among others. The needs for effective science teaching and learning in our schools as a possible means of improving students' achievement and teachers' productivity calls for appropriate intervention. Looking at the likely link between students' achievement in science and instructional strategies, it is a duty upon science teachers and all those concerned to come up with teaching methods among other intervention strategies as a way of improving students' academic achievement in science.

Ameh and Dantani (2012) pointed out that methodology is very vital in any teaching-learning situation. The method adopted by the teacher may promote or hinder learning. It may sharpen mental activities which are the basis of social power or may discourage initiatives and curiosity thus making self-reliance and survival difficult. There are many methods which are student-centred and activity-oriented in nature for effective and efficient science teaching and learning. According to Ameh and Dantani (2012) the adoption of lecture method by most teachers in order to overcome the bulky chemistry syllabus before the Senior School Certificate Examination (SSCE) affects students' performance. Researchers such as Njoku (2007) also believe that in the lecture method, theory is taught as an absolute knowledge: hence pupil-

centred activities for developing scientific reasoning skills and processes are lacking. The lecture method is also known to cause lack of interest and poor performance in science.

A number of studies were carried out on different instructional strategies/methods in relation to their effectiveness on students' academic achievement in science. For instance, Olubunmi (1991) compared the effectiveness of laboratory approach and lecture method of instruction on cognitive achievement of Integrated Science students and found significant difference in favour of laboratory method. Bichi (2002) compared problem-solving instructional method and lecture method in promoting students' academic achievement in evolution concepts and found problem-solving method to be more effective than lecture method. Similar findings have been reported by Martins (1994), Jensen and Finley (1996) and Amedu (1998). Narmadha and Chamundeswari (2013) compared the effectiveness of constructivist-based teaching strategy and lecture method on students' academic performance in Integrated Science. The results of this study revealed that the constructivist instructed students had higher scores in post test and delayed post test compared to those exposed to lecture method. Alake and Ogunseemi (2013) compared the effectiveness of scaffolding strategy and lecture method on learners' academic achievement in Integrated Science at the junior secondary school level. The results showed that students exposed to scaffolding strategy performed significantly better than their counterparts who were exposed to lecture method. Ameh and Dantani (2012) compared the effectiveness of lecture and demonstration methods on academic achievement of students in chemistry at the secondary level. The results revealed that students performed better in chemistry when taught using demonstration method as compared to lecture method.

Gender differences in self-efficacy have been reported in several researches. For instance, Sadker and Sadker (1995) in Tenaw (2013) reported that girls, starting in grade seven tend to

underestimate their abilities in mathematics and science. Smist and Owen (1994) and Kinsela (1998) have documented that female students have lower self-efficacy in mathematics and science compared to male students. Girls' capabilities are undermined by sex-role stereotypes in many cultures intimating that females are not as able as males, especially in such disciplines as mathematics and science (Bandura 1997). Another contributing factor could be the lower level of expectations that parents, teachers and counselors often hold for girls, which can discourage further study in scientific and technical fields (Bandura 1997, and American Association of University Women Education Foundation, 1999) among others. In their study on effect of learning about gender discrimination on girls attitudes toward science, Weisgram and Bigler (2007) mentioned that low confidence level of girls toward science is partially due to prejudge that girls developed over years: females are not as good as males in terms of science learning. Weisgram and Bigler (2007) also concluded that informing girls of the discrimination would increase their self-efficacy by changing their attribution of past experience.

In view of the foregoing, the researcher intended to use guided inquiry teaching method to teach NCE students and see if the method has an effect on both their self-efficacy and academic achievement in Integrated Science.

1.1.1 Theoretical Framework

The theoretical framework is based on Bruner's (1961) theory of learning and Bandura's (1977) social cognitive theory which emphasizes the role of observational learning and social experience in the development of personality. Bruner introduced the concept of learning by discovery. The theory stresses cognitive effectiveness. Because of this, some referred to Bruner's theory of learning as Bruner's theory of cognitive development.

Bruner believed that learning by discovery begins when science teachers purposefully (i.e. intentionally) create problem and present to students by introducing some inconsistencies (i.e. contradictions) among source of information which are given in the process of instruction. According to him, presenting such contradictory situations to students/learners lead to intellectual discomfort that will stimulate (motivate) the learners to figure out a solution by engaging in mental processes which involve observation, hypothesizing, measuring, stating problem, data collection, classifying, inferring, e.t.c. Bruner believed that the goal of education should be intellectual development and that science curriculum should foster development of problem-solving skills through inquiry and discovery.

Bruner (1961) further stressed that there are two forms of discovery processes; assimilation and accommodation. Assimilation occurs when a student recognizes a new situation that is familiar to one of the elements in the existing structure of knowledge (i.e. cognitive structure) and he easily assimilates it. Accommodation occurs when a new situation (i.e. a new knowledge) is incompatible to the existing structure of knowledge; the learner first restructures (i.e. reorganizes) his cognitive framework (i.e. cognitive structures) in order to be able to accommodate the new knowledge. According to Akanbi and Opasina (2000) discovery learning when encouraged in science class, aids problem-solving because learning by discovery starts with problem solving. Discovery learning also causes creativity in the student which is one of the objectives of science teaching.

Bruner suggested that teachers can nurture inductive thinking by encouraging students to make guesses based on incomplete evidence and then to confirm or disprove the guesses systematically. To apply Bruner's ideas in the classroom, teachers would present both examples

and non-examples of concepts, help students see connections among concepts with question, pose question and allow students to make intuitive guesses.

The concept of self-efficacy is based on Bandura's (1977) social cognitive theory which has been useful in examining people's beliefs. The theory focuses on the learning that occurs within a social context. It considers that people learn from one another, including such concepts as observational learning, imitation and modeling. A theory of situation-specific self-confidence proposes that self-efficacy is fundamental to initiating certain behavior necessary for competent performance (Bandura, 1997 & Michael, 2007). According to the theory, self-efficacy is enhanced by four factors: successful performances, vicarious experiences, verbal persuasion and emotional arousal. Successful performances, which can be achieved by participatory modeling, are regarded as the most important factor. Bandura (1977: 191) also states that "learning would be exceedingly laborious, not to mention hazardous, if people had to rely solely on the effects of their own actions to inform them on what to do. Fortunately, most human behaviour is learned observationally through modeling; from observing others one forms an idea of how new behaviours are performed, and on later occasions this coded information serves as a guide for action".

Bandura's theory on self-efficacy says that the ability to learn new skills and information is influenced by an individual's feeling of self-efficacy. Unlike self-esteem, self-efficacy is usually task specific. It can differ from one subject or performance area to another. Someone may have high self-efficacy concerning learning how to draw and low self-efficacy concerning science. According to Bandura's theory the two most powerful sources of self-efficacy are the learner's previous experiences with similar tasks and from observations. Bandura believes that the higher

the self-efficacy the students have for the specific task the more likely those students will be able to succeed at that given task.

According to Ormrod (1990) people are likely to engage in certain behaviours when they believe they are capable of executing those behaviours successfully. This means that they will have high self-efficacy. It is the work of the teacher to help the students to achieve that high self-efficacy. Since a good sense of self-efficacy in the teacher is an important variable to be considered in order to improve student's academic achievement, it is important for teacher trainers to find a method of instilling this into teachers in training, particularly in Integrated Science which is the foundation of science. This it is hoped will enable the teachers to be self-efficient in teaching the subject and give their students a good foundation in science. For those who may not continue school they would have had a good foundation that would help them cope with the new advances in technology. In this study therefore guided inquiry teaching method was used to see if it would improve the self-efficacy and academic achievement of NCE students in Integrated Science.

1.2 Statement of the Problem

Integrated Science course is the basic foundation for the separate science subjects taught especially at the senior secondary school level. Like any other science subject, the syllabus of this innovative course at any level of education (i.e. where it is being taught) emphasizes the use of activity-based method of instruction. Unfortunately, as reported by researchers such as Lakpini (2006) teachers shy away from activity-based teaching methods and rely on methods such as lecture method that are easy but most often inadequate and inappropriate. This makes students to achieve poorly in secondary school subjects, especially Biology. Other studies such as Ivowi, Okebukola, Oludotun, and Akpan (2004) revealed that students generally perform

poorly in sciences due to lack of using appropriate teaching methods. Thus the question of how students' academic achievement in sciences can be improved is still a pedagogical problem. James (2000), Usman (2000) and Duwan (2011) have suggested the use of inquiry teaching method which is an activity-based method in remediating problems of poor academic achievement in junior secondary school Integrated Science, and Biology at both senior secondary school and Nigeria Certificate in Education (NCE) levels.

Lack of considering the self-efficacy of students by the teachers in the cited studies might be another problem that affects teachers' productivity and students' academic achievement. A number of studies such as Palmer(2006) among others, have been conducted on self-efficacy, and most of such studies reported that many teachers lack a sense of school science self efficacy, which is crucial for the success of teaching and performance in classrooms. Lee (2002) in his study reported that the students' learning achievements in physics and chemistry at secondary school level were indeed influenced by self-efficacy. Since a good sense of self-efficacy is another important variable to be considered for the improvement of students' academic achievement, failure to incorporate self-efficacy in the teaching/learning of Integrated Science at NCE Level, the poor performance in Integrated Science may still persist. Therefore this study investigated the effects of guided inquiry teaching method on self-efficacy and academic achievement of NCE Integrated Science students.

1.3 Objectives of the Study

The objectives of the study are to:

i) determine the effect of guided inquiry teaching method on self-efficacy of NCE students in Integrated Science.

ii) investigate the extent to which male and female NCE students vary in their self-efficacy when exposed to guided inquiry teaching method in Integrated Science.

iii) find out the effect of guided inquiry teaching method on academic achievement of NCE students in Integrated Science.

iv) investigate the difference in the academic achievement (if any) of male and female NCE students when exposed to guided inquiry teaching method in Integrated Science.

1.4 Research Questions

The following research questions are set to guide the study:

i) What is the effect of guided inquiry teaching method on the self-efficacy of NCE students in Integrated Science?

ii) What is the difference in the mean scores of self-efficacy of male and female NCE students exposed to guided inquiry teaching method in Integrated Science?

iii) What is the effect of guided inquiry teaching method on the academic achievement of NCE students in Integrated Science?

iv) What is the difference if any in the mean scores of academic achievement of male and female NCE students exposed to guided inquiry teaching method in Integrated Science?

1.5 Hypotheses

Based on the research questions stated the following null hypotheses (H_O) are formulated for testing at $P \leq 0.05$.

H_{O1}: There is no significant difference in the mean scores of self-efficacy of NCE students exposed to guided inquiry teaching method and those exposed to lecture method in Integrated Science.

H_{O2}: There is no significant difference in the mean scores of self-efficacy of male and female NCE students exposed to guided inquiry teaching method in Integrated Science.

H_{O3}: There is no significant difference in the mean scores of academic achievement of NCE students exposed to guided inquiry teaching method and those exposed to lecture method in Integrated Science

H_{O4}: There is no significant difference in the mean scores of academic achievement of male and female NCE students exposed to guided inquiry teaching method in Integrated Science.

1.6 Significance of the Study

The findings of this study will hopefully uplift the standard of Integrated Science education in the following ways to:

- make teachers be aware of the effects of guided inquiry teaching method on self-efficacy and academic achievement at NCE level and employ it where necessary.
- enhance the confidence of NCE Integrated Science students as well as their academic achievement in the subject in Nigeria.
- enlighten curriculum planners on the effect of teaching Integrated Science at NCE level using guided inquiry teaching method. This would enable them make some modifications where necessary in the NCE curriculum (Minimum Standard) with reference to commonly employed instructional methods.
- make the textbooks publishers be aware of the effective method(s) of teaching Integrated Science at NCE level and incorporate using such methods in their publication for promoting effective teaching and learning of Integrated Science at this level.

- benefit fellow researchers as the findings might serve as foundation for further studies on teaching methods such as guided inquiry as it/they relate(s) to students' self-efficacy and academic achievement in sciences.
- serve as a contribution to the current literature in the area of self-efficacy as well as in the aspect of instructional methods.
- Professional bodies like STAN can use the findings of this study to organize workshops and or seminars for teachers especially on using activity-based methods of instruction such as guided inquiry to teach.

1.7 Basic Assumptions

The study is based on the assumptions:

1. The teachers at Colleges of Education under study adopt a child-centred approach in teaching Integrated Science at NCE level by using inquiry teaching, problem-solving activities and involving students in an open-ended laboratory exercise.
2. The students under study are familiar with the use of guided inquiry method of instruction.
3. The Colleges of Education in the North-West, Nigeria are equivalent academically. This is because they use the same syllabus (Minimum Standard) and operate under the same guidelines being produced by the National Commission for Colleges of Education (NCCE).

1.8 Scope of the Study

The study was delimited to NCE II Integrated Science students of both Federal and State Colleges of Education in the North-West geopolitical zone of Nigeria. The colleges are relatively equal as they both run the same Integrated Science program among others. Also, they operate

under the same guideline(s)-Minimum Standards for Nigeria Certificate in Education (NCE) produced by the NCCE. The researcher decided not to use NCE I or III students because, NCE I students are just new to the system and their newness in Integrated Science course at NCE level may likely affect the result of the study. NCE III students on the other hand had limited time as they are on teaching practice throughout the first semester, and as they returned for the second semester, they would be busy trying to catch up with the syllabus so that they could be fully prepared for their final examination.

Four different topics were selected to be used in teaching the groups (i.e. experimental and control), which are:

i. characteristic of living things,
ii. plant and animal cells,
iii. bacteria in ecological cycle and
iv. mode of nutrition in fungi.

The poor performance of students in these topics might be due to lack of using appropriate method(s) of teaching in some previous years (see tables 3.3–3.3.4). This attracted the researcher's interest in using them (i.e. the topics) for the study and see whether there would be a positive change in the students' performance

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The review of related literature was carried out under the following sub-headings:

- Historical Development of Integrated Science
- NCE Integrated Science Program
- Teaching and Learning Science as Inquiry
- Conventional Lecture Method
- Concept of Self- efficacy
- Self-efficacy and Academic Achievement
- Gender and Self-efficacy
- Gender and Academic Achievement in Science
- Overview of Similar Studies
- Implication of Literature Review on the Present Study

2.2 Historical Development of Integrated Science

The growth and development of science in one nation pose a challenge to the others. A case in point is the launching of the SPUTNIK 1 (a space exploration device/vehicle) by the defunct Soviet Union in October, 1957. This advancement caused a great revolution in the field of science in the United States and then led to curriculum reform in the sciences globally. Many nations reconsidered the nature and methods of science teaching in their schools. Between 1957 and 1969 a growing awareness was generated and efforts were made towards developing functional and Integrated Science curriculum for junior classes of secondary schools all over the world. For example, in the United States of America (USA) there was a move by the American

Association for the Advancement of Science (AAAS) towards curriculum reform. This led to the introduction of the curricula such as Science- A -Process Approach (SAPA) and Chemical Bond Approach (CBA). In the United Kingdom (UK) the Nuffield Junior Science Project (Science 5-13) was initiated as a curriculum reform. Others were the Scottish Integrated Science programme (SISP), Physical Science Study Committee (PSSC), Biological Science Curriculum Study (BSCS), among others.

According to Atadoga and Onaolapo (2008) these programs are lead ways to some form of inter-disciplinary or integrated approach. Prior to the introduction of Integrated Science, general science is what was being taught in schools, which does not emphasize processes of science but factual teaching of the separate sciences (physics, biology and chemistry). A number of conferences were held in different places such as Verna (Bulgaria) in 1968, USA in 1973, Nijimengen in 1978, etc. on Integrated Science teaching, stressing teaching science as a process (i.e. methods of teaching and learning science) and product (i.e. Laws, concepts, and theories). Again, Atadoga and Onaolapo (2008) stated that today, science has become more and more integrated and that learners are expected to understand science as process and product.

In Nigeria, the science Teachers Association of Nigeria (STAN) joined this world reconstruction of Science Curriculum. Early in 1968, the West African Examination Council (WAEC) called upon STAN to initiate something similar to Nuffield Science Projects in Nigeria. To answer the call, the STAN set up subject committees to bring about the structure of Integrated Science, taking into consideration the needs of Nigerian children and international trends of science in the individual subjects disciplines. This gave birth to the Nigerian Integrated Science Project (NISP). STAN in 1970 published its curriculum Development Newsletter No. 1 on the Nigerian Integrated Science Project for pupils in form one and two of the Nigerian secondary

schools. The newsletter contains guidelines for effecting a course on Integrated Science for the junior forms of the secondary schools. It also contains the philosophy, methodology, content and evaluation of Integrated Science. The document listed some of the skills students would acquire after having been exposed to a course in Integrated Science. The skills include the following:

- Observing carefully and thoroughly.
- Reporting completely and accurately what is observed.
- Organizing information acquired by the above processes.
- Generalizing on the basis of acquired information.
- Predicting as a result of these generalization
- Designing experiments including controls were necessary to check these predictions.
- Using models to explain phenomena where appropriate.
- Continuing the process of inquiring when new data do not conform to predictions (Bajah, 1983: 24)

According to Ogunleye (1999) the approach used in NISP was child-centered approach which was basically activity – oriented. This means involving the students actively in open-ended laboratory activities just as scientists do.

In 1971, a set of materials comprising pupil's text-books, pupils workbook and teachers guide were all published and introduced into secondary schools in 1972. This was the first time Integrated Science was introduced into secondary schools. It was formally called General Science. The NISP basic philosophy according to STAN (1970) was to teach students what science is and how scientists work. Between 1970 and 1978 STAN in her attempt to further promote NISP carried out an extensive revision of the project in line with the National Policy on Education. The outcome of this revision was the production of three books along with work-

books and teachers guide for the first three years of the 3-3 secondary education system. The book 1 was published in 1982, book 2 in 1983 and book 3 in 1984.

At post secondary school level, particularly colleges of education and some few universities such as Ahmadu Bello University, Zaria, the Nigerian Integrated Science Teacher Education Project (NISTEP) was developed with a view to improving the quality of teacher education of both the pre-service and in-service Integrated Science teachers in particular with the hope that they will be more effective in the classrooms. The project was established in 1989 and it took place in the institute of Education, Ahmadu Bello University (A.B.U) Zaria and was assisted by the Oversees Development Administration (ODA) of the United Kingdom through the British Council after the formal signing of a technical cooperation agreement between Nigeria and the Government of United Kingdom. The origin of NISTEP lies in the meeting of common wealth education held in London in 1983. At the meeting the new emphasis was on projects with identifiable objectives.

The institute of education, A.B.U. Zaria, in conjunction with King's college London had in 1982 designed the NISTEP mode of teaching and the syllabus. The syllabus is in semester format and is based upon the double major Integrated Science syllabus approved by the board of studies, institute of education, A.B.U. Zaria, in September 1989. The NISTEP (1991) Practical teaching steps include:

- Dividing students into small groups depending on the size of the class.
- Brainstorming session
- Presenting the various groups answers for the whole class discussion.
- Moderating group answers by the teacher to come up with final answers.

Like the NISP, the NISTEP mode/approach of teaching is child-centered, activity-oriented, comprising of process approach, inquiry, problem-solving, discovery method, pupils-centered activity (NISTEP Syllabus, 1991). Hence the reason for using guided inquiry teaching method in this study.

In the year 1999, the nine (9) –year Universal Basic Education (UBE) programme was introduced and launched by the former president Olusegun Obasanjo. The programme is an educational reform of the Federal Republic of Nigeria and is intended to be universal, free, compulsory and continuous 9 year education for all school age children irrespective of their socio-economic circumstance (Federal Government of Nigeria, 2006 in Danmole, 2011). The goal of the programme is providing functional, universal, and quality education for all Nigerians irrespective of age, sex, race, religion, occupation, or location. The philosophy of the 9 year Basic Education Curriculum as stipulated by the Nigeria Educational Research and Development Council (NERDC) is that every learner who has gone through the 9 years of basic education should have acquired appropriate levels of literacy, numeracy, manipulative, communicative and life-skills as well as the ethical, moral and civic values required for laying a solid foundation for life-long learning as a basis for scientific and reflective thinking.

In line with the philosophy, the 9 year Basic Education Curriculum was developed by the NERDC from the primary and junior secondary curricula. The new curriculum has been approved by the Federal Government in December 2005. And the existing Primary and Junior Secondary Curricula have been reviewed, re-structured and re-aligned to fit into a 9 –year of basic education and to meet the needs of the pupils and students, respectively (Danmole, 2011 & Bena and Chikwenze, 2012). These curricula were to take effect from September 2007 as

specified by the UBE Act (2004) which was signed into Law in May, 2004 and which provided the legal framework for the programme and an indication of its effective take off.

In the restructuring, Basic Science replaced Integrated Science (Bena and Chikwenze, 2012). The 9 year Basic Science and Technology Curriculum is the production of a restructuring and re-alignment of the revised Core Curriculum for Primary Science and the Integrated Science of the Junior Secondary School (Danmole, 2011 & Federal Ministry of Education, MOE, 2007).

In selection the content, three major issues shaping the development of nations worldwide and influencing the contemporary world of knowledge were identified. These are globalization, information and communication technology (ICT) and entrepreneurship education. The desire of Nigeria to be identified with contemporary development of the child, important in nation worldwide, called for the infusion of relevant contents into the school curriculum. Hence, four new areas approved for the Science and Technology Basic Education Curriculum are:

- Environmental Education (EE)
- Drug Abuse Education (DAE)
- Population and Family Life Education (POP & FLE)
- Sexually Transmitted Infections (STIs), including HIV/AIDS (Danmole, 2011, Bena and Chikwenze, 2012 & MOE,2007)

These have been infused into every class of Basic 1-9 and also some introductory technology topics have been included at the lower (Primary 1-3), middle (Primary 4-6) Basic levels while leaving the upper Basic (JSS 1-3) with purely science topics. According to Danmole (2011) and MOE (2007) the overall objectives of the new Basic Education Curriculum in Science and Technology are also spelt out thus to enable the learner to:

- Develop interest in science and technology
- Apply their basic knowledge and skills in science and technology to societal needs
- Take advantage of the numerous career opportunities offered by the study of science and technology and
- Become prepared for further study in science and technology

The Basic Science and Technology offered at the Lower and Middle Basic Education levels is separated at the Upper Basic Education level to provide students with appropriate experiences in science and technology in order to achieve the objectives of Science and Technology Curriculum. The overall goal is to ensure the development of survival strategies by learners to live effectively within the global community. In order to achieve a holistic representation of science and technology contents to learners, the thematic approach to content organization was adopted. Knowledge, skills and attitudinal requirements are addressed under these four themes (Danmole, 2011 & MOE, 2007):

- You and environment
- Living and non-living things
- You and technology
- You and energy

At the Upper Basic level however, "You and Technology" (theme 3) was changed to Science and Development. The essence of bringing in Science and Development is to expose students to development in science and technology alongside skills that will enable them to face challenges, make informed decisions, develop survival strategies, and learn to live effectively

within the global community. The topics under each theme were sequenced in a spiral form beginning with the simple to complex across the nine (9) years of Basic Education in order to sustain the interest of learners and promote meaningful learning. The curriculum offering at the lower, middle and the upper levels are shown below:

- Basic Science and Technology (Lower Basic Level, i.e. Primary 1-3)
- Basic Science and Technology (Lower Basic Level, i.e. Primary 4-6)
- Basic Science (Upper Basic Level 7-9, i.e. JS1-3)
- Basic Technology (Upper Basic Level 7-9, i.e. JS1-3)

In the new Basic Science curriculum, the use of guided inquiry method of teaching and learning is implied in the activities prescribed under each topic in order to promote learning by doing and skills development. In other word, the activities prescribed for each topic in the teaching and learning process imply full participation of pupils and students. Thus, encouraging a child-centered teaching and activity oriented learning (Danmole, 2011 & MOE, 2007).

The teacher is the key actor in the provision of quality education. Therefore, for the effective implementation of this curriculum, capacity building of the teacher should be ensured on a continuous basis (MOE, 2007).

2.2.1 Philosophy and Objectives of Integrated Science

For one to be able to teach a subject effectively he/she needs to have knowledge of the subject and understand the aims and objectives why such subject is introduced into the school curriculum. The philosophy and objectives of Integrated Science is primarily based on the

philosophy and objectives of National Policy on Education (NPE) (FRN, 2005) as they affect Integrated Science in particular and science education in general.

Primary education is the bedrock upon which the rest of the education system is built. Therefore, primary education level serves as the key to the success or failure of the whole system. As pointed out in the National Policy on Education (FME, 2005), the goals of education at this level as they relate to science and technology are to:

- lay a sound basis for scientific and reflective thinking;
- give the child the opportunities for developing manipulative skills that will enable the child function effectively in the society within the limits of the child's capacity;

Since NCE is considered as the nation's minimum qualification for entry into the teaching profession as stated in the National Policy on Education (FME, 2005: 19), therefore, to achieve the stated goals, there is the need to give adequate and appropriate training to our NCE students in such a way that their confidence and effectiveness in science teaching is developed. When this happened, it is likely to produce highly motivated, conscientious and efficient classroom teachers who will be capable of laying sound foundation in science both at primary and Junior Secondary (JS) levels. JS forms part of the secondary school education which based on the National Policy on Education (FME, 2005), is expected to:

i) prepare the children to become useful to themselves and their society

ii) prepare the children for higher education.

In specific terms, the secondary school education should according to Urevbu (1990:149) aims at the followings:

a) providing an increasing number of primary school pupils with the opportunities for education of a higher quality irrespective of sex or social, religious and ethnic background

b) diversifying its curriculum to cater for differences in talents, opportunities and roles poses by or open to students after the secondary school course.

c) equipping students to live effectively in our modern age of science and technology.

d) raising a generation of people who can think for themselves, respect and appreciate those values specified under our broad aims and live as good citizens.

Therefore, at JS education, Integrated Science in particular aimed at developing in the learners all round abilities if properly handled and its aims and objectives achieved. The products (learners) who are capable and willing should be able to function and relate well in their society and have acquired high potential for higher education. Therefore secondary education is a foundation for higher education.

Since Integrated Science is a foundation science at junior secondary school for fields of science and technology, the course must gently and gradually introduce students to what science is all about and how scientists work. In view of the above, STAN (1970) in its document caption "Curriculum Development Newsletter No. 1" expressed the fundamental issues of integration in science. The integrating principles according to the document are intended to produce among other things, a course which:

i. is relevant to student needs and experiences.

ii. stresses the fundamental unity of science,

iii. lays adequate foundations for subsequent specialist study and

iv. adds a cultural dimension to science education.

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The philosophy of integration was therefore designed to help the child to:

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

ii. gain the commonality of approach to problems of a scientific nature

iii. gain an understanding of the role and function of science in everyday life, and the world in which he/she lives (Ogunleye, 1999).

Based on the principles outlined, there may be many reasons for teaching Integrated Science to students. Some reasons are short term such as acquiring basic knowledge in science, and developing attitudes of scientists among others. While others are long term such as preparing for careers in science and technology and to pass a prescribed examination (STAN, 1970 & 1971 and Bajah, 1983).

However, STAN (1970 & 1971), Bajah (1983) and Atadoga and Onaolapo (2008) outlined the objectives of Integrated Science to train the students to be able to:

i) actively improve this learning process,

ii) develop the motivation and ability to work and think in an independent fashion,

iii) recall information and experiences,

iv) device schemes for solving problems,

v) classify and use given information,

vi) apply previous knowledge to new situations,

vii) interpret information showing evidence of judgment and assessment,

viii) communicate selectively and effectively,

ix) relate his experiences in each subject area to other subject areas and to live in society,

x) develop high skill of observation,

xi) contribute meaningfully to the development of their society,

xii) choose careers in science and technology and

xiii) scientifically manipulate their world for the good of all.

The list show the array of knowledge, attitudes and skills which the learners should acquire and develop after going through the Integrated Science course. That is, the course which focuses attention on giving the child a chance/free hand to explore and discover his environment through inquiry.

2.2.2 Importance of Teaching Integrated Science

A number of reasons have been stated for the teaching of Integrated Science as a school subject. National Teachers Institute (NTI, 1990). Some of the reasons are as follows:

i) Integrated Science as a school subject helps to prepare students for useful living in the society.

ii) It helps students learn what science is and how scientists work.

iii) It makes the students scientifically literate

iv) It serves as a gateway to the separate science subjects and a foundation of science learning in school.

v) Good grounding in Integrated Science, among other benefits as stated prepares the students for higher education at both the senior secondary and tertiary levels, as stipulated by the National Policy on Education (FME, 2005, & National Teachers Institute (NTI, 1990))

In favour of teaching of Integrated Science, Fafunwa (1971) pointed out that African child like any other child should be helped right from the beginning to start to develop basic scientific skills and abilities such as curiosity, manipulative ability and experimentation among others. Integrated Science, if properly taught, is aimed at developing in the learners all round

abilities that foster citizens who are potential leaders of tomorrow. In this vein, Balogun (1978) gave three practical reasons for teaching Integrated Science. The reasons according to him are as follows:

i) To ease the pressure of time-table, for instance, one subject instead of three.

ii) To yield coherent of time

iii) To minimize the economy of time.

2.2.3 General Problems in the Teaching of Integrated Science

The teaching of Integrated Science as an innovation in the country's educational system is expected to face one problem or another. There are series of problems that beset the teaching of Integrated Science. In his presidential address at the 24th Annual conference of STAN in Jos, Bajah in Gbamanja (1991) mentioned that most of the problems arise as a result of the inappropriate training background of science teachers which is not adequate for teaching Integrated Science. Some of the problems are as follows:

i. Lack of understanding the concept of integration in science by the teachers themselves: Teachers who are not well familiar with the concept of integration in science find it difficult to teach science in a unified way making use of relevant concepts from the various science disciplines.

ii. Lack of understanding the philosophy and methodology: most science teachers today do not fully understand the philosophy and methodology of Integrated Science. Integrated Science project is pupil-centered, activity – oriented, and above all it unites all the science disciplines. But most teachers do not have the requisite skills to put these characteristics into practice.

iii. Large class size: Integrated Science like any other child-centered course is best taught in small class sizes. But most classes in our schools today are overcrowded. This makes classroom control and management difficult thereby affecting the teaching at Integrated Science.

iv. Lack of equipment and materials: Lack of/inadequate equipment and materials required for the activities is another problem facing Integrated Science teaching in Nigeria. Although this problem can be solved or minimized through improvisation, most of the teachers do not have the skills needed for improvisation.

v. Insufficient quality teachers: There is inadequate supply of teachers to teach Integrated Science in all schools. In some schools, where there are no teachers, students are left without learning Integrated Science for one or two terms. The effect is that students are denied the knowledge, skills and attitudes that they are expected to acquire.

vi. Inadequate qualified teachers: Most of the teachers handling Integrated Science in our schools do not have the necessary training in teaching Integrated Science (Gbamanja, 1991 & National Teachers Institute (NTI), 1990).

vii. Allotted Time: Two double periods of 40 minutes per period per week are recommended in the Federal Ministry of Education (1981) core curriculum for Integrated Science at junior secondary level. But, unfortunately, many schools allocate only three periods and in some cases two periods for Integrated Science on the time table. These are single periods. The effect is that teachers can hardly engaged students in meaningful activities (NTI, 1990).

Therefore, in an attempt to rush and cover the syllabus, teachers might tend to use lecture method instead of the recommended inquiry-discovery method. The effect is that students might perform poorly in the subject due to using inappropriate method of teaching. This study, therefore, aims at investigating the effectiveness of a guided inquiry teaching method as it relates to the self-efficacy and academic achievement of NCE students in Integrated Science.

2.3 NCE Integrated Science Programme

Integrated Science programme is one of the innovative ideas brought about with the view to improving science education (teaching about science concepts). It is now the science of the junior secondary school of Nigeria (National Teachers' Institute (NTI), 1990:1). The course is being offered at Colleges of Education and some Universities in Nigeria. The essence is to produce qualified teachers who can handle the teaching of the subject both at Primary and Junior secondary levels; so that sound foundation for the study of the separate science subjects such as biology, chemistry, physics among others is laid. At College/NCE level, the course is being run under the auspices of the National Commission for Colleges of Education (NCCE). The Nigeria Certificate in Education (NCE) Integrated Science programme has its own philosophy, objectives and mode of teaching as specified in the NCE Curriculum popularly known as the Minimum Standards (NCCE, 2008:54-61).

The philosophy of the NCE Integrated Science is anchored on the following areas:

a) Fundamental unity of science

b) The use of scientific method as a common approach in solving problems

c) The role and function of science in everyday life

Integrated science has been described as that science which has not been disintegrated. It supposes to be an approach to the study of the environment, free of the limitation imposed the

separate subject disciplines. This is not to decry the of a subject discipline approach: it clearly has its uses. However, at the level of readiness for learning of secondary school students, the boundaries between the disciplines can only appear as artificial, man-made constructs which interfere with unified view of nature as a whole, when children bring to the classroom with them. Integrated science emphasizes those concepts which are common to all of science, the process of science and the skills associated with them. The great themes of science such as energy, field and particle theories, conservation, balance and cycles in nature are also emphasized as it's the relevance of science in everyday life. Integrated science also emphasizes inquiry into the nature of the environment. The scientific method of inquiry can be learned by everyone and a prime aim of the programme is to provide students with an introduction to this method and allow them to follow their own inquiries. The method of inquiry has cognitive practical aspects. These cognitive aspects include the ability to formulate questions, to identify variables and design experiments, to interpret results, recognize patterns, generate hypothesis, draw conclusions and develop theoretical models. The practical skills include general skills such as ability to observe and to measure, and more specialized skills in the handling and use of laboratory apparatus. living material and chemical.

In preparing teachers of Integrated Science, NCCE (2008: 54-55) stated that the principal objectives include the following:

i. Enabling students gain the concept of the fundamental unity of science.
ii. Installing in students a commonality of approach to problems of a scientific nature i.e. the scientific method.
iii. Increasing students' understanding of the role and functions of science in everyday life and in the world in which they live.

iv. Making students well informed and scientifically literate.

v. Enabling student acquire and demonstrate the intellectual competence and professional skills necessary to the teaching of Integrated Science in Primary and Junior Secondary Schools, as an inquiry based subject, inconformity with National Curriculum.

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

vii. Developing the ability and motivation in students to work and think in an independent manner

viii. Enabling students carry out scientific investigations, emphasizing co-operation, development of appropriate scientific processes and skills and improving their written and oral communication skills.

The most basic and fundamental approach (Mode of Teaching) to the teaching of teaching of Integrated Science at NCE level as stated by the NCCE (2008: 60-61) is that it must be activity-based at all points. This has been reflected in the time allocated to the various courses. Practical work is not listed separately since it forms an integral part of the teaching programme and can be assessed as part of the continuous assessment scores for the programme. It has long been noted that students *'teach as they have been taught'*. The aim of this programme is to capitalize on this phenomenon so that graduates of the programme will continue with the activity-based approach when they reach schools to teach pupils.

The development of the science skills of observing, classifying, measuring, organizing, formulating hypothesis, experimenting and interpreting data and reporting results should be a

major aim. A brief checklist for an activity-based approach to learning science according to NCCE (2008) is that students should be:

a. Handling material, living and non-living;
b. Designing, making or manipulating apparatus using a variety of materials including 'junk' items;
c. Moving around freely and finding the materials they need
d. Discussing their work with each other and the teacher;
e. Busy doing things they feel are important;
f. Trying to work out for themselves what to do, from step to step and not expecting to be told what to do;
g. Puzzling over problems;
h. Comparing their ideas or observations with those of others;
i. Embarking on Field Trips;
j. Excursion to places where students can observe science in operation/action to enhance better understanding of science (NCCE, 2008).

The Integrated Science Programme should be taught in such a way that those students:

a. Take the initiative in suggestive what to do and how to set about it;
b. Try out ideas to see what happens;
c. Observe sings closely for watching, listening, touching, smelling;
d. Try different ways of approaching a problem;
e. Classifying things according to their properties or characteristics;
f. Make sure record whey find out or observe;
g. Use instruments for aiding observation and measurement;

h. Devise and apply tests to find out what things will do;

i. Make predictions of what they expect to happen;

j. Look for evidence to support the statements they make;

k. Try to explain their observations;

l. Confirm their findings carefully before accepting them as evidence;

m. Have workshop's experience and practice (NCCE, 2008).

2.4 Teaching and Learning of Science as Inquiry

Educational Inquiry is defined by the National Research Council (1996) as the "the activities of students in which they develop knowledge and understanding of scientific ideas, as well as understanding how scientists study the natural world". In authentic Inquiry the students independently pose questions; use sources to see what is already known; plan investigation; make observations; use tools to gather and interpret data; propose explanations and communicate the results. Guided Inquiry is exactly this, only with slightly more guidance. Teachers can guide their students by acting as a resource person. Educators can provide materials and sources of information for the learners to use in their investigations. Possibly, the most important characteristic that teachers can posses is the ability to ask relevant and divergent questions. Teachers should guide their students in the right direction without handing them the answers. Learning science is something students do, not something that is done to them. Learners need to be engaged in critical and logical thought. In turns, teachers must ask questions that open the field of discussion instead of narrowing it into simply right and wrong answers.

The process by which students acquire their understandings and abilities of inquiry continues during their school career. Thus, when teaching is organized in such a way that students can apply inquiry-based approach to solve problems and interpret experimental data,

learning becomes effective (Biological Science Curriculum Study, 2005). Inquiry method is one of the strategies of science teaching. According to National Research Council (NRC) (1996) scientific inquiry involves many different ways that scientist investigates the natural world and put forward explanations based on the findings they provide from their researches. According to the recent science education reform documents, improving students' understanding of science and scientific inquiry is critical for developing a scientifically literate society (American Association for the Advancement of Science (AAAS) (1993) and National Research Council (NRC), (1996 & 2000). Teaching and learning of science as inquires not only grasp scientific information but also develop fundamental understandings and abilities to conduct scientific inquiry (NRC, 1996 & 2000). The NRC (2000) in its publication 'inquiry and the National Science Education Standards' identified the following five essential features of classroom inquiry:

i. Learners are engaged by scientifically oriented questions.
ii. Learners give priority to evidence in responding to questions.
iii. Learners formulate explanations from evidence to address scientifically oriented questions.
iv. Learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding.
v. Learners communicate and justify their proposed explanations.

2.5 Lecture or 'talk-chalk' method

The lecture in its many forms is the most commonly used method of transferring information in education. There are, however, serious questions regarding the effectiveness of the lecture approach. Arredondo (1994) pointed out that, although the lecture method is used

extensively in education, academic staffs often are not trained in giving effective lectures. Umeoduagu (1994), Akpochafo (2001) and Arisi (2002) have pointed out that despite the thirty year existence of learning style theories (dealing on how people learn) most teachers still dispense information using lecture methods without regard to students learning abilities. These teaching methods are theoretical, extremely didactic and teacher – centered instead of being experimental or activity-based. A study of teaching behaviour and student's achievement in science by Akuezuilo (1989) shows that student activities are better than teacher activities in promoting authentic learning, at least in junior secondary Integrated Science classrooms.

Lecture as a teaching method is an oral presentation intended to present information or teach people about a particular subject, for example by university or college teachers. According to Vella (1992), lecture method is the formal presentation of content by the educator (as subject expert) for the subsequent learning and recall in examination by students. Ruyle (1995) describes the lecture simply as an oral presentation of instructional material. Lectures are generally described from the instructor's point of view, where the student's need for interaction with the instructor is not addressed. In fact, lack of interaction is considered as one of the major limitations of the lecture method (Munson, 1992). McIntosh (1996) observes that lecturing is frequently a one-way process unaccompanied by discussion, questioning or immediate practice, which makes it a poor teaching method. Most educators learn how to teach based on their experiences as students. This "teaches as I was taught" approach tends to perpetuate the lecture as passive, one-way method of transferring information. The lack of faculty training in presenting effective lectures, rather than the method itself, may be the greatest weakness of the lecture (McIntosh 1996).

The amount of material remembered by students immediately after a lecture as reported by Ellington (1996) is comparatively low, ranging from a maximum of roughly 40% to as little as 5% in some cases. He also reported that a number of studies aimed at comparing lecture method with other teaching/learning methods have been carried out and shown that lecture is not particularly effective in achieving higher cognitive objectives (helping students to apply such basic facts and principles, analyze, synthesize, solve problems, and so on) or in achieving affective and other non-cognitive objectives. Arisi (2002) in a related study on the effects of instructional methods and cognitive style on students' academic achievement in junior secondary school social studies examined three methods – Advanced Organizer (ADO), Problem Solving Inquiry (PSI) and Activity Discussion Method – and found that all three had positive significant effects when compared to the lecture method. Students taught with the first three methods outperformed those taught with the lecture method.

However, in support of lecture method in Medical Education, Vella (1992) recommends the use of active learning activities including problem-solving exercises, student's presentations and students working cooperatively in groups. According to Twigg (1994) recent studies have shown that the majority of college students are active learners requiring learning experiences that engage their senses. Cavanagh, Hogan and Ramgopal (1995) in assessing learning styles of student nurses recommend using a variety of teaching styles with an emphasis on participatory and experimental learning. In this study, guided inquiry teaching method was used to see if the result would be similar or otherwise to that of Ellington (1996) and Arisi (2002) which found that methods such as advanced organizer (ADO), problem-solving and discussion had positive significant effects on students' academic achievement in Social Study when compared to the lecture method.

2.6 Concept of Self-efficacy

The term self-efficacy is viewed/defined differently by different people. For instance, Housego (1992) viewed self-efficacy as a degree of preparedness by virtue of training, experience, or talent. Bandura (1997) defined self-efficacy as the confidence people have in their abilities for success in a given task. Pajares (2002) viewed self-efficacy as people's judgments of their capabilities to organize and execute courses of action required for attaining designated types of performance. According to Salamah, Wahl, and Abrian (2003) self-efficacy is the confidence that one has in carrying out specific behaviours. Pajares (2002) is of the view that, of all the thoughs that affect human functioning and standing at the very core of social cognitive theory are self-efficacy beliefs. People's judgments of their capabilities to organize and execute courses of action required attaining designated types of performances (Pajares, 2002). He asserts that self-efficacy beliefs provide the foundation for human motivation, well-being and personal accomplishment. This is because unless people believe that their actions can produce the outcomes they desire, they have little incentive to act or persevere in the face of difficulties. Much empirical evidence now supports Bandura's (1997) contention as regards to the roles of self-efficacy beliefs in human functioning, that self-efficacy beliefs touch virtually every aspect of people's lives – whether they think productively, self debilitating, pessimistically or optimistically; how well they motivate themselves and persevere in the face of adversities than vulnerability to stress and depression and the life choices they make.

Since 1977 when Bandura published his seminar paper, "self-efficacy towards a unifying theory of behavioural change", the subject has become one of the most studied topics among psychologists and educators (Wagner, 2007). She asserts that Bandura and other researchers have demonstrated that self-efficacy can have an impact on everything from psychological states

to behaviour and motivation. Virtually all people can identify goals they want to accomplish, things they would like to change and things they would like to achieve. However, most people also realize that putting these plans into action is not quite so simple. Bandura found that an individual's self-efficacy plays a major role in how goals, tasks, and challenges are approached (Bandura, 1994). He asserts that:

People with a strong sense of self-efficacy (high self-efficacy):

- View challenging problems as tasks to be mastered
- Develop deeper interest in the activities in which they participate
- Form a stronger sense of commitment
- Recover quickly from setbacks and disappointments

People with a weak sense of self-efficacy (low self efficacy):

- Avoid challenging tasks
- Belief that difficult tasks and situations are beyond their capabilities
- Focus on personal feelings and negative outcome
- Quickly lose confidence in personal abilities

Because of the debilitating effects of low self-efficacy and the enabling effects of high self-efficacy, it is important for trainers to work at strengthening self-efficacy whenever it is particularly subject to influence. Self-efficacy is strengthened through practice and through the conditions and consequences that accompany the practice of the skills to be trained. The practice must be designed to lead to a series of successes (Mager 1992). A great amount of research has been done in relation to the self-efficacy perceptions of pre-service as well as working teachers. Specifically, Tschasen-Moran, Woolfork, and Hoy (1998) pointed out that teachers with high self-efficacy beliefs are more open to criticism, ask more questions and employ student-centered

teaching strategies whereas teachers with low self-efficacy beliefs prefer teacher-centered strategies more and are more dependent on course books. Tschasen-Moran and Hoy (2001) stated that teachers' self-efficacy affect educationally very significant outputs such as the teacher's willingness and instance, his adherence to the profession, determining the objectives, his efforts to conduct research and to put it in other words – his resistance and achievement when things go wrong. Pajares (1992) stated that close relation is available between teachers' self-efficacy beliefs and in-class applications in the process of teaching. Senemoglu, Demirel, Yagci, and Ustundag (2009) demonstrate that elementary school teachers' levels of self-efficacy are high. Research conducted by Savran and Cakiroglu (2001); Ozkan, Tekkaya, and Cakiroglu (2002) and Karagoz (2005) also find prospective teachers' levels of self-efficacy belief concerning science teaching quite high. Capa (2005) also showed that first-year teachers had high efficacy scores on three measures of teachers' sense of efficacy.

Self-efficacy beliefs begin to form in early childhood as children deal with a wide variety of experiences, tasks, and situations. However, the growth of self-efficacy does not end during youth but continues to evolve throughout life as people acquire new skills, experiences and understanding (Bandura, 1992). In this study, the researcher intends to use guided inquiry teaching method to see if it has the potential of enhancing the self-efficacy of NCE students in the area under study. According to Bandura (1992) people's beliefs about their efficacy can be developed by four basic sources of influence. They are:

2.6.1 Mastery Experiences

Mastering experience is the information obtained by an individual directly through his/her successful or unsuccessful activities (Sememoglu, Demirel, Yaga and Ustundag, 2009). According to Bandura (1994) the most effective way of devcloping a strong sense of self-

efficacy is through mastery experiences. He farther explained that performing a task successfully strengthens our sense of self-efficacy. However, failing to adequately deal with a task or challenge can undermine or weaken self-efficacy. Of course, people who possess low sense of efficacy often discount their success rather than change their self-belief. Even after individuals achieve success through determined effort, some continue to doubt their efficacy to mount a similar effort.

2.6.2 Vicarious Experience/Social Modeling

The second way of developing and strengthening self-beliefs of efficacy is through the vicarious experiences provided by social models. Witnessing other people successfully completing a task is an important source of self-efficacy. According to Bandura (1994: 71) "seeing people similar to one succeed by sustained effort raises observers' beliefs that they too possess the capabilities to master comparable activities to succeed". To better understand how teachers develop self-efficacy beliefs few studies focused on pre-service teachers and the sources that influence those beliefs. Specifically, Szabo, Bailey and Ward in Chen (2005) studied two sources of efficacy: vicarious experience and verbal persuasion that contributed to developing pre-service teachers' self-efficacy beliefs. Also examining the sources, Aydin (2005) who found that pre-service teachers' self-efficacy was related to positive relationships with mentors and teaching support. The effects of modeling are particularly relevant in this context especially when the individual has little prior experience with the task. Even experienced and self-efficacious individuals will raise their self-efficacy even higher if models teach them better ways of doing things. Vicarious experience is particularly powerful when observers see similarities in some attribute and then assume that the model's performance is diagnostic of their own capability. For example, a girl will raise her perceived physical efficacy on seeing a woman

model exhibit physical strength but not after seeing a male model do so. In this case, gender is the attribute for assumed similarity. Observing the successes of such models contributes to the observers' beliefs about their own capabilities (Bandura, 1994).

2.6.3 Social/verbal Persuasion

Encouragement that the individual can succeed or fail, suggestions, recommendations, affect self-efficacy in differing levels. (Senemoglu et al 2009). Bandura (1994) asserted that people could be persuaded to belief that they have the skills and capabilities to succeed. These social persuasions can involve exposure to the verbal judgment that others provide. Persuaders play an important part in the development of an individual's self-beliefs. Effective persuaders must cultivate people's beliefs in their capabilities while at the same time ensuring that the envisioned success is attainable. Bandura also asserted that just as positive persuasions may work to encourage and empower, negative persuasions can work to defeat and weaken self-efficacy beliefs.

2.6.4 Psychological Responses/Somatic and Emotional States

The individual's expectation of success or failure in a task influences self-efficacy perception. An individual with high level of perceived efficacy will make more efforts; will be more insistent and more determined than one with lower level of perceived efficacy to cope with a task (Senemoglu et al, 2009). Our own responses and emotional reactions to situations also play an important role in self-efficacy. Moods, emotional states, physical reactions and stress levels can all impact how a person feels about his personal abilities in a particular situation. A person who becomes extremely nervous before speaking in public may develop a weak sense of self-efficacy in these situations. (Bandura, 1994). However, Bandura also notes "it is not the sheer intensity of emotional and physical reactions that is important but rather how they are

perceived and interpreted". By learning how to minimize stress and elevate mood when facing difficult or challenging tasks, people can improve their sense of self efficacy. Because individuals have the capability to alter their own thinking and feeling, enhanced self-efficacy beliefs can in turn powerfully influence the physiological states themselves. As Bandura (1997) has observed, people live in psychic environments that are their own making. In this study, guided inquiry teaching method was employed to see if it could impact the self-efficacy of NCE Integrated Science students.

2.7 Self-efficacy and Academic Achievement in Science

The verdict of success or failure upon future job will influence practical performance (Bandura, 1989). Self efficacy would have a prominent impact on behavioural performance and personal confidence level toward an individual's job efficacy (Bandura, 1986). Bandura (1997) provides extensive evidence and documentation for the conclusion that self-efficacy is a key factor in the extent to which people can bring about significant outcomes in their lives. Specifically, there is considerate evidence to support the contention that self-efficacy beliefs contribute to academic achievement by enhancing the motivation to achieve. For example, Tuckman (1999) has shown that children with the same level of intellectual capability differ in their performance as a function of their level of self-efficacy. Tuckman and Sexton, in Tuckman (1999) have reported that the highest self-efficacy group was found to be 10 times as productive as the low group. Moreover, the high group outperformed their own expectations by 22% while the low group fell below their own expectations by 77%. The results reflect a clear relationship between self-efficacy beliefs and academic productivity. Many confirmatory studies indicated the significant aspects of self-efficacy on the learning achievement. For example, in Liu's (1992) study, a positive correlation between self-efficacy and academic achievement was found.

Hsu (2000) also indicated correlation between college student self-efficacy on the subject of biology and learning achievement. Schraw, Crippen, and Hartley (2006) also indicated that higher levels of self-efficacy are positively correlated to achievement at school and to education in general. Lee (2002) explored the impacts of multi-media instruction and self-efficacy on the learning achievement of the participants of physics and chemistry for junior high school students and found that the students learning achievements were indeed influenced by self-efficacy.

A great amount of research has also been conducted in relation to the self-efficacy perceptions of pre-service as well as working teachers (Senemoglu et al 2009) and found that teachers' self-efficacy beliefs were influenced in teachers' behaviours and that self-efficacy beliefs had high correlations with students' achievement and attitudes. Ashton (1984) claims that no other teacher property is as influential in students' achievement as self-efficacy. Senemoglu et al (2009) also reported that self-efficacy belief is a significant predictor of achievement in various academic situations. Research conducted by Pajares and Miller (1994) also found that self-efficacy perception affected mathematics achievement in positive way. In another study, Tschasen-Moran and Hoy (2001) state that teachers' self-efficacy affect educationally very significant outputs such as the teacher's willingness and insistence, his adherence to the profession, determining the objectives, his effort to conduct research and to put it in other words his resistance and achievements when things go wrong. Evidently, self-efficacy belief is correlated with both the teachers' effectiveness in the teaching – learning process and with students' achievement, attitudes, and self-efficacy perception which are the consequence of this. In this study, the effectiveness of guided inquiry teaching method on both the self-efficacy and academic achievement of NCE Integrated Science students was investigated.

2.8 Gender and Self-efficacy

Gender differences in self-efficacy have been reported in several researches. For instance, Sadker and Sadker (1995) in Tenaw (2013) reported that girls, starting in grade seven tends to underestimate their abilities in mathematics and science. Smist and Owen (1994) and Kinsella (1998) have documented that female students have lower self-efficacy in mathematics and science compared to male students. Girls' capabilities are undermined by sex-role stereotypes in many cultures intimating that females are not as able as males, especially in such disciplines as mathematics and science (Bandura, 1997). Another contributing factor could be the lower level of expectations that parents, teachers and counselors often hold for girls, which can discourage further study in scientific and technical fields (Bandura, 1997, and American Association of University Women Educational Foundation, 1999) among others. In their study on effect of learning about gender discrimination on girls attitudes toward science, Weisgram and Bigler (2007) mentioned that low confidence level of girls toward science is partially due to prejudge that girls developed over years: females are not as good as males in terms of science learning. Weisgram and Bigler (2007) also concluded that informing girls of the discrimination would increase their self-efficacy by changing their attribution of past experience.

Self-efficacy is an important factor that affects/influences both students' academic achievement and teachers' productivity. Self-efficacy, also called perceived ability refers to the confidence people have in their ability to succeed in a given task (Bandura, 1997). In science education therefore, the importance of self-efficacy cannot be overemphasized. This is because students with science self-efficacy tend to work harder to accomplish a given task and be more efficient in using problem solving strategies and management of the working time than students with low science self-efficacy (Zimmerman, 2000). Self-efficacy beliefs vary between

individuals and will actually fluctuate within an individual for different task (Bandura 1997). Self-efficacy is therefore not static.

Gender bias in mathematics and science classrooms has been and still continues to be a problem (American Association of University Women (AAUW), (1999). Despite the improvements in the past two decades, girls are still less likely than boys to take chemistry and high–level mathematics and science courses in high school (AAUW, 1999). As a consequence, fewer female students may study mathematics and science at the college level. According to Alper (1993) a loss of self-confidence rather than any differences in abilities may be what produces the first leak in the female science pipeline.

The relationship between gender and self-efficacy has been a focus of many self-efficacy researches. As a result, gender differences in self-efficacy have been reported in several researches. For instance, Wigfield, Eccles, MacIver, Reuman, and Midgley (1991) in Britner (2002) observed that in the area of mathematics, boys and girls reported equal confidence during the elementary years, but by middle school boys begin to rate themselves more efficacious than do girls. In their study on self-efficacy among the students of biological sciences at Cuddalore district of Tamil Nadu in India, Ruvikumar and Manimozhi (2011) reported that the self-efficacy in equipmentation of boys and girls is almost equal among the biology students in Cuddalore. But, they differ significantly in their self-efficacy in equipmentation with respect to their colleges they are studying. Researchers such as Pajares and Miller (1994), Debacker and Nelson (2000) among others reported that male students at high school and college tend to be more confident than females. In a year-long, inquiry-based physics course (Cavallo, Rozman, Larabee, & Ishikawa, 2001) found significant gender difference in students' science self-efficacy. Male students began the course with significantly higher self-efficacy and ended the course also with

higher self-efficacy. However, Britner and Pajares (2001) reported higher science self-efficacy among middle school girls than among middle school boys. Also, in their study on sources of science self-efficacy beliefs of middle school students, Britner and Pajares (2006) found that girls reported stronger science self-efficacy than did boys. Louis and Mistela (2012) reported that when controlled for self-efficacy, females hold lower self-efficacy in mathematics than males and in science there was no difference between females and males in terms of self-efficacy. Kiran and Sungur (2012) established that no gender difference was found concerning science self-efficacy.

2.9 Gender and Academic Achievement in Science

Gender differences may exist in many different areas of education; from performance to attitudes, from classroom activities and course enrolment to perceptions about careers. There are mixtures of the two traits in human beings, a normal man has a preponderance of masculinity and a normal female has a preponderance of feminity (Oakley, 1993). Oakley (1970) also used the word gender to describe certain characteristics of men and women which are culturally and socially determined while those that are biologically determined are regarded as sex. Gender is socially and culturally oriented and therefore it is dynamic. This means that gender patterns can change with time.

Academic achievement is affected by many factors such as motivation, student ability, and the quality of secondary education received, among others. Educational achievement according to Raji (1994) can be considered to mean the successful outcome of accomplished activities or tasks in educational measurement in relation to accepted standards. Tests are conducted to know the rate of achievements of students in stated objectives. Several issues regarding gender and science remain controversial. Ditch and Scott, in Bichi (2002) stated that

one such controversy is that girls do not like practical work and can't handle the inquiry method. Stereotypic views on teaching styles are yet another issue in science teaching. Presently in our schools there exist gender differences in science achievement and these have attracted some debates (Oraifo, 1990 & Njoku, 2003 in Nworgu, 2005). Some researchers link the differences to the way science is being taught in our secondary schools (Baker and Leary, 1995).

Njoku (2003) in Nworgu (2005) in a study on trends in students' achievement in Integrated Science observed that male students performed significantly better than female students. These differences were therefore attributed to gender. Furthermore, Oraifo (1990) explained the pattern of performance among male and female students in science. The result showed that there is a significant difference in the performance of male and female students in school science in favour of males. OneKutu and Onekutu (2002) and Eriba and Sesugh (2006) have reported that boys outperformed girls in science and mathematics achievement. In her study of science achievement, Greenfield (1996) concluded that males reported more stereotyped views of science than females.

Other researchers have reported differently on this issue. For example, Afuwape and Oludipe (2008); Bile Sanmi – Awoderru (2006), David and Stanley (2002), Din, Mingi and Ho (2004), Freedman (2002), Sungur and Tekkaya (2003) have provided reports that there are no longer distinguishing difference in the cognitive, affective and psychomotor skill achievements of students in respect of gender. Girls are being encouraged and sensitized into developing positive attitudes to read sciences. In a similar vein, Valanide (1996) did not find differences in how males and females engage in reasoning process. Ameh and Dantani (2012) reported that the boys and girls are equally better in academic achievement when taught using demonstration

method than when lecture method was used. Ayodele (2009) found that there was no significant difference between male and female students in private and public schools.

However, in terms of academic achievement, Lee and Burkam (1996) have reported that females benefited much more than boys did from laboratory experiences. Orabi (2007) also reported that females are outperforming males across a range of subjects. Akinsola (2013) observed that females outperformed males in Integrated Science at the junior secondary school level. Louis and Mistele (2012) reported that a statistically significant difference was found in the academic achievement scores between males and females by subjects, where females scored higher in Algebra, but males scored higher in other mathematics subjects. Likewise, they also reported that there is a statistically significant difference in the achievement scores of earth science, physics and biology between males and females, where males scored higher in science subjects. In their study, Olagunju and Balogun (2006) also reported that females in the control classes/group performed better than males in the same group. Some other research studies reported that males are becoming the disadvantaged gender in schools, and that fewer males are interested in science (Alkhateeb, 2001; Bleuer & Waltz, 2002; Omoniyi, 2006 & Weaver – Hightower, 2003). Lee and Burkam (1996) concluded that science laboratory experiences and other forms of hands-on learning, particularly in physical sciences, could help to promote gender equity and science achievement in our schools. According to Levi (2000) teacher plays a vital role in addressing the problem of gender equity in science education. To him, there are three main roles a teacher must play, namely:

a) Ensure provision of equal opportunities and respect for differences in the classroom.
b) Ensure that boys and girls have the same experience, that is, treat boys and girls equally.
c) Compensate for gender differences in society.

In this study guided inquiry teaching method was used to see if the result would be similar or otherwise to that of Lee and Burkan (1996) who concluded that science laboratory experiences and other forms of hands-on learning promote gender equity and science achievement in physical sciences in our schools. The difference in the mean scores of gender academic achievement in Integrated Science was investigated in this study.

2.10 Overview of Similar Studies

Numerous studies reveal mixed results with regard to instructional methods, students' self-efficacy and academic achievement in science in general and as they specifically relate to gender differences/gap. Such studies include the following among others:

The National Research Council (NRC, 2000) pointed out that guided inquiry environment can best facilitate focusing on learning the developing of certain scientific concepts. However, if students under the teachers' guidance focus their attention on the content they have less suitable means for discovering scientific thinking, process and gaining experience (Kai & Krajcik, 2006). Liang and Richardson (2009) have reported the positive effects that inquiry-oriented science learning and teaching have on pre-service teachers understanding of the nature of attitudes and beliefs about science learning and teaching and their classroom teaching performance. It has also been reported that students who enrolled in inquiry-based science classes with metacognitive facilitation or a reflective assessment component outperformed their counterparts in similar classes without metacognitive facilitation (NRC, in Liang and Richardson, 2009). In guided inquiry teaching method, teachers and learners play a crucial role in asking questions, developing answers and structuring of materials and cases. The usage of guided inquiry teaching method is very important in transition from lecturing method to other methods which are less and more clearly structured for alternative solutions (Bilgin, 2009).

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Fruge (2007) examines the use of Guided Inquiry teaching method in local classrooms. He used survey as the design of the study. The author was able to observe seven classrooms covering two Physics classes, one Mathematics class, one Biology class, one Chemistry class, one English class and one psycholinguistics in Education class. The instrument used for the study was the Reformed Teaching Observation Protocol (RTOP). The RTOP data for each classroom were analyzed using Q-test statistical tool. The results of the study revealed that the use of guided inquiry teaching method in local schools is lacking, especially in university level school classrooms. The finding suggest that more effort in training teachers/educators in the use of Guided Inquiry teaching method is required at all levels and that future studies to fully determine not only the extent to which Guided Inquiry is being used but also the degree of its success/effectiveness on students' academic achievement in sciences. Bilgin (2009) investigated the effects of Guided Inquiry instruction incorporating with cooperative learning approach on University students' achievement of acid and bases concepts and attitude toward Guided Inquiry instruction. He used fifty five (55) students as the sample of the study. The instruments used were Acid and Bases Achievement Tests (ABAT) and Attitude Toward Guided Inquiry Instruction Scale (ATGIIS). Multi Variance Analysis (MANOVA) was used as the statistical tool. The results showed that the students in the experimental group had better understanding of acid and bases concepts and more positive attitude toward guided inquiry instruction.

Ameh and Dantani (2012) determined the effects of lecture and demonstration methods on academic achievement of students in chemistry. They used fifty eight (58) chemistry students (boys and girls) in Senior Secondary School One (SS1) from two randomly selected schools. The data collected were analyzed using t-test statistics at a significant level of 0.05. The results revealed that students performed better in chemistry when taught using demonstration method as

compared to the lecture method. Also, boys and girls are better in academic achievement when taught using demonstration method than when lecture method was used. Alake and Ogunseemi (2013) assessed the effects of scaffolding strategy on the academic achievement of students in Integrated Science in the junior secondary school (JSS). They used 450 JSS 2 students as the sample for the study. The instrument used was the Integrated Science Achievement Test (ISAT)and t-test statistics was used in analyzing the result. The results showed that students exposed to scaffolding strategy performed significantly better than their counterparts who were exposed to lecture method. Namardha and Chamundeswari (2013) examined the effectiveness of constructivist-based teaching strategy on academic performance in Integrated Science by junior secondary school students in South-West, Nigeria. They used 120 JSS students as the sample size. The findings revealed that the constructivist instructed students had higher scores on the post test and the delayed post test, compared to those exposed to lecture method of teaching. The authors concluded that if Integrated Science teachers could incorporate constructivist-based teaching strategy into their teaching methods, there could be an improvement in academic performance of JSS students in Integrated Science.

Akinsola (2013) investigated the relative effectiveness of mastery learning, cooperative learning, combined mastery learning and cooperative learning strategy on students' achievement in Integrated Science. The subjects consisted of two hundred (200) JSS students. Analysis of Covariance (ANCOVA) and the Duncan post-hoc analysis were used in analyzing the data collected. The results revealed that combined mastery learning and cooperative learning strategy was found to be more suitable in facilitating achievement in Integrated Science in the JSS. Females outperformed males in Integrated Science at the JSS level.

Louis and Mistele (2012) examined the difference in scores and self-efficacy by students' gender in mathematics and science. They were able to demonstrate that there is a statistically significant difference in the academic scores in Earth Science, Physics and Biology between males and females were males scored higher in science subjects. In both mathematics and science examination they controlled for self-efficacy, were in mathematics females hold lower self-efficacy than males and in science there is no difference between females and males in terms of self-efficacy. They concluded that mathematics and science classrooms that consider self-efficacy may impact students' achievement scores by subjects. Tenaw (2013) investigated the level of students' self-efficacy, gender differences in self-efficacy and achievement and relationships between self-efficacy and achievement for second year students in the fall of 2012 in Analytical Chemistry 1 (AC1) at Debre Markos College of Teacher Education. He used a sample of 100 students. Self-efficacy Questionnaire and AC1 achievement test were used as the instruments of the study. The difference of self-efficacy and achievement was calculated using t-test and the relationships between self-efficacy and achievement was investigated using Pearson correlation. The results indicated that students' level of self-efficacy is medium and there is no significant difference in their self-efficacy between sexes. But, there is a statistically significant difference in achievement between sexes. Also, a significant relationship exists between self-efficacy and achievement. Kiran and Sungur (2012) investigated middle school students' science self-efficacy as well as its sources and outcomes as a function of gender. 1932 students participated in the study. The results revealed that no gender difference was found concerning science self-efficacy and strategy level. Britner and Pajares (2006) investigated the degree to which Albert Bandura's (1997) hypothesized sources of self-efficacy predict self-efficacy beliefs of middle school students. They found that girls reported stronger science self-efficacy than did

boys. The concern of the present study was to investigate the effects of Guided Inquiry teaching method on NCE Students' self-efficacy and academic achievement in Integrated Science.

2.11 Implications of the Literature Reviewed on the Present Study

This study has reviewed literature on the previous works done related to the problems which are being faced in the teaching and learning of science. Of particular interest is the failure of most science teachers to use appropriate teaching methods that enhance students' confidence and academic achievement in sciences. Many research works such as Ellington (1996) aimed at comparing lecture method and other teaching methods have been carried out and shown that lecture method was not particularly effective in achieving higher cognitive objectives or in achieving affective and other non-cognitive objectives.

However, most of the research works done on the use of instructional methods as they relate to the self-efficacy of pre-service and or practicing teachers where outside Nigeria. As regard to the academic achievement, most of these research works involved primary school pupils and secondary school students and were carried out either in biology, physics, chemistry and social sciences and very few or none in Integrated Science at NCE level. Palmer (2006) worked on pre-service teachers in Turkey and look at the effectiveness of guided inquiry teaching method on their self-efficacy and performance. The present study is carried out in Nigeria; therefore it is different from palmer's (2006) work in terms of location. Work by Usman (2000), Bichi (2002) and Lakpini (2006) among others were on Secondary School Biology, Olubunmi (1991) and Martins and Oyebanji (2000) were among the researchers who worked on Junior Secondary Integrated Science, While Lee (2002) among others worked on Physics and Chemistry at Secondary School level. These researchers did not include self-efficacy of students which could in turn enhance their academic achievement, and no research was done in Nigeria

on NCE Integrated Science in relation to their self-efficacy and their academic achievement as well. Therefore, the purpose of this study was to investigate the effects of guided inquiry teaching method on the self-efficacy and academic achievement of NCE Integrated Science students in North-West geopolitical zone of Nigeria.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This study aims at investigating effects of guided inquiry teaching method on NCE Students' self-efficacy and academic achievement in Integrated Science at Colleges of Education in North-West geopolitical zone of Nigeria. In this chapter, the methodology is presented under the following sub-headings:

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

3.2 Research Design

A quasi-experimental control group design using pretest and posttest was used. The experimental group was exposed to guided inquiry approach, while the control group was exposed to lecture method. The pretest is used to determine the equivalence of the two groups in their self-efficacy and academic achievement in Integrated Science before the treatment, while the posttest is used to find out whether or not guided inquiry has an impact on both NCE Students' self-efficacy

beliefs and academic achievement after exposure to the treatment (i.e. guided inquiry teaching method). The design is illustrated in Figure 3.1

$$EG \rightarrow \overset{SE}{\underset{AA}{O_1}} \rightarrow X_1 \rightarrow \overset{SE}{\underset{AA}{O_2}}$$

$$CG \rightarrow \overset{SE}{\underset{AA}{O_1}} \rightarrow X_O \rightarrow \overset{SE}{\underset{AA}{O_2}}$$

Figure 3.1 Research Design Illustrations

Where EG = Experimental group

CG = Control group

O_1 = Pretest administered to the experimental and control groups

X_1 = Treatment variable (guided inquiry teaching method) given to the experimental group only

X_O = No treatment (i.e. lecture method)

O_2 = Posttest administered to the experimental and control groups

SE = Self-Efficacy

AA = Academic Achievement

3.3 Population of the Study

The population of the study comprises of all the NCE II Integrated Science students who registered for 2010/2011 session in Colleges of Education (COE) in the North-West Nigeria. The area consists of six (6) states whose Colleges of Education (11) offer Integrated Science. The colleges are categorized into Federal (FCE) and State (COE)-owned ones. The total number of the population is one thousand two hundred and seven (1207), consisting of seven hundred and

twenty one (721) male and four hundred and eighty six (486) female students. The detail of the population is presented in Table 3.1.

Table 3.1: Population of the Study

			NCE II Integrated Science Students Enrolment			
S/No.	**State**	**College**	**Male**	**Female**	**Total**	**Remark**
1.	Jigawa,	i). COE, Gumel	30	28	58	State
2.	Kano,	i). COE, Kumbotso	121	59	180	State
		ii). FCE, Kano	50	39	89	Federal
		iii). FCE (T), Bichi	73	21	94	Federal
3.	Kaduna,	i). COE, G/Waya, Kafanchan	25	27	52	State
		ii). FCE, Zaria	173	104	277	Federal
4.	Katsina,	i). COE, Dutsin-ma	80	23	103	State
		ii). FCE, Katsina	51	46	97	Federal
6.	Sokoto,	i). COE, Sokoto	37	31	68	State
6.	Zamfara,	i). COE, Maru	81	16	97	State
		ii). FCE (T), Gusau (Female)	Nil	92	92	Federal
Total		**11**	**721**	**486**	**1207**	

Sources: National Commission for Colleges of Education (NCCE), Abuja, Nigeria and Integrated Science Departments of the Colleges in the population (2011).

3.4 Sample and Sampling Techniques

Cluster/Area sampling was first employed to divide the population of the study into sampling units (i.e. States (6 in number) and Colleges (11 in number)). Simple random sampling involving the fish bowl method was then used to select two (2) out of the eleven (11) Colleges and use them as the study subjects. This was done by writing the name of each College on a piece of paper as they appear in Table 3.1 above, to have a total of eleven (11) pieces of papers

representing the eleven Colleges. The pieces of papers were then squeezed and put into a container; it was well shaken and a student was asked to randomly pick/ select any two (2) slips, one after the other from the container. The selected Colleges are FCE, Katsina and COE, Dutsin-ma. The two Colleges were assigned to groups; experimental (i.e. FCE, Katsina) and control (i.e. COE, Dutsin-ma) using the same fish bowl method system. That is, the first selected College this time around was considered as the experimental while the remaining College as the control. Intact classes of the two Colleges with a total of two hundred (200) students were used for the study. This sample size is viable for the study going by the Central Limit Theorem; Tuckman's (1975) recommendation and Roscoe's (1975) suggestion. The former recommended that the sample size of minimum of thirty (30) subjects is viable for experimental study of this nature. While the latter suggested that at least 10% of the total population can be taken as sample size. The detail of the sample of the study is presented in Table 3.2

Table 3.2: Sample for the Study

S/No.	College	NCE II Integrated Science Students Enrolment		
		Male	**Female**	**Total**
1.	FCE, Katsina	51	46	97
2.	IKCOE, Dutsin-ma	80	23	103
Total		**131**	**69**	**200**

3.5 Selection of Topics for the Study

In carrying out the study, the following topics were selected for teaching from Integrated Science course (ISC 211; Components of the environment II) of the NCE Minimum Standard (4^{th} edition), produced by the National Commission for Colleges of Education (NCCE, 2008).

- Characteristics of Living Things
- Plant and Animal Cells
- Bacteria in Ecological Cycle and
- Mode of Nutrition in Fungi

The researcher checked through some examination scripts for the course for some previous years (i.e. 2005/2006-2009/2010) and found out that most students performed poorly in the area of the selected topics of the course. Hence, these topics were selected to be used in the study. The average performance of students in each of the selected topics for some previous years is presented in Tables 3.3.

Table 3.3 Students' Average Performance from 2005/2006 to 2009/2010 Sessions

S/No.	Topics	Average No. Passed	Average No. Failed	Average % Pass	Average % Fail
1.	Characteristics of living things	42.0	46.8	47.232	52.768
2.	Plant and animal cells	41.4	47.4	46.414	53.586
3.	Bacteria in ecological cycle	38.6	50.2	43.342	57.058
4.	Mode of nutrition in fungi	42.2	46.0	47.440	52.560
Total		**164.2**	**190.4**	**184.428**	**215.972**

Source: Examination office, Department of Integrated Science, FCE, Katsina.

3.6 Instrumentations

For this research work, the following instruments were used:

a. NCE Students' Self-efficacy Questionnaire (NSSQ)

b. Integrated Science Achievement Test (ISAT)

3.6.1 NCE Students' Self-efficacy Questionnaire (NSSQ)

The Science Teachers' Efficacy Belief Instrument (STEBI) developed by Riggs and Enochs (1990), which is a 5 point-Likert-scale questionnaire and which has a reliability coefficient of 0.90, was adapted by making some adjustments such as:

- I can prepare an onion cell for viewing under a microscope.
- I can sketch and explain the diagram of nitrogen cycle.
- I wonder if I can explain the three forms of nutrition in fungi etc.

The adapted instrument consists of **20** statements and each has five options (i.e. Strongly Agree, Agree, Undecided, Disagree, and Strongly Disagree), (see appendix D). The instrument was revalidated and its new reliability coefficient value was determined as 0.96.

3.6.1.1 Validation of the Instrument (NSSQ)

The validation of the instrument was done by three senior lecturers with minimum qualification of PhD. Two of them are from science education department and other one is from psychology department, Ahmadu Bello University, Zaria. Also, two principal lecturers with the minimum qualification of master degree, from Integrated Science department of Federal College of Education, Katsina were involved in the validation of the same instrument.

The lecturers from the two institutions were asked to assess among other things the content validity of the instrument, language component of the instrument, appropriateness of the items in terms of reading difficulty level for the groups that they are meant for and clarity of statements in the instrument. The experts made constructive criticisms and corrections on the basis of content and face validity of the instrument and **20** items were selected out of **25** based on the validity result.

3.6.2 Integrated Science Achievement Test (ISAT)

Another instrument used for the study is the ISAT which was developed by the researcher himself. The instrument consists of 50 items and each has four options (A-D) in the multiple choice format (see appendix E). The questions covered all the four selected topics and the subjects are expected to answer all the questions. The instrument was validated and its reliability was also determined as 0.69

3.6.2.1 Validation of the instrument (ISAT)

This instrument (ISAT) was also validated by the same lecturers from science education department of Ahmadu Bello University, Zaria and Integrated Science department of Federal College of Education, Katsina who validated the NSSQ. The lecturers were asked to assess among other things the content validity of the instrument, language component of the instrument, appropriateness of the items in terms of reading difficulty for the groups that they are meant for and clarity of statements in the instrument and check possible errors in the suggested answers. The experts made constructive criticisms and corrections on the basis of content and face validity of the instrument and 50 items were selected based on the validity result.

The lesson notes prepared for teaching the experimental group (i.e. appendix A) and the control group (i.e. appendix B) as well as the corresponding marking scheme for the ISAT (i.e. appendix F) were also validated by the same lecturers who validated the instruments.

The items specification of content areas is presented in Table 3.4

Table 3.4 Items Specification Based on Content Areas

S/No.	Topics	Items	Total
1.	Characteristics of living things	11, 12, 13, 14, 15, 16, 26, 27, 38, 41, 42, 44, 49	13
2.	Plant and animal cells	1, 2, 3, 4, 5, 31, 32, 33, 34, 39, 40, 43, 50	13
3.	Bacteria in ecological cycle	6, 7, 8, 9, 10, 28, 29, 30, 45, 46, 47	11
4.	Mode of nutrition in fungi	17, 18, 19, 20, 21, 22, 23, 24, 25, 35, 36, 37, 48	13
Total			**50**

The items specification based on Bloom's (1956) taxonomy of cognitive level/objectives is also presented in Table 3.5

Table 3.5 Items Specification Based on Bloom's Taxonomy of Cognitive level

S/No.	Level	Items	Total
1.	Knowledge	1, 2, 3, 4, 7, 10, 27, 30, 31, 32, 34, 40, 43, 46, 49	15
2.	Comprehension	5, 6, 8, 9, 12, 13, 15, 17, 19, 23, 33, 41, 45, 47, 50	15
3.	Application	36, 37	02
4.	Analysis	18, 21	02
5.	Synthesis	11, 26, 29	03
6.	Evaluation	14, 16, 20, 22, 24, 25, 28, 35, 38, 39, 42, 44, 48	13
Total			**50**

3.7 Pilot Study

In the pilot study, two instrument; NCE Students' Self-efficacy Questionnaire (NSSQ) and Integrated Science Achievement Test (ISAT) were tested. The instruments were pilot tested

using 2010/2011 NCE II Integrated Science students of Federal College of Education (FCE), Kano. The pilot study was to:

i. find out the characteristics of ISAT through item analysis,

ii. determine the correct length of time required to do the test,

iii. determine the appropriateness of the wordings of the ISAT and the questionnaire items,

iv. find the reliability of both NSSQ and ISAT.

According to Iyang (1988) and James (2000) items with discrimination index which ranged from 0.30 to 0.4 are moderately positive and those above 0.49 are highly positive. The discrimination indices for all the items used for the Integrated Science Achievement Test (ISAT) fall within 0.29 to 0.71. This shows that the discrimination indices are highly positive, which implies that the ISAT is now suitable for what it meant for (i.e. testing the Integrated Science achievement of NCE students). Difficulty index of 75% or higher is regarded as easy in terms of difficulty level. Where the index is 25% or less, the item is hard in terms of difficulty level. In the Integrated Science Achievement Test (ISAT) the difficulty index that falls between the range 25% to 70% was retained. The pilot study result in respect of the difficulty (P) and discrimination (D) indices of the ISAT is presented in appendix G.

3.7.1 Reliability of the Instrument (NSSQ)

From the pilot study results, the reliability coefficient value for the instrument was re-determined to be 0.96. The value was obtained using test-retest reliability method by the application of Pearson Product-Moment Correlation Coefficient (PPMCC) statistic. Thus the instrument is reliable and used for data collection on self-efficacy in this study.

3.7.2 Reliability of the Instrument (ISAT)

The reliability of the instrument (ISAT) was also determined using test-retest method. The scores of the test (first test) were correlated with those of the retest (second test) using Pearson Product-Moment Correlation Coefficient (PPMCC) statistic and the reliability coefficient value of 0.69 was obtained for ISAT. An interval of two weeks was given between the first administration of the test and the second one. This is in line with Tuckman (1975) who recommended that a minimum interval of a week is advisable to be given before the administration of the second test so as to avoid influence of familiarity of research instrument.

On the basis of the reliability coefficient values (i.e. 0.96 and 0.69 for NSSQ and ISAT respectively) obtained from pilot testing of the instruments, the instruments are found to be reliable. This shows that they can be used for this study.

3.8 Treatment Administration

Both the experimental and the control groups were exposed to teaching for the period of 6 weeks of 2 hours per lesson per week. The two groups were taught by the researcher himself in order to give them equal chance and to avoid any dichotomy in the focus of the study and to minimize intervening variable(s).

The experimental group was taught using guided inquiry teaching method, while the control group in the control school was taught using lecture method. In the experimental class, the students were assigned to work in groups of eight (8) students per group for them to carry out some activities in accordance with the lesson plan. The lecture group in the other hand was not given `opportunity to carry out activities.

Two lesson notes, one for experimental group (See appendices A) and the other for control group (See appendices B) were prepared for each of the selected topics. Therefore, eight lesson notes were prepared altogether.

3.9 Data Collection Procedure

By the end of the treatment the students in the two groups were examined by the administration of the test instruments as posttest which lasted for one hour twenty (1:20) minutes. That is, 50 minutes for ISAT and 30 minutes for NSSQ based on the pretest duration. All the completed test sheets were collected and marked based on the marking scheme demand. The scores of the two groups were subjected to analysis.

3.10 Data Analysis

The data collected for this study were analyzed at $P \leq 0.05$ by re-stating the null hypotheses (H_O) as follows:

H_{O1}: There is no significant difference in the mean scores of self-efficacy of NCE students exposed to guided inquiry teaching method and those exposed to lecture method in Integrated Science. This hypothesis was analyzed using t-test statistic.

H_{O2}: There is no significant difference in the mean scores of self-efficacy of male and female NCE students exposed to guided inquiry teaching method in Integrated Science. To analyze this hypothesis t-test statistic was used.

H_{O3}: There is no significant difference in the mean scores of academic achievement of NCE students exposed to guided inquiry teaching method and those exposed to lecture method in Integrated Science. This hypothesis was analyzed using t-test statistic.

H_{O4}: There is no significant difference in the mean scores of academic achievement of male and female NCE students exposed to guided inquiry teaching method in Integrated Science. Again, this hypothesis was analyzed using t-test statistic.

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

This chapter contains data analysis, results presentation and discussion. The analysis involves statistical testing of the hypotheses stated in chapters one and three. The level of significance (alpha (α) level) used for the analysis is $P \leq 0.05$. This level of significance forms the basis for retaining or rejecting each of the null hypotheses.

4.2 Analysis and Results Presentation

The data collected for the purpose of this study were analyzed based on the research questions and hypotheses formulated.

Research Question 1: What is the effect of guided inquiry teaching method on the self-efficacy of NCE students in Integrated Science?

The data collected for the purpose of answering research question one was analyzed using descriptive statistics in form of mean and standard deviation as shown in Table 4.1a.

Table 4.1a: Mean Scores and Standard Deviation in NSSQ of the Experimental and Control Groups.

Group	N	$\overline{X}$	SD
Experimental	97	75.09	4.02
Control	103	61.03	4.84

Table 4.1a shows that there is a difference between the experimental and the control groups. From their mean scores, the experimental group performed better than the control group.

To test whether there was a significant difference or not in the mean scores of the experimental and control groups, Ho_1 was used which states as follows:

There is no significant difference in the mean scores of self-efficacy of NCE students exposed to guided inquiry teaching method and those exposed to lecture method in Integrated Science.

The Ho_1 was analyzed using t-test statistic at $P \leq 0.05$. The result is presented in Table 4.1b.

Table 4.1b: t-test of the Posttest Mean Scores of the Experimental and Control Groups on Self-efficacy Questionnaire

Group	N	$\overline{X}$	SD	df	t-value	P-value	Remark
Experimental	97	75.09	4.02				
				198	22.27	0.00	*Significant
Control	103	61.03	4.84				

*Significant at $P \leq 0.05$

The result in Table 4.1b reveals that the t-value calculated is 22.27 and the P-value observed is 0.00 at degree of freedom (df) = 198. Since the P-value observed (0.00) is less than P 0.05, it means that there is a significant difference in the mean scores of the experimental and the control groups. The significant difference is in favour of the experimental group exposed to guided inquiry teaching method as indicated by the mean scores. The null hypothesis which stated that there is no significant difference in the mean scores of self-efficacy of the two groups is therefore rejected.

Research Question 2: What is the difference in the mean scores of self-efficacy of male and female NCE students exposed to guided inquiry teaching method in Integrated Science?

For the purpose of answering research question two, the data collected was analyzed using descriptive statistics in form of mean and standard deviation as presented in Table 4.2a.

Table 4.2a: Mean Scores and Standard Deviation in NSSQ of Males and Females in the Experimental Group.

Group	N	$\overline{X}$	SD
Males	51	76.92	3.67
Females	46	73.07	3.68

Table 4.2a reveals that there is difference between the males and the females in the experimental group. From their mean scores, the males performed better than the females.

Ho_2 was used to test for significant difference in the mean scores of self-efficacy of males and females in the experimental group. The hypothesis states as follows:

There is no significant difference in the mean scores of self-efficacy of male and female NCE students exposed to guided inquiry teaching method in Integrated Science.

The Ho_2 was analyzed using t-test statistic at $P \leq 0.05$. The result is presented in Table 4.2b.

Table 4.2b: t-test of the Posttest Means Scores of Males and Females in the Experimental Group on Self-efficacy Questionnaire

Group	N	$\overline{X}$	SD	df	t-value	P-value	Remark
Males	51	76.92	3.67				
				95	5.17	0.00	*Significant
Females	46	73.07	3.68				

*Significant at $P \leq 0.05$

Table 4.2b shows that the t-value calculated is 5.17 and the P-value observed is 0.00 at df = 95. Since the P-value observed (0.00) is less than P 0.05, it means that there was a significant difference in the self-efficacy of males and females in the experimental group. As indicated by the mean scores, the significant difference is in favour of the males. The null hypothesis which stated that there was no significant difference in the mean scores of self-efficacy of the two sexes is therefore rejected.

Research Question 3: What is the effect of guided inquiry teaching method on academic achievement of NCE students in Integrated Science?

The data collected for the purpose of answering research question three was analyzed using descriptive statistics in form of mean and standard deviation as shown in Table 4.3a.

Table 4.3a: Mean Scores and Standard Deviation in ISAT of the Experimental and Control Groups.

Group	N	$\overline{X}$	SD
Experimental	97	37.40	6.46
Control	103	33.07	7.79

Table 4.3a shows that there is difference between the experimental and the control groups. From their mean scores, the experimental group performed better than the control group.

To test whether there was a significant difference in the mean scores of the experimental and the control groups, Ho_3 was used, which states that:

Ho_3: There is no significant difference in the mean scores of academic achievement of NCE students exposed to guided inquiry teaching method and those exposed to lecture method in Integrated Science.

The Ho_3 was analyzed using t-test statistic at $P \leq 0.05$. The result is presented in Table 4.3b.

Table 4.3b t-test of the Posttest Mean Scores of the Experimental and Control Groups on Integrated Science Achievement Test (ISAT)

Group	N	$\overline{X}$	SD	df	t-value	P-value	Remark
Experimental	97	37.40	6.46	198	4.27	0.00	*Significant
Control	103	33.07	7.79				

*Significant at $P \leq 0.05$

From Table 4.3b the result of the analysis revealed that the t-value calculated is 4.27 and the P-value observed is 0.00 at df = 198. Since the P-value observed (0.00) is less than P 0.05, it means that there was a significant difference in the mean scores of the experimental and the control groups. The significant difference is in favour of the experimental group exposed to guided inquiry teaching method as indicated by the mean scores. The null hypothesis which stated that there was no significant difference in the mean scores of academic achievement of the two groups is therefore rejected.

Research Question 4: What is the difference in the mean scores of academic achievement of male and female NCE students exposed to guided inquiry teaching method in Integrated Science?

The data collected for the purpose of answering research question four was analyzed using descriptive statistics in form of mean and standard deviation as in Table 4.4a

Table 4.4a: Mean Scores and Standard Deviation in ISAT of Males and Females in the Experimental Groups.

Group	N	$\overline{X}$	SD
Males	51	37.25	7.05
Females	46	38.00	6.16

Table 4.4a revealed that the difference between males and females in the experimental group was negligible. From their mean scores, neither the males nor the females performed better than the other.

Ho_4 was used to test for significant difference in the mean scores of academic achievement of males and females in the experimental group. The hypothesis states as that:

There is no significant difference in the mean scores of academic achievement of male and female NCE students exposed to guided inquiry teaching method in Integrated Science.

The Ho_4 was analyzed using t-test statistic at $P \leq 0.05$. The result is presented in Table 4.4b.

Table 4.4b t-test of the Posttest Means Scores of Males and Females in the Experimental Group on Integrated Science Achievement Test (ISAT)

Group	N	$\overline{X}$	SD	df	t-value	P-value	Remark
Males	51	37.25	7.05				
				95	0.55	0.58	*Not Significant
Females	46	38.00	6.16				

*Not Significant at $P \leq 0.05$

The results presented in Table 4.4b reveals that the t-value calculated is 0.55 and the P-value observed is 0.58 at df = 95. Since the P-value observed (0.58) is greater than P 0.05, it indicates that there was no significant difference in the mean scores of males and females in the experimental group. The null hypothesis which stated that there was no significant difference in the mean scores of academic achievement of male and female NCE students exposed to guided inquiry teaching method in Integrated Science is therefore retained.

4.3 Summary of Findings

The following are the findings after the statistical analysis of the data collected in the course of this study:

1. There is a significant difference in the self-efficacy of NCE students exposed to guided inquiry teaching method and those exposed to lecture method in Integrated Science. The observed difference is in favour of the experimental group (i.e. those exposed to guided inquiry teaching method). This finding answered the stated research question number one.
2. There is a significant difference in the self-efficacy of male and female NCE students exposed to guided inquiry teaching method in Integrated Science. i.e. in the experimental group). The difference is in favour of the males' group. This finding answered the stated research question number two.
3. There is a significant difference in the academic achievement of NCE students exposed to guided inquiry teaching method (i.e. experimental group) and those exposed to lecture method (control group) in Integrated Science. As indicated by the mean scores, the difference is in favour of the experimental group. This finding answered the stated research question number three.
4. There is no significant difference in the academic achievement of male and female NCE students exposed to guided inquiry teaching method (i.e. the experimental group) Integrated science. As indicated by the mean scores, neither the males nor the females performed significantly better than the other. This finding answered the stated research question number four.

4.4 Discussion of the Results

This study investigated the effect of guided inquiry teaching method on self-efficacy and academic achievement of NCE students. The data collected from the test administered were analyzed using t-test statistic at $P \leq 0.05$ level of significance. The t-test statistic was used to test

if there was significant difference between the mean scores of the group exposed to guided inquiry teaching method (experimental) and that which was exposed to lecture method (control). This was done in relation to both the self-efficacy and academic achievement of the two groups. The mean scores of males and females in the experimental group were also tested using t-test statistic to determine if there was significant difference in both the self-efficacy and academic achievement of the two sexes. The analysis addressed the research question, formulated hypotheses and the design of the study.

The result from Table 4.1b revealed that there was a significant difference in the mean scores of self-efficacy of NCE students exposed to guided inquiry teaching method (i.e. experimental group) and those exposed to lecture method (control group). The difference is in favour of the experimental group. The significant difference found between the two groups was likely due to the use of guided inquiry teaching method on the experimental group. If the treatment administered has no effect, the two groups are expected to perform equally the same since they were both pretested and found to be of equivalent.

The finding of this study is in line with the Palmer's (2006) findings of his longitudinal studies with pre-service teachers in Turkey in which he determined the effectiveness of guided inquiry teaching method on their self-efficacy and performance in their micro-teaching. He found that the method had increased pre-service teachers' confidence about their ability to perform teaching behaviour after their exposure to the instruction. Palmer (2006) also interviewed his students and reported that there were strong positive changes in self-efficacy as a result of using the approach. The finding also confirms those of Akerson, Hanson and Cullen (2007) in which they observed that pre-service teachers who experienced guided inquiry as part of instructional framework improved in their prior ideas of science teaching and felt that this has

increased their knowledge and confidence on how to teach science, hence improved in their self-efficacy. The result is in agreement with that of Ozdilek and Bulunuz (2009) who also conducted similar study in Turkey and reported that teachers improved their scores after exposure to guided inquiry in the science laboratory course and that their self-efficacy could be improved by appropriate teaching approaches such as guided inquiry. Liang and Richard (2009) reported the positive effects that inquiry-oriented science learning and teaching have on pre-service teachers' understanding of the nature of attitudes and beliefs about science learning and teaching and their classroom teaching performance.

Results from this study as presented in Table 4.2b indicated that there was a significant difference in the mean scores of self-efficacy of male and female NCE students exposed to guided inquiry teaching method in Integrated Science. The results showed that the males performed significantly better than the females, meaning that males showed a high sense of self-efficacy in Integrated Science than the females. Therefore, the results reflect a clear relationship between self-efficacy and academic productivity.

The findings of this study support those of Pajares and Miller (1994), Debacker and Nelson (2000) which revealed that male students at high school and college tend to be more efficacious than females. In a year-long inquiry-based physics course, Cavallo et al (2001) found significant gender difference in students' science self-efficacy. They reported that male students began the course with significantly higher self-efficacy and ended the course also with higher self-efficacy than their female counterparts. The result is also consistent with Wigfield et al (1991) in Britner (2002) who reported that boys tend to be more efficacious than do girls during the middle school years.

However, the results contradict the findings of Ravikumar and Manimozhi (2001) who worked with the students of biological sciences at Cuddalore district of Tamil Nadu, India. They reported that the self-efficacy in equipmentation of boys and girls is almost equal among the biology students of Cuddalore. The results also disagree with Wigfield et al (1991) in Britner (2002) who observed that in the area of mathematics and science, boys and girls report equal confidence during the elementary years. Kiran and Sungur (2912) established that no gender difference was found concerning science self-efficacy. Louis and Mistele (2012) reported that when controlled for self-efficacy, females hold lower self-efficacy in mathematics than males and in science there was no difference between females and males in terms of self-efficacy.

The results of the present study also showed inconsistency with other researches which reported a situation different from the above. For instance, Britner and Pajares (2001) reported higher science self-efficacy among middle school girls than among middle school boys. Also, in their study on sources of science self-efficacy beliefs of middle school students, Britner and Pajares (2006) found that girls reported stronger science self-efficacy than did boys.

The results from 4.3b revealed that there was a significant difference in the mean scores of academic achievement of the group exposed to guided inquiry teaching method (experimental) and the one exposed to lecture method (control). The significant difference found between the two groups was in favour of the experimental group.

The finding of this study is in agreement with those of Ellington (1996) and Arisi (2002) who found that methods such as Advance Oganisers (ADO), Problem-Solving Inquiry (PSI) and Activity Discussion Methods among others had positive significant effects on students' academic achievement in Social Studies when compared to lecture method. The findings also confirms those of James (2000) , Usman (2000), and Duwan (2010 & 2011) who suggested the use of

inquiry teaching method in improving/remediating problems of poor academic achievement in Primary science, junior Secondary Integrated Science and biology at both senior secondary and Nigeria Certificate in Education (NCE) levels.

The results presented in Table 4.4b revealed that there was no significant difference in the mean scores of academic achievement of male and female NCE students exposed to guided inquiry teaching method in Integrated Science. This means that neither the males nor the females performed significantly better than the other as indicated by the mean scores.

The result of this study is in support of those of Valanide (1996) who reported that there was no difference in how males and females engage in reasoning process. Usman (2000) found out that there was no gender difference in the academic achievement of students when exposed to activity-based methods of instruction such as discovery, problem-solving, process approach, among others. Freedman (2002), David and Stanley (2002), Sungur and Tekkaya (2003), Bile Sanmi – Awoderu (2006) and Afuwape and Oludipe (2008) also reported that there are no longer distinguishing difference in the cognitive, affective and psychomotor skill achievements of students in respect of gender. The results of the present study showed inconsistency with Ayodele's (2009) who reported that there was no significant difference between male and female achievement in private and public schools. Ameh and Dantani (2012) also revealed that boys and girls are equally better in academic achievement when taught using demonstration method than when lecture method was used.

However, the results contradict those of Njoku (2003) in Nworgu (2005) who observed that male students performed significantly better than female students in Integrated Science. OneKutu and Onekutu (2002) and Eriba and Sesugh (2006) have also reported that boys outperformed girls in science and mathematics achievement. Louis and Mistele (2012) reported

that there is a statistically significant difference in the achievement scores of earth science, physics and biology between males and females, where males scored higher in science subjects.

The difference in males and females achievement in favour of males might be due to the fact that males are more willing and eager to face difficult situation/event or risk with a sense of confidence and fearlessness than females. Also, teachers view boys as more independent thinkers and more likely to do better in mathematics and science.

Still, in the area of academic achievement as it relates to gender, other researchers reported differently from the present study and from the above researches as well. For instance, Lee and Burkam (1996) who have reported that females benefited much more than boys did from laboratory experiences. Orabi (2007) observed that females are outperforming males across a range of subjects. Another studies such as Alkhateeb (2001), Bleuer and Waltz (2002), Weaver – Hightower (2003) Omoniyi (2006) established that males are becoming the disadvantaged gender in schools, and that fewer males are interested in science. Olagunju and Balogun (200) reported that females in the control group performed better than males in the same group. Orabi (2007) observed that females are outperforming males across a range of subjects. Also, Akinsola (2007) observed that females outperformed males in Integrated Science at junior secondary school level. Louis and Mistele (2012) reported that a statistically significant difference was found in the academic achievement scores between males and females by subjects, were females scored higher in Algebra, but males scored higher in other mathematics subjects.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The study investigated the effects of guided inquiry teaching method on NCE students' self-efficacy and academic achievement in Integrated Science at colleges of education in North-West geopolitical zone of Nigeria. The data collected were analyzed using t-test statistic. This chapter is presented under the following sub-headings:

- Summary
- Summary of Major Findings
- Conclusion
- Recommendations
- Contribution to Knowledge
- Limitations of the study
- Suggestions for further studies

5.2 Summary

The study attempted to find out the effect of guided inquiry teaching method on NCE Students' self-efficacy and academic achievement in Integrated Science. The subjects for the study were NCE II Integrated Science students of Federal College of Education, Katsina and Isah Kiata College of Education, Dutsin-ma. Simple random technique involving balloting method was employed in selecting the sample. Four research questions were stated and four null hypotheses were formulated and tested using t-test statistic.

Relevant literatures related to the study were reviewed and these provided insight into already existing problem. A 20 items NCE Students' Self-efficacy Questionnaire (NSSQ) using the likert scale was used as one of the two instruments for the study. The other was the Integrated Science Achievement Test (ISAT) which contained 50 items (i.e. multiple choice questions). The two instruments were validated and the facility and discrimination indices of the achievement test (ISAT) were determined. A pre and post tests design was used for the study using two groups, experimental and control. Guided inquiry teaching method was used in teaching the experimental group while the control group was taught using normal lecture method.

5.3 Summary of Major Findings

The following are the major findings after the analysis of data collected for the study:

1. There is a significant difference in the mean NCE Students' self-efficacy questionnaire scores of students exposed to guided inquiry teaching method compared to their counterpart exposed to lecture method of instruction in Integrated Science. The observed difference was in favour of the experimental group (i.e. those exposed to guided inquiry teaching method).
2. There is a significant difference in the mean NCE Students' self-efficacy questionnaire scores of male and female students in the experimental group (i.e. those exposed to guided inquiry teaching method). The significant difference was in favour of the males.
3. There is a significant difference in the mean academic achievement scores of students exposed to guided inquiry teaching method (i.e. experimental group) compared to those exposed to lecture method (i.e. control group). The significant difference observed was in favour of the experimental group.

4. There is no significant difference in the mean academic achievement scores of male and female students in the experimental group (i.e. those exposed to guided inquiry teaching method). That is, Male and Female NCE students exposed to guided inquiry teaching method performed equally the same in Integrated Science.

5.4 Conclusion

The present study aimed to determine the effectiveness of guided inquiry teaching method on self-efficacy and academic achievement of NCE Integrated Science students. From the findings of the study, it is concluded that:

i. There is a difference in the self-efficacy of NCE Integrated Science students exposed to guided inquiry teaching method and those exposed to lecture method of instruction. The observed difference is in favour of the experimental group (i.e. the group exposed to guided inquiry teaching method).

ii. There is a difference in the self-efficacy of male and female NCE Integrated Science students exposed to guided inquiry teaching method. Males showed a higher sense of self-efficacy than females.

iii. There is a difference in the academic achievement of NCE Integrated Science students exposed to guided inquiry teaching method (i.e. experimental group) and those exposed to lecture method (i.e. control group). As indicated by the mean scores, the difference is in favour of the experimental group.

iv. There is no difference in the academic achievement of male and female NCE Integrated Science students in the experimental group (i.e. exposed to guided inquiry teaching method). In other word, neither males nor females performed significantly better than the other.

In the light of the findings, it is also concluded that:

v. Guided inquiry teaching method has the potential of improving the self-efficacy and academic achievement of students in Integrated Science at NCE level, as well as their confidence as teachers when they finish school and they begin to teach. The implication of this is that the graduate NCE teachers will likely use this method to teach their own students in the primary and junior secondary classes and not the usual didactic lecture method. This is because teachers often teach the same way in which they have been taught.

vi. Since neither the male nor the female NCE students performed significantly better than the other in Integrated Science Achievement Test (ISAT), it means that gender has no influence on the students' academic achievement in Integrated Science. This implies that hopefully the gender gap in integrated science achievement in Nigeria is disappearing.

vii. Students activities are better than teacher activities in promoting authentic learning of Integrated Science, an activity – oriented course especially at NCE level, the product of which are expected to handle science teaching at primary and junior secondary school levels. In other word, the nature of science teaching affects both the self-efficacy and academic achievement of students.

5.5 Recommendations

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

1. Since teachers often teach the same way in which they are taught, activity-based methods of instruction such as guided inquiry should be used in teaching NCE students so that they can also be confident in using the methods when in class with their students.

2. Science teachers who are already in the field should be sponsored for training and retraining through attending seminars/workshops on regular basis so as to acquaint them with the new trends in science teaching, more especially as it relates to the use of activity-based methods of instruction such as guided inquiry.
3. Government agencies such as Federal Ministry of Education, National Commission for College of Education and other stakeholders in educational sector should provide adequate and relevant instructional materials for effective utilization of inquiry method of instruction in teaching and learning of Integrated Science at NCE level.
4. Curriculum planners should make some modifications which will ensure that lecturers in the Colleges of Education give the students the actual experience in using guided inquiry teaching method among other activity – based methods of instruction.
5. Teachers should ensure provision of equal opportunities and respect for differences in the classroom so as to encourage and enable female students work hand in hand with their male counterpart especially during the activity section of the science class/lesson.
6. Non Governmental Organizations (NGOs) and Parent Teachers Association (PTA) should also assist in provision of instructional materials for effective utilization of activity-based methods of instruction such as guided inquiry.

5.6 Contribution to Knowledge

Science education is dynamic. It changes base on frontier of new knowledge which makes it to be dynamic. Based on this several studies were carried out on inquiry method of teaching. These studies focused mostly either on secondary school students (both junior and senior) or NCE biology students and also some were based on academic achievement and creativity and attitudes. The present study was carried out on guided inquiry teaching method in different dimension; that is using Integrated Science students at NCE level and in another different variable such as self-efficacy. The researcher from his findings now provides new innovation that yield a better achievement of NCE Integrated Science students as well as developing their self-efficacy. Without taking cognisance of the importance of self-efficacy, the aspect of academic achievement of Integrated Science students at NCE level may be at fault. Therefore this study provides new area where guided inquiry teaching method has positive impact.

5.7 Limitations of the Study

One major limitation of the study is that the samples used were the NCE II Integrated Science students of Federal College of Education, Katsina and Isah Kaita College of Education, Dutsin-ma. This has limited the application of the findings to only those students. The results and the conclusions are restricted to the population from which the sample was drawn. The findings might be different or otherwise if there were a large samples or if Colleges from other states of the zone or from different geopolitical zone of the country were used. However, other limitations are the followings:

i. Only government (i.e. State and Federal) Colleges of Education were used. Private Colleges of Education were not involved to see what the result would be.

ii. Although the lessons used were clearly planed and validated, the fact that they were taught by the researcher himself might be a limitation.

iii. Attendance to every lesson by all the students/participants in the experimental and control Colleges/groups was not always hundred percent (100%) throughout the treatment period.

iv. The distance of about sixty five (65) kilometers which the researcher had to cover on every lesson's day between the experimental and control Colleges might be another limitation.

5.8 Suggestions for Further Studies

1. It is suggested that similar study/work should be carried out in other colleges of education in other states or zones of the federation so that the validity and scope of generalization made in this study can be extended.
2. The effectiveness of guided inquiry teaching method on NCE Students' self-efficacy and academic achievement in Integrated Science only, was investigated. Therefore, there is the need to try the method in other disciplines such as Biology, Physics and Chemistry among others to see what the result will be.
3. The use of other activity-based methods of instruction such as process approach, discovery, laboratory, experimental, among others should be tried in relation to the self efficacy and academic achievement of Integrated Science students at NCE level to see if they too have the potentiality of improving the self-efficacy and academic achievement of such students at this level.
4. Since teachers teach the way they were taught and that this study was carried out on NCE students who are still under-training, it should be replicated using teachers

who are already in the field so as to assess their level of Integrated Science teaching efficacy for the purpose of greater generalization, particularly in the use of activity-based method(s) of instruction. This can be achieved through workshop, seminar, symposium or conference attendance.

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APPENDIX A

LESSON NOTES FOR EXPERIMENTAL GROUP

LESSON ONE - Week 1

Group - Experimental

Class Level - N.C.E. II

Subject - Integrated Science

Course - ISC 211, Component of the environment II

Topic - Characteristics of living things

Duration - 2 hours

Instructional materials: - An uprooted flowering plants, some living animals in the aquarium and around the class such as cockroach, house fly, bird, spider, bean seedlings, slides, light microscope, stone, book, seed, e.t.c.

Behavioural objectives: - By the end of the lesson, the students should be able to:

a) State what living things are or can do

b) List five characteristics of living things

c) Compare characteristics of human beings with those of other living things

d) Identify living organisms

Previous knowledge: The students are familiar with the classification of things

Introduction: The teacher introduces the lesson by asking the students the following questions:

a) What are the observable differences between a man and a stone?

b) What is the main difference between the mechanism of movement in man and a car?

Presentation:

Step I: The teacher asks the students to bring some things they consider living/non-living.

Step II: The teacher asks them why they consider the things they brought as living/non-living.

Step III: The teacher leads the students on to the definition of living things and non-living things and asks them to give some examples of living things.

Step IV: Here the students are to identify some activities they observe living things can do which non-living things cannot do. The teacher reinforces the students' responses and then states that the characteristics of living things include: ability to move, to respire, to feed, to respond to external stimuli, to grow, to excrete, and to reproduce with brief explanation of each character

Activity I: Living or non-living?

The students are to study the activities in "a" below and use it to answer the following questions:

a) Running, growth movement, feeding, respiration, excretion, reproduction, sensitivity, growth.

i) Which of the following objects perform any or all the activities listed in "a" above?

Book, spider, Water, human, television, tree, dog, stone, wooden wheel, seed,

Objects	Activity performed

ii) Which of the objects cannot perform any of the activities and why?

Step V: The students receive a brief exposition on "growth" as a characteristic of living things, using the bean seedlings which have been previously planted at different time.

Step VI: The teacher asks the students to watch the moving animals in and around the class as well as in the aquarium to show that "locomotion" is one of the characteristics of living things but more noticeable in animals which have to search for their food.

Evaluation: The teacher asks the following questions to check for understanding of the lesson:

i) What do you understand by the term living things?

ii) List five characteristics of living things

iii) Compare the characteristics of human beings with those of other living things

iv) What living things can you identify both in the aquarium and around the class?

Summary: The teacher reinforces the students' responses to the above questions and writes them out on the board.

Assignment: The teacher asks the students to match the following words in the left-hand column with those in the right-hand column during the lesson period in the class.

Locomotion	getting rid of poisonous waste
Excretion	releasing energy from food
Reproduction	feeding
Nutrition	responding to stimuli
Sensitivity	movement from place to place
Respiration	producing offspring

LESSON TWO AND THREE - Week 2 &3

Group - Experimental

Class Level - N.C.E. II

Subject - Integrated Science

Course - ISC 211, Component of the environment II

Topic - Plant and animal cells

Duration - 2 hours

Instructional materials:- Charts of plant and animal cells, a microscope, slides, cover slips, a wooden spatula, methylene blue stain, iodine solution,an onion, tissue paper, iodine solution, sharp knife, permanent slides

Behavioural objectives: - By the end of the lesson, the students should be able to:

a) Explain what a cell is

b) Prepare cheek cells and onion cells for viewing under a microscope

c) Draw and label both plant and animal cells

d) List the organelles that are common to both plant and animal cells

e) Differentiate between plant and animal cells

Previous knowledge: - Students are familiar with living and non-living things as well as their characteristics.

Introduction: - The teacher introduces the lesson by asking the students the following questions:

a) Which of the characteristics of living things is more noticeable in animals than in plants?

b) State any three observable differences between living and non- living things

Following the students responses which the teacher reinforces, the teacher then explains to the students that living things (plants and animals) are made of cells.

Presentation:

Step I: The teacher asks the students to explain what a cell is. Following the students responses which the teacher reinforces, he then states that a cell is a unit structure and function of life. In other word, it is the smallest functional and structural unit of life. It is a substance upon which living things are formed. It is therefore found in both plants and animals.

Step II: The teacher instructs and guides the students on how to prepare onion and cheek cells for viewing under a microscope.

Students' activity 2: Viewing onion cells with a microscope

Items/materials needed: Microscope with slides and cover slip, an onion, iodine solution, tissue paper and sharp knife.

The teacher divides the students into groups and under his guide and supervision; each student in each group is to prepare both plant and animal cells using the following procedures:

Plant cell preparation procedure:

The teacher asks each student in each group to do the following while he goes round at each step to supervise and guide the students:

- Select an onion bulb; discard the brown dry outer scales.
- Take a sharp knife or razor blade and cut the onion bulb into four pieces (quarters) vertically. Remove one fleshy scale.
- Bend the outer (convex) surface of the flushing scale towards you with your right hand to break it.
- Generally pull the broken end. You will find that from other half of the scale hold in your left hand, a thin transparent layer of epidermis is peeling off easily.

- If the peal is large, use a fine pair of scissor or a blade to cut a small piece of about 2mm. To do this place the peel in a drop of water on a clean slide and trim it.
- If there are many wrinkles in the peel, stretch it with the help of dissecting needle.
- Place this neatly cut (i.e. the specimen) on the centre of a clean slide.
- Add a fresh drop of water or designated stain if required. (Note: liquid cultures do not require adding water).
- Place one edge of the cover slip on the slide near the specimen. Gently lower the cover slip on top of the specimen. You may want to use dissecting needle to help lower the over slip. Try to avoid air bubbles in the process.
- Blot (soak out) any excess fluid on the slide with tissue or lens paper.
- Mount/place the slide on the stage of the microscope.
- Use a low power objective lens and adjust for viewing (i.e. examine the slide under low power of the microscope.

What do you observe?

- Draw a diagram of what you observe.
- Adjust the objective lens to medium or high power and observe again
- With the help of the charts/ diagrams provided, draw and label the diagram of what you observe
- After you have made your observations the slide and cover slip should be washed, dried and replaced in their appropriate locations.

Precaution

i. Do not leave the peel too long in air, otherwise it will dry and show air bubbles in it.

ii. The peel should be mounted in the centre of the slide.

iii. Always use a brush (not a needle) to transfer the peel from petridish to the slide or from one slide to another. Otherwise, the peel will tear off.

iv. Avoid the entry of any air-bubbles in the mount.

v. Use clean slides and cover slips for mounting.

Students' activity 3: Viewing cheek cells with a microscope

Items/materials needed: A microscope with slide and cover slip, a wooden spatula, tissue paper, methylene blue stain.

Note: - The spatula should only be used once by one person and then thrown away.

Animal cell (human cheek cells) preparation procedure:

The teacher asks each student in each group to do the following while he goes round at each step to supervise and guide the students:

- Take a clean tooth pick/wooden spatula/uncoated end of a matchstick and gently scrape the inner lining of your check. Its tip would collect some viscous transparent substance.
- Smear (spread) this substance on a slide.
- Add a drop of water to the smear and also a drop or tow of methylene blue stain.
- Leave for about one minute.
- Tilt the slide to let the extra stain drain off. Wash gently with water.
- Put a cover slip gently over the material with the help of a needle avoiding entry of any air bubbles.
- Press the cover slip gently with a needle to make the cells under the cover slip uniform.
- Soak away any extra stain with tissue paper or by placing the slide within a folded filter paper, taking care not to move the cover slip.

- Examine /observe the slide under a microscope using low power.
- Draw a diagram of what you observe.
- Adjust the objective lens to medium or high power and observe again.
- Draw a diagram of what you observe.
- Compare the charts/diagrams provided with the slide as seen under the microscope.

Precautions

- Scrape the inner surface of the check gently to avoid any damage or bleeding.
- See that you do not break the cover slip.
- While removing the extra stain, make sure you do not move the cover slip and the materials under it.

Step III: The teacher pastes the charts of both plant and animal cells on the board and asks the students to critically observe each chart and compare it with what they have drawn from the microscope. He then uses the charts and the permanent slides to explain the organelles present in each of the two cells.

Step IV: Here the students are to observe the charts carefully again with a view to identifying the organelles that are common to both plant and animal cells. The teacher reinforces the students' responses and then states that the organelles that are common to both cells include: cell membrane, mitochondria, golgi body, ribosome, endoplasmic reticulum, vacuole, nuclear membrane, cytoplasm, nucleus, and nucleolus.

Step V: The leads the students on to the differentiation between plant and animal cells. This is by comparing the two charts presented along with the two different diagrams drawn from the microscope.

Evaluation: The teacher evaluates the lesson as follows:

a) Explain briefly what a cell is

b) In the preparation of cheek cells for viewing under a microscope, why should the spatula be used only once, by one person and then thrown away?

c) List any five organelles common to both plant and animal cells

d) In a tabular form, distinguish between plant and animal cells e.t.c.

Summary: The teacher summarizes the lesson by highlighting that:

a) No two persons should use same spatula to scrape the inner lining of their cheeks for viewing under a microscope. This is to avoid infection of any disease

b) Plant and animal cells can be differentiated as follows:

S/NO	Plant cell	Animal cell
1	Cellulose cell wall present	Cellulose cell wall absent
2	Plastids (chloroplasts) present	Plastids (chloroplasts) absent
3	Vacuoles are few and large	Vacuoles are many and small
4	Have definite shape	No definite shape
5	Protoplasm less dense	Protoplasm denser
6	Store food as starch	Store food as glycogen
7	Have cell sap in their vacuoles	Have no cell sap in their vacuoles

LESSON FOUR AND FIVE - Week 4 &5

Group - Experimental

Class Level - N.C.E. II

Subject - Integrated Science

Course - ISC 211, Component of the environment II

Topic - Mode of nutrition in fungi

Duration - 2 hours

Instructional material: Water, slices of bread, yeast, mushroom, bracket fungi, petri dish, glass container, hand lens, microscope, slide, cover slip, methylene blue and charts of some fungi.

Behavioural objectives: By the end the lesson, the students should be able to:

a) Explain what nutrition is.

b) Identify and explain the forms of nutrition in fungi.

c) State and explain the type of fungal parasites

d) Cultivate and observe pin mould (mucor) on bread.

e) List some digestive enzymes being produced by fungal saprotrophs.

f) Identify and explain the two types of mutualistic union being made by fungi.

Previous knowledge: Students are familiar with some fungi, their characteristics, occurrence, and uses as food and in industry.

Introduction: The teacher introduces the lesson by asking the students the following questions:

a) How many types of fungi do you know?

b) State the two common characteristics of fungi.

c) Identify at least 4 places where fungi can be found and state the 2 major conditions that enable fungi to occur in abundance in a place. e.t.c.

The teacher reinforces the students' responses and then explains that, like any other living organisms, fungi also require food material for metabolic activities to take place in them.

Presentation:

Step I: The teacher asks the students to explain the term nutrition being one of the characteristics of living things. Following their responses which the teacher reinforces, he then highlights that in fungi, nutrition is based on absorption of organic matter. It is the process by which living organisms obtain and utilize materials from external environment for metabolic activities such as respiration, growth, excretion and reproduction.

Step II: The teacher points out that living organisms have evolved different modes of nutrition. In the case of fungi, nutrition can be parasitic, saprophytic, or symbiotic (mutualistic).

Step III: The teacher asks the students to give a brief explanation of each of the three forms of nutrition stated above. He reinforces their responses and then highlights that:

Parasitic nutrition- is one in which one organism obtains food from another organism and during the feeding process the organism providing food, protection, and shelter is harmed and is called the **host**, while the benefiting organism is called the **parasite**. The host-parasite relationship is known as **parasitism**.

Saprophytic nutrition- is one in which an organism feed on dead and decaying organic matter. Enzymes are secreted from the cells of the saprophytic organisms (saprophytes) to the dead organic matter and the digestion of the dead organic matter is extracellular. The digested and soluble food substances are then absorbed.

Symbiotic nutrition- is one in which two organisms of different species live together to take advantage of each other. In some cases the two organisms become so dependent on each other

that each one cannot live independent of the other .This type of association is called **symbiosis** or **mutualism.**

Step IV: The teacher explains to the students that fungal parasites may be:

1. **Facultative** (temporary) - these are parasites that can infect a host, bring about its death and then live saprophytically on the remains. That is they do not depend on their hosts for survival, e.g. Bracket fungi, and lichens.
2. **Obligate-** these are parasites that can only survive and grow in living cells. That is they are incapable of living as saprotophs. Therefore, they are strictly restricted to their host for their survival, e.g. bacteriophage.
3. **Biotrophic** (biotrophs)- is a fungus which is parasitic on another fungi and which does not kill its host, but feeds on the living cells.
4. **Necrotrophic** (necrotrophs)- is a fungus also parasitic on another fungi but in this case it kills its host and feeds on the dead cells.

Step V: Activity 5: Cultivating and observing pin mould (mucor) on bread.

Items/materials needed: Water, slices of bread, petri dish, glass container, hand lens, microscope, slide and cover slip, methylene blue.

The teacher leads and guides the students on how to conduct the activity going by the steps below. That is each student in each group is to:

- Sprinkle water on the surface of a slice of bread that has been exposed to air for some time
- Put the bread in a petri dish, cover it with a glass container and put it in a dark warm place
- Using a hand lens, observe the bread daily and record your observation

Teacher's question:

- What can you observe on the surface of the bread?
- Draw and describe the structure of what you observe

Teacher's questions:

- How long does it take for the mould to appear on the bread?
- How long after the first appearance of the mould are the sporangia (spore cases) formed?
- Scrape a little of the mould from the bread and place it on the microscope slide
- Add a drop of water and cover it with a cover slip or add a drop of methylene blue stain to colour the living cells
- Observe the material under the low power of the microscope and under medium/high power
- Describe the appearance and shape of the mould
- Make a drawing showing the structure of the mycelium
- Examine a hypha under high power objective

Teacher's questions:

- Does it have cross walls dividing it up into cells?
- Does it have chloroplasts?
- Are the nuclei scattered or clumped in the cytoplasm?
- Crush the sporangium and examine the spores under high power objective of microscope

Teacher's questions:

- What is the shape of the spores?

- Do the spores contain a single nucleus or many nuclei?

Step VI: The teacher explains to the students that fungal saprotrophs produce a variety of digestive enzymes that can enable them utilize a wide range of substrates. Such enzymes include:

Carbohydrase- digests carbohydrates e.g.

- Maltase- changes maltose to glucose
- Sucrose- changes sucrose to glucose and fructose
- Lactase- changes lactose to galactose and glucose
- Ptyalin- changes starch to maltose sugar

Lipases (digest lipids) i.e. they act on fats and oils changing them into fatty acids and glycerol

Proteases (digest proteins). These enzymes act on proteins changing them into amino acids. The proteases include:

- Pepsin- changes proteins to peptones
- Rennin- coagulates milk proteins
- Trypsin- also changes proteins to peptones
- Erepsin- changes proteins to amino acids

Step VII: The teacher asks the students to give a brief explanation of a symbiotic union/relationship. Following the students' responses which the teacher reinforces, he then highlights that a mutualistic (symbiotic) union made by fungi can be seen in:

1. **Lichen**- is the association between fungi and green algae or blue green bacteria. The fungi provide moisture (water), mineral salts, and support for the algae which the algae use in manufacturing food by photosynthesis for the fungi and itself. The fungus is also protected from high light intensity. Both the fungus and the algae cannot live independently.

2. **Mycorrhiza-** is an association between fungus and a plant root. The fungus absorbs water and mineral salts which pass to the plant, and in turn receives organic products (food) of photosynthesis from the plant.

Evaluation: The teacher evaluates the lesson by asking the following questions:

a) What do you understand by the term "nutrition"?

b) How many forms of nutrition do we have in fungi and what are they?

c) State the 4 types of fungal parasites and explain any two of them

d) List the three main digestive enzymes being produced by fungal saprotrophs

Summary: Following the students responses, the teacher summarizes the lesson as follows:

i) All living organisms require food for metabolic activities to take place in them

ii) Nutrition in fungi can be parasitic, saprophytic, or mutualistic. The host-parasite relationship is called parasitism. Organisms which feed saprophytically are known as saprophytes. Lichens and mycorrhizas are examples of mutualistic union in fungi.

iii) Carbohydrases, proteases, and lipases are the mains digestive enzymes being produced by fungal saprotrophs.

iv) Moisture and warm condition are necessary for cultivating pin mould (mucor) on bread e.t.c.

LESSON SIX - Week 6

Group - Experimental

Class Level - N.C.E. II

Subject - Integrated Science

Course - ISC 211, Component of the environment II

Topic - Bacteria in ecological cycle

Duration - 2 hours

Instructional material: bean plant, water, microscope, glass slide, methylene blue.

Behavioural objectives: By the end of the lesson, the students should be able to:

a) Explain what ecological cycle is

b) Define nitrogen cycle

c) Identify and explain briefly the processes involved in nitrogen cycle

d) Sketch the diagram of the nitrogen cycle

e) Observe nitrogen fixing bacteria

Previous knowledge: The students are familiar with the occurrence and classification of bacteria, some diseases caused by bacteria and the effects of bacteria on food.

Introduction: The teacher introduces the lesson by asking some questions as follows:

i) Identify at least 5 places where bacteria can be found.

ii) What is the shape of each of following types of bacteria: bacilli, vibrio, spirilla and spirochete?

iii) State any 4 diseases known to you caused by bacteria each in plants and animals e.t.c.

The teacher reinforces the students' responses and then explains that bacteria play an important role in the environment, for instance in the nitrogen cycle.

Presentation:

Step I: The teacher asks the students to explain the term ecological cycle and give some examples of such a cycle. Following their responses which the teacher reinforces, he then explains that, in addition to exchange of energy, ecosystems are characterized by several cycles. The process by which elements such as carbon, nitrogen and water travel throughout the biotic and abiotic components of an ecosystem is known as ecological cycle.

Step II: The teacher asks the students to give a brief explanation of nitrogen cycle. Following the students' responses, the teacher states that bacteria play a role in decaying dead materials so as to produce nitrates which can be recycled. This process is called the nitrogen cycle. It is therefore defined as a path way through which nitrogen elements are replaced and circulated in an ecosystem (environment).

Step III: The teacher asks the students to identify and explain briefly the stages/processes involved in nitrogen cycle. Following the students' responses, the teacher states that nitrogen cycle has 5 different stages/processes. They are:

1) Chemical Nitrogen Fixation: During thunderstorm, energy from lightning discharge causes atmospheric oxygen to form nitrogen dioxide (NO_2). This compound mixes with rain water to form nitric acid which reacts with metallic ions in the soil to form nitrates.
2) Biological Fixation by nitrogen fixing bacteria: The nitrogen fixing bacteria live freely in the soil or in the bumps (nodules) on roots of legumes such as beans and peas. These bacteria are of two kinds:

a) Symbolic (e.g. Bacillus species & Rhizobium) which live in the root nodules of leguminous plants and which convert free atmospheric nitrogen to nitrates which are used by plants. The plants in turn provide carbohydrates and shelter to the bacteria.

b) Non-symbolic (e.g. Azotobacter & Clostridium) which live freely in the soil and convert free nitrogen in the soil into nitrates in the soil.

3) Putrefaction by putrefying (decay) bacteria: These bacteria act on dead organisms and their wastes (excreta and faeces), to produce ammonium compounds, water and carbon (IV) oxide (O_2). The ammonia produced may be taken by plants.

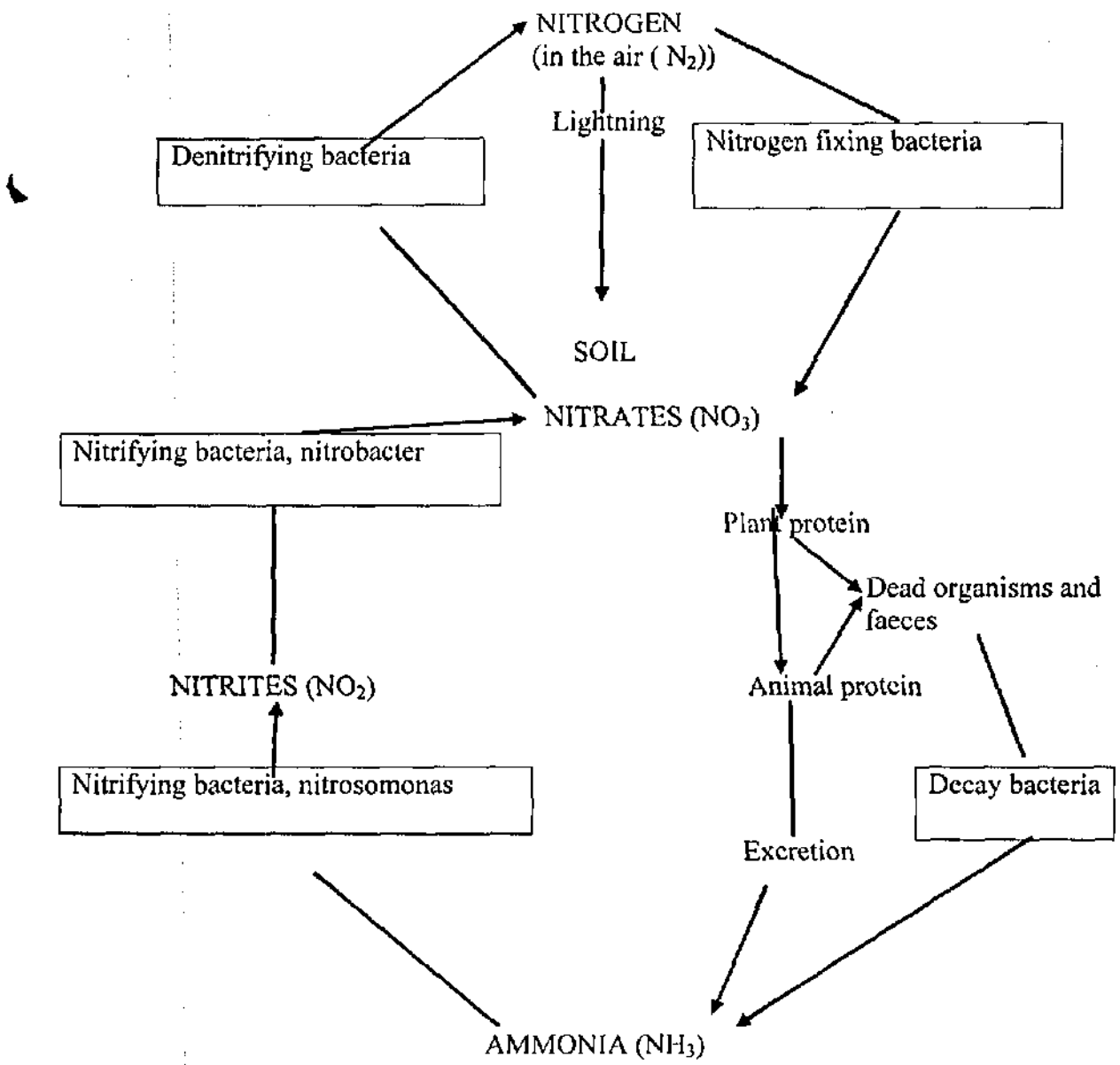
4) Nitrification by nitrifying bacteria: These bacteria are of two types:

a) Nitrosomonas which convert ammonium compounds into nitrites compounds and

b) Nitrobacter which convert nitrites to nitrates which can be taken up by plant roots.

5) Denitrification by denitrifying bacteria: These bacteria undo the good work of other bacteria. They are commonly found in waterlogged soils because they can work without oxygen. They convert nitrates back to free atmospheric nitrogen and replace the lost nitrogen in the air, so these nitrates cannot be used by plants.

Step IV: The teacher leads and guides the students on how to sketch the diagram of the nitrogen cycle to summarize the whole processes involved as follows:



Step V: Activity 6: Observing Nitrogen Fixing Bacteria

Items/materials needed: bean plant, water, glass slide, methylene blue, and microscope

Procedure:

Under the guidance of the teacher, the students are to carry out the activity. The teacher asks the students to:

- Bring a bean plant from the school farm/garden (NB: make sure that the roots are not tempered with while digging up)
- Wash the soil off the roots and look for nodules on the roots
- Crush one of the nodules on the glass slide and spread the content thinly over the slide and then allow to dry
- When the smear is dry, stain it with methylene blue
- About two minutes later, dip the slide in water for a few seconds
- Dry the slide and examine under the high power of the microscope

Teacher's questions:

- What is the shape of the nitrogen fixing bacteria observed?
- Why are these bacteria important to humans?

Evaluation: The teacher evaluates the lesson by asking the following questions:

i) What do you understand by the term "ecological cycle"?

ii) Define nitrogen cycle

iii) Identify the five processes involved in nitrogen cycle and briefly describe any two of them

iv) In a nitrogen cycle, what is the role of the nitrifying bacteria? e.t.c

Summary: The teacher reinforces the students' responses and then summarizes the lesson as follows:

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i) Nitrogen cycle is one of the cycles by which ecosystems are characterized. Carbon and water also have their own cycles.

ii) Nitrogen cycle provides the avenue for a continuous circulation of nitrogen in the environment.

iii) The relationship between the nitrogen fixing bacteria and the plants is mutuality/symbiosis.

iv) Denitrifying bacteria play the role opposite to the role being played by the other forms of bacteria involved in nitrogen cycle

v) The teacher then allows/asks the students to copy down the diagram of the nitrogen cycle for future reference.

APPENDIX B

LESSON NOTES FOR CONTROLGROUP

LESSON ONE - Week 1

Group - Control

Class Level - N.C.E. II

Subject - Integrated Science

Course - ISC 211, Component of the environment II

Topic - Characteristics of living things

Duration - 2 hours

Instructional materials: - An uprooted flowering plants, some living animals in the aquarium and around the class, bean seedlings, slides, light microscope, stone

Behavioural objectives: - By the end of the lesson, the students should be able to:

a) State what living things are or can do

b) List seven characteristics of living things

c) Compare characteristics of animals with those of plants

d) Identify living organisms

Previous knowledge: The students are familiar with different plants and animals

Introduction: The teacher introduces the lesson by asking the students to go out and uproot different plants and bring different animals

Presentation:

Step I: The teacher explains to the students that living things are characterized by doing certain activities which non-living things cannot.

Step II: The teacher further explains to the students that the characteristics which living things posses and which non-living things don't, include possession of cells, ability to move, to respire, to feed, to respond to external stimuli, to grow, to excrete, and to reproduce; with brief explanation of each character.

Step III: The teacher gives a brief exposition on "growth" as a characteristic of living things, using bean seedlings which have been planted at different time.

Step IV: The teacher asks the students to watch the moving animals in and around the class as well as in the aquarium to show that "locomotion" is one of the characteristics of living things but more noticeable in animals which have to search for their food.

Evaluation: The teacher asks the following questions to check for understanding of the lesson:

i) What do you understand by the term living things?

ii) List seven characteristics of living things

iii) Compare the characteristics of animals with those of plants

iv) What living things can you identify both in the aquarium and around the class?

Summary: The teacher reinforces the students' responses to the above questions and writes them out on the board.

Assignment: The teacher asks the students to match the following words in the left-hand column with those in the right-hand column during the lesson period in the class.

Locomotion	getting rid of poisonous waste
Excretion	releasing energy from food
Reproduction	feeding
Nutrition	responding to stimuli
Sensitivity	movement from place to place
Respiration	producing offspring

LESSON TWO AND THREE - Week 2 & 3

Group - Control

Class Level - N.C.E. II

Subject - Integrated Science

Course - ISC 211, Component of the environment II

Topic - Plant and animal cells

Duration - 2 hours

Instructional materials:- Charts of plant and animal cells, a microscope, slides, cover slips, a wooden spatula, methylene blue stain, an onion, tissue paper, iodine solution, sharp knife, and permanent slides

Behavioural objectives: - By the end of the lesson, the students should be able to:

a) Explain what a cell is

b) Prepare cheek cells and onion cells for viewing under a microscope

c) Draw and label both plant and animal cells

d) List the organelles that are common to both plant and animal cells

e) Differentiate between plant and animal cells

Previous knowledge: - Students are familiar with living and non-living things as well as their characteristics.

Introduction: - The teacher introduces the lesson by asking the students the following questions:

a) Which of the characteristics of living things is more noticeable in animals than in plants?

b) State any three observable differences between living and non- living things

Following the students responses which the teacher reinforces, the teacher then explains to the students that living things (plants and animals) are made of cells.

Presentation:

Step I: The teacher explains to the students that a cell is a unit structure and function of life. In other word, it is the smallest functional and structural unit of life. It is a substance upon which living things are formed. It is therefore found in both plants and animals.

Step II: The teacher further explains to the students how both cheek and onion cells can be prepared for viewing under a microscope.

Step III: The teacher pastes the charts of both plant and animal cells on the board and ask the students to critically observe each chart and compare the two. He then uses the charts and the permanent slides to explain the organelles present in each of the two cells.

Step IV: The teacher explains to the students that the organelles common to both plant and animal cells include cell membrane, mitochondria, golgi body, ribosome, endoplasmic reticulum, vacuole, nuclear membrane, cytoplasm, nucleus, and nucleolus.

Step V: The teacher uses the charts again to further explain to students the differences between plant and animal cells.

Evaluation: The teacher evaluates the lesson as follows:

i) Explain briefly what a cell is

ii) In the preparation of cheek cells for viewing under a microscope, why should the spatula be used only once, by one person and then thrown away?

iii) List any five organelles common to both plant and animal cells

iv) In a tabular form, distinguish between plant and animal cells e.t.c.

Summary: The teacher summarizes the lesson by highlighting that:

i) No two persons should use same spatula to scrape the inner lining of their cheeks for viewing under a microscope. This is to avoid infection of any disease

ii) Plant and animal cells can be differentiated as follows:

S/NO	Plant cell	Animal cell
1	Cellulose cell wall present	Cellulose cell wall absent
2	Plastids (chloroplasts) present	Plastids (chloroplasts) absent
3	Vacuoles are few and large	Vacuoles are many and small
4	Have definite shape	No definite shape
5	Protoplasm less dense	Protoplasm denser
6	Store food as starch	Store food as glycogen
7	Have cell sap in their vacuoles	Have no cell sap in their vacuoles

LESSON FOUR AND FIVE - Week 4 & 5

Group - Control

Class Level - N.C.E. II

Subject - Integrated Science

Course - ISC 211, Component of the environment II

Topic - Mode of nutrition in fungi

Duration - 2 hours

Instructional material: Water, slices of bread, yeast, mushroom, bracket fungi, petri dish, glass container, hand lens, microscope, slide, cover slip, methylene, blue and charts of some fungi.

Behavioural objectives: By the end the lesson, the students should be able to:

a) Explain what nutrition is.

b) Identify and explain the forms of nutrition in fungi.

c) State and explain the type of fungal parasites

d) Cultivate and observe pin mould (mucor) on bread.

e) List some digestive enzymes being produced by fungal saprotrophs.

f) Identify and explain the two types of mutualistic union being made by fungi.

Previous knowledge: Students are familiar with some fungi, their characteristics, occurrence, and uses as food and in industry.

Introduction: The teacher introduces the lesson by asking the students the following questions:

i) How many types of fungi do you know?

ii) State the two common characteristics of fungi.

iii) Identify at least 4 places where fungi can be found and state the 2 major conditions that enable fungi to occur in abundance in a place.

The teacher reinforces the students' responses and then explains to them that, like any other living organisms, fungi also require food material for metabolic activities to take place in them.

Presentation:

Step I: The teacher explains to the students that nutrition being one of the characteristics of living things, in fungi; it is based on absorption of organic matter. It is the process by which living organisms obtain and utilize materials from external environment for metabolic activities such as respiration, growth, excretion and reproduction.

Step II: The teacher points out that living organisms evolve different modes of nutrition. In the case of fungi, nutrition can be parasitic, saprophytic, or symbiotic (mutualistic). He then explains the three forms of nutrition as follows:

Parasitic nutrition- is one in which one organism obtains food from another organism and during the feeding process the organism providing food, protection, and shelter is harmed and is called the **host**, while the benefiting organism is called the **parasite**. The host-parasite relationship is known as **parasitism**.

Saprophytic nutrition- is one in which an organism feed on dead and decaying organic matter. Enzymes are secreted from the cells of the saprophytic organisms (saprophytes) to the dead organic matter and the digestion of the dead organic matter is extracellular. The digested and soluble food substances are then absorbed.

Symbiotic nutrition- is one in which two organisms of different species live together to take advantage of each other. In some cases the two organisms become so dependent on each other that each one cannot live independent of the other .This type of association is called **symbiosis** or **mutualism.**

Step III: The teacher again explains to the students that fungal parasites may be:

1. **Facultative** (temporary) - these are parasites that can infect a host, bring about its death and then live saprophytically on the remains, e.g. Bracket fungi.

2. **Obligate**- these are parasites that can only survive and grow in living cells. That is they are incapable of living as saprotophs. Therefore, they are strictly restricted to their host.

3. **Biotrophic** (biotrophs) - is a fungus which is parasitic on another fungi and which does not kill its host, but feeds on the living cells.

4. **Necrotrophic** (necrotrophs) - is a fungus also parasitic on other fungi but in this case it kills its host and feeds on the dead cells.

Step IV: The teacher further explains to the students how pin mould (mucor) can be cultivated and observe on bread by the following procedure:

- Sprinkle water on the surface of a slice of bread that has been exposed to air for some time
- Put the bread in a petri dish, cover it with a glass container and put it in a dark warm place
- Using a hand lens, observe the bread daily and record your observation
- What can you observe on the surface of the bread?
- Draw and describe the structure of what you observe
- How long does it take for the mould to appear on the bread?
- How long after the first appearance of the mould are the sporangia (spore cases) formed?
- Scrape a little of the mould from the bread and place it on the microscope slide
- Add a drop of water and cover it with a cover slip or add a drop of methylene blue stain to colour the living cells

- Observe the material under the low power of the microscope and under medium/high power
- Describe the appearance and shape of the mould
- Make a drawing showing the structure of the mycelium
- Examine a hypha under high power objective
- Does it have cross walls dividing it up into cells?
- Does it have chloroplasts?
- Are the nuclei scattered or clumped in the cytoplasm?
- Crush the sporangium and examine the spores under high power objective of microscope
- What is the shape of the spores?
- Do the spores contain a single nucleus or many nuclei?

Step V: The teacher explains to the students that fungal saprotrophs produce a variety of digestive enzymes that can enable them utilize a wide range of substrates. Such enzymes include:

Carbohydrase- digests carbohydrates e.g.

- Maltase- changes maltose to glucose
- Sucrase- changes sucrose to glucose and fructose
- Lactase- changes lactose to galactose and glucose
- Ptyalin- changes starch to maltose sugar

Lipases (digest lipids) i.e. they act on fats and oils changing them into fatty acids and glycerol

Proteases (digest proteins). These enzymes act on proteins changing them into amino acids. The proteases include:

- Pepsin- changes proteins to peptones

- Rennin- coagulates milk proteins
- Trypsin- also changes proteins to peptones
- Erepsin- changes proteins to amino acids

Step VI: The teacher explains to the students that a mutualistic (symbiotic) union made by fungi is seen in:

1. **Lichen-** is the association between fungi and green algae or blue green bacteria. The fungi provide moisture (water), mineral salts, and support for the algae which the algae use in manufacturing food by photosynthesis for the fungi and itself. The fungus is also protected from high light intensity. Both the fungus and the algae cannot live independently.
2. **Mycorrhiza-** is an association between fungus and a plant root. The fungus absorbs water and mineral salts which pass to the plant, and in turn receives organic products (food) of photosynthesis from the plant.

Evaluation: The teacher evaluates the lesson by asking the following questions:

i) What do you understand by the term "nutrition"?

ii) How many forms of nutrition do we have in fungi and what are they?

iii) State the 4 types of fungal parasites and explain any two of them

iv) List the three main digestive enzymes being produced by fungal saprotrophs

Summary: Following the students responses, the teacher summarizes the lesson as follows:

i) All living organisms require food for metabolic activities to take place in them.

ii) Nutrition in fungi can be parasitic, saprophytic, or mutualistic. The host-parasite relationship is called parasitism. Organisms which feed saprophytically are known as saprophytes. Lichens and mycorrhizas are examples of mutualistic union in fungi.

iii) Carbohydrases, proteases, and lipases are the main digestive enzymes being produced by fungal saprotrophs.

iv) Moisture and warm condition are necessary for cultivating pin mould (mucor) on bread e.t.c.

LESSON SIX	-	Week 6
Group	-	Control
Class Level	-	N.C.E. II
Subject	-	Integrated Science
Course	-	ISC 211, Component of the environment II
Topic	-	Bacteria in ecological cycle
Duration	-	2 hours

Instructional material: bean plant, water, microscope, glass slide, methylene blue.

Behavioural objectives: By the end of the lesson, the students should be able to:

a) Explain what ecological cycle is

b) Define nitrogen cycle

c) Identify and explain briefly the processes involved in nitrogen cycle

d) Sketch the diagram of the nitrogen cycle

e) Observe nitrogen fixing bacteria

Previous knowledge: The students are familiar with the occurrence and classification of bacteria, some diseases caused by bacteria and the effects of bacteria on food.

Introduction: The teacher introduces the lesson by asking some questions as follows:

i) Identify at least 5 places where bacteria can be found.

ii) What is the shape of each of following types of bacteria: bacilli, vibrio, spirilla and spirochete?

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iii) State any 4 diseases known to you caused by bacteria each in plants and animals e.t.c.

The teacher reinforces the students' responses and then explains that bacteria play an important role in the environment, for instance in the nitrogen cycle.

Presentation:

Step I: The teacher explains to the students that, in addition to exchange of energy, ecosystems are characterized by several cycles. The process by which elements such as carbon, nitrogen and water travel throughout the biotic and abiotic components of an ecosystem is known as ecological cycle.

Step II: The teacher explains to the students that bacteria play a role in decaying dead materials so as to produce nitrates which can be recycled. This process is called the nitrogen cycle. It is therefore defined as a path way through which nitrogen elements are replaced and circulated in an ecosystem (environment).

Step III: The teacher explains to the students that nitrogen cycle has 5 different processes. They are:

1. Chemical Nitrogen Fixation: During thunderstorm, energy from lightning discharge causes atmospheric oxygen to form nitrogen dioxide (NO_2). This compound mixes with rain water to form nitric acid which reacts with metallic ions in the soil to form nitrates.
2. Biological Fixation by nitrogen fixing bacteria: The nitrogen fixing bacteria live freely in the soil or in the bumps (nodules) on roots of legumes such as beans and peas. These bacteria are of two kinds:

a) Symbolic (e.g. Bacillus species & Rhizobium) which live in the root nodules of leguminous plants and which convert free atmospheric nitrogen to nitrates which are used by plants. The plants in turn provide carbohydrates and shelter to the bacteria.

b) Non-symbolic (e.g. Azotobacter & Clostridium) which live freely in the soil and convert free nitrogen in the soil into nitrates in the soil.

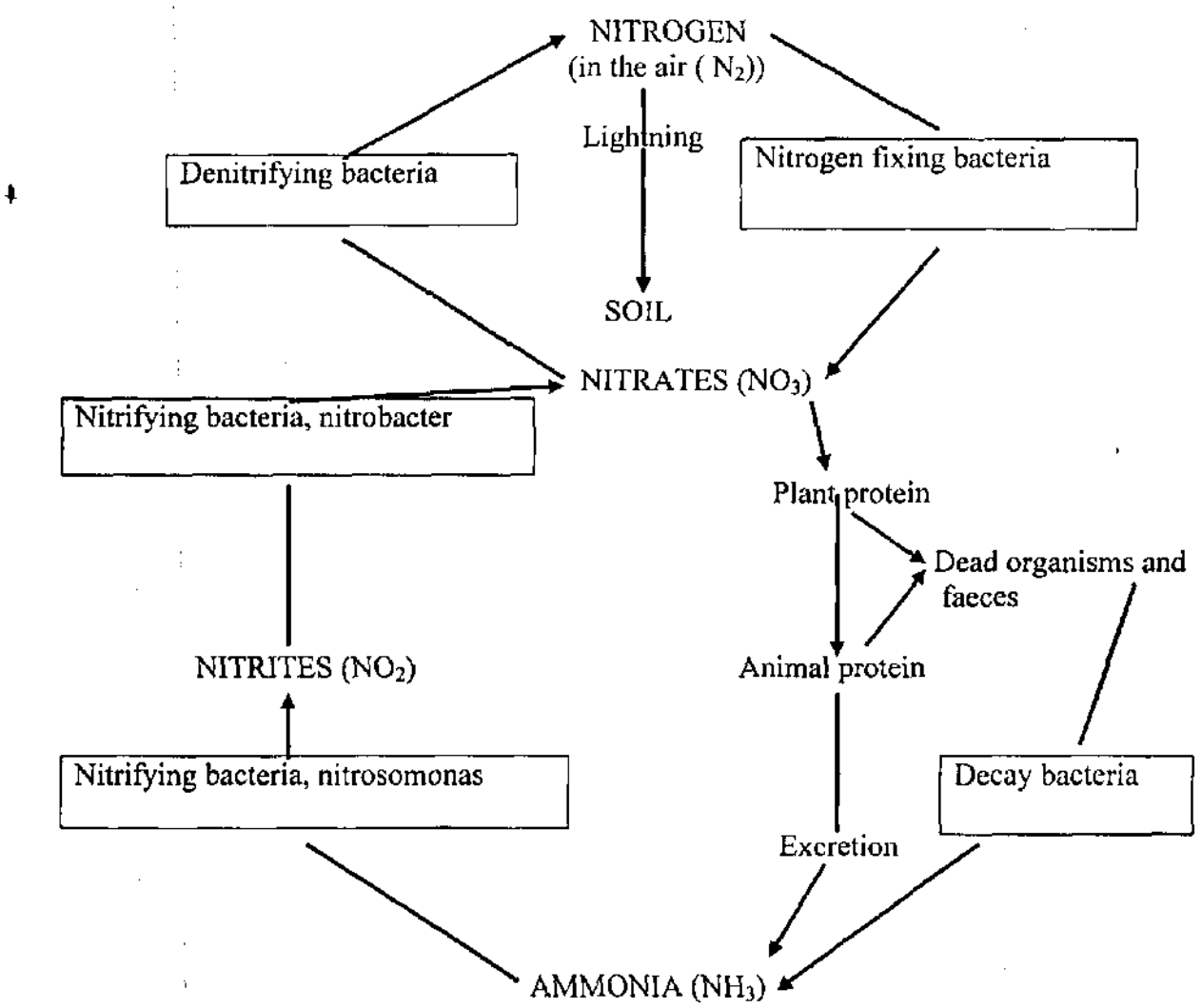
3. Putrefaction by putrefying (decay) bacteria: These bacteria act on dead organisms and their wastes (excreta and faeces), to produce ammonium compounds, water and carbon (IV) oxide (CO_2). The ammonia produced may be taken by plants.
4. Nitrification by nitrifying bacteria: These bacteria are of two types:

a) Nitrosomonas which convert ammonium compounds into nitrites compounds and

b) Nitrobacter which convert nitrites to nitrates which can be taken up by plant roots.

5 Denitrification by denitrifying bacteria: These bacteria undo the good work of other bacteria. They are commonly found in waterlogged soils because they can work without oxygen. They convert nitrates back to free atmospheric nitrogen and replace the lost nitrogen in the air, so these nitrates cannot be used by plants.

Step IV: The teacher sketches the diagram of the nitrogen cycle to summarize the whole processes involved as follows:



Step V: At this stage, the teacher explains to the students in detail the procedure by which nitrogen fixing bacteria can be observed. No any practical activity is involved in this case. Thus:

- Dig up a bean plant
- Wash the soil off the roots and look for nodules on the roots
- Crush one the nodules on the glass slide and spread the content thinly over the slide
- When the smear is dry, stain it with methylene blue
- About two minutes later, dip the slide in water for a few seconds
- Dry the slide and examine under the high power of the microscope
- What is the shape of the nitrogen fixing bacteria?

- Why are these bacteria important to humans?

Evaluation: The teacher evaluates the lesson by asking the following questions:

i) What do you understand by the term "ecological cycle"?

ii) Define nitrogen cycle

iii) Identify the five processes involved in nitrogen cycle and briefly describe any two of them

iv) In a nitrogen cycle, what is the role of the nitrifying bacteria? e.t.c

Summary: The teacher reinforces the students' responses and then summarizes the lesson as follows:

i) Nitrogen cycle is one of the cycles by which ecosystems are characterized. Carbon and water also have their own cycles.

ii) Nitrogen cycle provides the avenue for a continuous circulation of nitrogen in the environment.

iii) The relationship between the nitrogen fixing bacteria and the plants is mutuality/symbiosis.

iv) Denitrifying bacteria play the role opposite to the role being played by the other forms of bacteria involved in nitrogen cycle

v) The teacher then allows/asks the students to copy down the diagram of the nitrogen cycle for future reference.

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APPENDIX C

SAMPLE PACKAGE OF THE METHOD (GUIDED INQUIRY) USED FOR TREATING THE SELECTED TOPICS

Topic: characteristics of living things

- The teacher asks the students to bring some things they considered living/non-living. They may include the following: cockroach, house fly, snail, fish, earthworm, toad, bird, spider, hibiscus plant, stone, seed, yam, chalk, water, book, cloth, among others.
- The teacher asks them why they consider the things they brought as living/non-living.
- The teacher leads the students on to the definition of 'living things' and 'non-living things' and asks them to give example of living things.
- The students are to identify some activities they observe living things can do which non-living things cannot. The teacher reinforces the students' responses and then states that the characteristics of living things include: ability to move, respire, feed, respond to external stimuli, grow, excrete, and to reproduce with brief explanation of each character
- Here the students are to take each of the things/objects listed in step I and fill in the Table below, writing 'yes' or 'no' as the case may be:

Table of Characteristics of Living Things

Thing/ object	Does it feed?	Does it move on its own?	Does it respire?	Does it grow?	Does it reproduce?	Does it give out west materials?	Does it respond to stimuli?
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
X.							

The teacher asks the students the following questions:

i). Consider yourself as one of the things/objects listed in Table 3.7 and complete the table using the space marked **X**.

ii). List the things/objects which perform the same activities as yourself.

iii). Hold your breath for a short while and describe how you feel.

iv). What will happen if you continue to hold your breath for too long and why? e.t.c.

Topic: Plant and animal cells

- The teacher asks the students to explain what they understand by the term 'cell'. The teacher reinforces the students' responses and then displayed the charts of plant and animal cells and all the materials needed.

- The teacher divides the students into eight (8) groups of twelve (12) students each according to the number of microscopes available and asks each group members to assign a group leader.
- Here the teacher instructs and guides the students on how to prepare cheek and onion cells for viewing under a microscope.
- The students in each group are to prepare both plant and animal cells using the following procedures.

Plant cell preparation procedure:

The teacher asks each student in each group to do the following while he goes round at each step to supervise and guide the students:

- Select an onion bulb; discard the brown dry outer scales.
- Take a sharp knife or razor blade and cut the onion bulb into four pieces (quarters) vertically. Remove one fleshy scale.
- Bend the outer (convex) surface of the flushing scale towards you with your right hand to break it.
- Generally pull the broken end. You will find that from other half of the scale hold in your left hand, a thin transparent layer of epidermis is peeling off easily.
- If the peal is large, use a fine pair of scissor or a blade to cut a small piece of about 2mm. To do this place the peel in a drop of water on a clean slide and trim it.
- If there are many wrinkles in the peel, stretch it with the help of dissecting needle.
- Place this neatly cut (i.e. the specimen) on the centre of a clean slide.
- Add a fresh drop of water or designated stain if required. (Note: liquid cultures do not require adding water).

- Place one edge of the cover slip on the slide near the specimen. Gently lower the cover slip on top of the specimen. You may want to use dissecting needle to help lower the over slip. Try to avoid air bubbles in the process.
- Blot (soak out) any excess fluid on the slide with tissue or lens paper.
- Mount/place the slide on the stage of the microscope.
- Use a low power objective lens and adjust for viewing (i.e. examine the slide under low power of the microscope.

What did you observed?

- Draw a diagram of what you observed.
- Adjust the objective lens to medium or high power and observe again
- With the help of the charts/ diagrams provided, draw and label the diagram of what you observed.
- After you have made your observations the slide and cover slip should be washed, dried and replaced in their appropriate locations.

Precaution

vi. Do not leave the peel too long in air, otherwise it will dry and show air bubbles in it.

vii. The peel should be mounted in the centre of the slide.

viii. Always use a brush (not a needle) to transfer the peel from petridish to the slide or from one slide to another. Otherwise, the peel will tear off.

ix. Avoid the entry of any air-bubbles in the mount.

x. Use clean slides and cover slips for mounting.

Animal cell (Human Check Cells) preparation procedure:

The teacher asks each student in each group to do the following while he goes round at each step to supervise and guide the students:

- Take a clean tooth pick/wooden spatula/uncoated end of a matchstick and gently scrape the inner lining of your check. Its tip would collect some viscous transparent substance.
- Smear (spread) this substance on a slide.
- Add a drop of water to the smear and also a drop or tow of methylene blue stain.
- Leave for about one minute.
- Tilt the slide to let the extra stain drain off. Wash gently with water.
- Put a cover slip gently over the material with the help of a needle avoiding entry of any air bubbles.
- Press the cover slip gently with a needle to make the cells under the cover slip uniform.
- Soak away any extra stain with tissue paper or by placing the slide within a folded filter paper, taking care not to move the cover slip.
- Examine /observe the slide under a microscope using low power.
- Draw a diagram of what you observe.
- Adjust the objective lens to medium or high power and observe again.
- Draw a diagram of what you observe.
- Compare the charts/diagrams provided with the slide as seen under the microscope.

Precautions

- Scrape the inner surface of the check gently to avoid any damage or bleeding.
- See that you do not break the cover slip.

- While removing the extra stain, make sure you do not move the cover slip and the materials under it.

The teacher asks the students to observe carefully the charts/diagrams of plant and animal cells provided and list their parts in the Table below:

Table of Parts of Plant and Animal Cells

S/No.	Typical plant cell	Typical animal cell
1.		
2.		
3.		
4.		
5. e.t.c.		

The teacher also asks the students the following questions:

i) What parts are present in both plant and animal cells?

ii) What parts are not found in both of them? e.t, c.

APPENDIX D

NCE STUDENTS' SELF-EFFICACY QUESTIONNAIRE (NSSQ)

TIME: 30 MINUTES

College----------

Level---------- **Course Combination** ----------

Registration Number---------- **Gender**----------

This instrument is a five-point Likert-type scale consisting of 20 statements about your confidence in doing things related to Integrated Science. For each statement, think about how confident you would be in carrying out a given task. They are no right or wrong answers. They are just your thoughts and feelings about the subject. For each of the statements below, indicate the degree to which you agree or disagree with it by ticking one of the following responses next to and to the right of each statement. The responses are: strongly agree (5), agree (4), undecided (3), disagree (2), or strongly disagree (1). Any positively worded statement is scored by awarding five (5) points for 'strongly agree' responses, four (4) points for 'agree' responses, and so forth. Negatively worded statements are scored by reversing the numeric values.

SD= Strongly Agree

A= Agree

UD= Undecided

D= Disagree

SD= Strongly Disagree

S/N	STATEMENT	SA	A	UD	D	SD
1	I can prepare an onion cells for viewing under a microscope					
2	I wonder if I can prepare cheek cells for viewing under a microscope					

3	I can manipulate a microscope to view a slide under it					
4	Confidence and effectiveness in Integrated Science teaching has Little influence on the achievement of students					
5	I can lead my students to discovery					
6	I can sketch and explain the diagram of nitrogen cycle					
7	I can explain the role of each of the bacteria involved in nitrogen cycle					
8	I can organize and conduct an experiment for observing nitrogen fixing bacteria using a bean plant					
9	I can give a brief exposition on "growth" as a characteristic of living things using bean seedlings planted at different times					
10	Students achievement in Integrated Science is directly related to their teacher's confidence and effectiveness in Integrated Science teaching					
11	I am continually getting better ways to teach Integrated Science					
12	I can cultivate and observe pin mould (mucor) on bread using both hand lens and a microscope					
13	I wonder if I can explain the three forms of nutrition in fungi					
14	I can identify and explain the two forms of mutualistic union being made by fungi					
15	I can identify some activities which living things can do and non-living things cannot					
16	I can give a brief explanation of each of the characteristics of living things					
17	The teacher is generally responsible for the achievement of students in Integrated Science					
18	I can organize activities through which I can lead my students to be productive and creative					
19	I wonder if I can identify all the organelles that are common to both plant and animal cells					
20	I can motivate my students to the lessons and various activities effectively					

APPENDIX E

INTEGRATED SCIENCE ACHIEVEMENT TEST (ISAT)

INSTRUCTION **TIME: 1 HOUR**

- Answer all the questions on the question paper by circling/ticking the correct option for each question. Four responses letter A-D are provided.

1). The smallest functional and structural unit of life is referred to as

a) gene b) chromosome c) cell d) DNA

2). The book, MICHROGRAPHIA was published by

a) Felix Dujardin b) Rudolf Vonvirchov c) Robert Hooke d) Mathias Schleiden

3). One the following scientists is described as the pioneer of cell

a) Robert Hooke b) Mathias Schleiden c) Theodor Schwan d) Felix Dujardin

4). The cell theory came into existence in the year

a) 1839 b) 1835 c) 1838 d) 1883

5). Storing food as glycogen is associated with

a) plant cell b) animal cell c) both plant and animal cells d) none of the above

6). Which of the following organisms play a great role in decaying dead materials so as to produce nitrates?

a) fungi b) bacteria c) viruses d) none of the above

7). One the following bacteria live in the root nodules of leguminous plants

a) Azortobacter b) Rhizobium c) Clostridium d) Nitrobacter

8). The bacteria that act on dead organisms and their wastes (excreta and faeces) to produce ammonium compounds is known as

a) nitrifying bacteria b) putrefying bacteria c) denitrifying bacteria d) Nitrosomonas

9). The role of ----------in nitrogen cycle is to convert ammonia into nitrites.

a) Nitrosomonas b) Nitrobacter c) Rhizobium d) Azotobacter

10). Denitrifying bacteria are common in

a) dry soil b) salty soil c) waterlogged soil d) all of the above

11). The equation $C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6H_2O$ + ENERGY represents

a) Aerobic respiration b) Anaerobic respiration c) photosynthesis d) none of the above

12). Aerobic respiration is an example of

a) external respiration b) exhalation c) internal respiration d) all of the above

13). The form of nutrition which proceeds in five different stages—ingestion, digestion, absorption, and egestion, which come one after the other is known as

a) symbolic nutrition b) parasitic nutrition c) holozoic nutrition d) saprophytic nutrition

14). Which of the following types of growth do animals generally show?

a) intercalary only b) apical only c) both intercalary and apical d) none of the above

15). The form of growth that is restricted to growth regions only is described as

a) intercalary b) apical c) development d) enlargement

16). The process by which living organisms obtain and utilize materials from external environment for metabolic activities is known as

a) respiration b) growth c) nutrition d) excretion

17). The host-parasite relationship is known as

a) parasitology b) parasitologist c) parasitism d) parasite

18). In which of the following do we have extracellular digestion?

a) autotrophs b) sprotrophs c) hetrotrophs d) none of the above

19). Parasites that can only survive and grow in living cells are described as

a) facultative b) obligate c) biotrophic d) necrotrophs

20). One of the following is an example of facultative parasites

a) bracket fungi b) mushroom c) mucor d) none of the above

21). The three main digestive enzymes being produced by fungal saprotrophs are

a) carbohydrase, lipase and protease b) carbohydrase, lactase and sucrase

c) carbohydrase, pepsin and rennin d) carbohydrase, sucrose and lipase

22). In the symbiotic association between fungi and green algae, which of the two provides moisture (water), mineral salts and support for the other?

a) Fungi b) algae c) both fungi and algae d) none of the above

23). The association between a fungus and a plant root is described as

a) lichens b) saprotrophic c) mycorrhizas d) parasitic

24). One of the following pairs of enzymes is an example of proteases

a) maltase and erepsin b) ptyalin and rennin c) erepsin and pepsin d) pepsin and lactase

25). Which of the following pairs is needed for cultivating and observing pin mould (mucor) on bread?

a) Water and ethanol b) water and methylene blue c) water and iodine solution

d) none of the above

26). One of the following equations represents anaerobic respiration

a) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ENERGY$

b) $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2 +$ Small amount of energy

c) $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

d) $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

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27) The process of eliminating toxic waste substances from the body is known as

a) excretion b) sweating c) egestion d) ingestion

28). Free atmospheric nitrogen is converted to nitrates by the action of

a) bacillus species and rhizobium b) nitrosomonas and nitrobacter

c) azotobacter and clostridium d) rhizobium and azotobacter

29). The nitrates can be written as

a) NO_2 b) HNO_3 c) NO_3 d) none of the above

30). Nitrogen fixing bacteria are classified into symbolic and non- symbolic. Which of the following bacteria falls into non-symbolic group?

a) bacillus species b) rhizobium c) azotobacter d) nitrobacter

31). In the year---------- a German botanist called Mathias Schleden revealed that all plants were made up of cells

a) 1858 b) 1838 c) 1839 d) 1885

32). Robert Hooke was the first person to discover the honey comb structure of the cell in

a) 1665 b) 1656 c) 1666 d) 1658

33). All the following organelles are common to both plant and animal cells except

a) cell membrane b) golgi body c) cell wall d) mitochondria

34). The theory which states that lower organisms like worms originated from muds, while maggots originated from the flesh of dead animals is referred to as

a) biogenesis b) spontaneous generation c) cell theory d) biotechnology

35). The hyphae of some fungal saprotrophs are usually

a) chemotropic b) phototropic c) biotrophic d) none of the above

36). Which of the following enzymes converts starch to maltose sugar?

a) maltase b) lactase c) ptyalin d) sucrase

37). All the following enzymes converts proteins to peptones except

a) pepsin only b) pepsin and trypsin c) trypsin only d) erepsin

38). Somersaulting/looping movement is seen in

a) hydra b) euglena c) amoeba d) none of the above

39). In which of the following do we find mitochondria?

a) plant cell only b) animal cell only c) both plant and animal cells d) none of the above

40). The disclosure of one of the following scientists gave rise to biogenesis

a) Schwann b) Rudolf Vonvirchov c) Schleden d) Robert Hooke

41). The nutrition in which animals generally feed on readymade organic matter is known as

a) autotrophic nutrition b) heterotrophic nutrition c) holozoic nutrition

d) facultative nutrition

42). Growth in plant is confined to

a) root apex only b) stem apex only c) both root and stem apexes d) all parts of the body

43). The statement which says "cells give birth to cells or cells beget cells" is associated with

a) biogenesis b) cell theory c) theory of spontaneous generation d) all of the above

44). Autotrophic nutrition is associated with

a) animals b) green plants and certain bacteria c) green plants only d) all kinds of plants

45). Oxygen is not always necessary for one of the following bacteria to work in nitrogen cycle

a) denitrifying bacteria b) nitrifying bacteria c) putrefying bacteria d) symbiotic bacteria

46). Which of the following bacteria work to prevent plants from using the nitrates formed dur-

ing the nitrogen cycle?

a) Decay bacteria b) nitrogen fixing bacteria c) denitrifying bacteria d) nitrifying bacteria

47). In nitrogen cycle, decay bacteria act on dead organisms and feaces to produce

a) ammonia b) nitrites c) nitrates d) none of the above

48). One of the following fungi form a green and blue moulds on damp leather, decay fruits etc.

a) penicillium species b) mushroom c) rhizopus d) bracket fungi

49). Growth in plants is described as----------when it is directed towards light

a) chemotropic b) biotropic c) phototropic d) light reaction stage

50). Few and large vacuoles are associated with

a) glycogen granules b) starch granules c) cell wall d) chloroplasts

APPENDIX F

INTEGRATED SCIENCE ACHIEVEMENT TEST (ISAT)

MARKING SCHEME

1) – C
2) – C
3) – A
4) – A
5) – B
6) – B
7) – B
8) – B
9) – A
10) – C
11) – A
12) – C
13) – C
14) – A
15) – B
16) – C
17) – C
18) – B
19) – B
20) – A
21) – A
22) – A
23) – C
24) – C
25) – B
26) – B
27) – A
28) – A
29) – C
30) – C
31) – B
32) – A
33) – C
34) – B
35) – A
36) – C
37) – B
38) – A
39) – C
40) – B
41) – B
42) – C
43) – B
44) – B
45) – A
46) – C
47) – A
48) – A
49) – C
50) – A

NB: - Each question carries one (1) mark, i.e. 1 x 50 = 50 marks.

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APPENDIX G

ITEM ANALYSIS FOR THE MULTIPLE CHOICE QUESTIONS (ISAT): TABLE OF FACILITY (DIFFICULTY) AND DISCRIMINATION INDICES

Item	Key	RU	RL	P= RU+RL / N	P %	D= RU-RL / I/2N
1	A	7	6	0.65	65	- 0.14
2	B	7	5	0.60	60	0.29
3	A	7	7	0.70	70	0.00
4	C	5	3	0.40	40	0.29
5	B	7	4	0.55	55	0.45
6	B	6	4	0.50	50	0.29
7	C	5	3	0.40	40	0.29
8	D	6	1	0.35	35	0.71
9	C	5	4	0.45	45	0.14
10	C	6	3	0.45	45	0.43
11	D	6	1	0.35	35	0.71
12	E	2	3	0.25	25	- 0.14
13	D	4	2	0.30	30	0.29
14	D	3	3	0.30	30	0.00
15	D	4	3	0.35	35	0.14
16	B	6	4	0.50	50	0.29
17	B	7	4	0.55	55	0.43
18	D	4	2	0.30	30	0.29
19	C	5	3	0.40	40	0.29
20	E	1	1	0.10	10	0.00
21	D	5	2	0.35	35	0.43
22	C	4	4	0.40	40	0.00
23	C	6	2	0.40	40	0.57
24	B	5	6	0.55	55	- 0.14
25	C	2	4	0.40	40	- 0.29
26	C	5	4	0.45	45	0.14
27	B	7	3	0.50	50	0.57
28	D	5	2	0.35	35	0.43
29	B	4	6	0.50	50	- 0.29
30	C	5	3	0.40	40	0.29
31	A	7	6	0.65	65	0.14
32	B	6	5	0.55	55	0.14

33	C	6	2	0.40	40	0.57
34	B	6	4	0.50	50	0.43
35	D	3	3	0.30	30	0.00
36	D	3	3	0.30	30	0.00
37	C	5	4	0.45	45	0.14
38	E	0	0	0.00	00	0.00
39	B	7	4	0.55	55	0.43
40	C	6	3	0.45	45	0.43
41	C	5	4	0.45	45	0.14
42	C	5	4	0.45	45	0.14
43	E	1	2	0.15	15	- 0.14
44	C	5	4	0.45	45	0.14
45	C	6	3	0.45	45	0.43
46	B	6	4	0.50	50	0.29
47	C	5	4	0.45	45	0.14
48	C	6	2	0.40	40	0.57
49	B	6	5	0.55	55	0.14
50	D	5	2	0.35	35	0.43

Key:

RU = number of students who scored the item correct in the upper group;

RL = number of students who scored the item correct in the lower group;

P = item difficulty index

P% = percentage difficulty

D = discrimination index

N = number of respondents in each of the upper and lower groups.