IMPACT OF PROBLEM SOLVING AND DISCOVERY STRATEGIES ON ATTITUDE, RETENTION AND PERFORMANCE IN GENETICS CONCEPTS AMONG SECONDARY SCHOOL STUDENTS IN ZARIA, KADUNA STATE NIGERIA

BY

Abdurahaman MAHMUD
BSc (Ed) (Biology) A.B.U, ZARIA (1999)
M.Ed (Science Education) A.B.U, ZARIA (2008)
PhD/EDUC/531/11 – 12

A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DOCTOR OF PHILOSOPHY (Ph.D) IN SCIENCE EDUCATION

DEPARTMENT OF SCIENCE EDUCATION,
FACULTY OF EDUCATION
AHMADU BELLO UNIVERSITY,
ZARIA NIGERIA

APRIL, 2017

DECLARATION

I declare that, this thesis entitled,"Impactof Problem - Solving and Discovery Strategies on Attitude, Retention and Performance in Genetic Concepts among Secondary School Students in Zaria,Kaduna State, Nigeria"has been carried out by me in the Department of Science Education, Ahmadu Bello University, Zaria. The information derived from literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented anywhere for another degree or diploma at any university.

_____ _____

Abdurahaman MAHMUD **Date**

PhD/EDUC/531-11/12

CERTIFICATION

This thesis entitled "Impact of Problem-solving and Discovery Strategies on Attitude, Retention and Performance in Genetic Concepts Among Secondary School Students in Zaria, Kaduna State, Nigeria"by Abdurahaman MAHMUD Ph.D./EDUC/531/11-12 meets the regulation governing the award of the Degree of Doctor of Philosophy in Science Education (Ph.D) of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

_____ _____

Prof. I.A. Usman **Date**
Chairman, Supervisory Committee

_____ _____

Dr. S.B. Olorukooba **Date**
Member

_____ _____

Dr. S.S. Bichi **Date**
Member

_____ _____

Prof. M. Musa **Date**
H.O.D, Science Education Department

_____ _____

Prof.S.Z. Abubakar **Date**
Dean, School of Postgraduate Studies

DEDICATION

This work is dedicated to my late parents,Malam Dalhatu Abdullahi and Hajiya Zainab Idiris, to my beloved wife Hauwa, and our children, Mohammed Bello, Imran, Aisha, Khadijat and Farida.

ACKNOWLEDGEMENTS

All thanks be to Almighty Allah, the Lord of the entire universe. May His peace and Blessing be upon His Messenger, Prophet Muhammad (S.A.W.).

My sincere gratitude go to my able, active and dedicated supervisors, ProfessorI.A. Usman, Dr. S.B. Olorukooba, and Dr. S.S. Bichi for sparing their time to go through the manuscripts of this thesis. I would also like to acknowledge the intellectual support and moral guidance from my lecturers Prof. J.S. Mari, Dr. F.K. Lawal, Dr. T.E. Lawal, Prof. A. A. M. Shaibu, Prof. M.M. Atadoga, Dr. J.O Olajide Dr. B. Abdulkarim, Prof. M.A. Lakpini, Dr. M.I. Dikko, Hajia S.L. Muhammad, Dr. M.K. Falalu, Dr. M.O. Ibrahim,Prof. S. A. Abdullahi and Mr. D.B. Tete. I am highly indebted to my friends Mohammed Lawal, Ibrahim Shehu Shika, Suleman Saidu who gavetheir supportsto this work. My special thanks and sincere appreciation also go to Acting Provost, Dr. Ango Ladan, Dr. B.A. Mohammed, Dr. J. Adamu, Bala Bello, my uncle Attahiru Bello, Ibrahim Bello and Mal. Najmuddeen Alhassan for all their support.

I will not forget to thank the staff of Zaria Zonal Education Office, Alh. Adamu Aliyu Shika, former Rector of Nuhu Bamalli Polytechnic, Alh. Mahmuda Saidu, Dahiru Dalhatu, Shaibu Aliyu; and Omoru Ojo Samaila. I found it necessary to express gratitude to my sister Safiya Jumare. I also thank Mohammed Rabiu Ibrahim, Alh. Shehu Aboki, Abdulkarim Aboki for their support, prayerand advice during the course of this study. Also thank Garkuwan Kudun Zazzau, Mohammed Sani Uwaisu, Alh. Tanimu Yaro NNPC Abuja for their financial support.Finally, I thank Mr. Elijah Agala for taking his time to typeset this work.

ABBREVIATIONS USED

The following abbreviations are used in the study:

GPT	-	GeneticsPerformance Test
FRN	-	Federal Republic of Nigeria
NERDC		National Education Research and Development Council
AAAS	-	America Association for the Advancement of Science
WAEC	-	West Africa Examination Council
SSCE	-	Senior Secondary Certificate Examination
STAN	-	Science Teachers Association of Nigeria
TRCN	-	Teachers Registration Council of Nigeria
NUT	-	National Union of Teachers
F.I	-	Facility Index
D.I	-	Discrimination Index
PSIS	-	Problem Solving Instructional Strategy
ANOVA	-	One way Analysis of Variance
SAGQ	-	Students Attitude in Genetics Questionaire
MOE	-	Ministry of Education

OPERATIONAL DEFINITION OF TERMS

Problem Solving Strategy: This is a step by step strategy that allows the learners to construct their own knowledge and the teacher serves as a facilitator.

Attitude: a feeling or way of thinking that affects a person's behavioreitherpositively or negatively.

Retention: The ability to recall information/learned conceptafter some period of time.

Discovery: Discovery teaching strategy allows students to discover certain concept but not necessarily to solve the problems.

Genetics: is a branch of biology that deals with hereditry as well as variation in which characters are passed from one parent to offspring.

TABLE OF CONTENTS

Contents		Page
Tittle page		i
Declaration		ii
Certification		iii
Dedication		iv
Acknowledgement		v
Abreviations Used		vii
Operational Defination of Terms		viii
Table of Contents		xii
List of Tables		ix
List of Figures		x
List of Appendices		xi
Abstract		vi
CHAPTER ONE: THE PROBLEM		
1.1	Introduction	1
1.1.1	Theoretical Framework	11
1.2	Statement of the Problem	12
1.3	Objectives of the Study	14
1.4	Research Questions	15
1.5	Null Hypotheses	15
1.6	Significance of the Study	16
1.7	Scope/Delimitation of the Study	16
1.8	Basic Assumptions	17
CHAPTER TWO: LITERATURE REVIEW		
2.1	Introduction	18
2.2	Teaching Genetics at Secondary Schools	19
2.3	Science Teaching Instructional Strategies	20
2.4	Constructivist Teaching Strategies	23
2.5	Instructional Strategies and Students' Attitude to Science	35
2.5.1	Students Attitude and Academic Performance in Science	36
2.6	Instructional Strategies and Students Retention Ability in Science	39
2.7	Gender and Academic Performance in Science	42
2.8	Overview of Similar Studies	44
2.9	Implications of Literature Reviewed for the Present Study	54

CHAPTER THREE: METHODOLOGY

3.1 Introduction 57

3.2 Research Design 58

3.3 Population of the Study 59

3.4 Sample and Samplng Procedure 60

3.5 Selection of Topics for the Study 62

3.6 Instrumentation 62

3.6.1 Validation of the Instruments 64

3.6.2 Pilot Testing of the Instruments 65

3.6.3 Reliability of the Instrument 66

3.6.4 Item Analysis (FI & DI) 67

3.7 Administration of Treaments 69

3.7.1 Problem Solving Instructional Strategy 69

3.7.2 Discovery Teaching Strategy 70

3.7.3 Teaching the Control Group 74

3.9 Data Collection Procedure 75

3.10 Procedure for Data Analysis 75

CHAPTER FOUR: DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction 77

4.2 Data Analysis and Presentation of Results 77

4.3 Summary of Findings 86

4.4 Discussion of Results 87

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction 91

5.2 Summary 91

5.3 Conclusion 94

5.4 Contributions to Knowledge 95

5.5 Recommendations 96

5.6 Limitation of the Study 97

5.7 Suggestions for Further Studies 97

References 98

Appendices 113

LIST OF TABLES

Table		Page
1.1	Performance of Kaduna State Students in Biology at WAEC(2012-2015)	2
3.1	Population of the Study 60	
3.2	Sample for the Study 61	
3.3: Table of Items Specification of Genetic Concepts Selected Based on Bloom Taxonomy of Cognitive Domain 63		
3.4	Table of Items Specification of Genetic Concepts Selected and Genetic Performance Test (GPT) Based on Bloom Taxonomy of Cognitive Domain 63	
4.1	Posttest Mean Scores and Standard Deviation of Students Exposed to Problem-solving, Discovery Strategies and Lecture Method	78
4.2a	ANOVA Result of Posttest on Academic Performance of Problem-Solving, Discovery, and Lecture Method of Genetics Students	79
4.2b	Results of Scheffe's Post Hoc Test Between Students in Experimental and Control Groups 80	
4.3a	Retention Mean Scores of Problem-solving, Discovery Strategies and Lecture Method of Genetic Students 81	
4.4a	One-Way ANOVA Mean Score Results of Retention of Problem Solving, Discovery Strategies and Lecture Method 81	
4.4b	Sheffe's Post Hoc Test of Mean Score of Students Exposed to Problem-Solving, Discovery Strategies and Lecture Method on Academic Performance in Genetics. 82	
4.5	Mean Rank Scores of Attitude of Students Exposed to Problem-Solving, Discovery Strategies and Lecture Method in Genetics	83
4.6a	Non-Parametric Test of Kruskal Wallis Test of Problem-Solving, Discovery Strategies and Lecture Method 84	
4.6b	Dunn Bonferrari Post Hoc Test of Attitude of Genetic Students Exposed to Problem-Solving, Discovery Strategy and Lecture Method	84
4.7a	Posttest Mean Scores of Problem-solving and Discovery Strategies of Male and Female Students on Academic Performance in Genetics	85
4.8	One-Way ANOVA of Mean Scores of Male and Female Students Exposed to Problem-Solving and those Exposed to Discovery Strategy	86

LIST OF FIGURES

Figure	Page
3.1 Research Design - - - - - - - --	58
3.3 Flowchart of Problem-solving Teaching Strategy - - -	73
3.4 Flowchart of Discovery Teaching Strategy - - - -	74

LIST OF APPENDICES

Appendix		Page
A.	Lesson Plan for Expirmental Group 1 using Problem Solving Teaching Strategy	113
B.	Lesson Plan for Expirmental Group 2 using Discovery Teaching Strategy.	126
C.	Lesson Plan for Control group using Lecture Teaching Strategy	138
D.	Letter for Permission to Visit some Schools for Collecting Data	150
E.	Validation of a Research Instrument	151
F.	Genetic Performance Test and Marking Scheme	153
G.	Students Attitude towards Genetics Questionnaire	159
H.	Items Facility Index (FI) and difficulty Index (DI) for Genetic Performance Test	161
I.	Letter of Introduction	162

ABSTRACT

This study investigated the impact of problemsolving and discovery strategies on attitude, retention and academic performance in genetic concepts among secodnary school students in Zaria, Nigeria. The research design for the study Quasi-experimental and control group involving pretest andposttest. The population of the study consisted of 527, (264 male and 263 female) students. Simple random sampling technique by balloting method was used to select three schools out of five co-educational schools. A sample of three hundred and forty-five (345) secondary school students consisting of 182 male and 163 female students were randomly selected and used for the study. The sample was divided into three groups – experimental and control groups. Both groups were pre-tested before the treatment, and post testedafter treatment. Two instruments were used for gathering data, Genetic Performance Test (GPT) with reliability co-efficient of r=0.87 and Students' Attitude to Genetics Questionnaire (SAGQ) with reliability co-efficient of r=0.79. Two statistical tools – Analysis of Variance (ANOVA) and Kruskal Wallis were used for analysing the data gathered at $P \leq 0.05$ level of significance. Findings revealed that students taught using problem-solving and discovery strategies performed better than those taught usinglecture method. From the means scores of problemsolving and discovery teaching strategy the problemsolving mean scores was 24.74 while discovery strategy was 25.78 which is the highest mean scores. This shows that discoverystrategy have more impact in enhancing students academic performance in genetics. The same results was obtained in their retention ability and attitude change. However, gender did not affect their performance in anyway in all the teaching strategies. Based on the findings recommendations were made one of which urged biology teachers to use problem-solving and discovery strategies to improve students perforance in teaching genetics genetics at secondary school.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

Science education is an indispensable tool for national development because the economic and political strength of a nation is mostly assessed in terms of her performance in science and technology (Olarinoye 2001, Otuka 2006 & Wasagu 2007). In view of its importance to nation building, the Federal Government of Nigeria emphasized the teaching of science and technology at all levels of education in the country as stipulated in the National Policy on Education (FRN, 2013). This advocacy is sometimes inconsistent with various reform initiatives around the globe for both science and mathematics curricular and classroom practices. For instance, the need to develop students' understanding and scientific literacy by using inquiry and problem – solving experiences and skills acquisition, has been emphasized in the United States reform document of the American Association for Advancement of Science (AAAS, 2006) and National Research Council (NRC, 2006) which are also adopted in the teaching of basic science such as Chemistry, Physics and Biology.

Biology is a branch of science that deals with the systematic study of life. Biology as a science subject, has many branches notably Zoology, study of animals and Botany:the study of plants. Biology has other concepts under it such as ecology, microbiology, evolution, genetics and many others. Biology serves as a pre-requisite or a core subject to many science disciplines notably human medicine, food technology, agriculture, pharmacy, veterinary medicine and health education. It is reflected as a requirement for admission into science-based courses at Universities, Colleges of Education, Polytechnics and other tertiary institutions.

In spite of the strategic position of Biology among other science and science related disciplines, students'performance hasconsistently been below expectation and unimpressive.Oloyede (2008) reported that, the failure rate inBiology examination culminated in to the poor performances of students over the years. Biology is one of the natural sciences that the level of students' performance was below expectation. In this vein, the performance of students in science is reflected on how well they understood science concepts and it boiled down to how well the instructor is giving the instruction (Jegede, 1996). The performance of Biology students in SSCE examination in Kaduna state had been declining over the years as presented in Table 1.1

Table 1.1 Students Performance in Biology in Kaduna State WAEC May/June 2012-2015

Years	Total Sat for Exams	% Pass	% Fail
2012	26,821	47.04	52.96
2013	34,852	41.95	58.05
2014	30,653	42.98	57.02
2015	50,896	47.83	52.17

Source: (West African Examination Council Chief Examiner's Report 2012 – 2015)

The need to find solution to students' low performance in Biology is therefore an obvious factor as Damide (2000), Oloyede (2008) and Zayun (2008) opined that several factors have been advanced for the low performance of students in Biology. These include non-availability ofteaching and learning materials, abstract nature of some concepts in Biology, poor language skillson the part of both the teachers and the student societal factors, instruction and strategies employed by the teacher among others Oloyede (2008)

observedthe students poor interest in Biology contributes substantially to the failure rate inBiology. The West African Examination Council (WAEC, 2010) examination report showed that students'performances are generally low in Biology.

Ineffective instructional method of teaching as well as lack of practical work resulted into the poor performance of candidates in genetics at senior secondary school as observed by Okebukola (2000).The result also revealed that secondary school students perceived genetics as a difficult concept. This is as a result of the abstract nature of genetic concepts which makes the understanding difficult and resulting in poor performance (Lawal, 2009). The persistent poor performance in Biology at SSS levels need to be improved by using activity – based teaching strategies such as problem-solving, and discovery which allow active students' participation. This type of study is necessary because it encourages hands on activities needed for effective learning process at SSS level.Specifically, therefore, this study investigates what will be the impact of two constructivist teaching strategies: Problem solving and discovery teaching strategies on academic performance, retention, and attitude to genetic among Senior Secondary Schoolstudents. Previous researches were done on the use of activity based teaching strategy such as problem solving, discovery, collaboration separately but this research used the two strategies to find out which one is probably more appropriate in learning genetics concepts at secondary schools.

Genetics being an integral part of Biology syllabus constitutes the last aspect of senior secondary schools curriculum beside evolution and ecology. Consequently, the teachers find it difficult to teach the students genetic concepts appropriately due to its abstract nature. This contributes to the poor performance of students in Biology S.S.C.E as observed by WAEC and NECO Chief Examiners' Reports (2015). Also, Okeke (2010) observed that, lack of appropriate teaching strategies usually affect students' academic

performance adversely in science subjects due to the fact that most of the contents of science subjects are all abstract and difficult to learn more especially genetics concepts among others. In view of the above, the study is aimed at providing strategies such as problem-solving and discovery strategy in teaching genetics at senior secondary schools which may probably have a far reaching effect in imparting knowledge to the Biology students and that could help to reduce the poor performance of students.

Genetics is a branch of Biology that deals with the study of heredity and variations, the principle that accounts for the diversity of organism (Kala, 2012). Also, according to Kala (2012),the understanding of genetics at colleges of education and universities very much depends on the pre-requisite of understanding of genetics concepts like the cell, its structure and functions among others. A good knowledge of genetics is very important to students of Biology and related courses such as genetic engineering, plant breeding etc., most especially in their later years of study (Okebukola, 2002). However, many students avoid genetics-related questions in Biology at secondary school level, which is the foundation of Senior Secondary School level. Okebukola (2000) also found that,in addition to the above, teachers and students' negative attitudes towards genetics teaching and learning play vital role in their poor performances. Umeh (2002) also found that, using lecture method retards meaningful learning of genetics. Genetics is an important component of Biology all over the world and it has attracted many researchers in recent years (Kindfield, 2007). Understanding of genetics does not only mean that knowing how one generation of living organism transfers its traits to the next one and so on, but it is a basic conceptual framework to understand other biological phenomena such as reproduction in living things, evolution and biodiversity (Ayuso, 2003, Chi-Yan & Treagust, 2003& Mahmud 2009).

Mahmud (2009) in his study observed that students' poor academic performance in Biology was as a result of their poor knowledge of genetics taught. The academic performances are also low as a result of non coverage of the syllabus in the area of genetics as well as the use of appropriate teaching strategies which make students hate the topic and the situation leads to poor performance of students in genetic and especially Biology, at senior secondaryschools. Previous studies like that of Lawal (2005), Umeh (2006), Rotbin (2006), Araz (2007) and Lawal (2010) show that students have difficulties and confusionin learning genetics in which the situation leads to poor performance of students in Biology, especially at senior secondary school, level (WAEC Chief Examiners' Report, 2015).

However, there are some opinions among researchers that genetics is quite difficult for students to learn (Johnstone& Mahmoud, 1999). To Banet and Ayuso (2000), genetics is one of the domains that require learners to use multilevel thinking and reasoning involving higher – order thinking. The overview of comparison between teachers and students' perception showed that most students thought that, genetics is difficult to learn. According to (Chief Examiner'sReport, WAEC (2012-2015), students who attempted questions in genetics were not able to link biological concepts to real life situations. Umeh (2002) also noted that many teachers have phobia for genetics. James (2000) observed that Senior Secondary School teachers also performed poorly when teaching genetics at secondary level, thereby leading to poor performance of secondary school students.

To further buttress the fact that learning of genetics – related concepts has been posing problems to students of Biology, Tsui and Treagust (2002) reported in their study that certain level of knowledge of numeracy as well as analytical ability which is lacking in many students of Biology for proper understanding of genetics is a contributory factor to their poor performance and hence their dislike of the concept. In this study, an attempt

will be made to compare two constructivist teaching strategies (problem-solving and discovery strategy) in order to determine their effectiveness or otherwise in teaching genetics in senior secondary school.

Constructivism is a paradigm or ideology which views learning as an active process in which students consciously construct their own knowledge based on the existing knowledge. Constructivism sees students as active participants with knowledge construction and not passive listeners. Several constructivist teaching strategies exist, some of which include; problem-solving, discovery, corporative inquiry among others.

Constructivist teaching strategy of problem-solving and discovery strategiesare used in this study. Problem solving is a strategy to be used in this study. Problem – solving is viewed by researchers from different points of view. Among the researchers that viewed problem-solving were Duke (1999) and Danjuma (2005) who opined that, problem – solving is a request for a certifiable outcome to a situation. They further added that solving problem is a method of organizing information and using that information, along with the knowledge possessed to obtain the desired outcome or solution. Bransford and Stein (2000) viewed problem – solving as the process of moving towards a goal when the path to that goal is uncertain. They added that to solve a problem is to find a way around an obstacle and attain a desired end that is not attainable by appropriate means.Problem solving being an activity based where students learn by themselves through various activities in which students acquire meaningful learning as stated (Bankure, 2012). Problem – solving teaching strategy is said to have contributed in enhancing students' academic performance in science, (Adamu, 2014). In this study, problem solving teaching strategy ofpolya's models(Jensen, 1996), was used to find out its effectiveness or otherwise in enhancing students' academic performance in genetics at Senior Secondary School.

Another method of instruction which is activity-basedthat would be deployed in this study is discovery. This method in science teaching was postulated by Bruner (1961). The method enables students to gain experience in using facts, concepts and principles, by using mental processes and manipulating scientific equipment and materials. Bruner believes that a child who is exposed to the heuristics of discovery gets some benefits in learning concepts. Finally, the method is one of the activity – based, as teachers cannot teach science effectively without employing activity – based method.Among others, discovery strategy allows students to actively participate in learning activities and this make students to gain meaningful learning through discoveryof certain concepts on their own (Usman 2000, & James 2000).

This study is necessary becausethe two strategies have different types of approaches.For example, problem-solving strategy allows students to discover certain concepts and also makes ability to solve problems by themselves. Problem-solving consists of five stages:

1. Introduction: the teacher presents a problem to the students with relevant concept of genetics.
2. Students' activities: students are allowed to think and solve the problem presented individually on paper.
3. Discussion: students discuss some similarities and difference of their answer with a partner sitting.
4. Students' activities: students share their ideas and findings together.
5. Evaluation: students are asked questions on what they have learned using problem-solving.

While discovery teaching strategy allows students to discover certain concepts but not necessary to solving them, it consists of four stages as follows:

1. Introduction of genetic concepts.
2. Students' activities using discovery strategy of students' activities on genetic concepts.
3. Discussion: the teacher asks the students to present their findings from activities carried out and observations made.
4. Evaluation: the teacher evaluates the lesson by asking the students some questions based on what they have discovered by themselves. Based on this, there is need to determine which is more effective in the teaching and learning of gentics at senior secondary school level due to their different strategies and approaches.

Therefore, in this study, discovery teaching method as one of the constructivist teaching strategies was explored and compared to problem solving strategy to find out which of them will improve students' performance in genetics, retention ability and attitude and to determine the strategies have upper hand.

Lecture method, also known as traditional method of instruction, is a method of teaching that emphasizes "talk and chalk" in the teaching of science subjects. More than 80% of scientific information and principles are delivered to students' through lectures, (James, 2000). Teachers embrace the method for easy coverage of the school syllabus. It is characterized by one way flow of information and as such, it makes the teacher active, while students are passive. It is one way flow of information which some researchers believe does not promote meaningful learning (Usman & James, 2000). The lecture method will be used as a control teaching method in this study.

Attitude is one of the most important and frequently researched variables in science teaching. Ibraheem (2008) defined attitude as a learners disposition to respond in a consistently favourable or unfavourable manner with respect to a given object. Attitude of students towards science forms an aspect of this study so as to establish the differences (if any) in the attitude of students before and after exposure to two constructivist instructional strategies. Apparently, some studies, Dana (2006) and Adesoji (2008) have been conducted into the area of attitude. Such studies revealed that, students attitude to science is affected by some instructional methods among others. There is need to conduct a study to investigate the effects of constructivist teaching strategies (problem solving, and discovery) on students' attitude towards genetic concept. Therefore, the two constructivist teaching strategies wereused with lecture method to see whether they could improve SSS students' attitude, retention and academic performance in genetics.

Another variable of this study is the issue of retention ability. Retention is the ability of a learner to recall, remember and recollect a body of knowledge after passing through instruction at a given time duration (Oyetunde, 2000). Permanent and meaningful learning is the ultimate target of our educational endeavour. Understanding and retention are products of meaningful learning when teaching is effective and meaningful to the students (Bichi,2002). Bichi (2002) also observed that retention is the ability to retain and consequently remember things, experienced or learned by an individual at a later time. It takes place when learning is coded into memory. Thus, appropriate coding of information provides the index that may be consulted so that retention takes place without an elaborate search in the memory line. The nature of the materials to be coded contributed to the level of retention. Materials are related to the quality of retention in terms of their meaningfulness, that is when students are able to see what they learn using laboratory strategy and mental processes to carryout activities inform of problems solving.

Muhammad (2011) stresses that anything that aids learning should improve retention while those leading to confusion or misinformation among learning materials decrease the speed and efficacy and accelerate forgetting. In this study, the constructivist teaching strategies wereused with the lecture method as a control to find out if it could improve SSS students' retention ability in genetics or not.

Gender is another factor in science education. Bichi (2002) defined gender as the amount of masculinity and femininity found in a person and obviously while there are mixtures of both in most human beings, normally male has a preponderance of masculinity and the normal female has a preponderances of feminity. The concept "gender" has attracted the attention of many psychologistsand researchers as a result of which a lot of literature exist on different aspect of science education. The influence of gender on students' performance has for a long time been a concern to many educational researchers. But surprisingly no consistent results have been obtained (Francis & Babatunde, 2008). Philips (2006) had opined that girls excel consistently in arithmetic computation and supervision in reading and hand writing, while boys are slightly better in arithmetic reasoning, geography, geometry and history. Usman (2000) observed that if male and female are exposed to activity-teaching strategy such as discovery outdoor and indoor strategies they will perform equally well. What will be the case if problem-solving and discovery strategies are used? The present study, therefore examined the impact of problem-solving and discovery strategies on attitude, retention, and performance in genetics concept to see which of them will improve the gender difference or otherwise.

1.1.1 Theoretical Framework.

The theoretical frame work of this study is based on constructivist Piaget (1967) and Bruner (1961) and Gagne (1970) theories of learning. These constructivist theories of

learning have its roots in cognitive psychology, philosophy, learning theory and education theory. Also,constructivist streams from several theories such as information processing theory and Bruner learning theory (1961) suggested that learning can be meaningful by using activity-based instructional strategy such as problem solving, discovery, inquiry, among others. Problem-solving is a set of steps to reach a goal using problem-solving skills. Problem-solving strategyis among the constructivist activities that are activity-based.Inconstructivist learning the role of the teacher is to guide and channel the learning process rather than providing knowledge.

Gagne, (1970) suggests that problem solving can be viewed as a process by which the learner discovers the combination of previously learned rules that can be applied to achieve a solution for a novel situation, in form of hierarchy of knowledge but it is also a process that yields new learning. These are as follows: (a) The learner discovers. (b) Previously learned rules. (c) Achieves solution. (d) Novel situation; and (e) New learning.The processes stated are important to be followed when employing problem solving strategy which is part of the treatment to be administered in this study. Problem solving as a constructivism teaching strategy was used in this study to determine its effectiveness on students' academic performances in genetics. Bruner, (1961) explained that; it is only through the exercise of problem – solving and the effort of discovery that one learns the working heuristic of discovery.

Discovery strategy is another constructivist idea, Piaget (1967) believed that, individuals construct their own knowledge as a result of their interaction with specific phenomenon as in the case of discovery concepts. Such constructed knowledge usually formed the basis upon which new knowledge is anchored and ideas from rote learning to meaningful learning through exploration of the environment by the child are explored. The use of activity – based method of instructions such as discovery method advocated for

science educators to help shift the learners from passive to active participation(Kikas, 2004). The method makes use of theories of learning by psychologists such as problem-solving which is one of the strategies of science teaching. Ajewole (2007) observed thatdiscovery is an approach to investigation/inquiry teaching whereby students are guided or assisted in a way in their learning activities so that they can arrive at finding a concept of the subject matter. In this research, the problem-solving theory of Bruner (1961)was adopted as well as discovery strategies of Piaget (1967) in which the impact of problem-solving and discovery strategies on attitude, retention and academic performance in genetics was investigated among SSII students' in Zaria.

1.2 Statement of the Problem

The poor performance in Biology has been attributed to so many factors.For example Bichi (2002), Danjuma (2005), Adamu (2014) and Suleiman (2015) observed that activity based instructional strategy such as problem-solving, discovery, inquiry, demonstration could enhance academic performance of students.Since poor academic achievement in genetics according to Okebukola (2000) has been attributed to students' poor manipulative skills, insufficient materials, poor teaching strategies and difficult genetic concepts could be as a result of teaching strategy used by Biology teachers. It also record that 70% of the scientific information is passed to students via traditional method, (Bichi, 2002).Most teachers use lecture methods hence the low performance.Lack of problem solving ability. Students' perception of genetics concept as a difficult subject, lack of qualified teachers, lack ofteaching facilities, inadequate coverage of syllabus, persistent use of lecture strategy and the complex nature of genetics concepts may be among the factors leading to poor performance. Several studies were carried out using problem-solving and discovery teaching strategysuch as does of Adamu (2014) and Suleiman (2015);individually in teaching genetic concepts using separate teaching

method.Despite the researcher by using problem-solving and discovery strategy students' performance in genetics still persist. Therefore is indebted to fill this gap. In line with this, the researcher sought to investigate the impact of problem-solving and discovery strategies on attitude, retention and performance in genetics concept among secondary school students.

A number of studies on teaching strategies have been carried out in genetics at secondary and tertiary levels by several science educators, such as, Ibraheem, (2004) and Lakpini (2006) among others. Genetics is one of the important aspects of Biology curriculum at secondary school level. Students who were taught genetics at the Senior Secondary School level found genetic concepts difficult to understand, thereby leading to their poor academic performance (Wynne, 2001). Also, studies have shown that, students performed poorly in Biology as a result of their poor performance in genetics. However, there are agreements among some researchers that genetics is quite difficult for students to learn (Banet & Ayuso 2000), because it is one of the domains that require learners to use multiple thinking and reasoning that is central to higher order thinking (Chiyan & Treagust, 2003). West African Examination Councils Chief Examiner's Report, (2014) reported that, only few candidates attempted questions in genetics and those who attempted genetic questions failed them. The failure of SSS students in genetics as observed by Okebukola (2001) was linked to the way teachers teach genetics at Senior Secondary School level by constant use of lecture method which does not allow students' active participation.

From researches conducted, the empirical evidence supports the use of problem-solving and discovery teaching strategy,but most studies were concerned with one experimental teaching strategy without making multiple comparison and indicating which of them is the best.The researcher in this study therefore uses more than one

teachingstrategy to findout which one has more impact or otherwise in the teaching of genetic concepts. The persistent poor performance in genetics at Senior Secondary School level therefore, needs to be addressed possibly by using constructivist teaching strategies such as discovery strategy, problem solving which allow active students' participation. For this reason, the researcher provided empirical evidence to support the effectiveness of the two teaching strategies on academic performance, attitude, retention in genetic at the Senior Secondary Schools.

1.3 Objectives of the Study

This study has the following objectives, which are to:

1. examine if problem solving and discovery strategieswould enhance academic performance in genetic concepts among SS II Students.
2. investigate whetherproblem solving and discovery strategieswould improve retention ability of SS IIstudents in genetic concepts at senior secodnary school.
3. determine if problem-solving and discovery strategieswould enhance SS II students' attitudetowards genetic concepts.
4. investigate whether problem-solving and discovery strategies would have effectson male and female students' academic performance in genetics concepts.

1.4 Research Questions

For the purpose of this study, the following research questions were formulated to be answered:

1. What is the difference in the academic performance post test mean scores of SS II students taught genetics concepts using problem-solving and discovery teaching strategies compared to their counterparts taught using lecture method?

2. What are the differences in postpost test mean scores of SS II students taught genetic concepts using problem-solving and discovery teaching strategies compared to their counterparts taught using lecture method?
3. What is the difference in the attitudinal change of senior secondary school SS II students towards genetic concepts when exposed to problem-solving, discovery strategies and those taught with lecture method?
4. What are the differences in academic performance of male and female SS II students in genetic concepts when taught using problem-solving and discovery strategies?

1.5 Null Hypotheses

The following null hypotheses were formulated for testing at $P \leq 0.05$.

Ho_1: There is no significant difference in the posttest mean scores of SS II students taught genetic concepts using problem-solving and discovery teaching strategies compared to their counterparts taught using lecture method.

Ho_2: There is no significant difference in the post post test mean scores of SS II students taught genetic concepts using problem solving and discovery teaching strategies compared to their counterparts taught using lecture method.

Ho_3: There is no significant difference in attitudinal change between students taught using problem-solving, discovery and those taught genetics with lecture method at SS II students.

Ho_4: There is no significant difference in the post test means scores among male and female

SS II students taught genetic concepts using problem-solving and discovery strategies.

1.6 Significance of the Study

The findings of this study would hopefully uplift the standard of Biology education in the following ways:

Biology Teachers: The research findings would hopefully benefit Secondary School Biology teachers towards using more effective teaching strategies for effective learning of genetic concepts such as problems solving and discovery teaching strategies.

Biology Students: It would be of benefit to the students as the findings may lead to an improvement in their academic performance and retention through the use of three consrtructivist strategies of teaching genetics concepts, i.e concept of cell,types of cells in a living organism, function of cell in a living organism, mitosis, meiosis, differences betwen mitosis and meiosis.

Professional Bodies: The findings will be useful to various professional agencies and associations such as Science Teachers' Association of Nigeria (STAN), Nigeria, Education Research Development Council (NERDC) and Teachers' Registration Council of Nigeria (TRCN) who are concerned with outcomes of research especially in the area of instructional innovation for effective teaching and learning.

Textbooks Publishers: Textbooks Publishers will find this work useful as it will assist in selecting materials and exercises to be incorporated in it, making refrence to constructivist teaching strategies used in this study.

Researchers: The findings will also provide new information to the existing literature in biology education and it will also serve as a foundation for the further similar studies.

1.7 Scope of the Study:

The subjects used for this study were public secondary school students in Zaria Metropolis Zone, Kaduna State. SS II students were used because the SSI students could

not be used because they have just been introduced to genetics in Biology syllabus. While SSIII students are preparing for their SSCE and they may not concentrate effectively on this study consequently, SS II students were be used for the study. The scope of the study comprises of secondary schools which spreads through Zaria Metropolis. The public secondary schools were used for the study.

The concepts taught in genetic have been chosen for the study because the genetics concepts are centred on the biologistunderstanding of a number of aspects of the living system and also has been proved to be difficult for students to understand (West Africa Examinations Council (WAEC) Chief Examiners' Report, 2012 & 2015. These concepts are:

- Cell.
- Types of cellin a living organism.
- Functions of cell in a living organism.
- Mitosis.
- Meiosis
- Differences between mitosis and meiosis.

1.8 Basic Assumptions

The study has the following basic assumptions put forward for the study:

1. The subjects for the study are familiar with the use of activity - based teaching strategies such as Problem solving and discovery.
2. Biology teachers are familiar with the teaching of genetics using appropriate teaching strategies, such as problem-solving and discovery.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The main aim of this study is to investigate the impact ofproblem-solving and discoverystrategies on academic performance, attitude, retention in genetic concepts among Senior Secondary School students. In this chapter the literature for the study was reviewed and presented under the following subheadings:

2.2 Teaching Genetics at Secondary School

2.3 Science Teaching Instructional Strategies

2.4 Constructivist Teaching Strategies in Sciences

2.4.1 Problem-solving Teaching Strategy in Sciences

2.4.2 Discovery Teaching Strategy in Sciences

2.5 Instructional Strategies and Students' Attitude to Sciences

2.6 Students Attitude and Academic Performance in Sciences

2.7 Instructional Strategies and Student Retention Ability in Science

2.8 Gender and Academic Performance in Sciences

2.9 Overview of Similar Studies

2.10 Implications of Literature Reviewed for the Present Study.

2.2 Teaching Genetics at Secondary School

Biology is a branch of science that deals with the science of life. Although, Biology is a single science subject, it is often divided for convenience into many branches Zoology the study of animal, Botany the study of plant and general Biology such as ecology, Microbiology, Evolution and Genetic which deals with the study of heredity and variation in living things, Michael (2000) states that, Biology serves as a core subject for

science disciplines among which are human medicine, food technology, agriculture, pharmacy, veterinary medicine and many others. Genetics is a branch of Biology that deals with the heredity as well as variation in which characters are passed from parents to offspring. The understanding of genetics at both post-primary and tertiary levels, depend on the understanding of genetic concepts like cell, its structure functions, as well as Mitosis and meiosis. And of course, the behaviour of genes which constitutes the major part of genetic concepts at SSS Level which very much depends on understanding of those concepts at tertiary level.

A good knowledge of genetics is very important to students of Biology and other science related courses, especially in their later years of study. However, many students avoid genetics related questions in Biology at secondary school, which is the foundation level. Okebukola (2002), Mahmud (2009), Lawal (2009) reported that genetic is one of the areas in Biology that students perceived as being difficult as such not easy to pass at SSS level. The West Africa Examination Council reports on performance of candidates in Biology (WAEC) from 2010-2015, also confirmed this when they reported poor attempt on the part of students who answered genetics and ecology related questions in the theory parts of their examinations.Tsui and Treagust (2002) reported in their study that certain level of knowledge of numeracy as well as ability level is lacking in many of the Biology students studying genetic concepts. Failure to understand genetics is a contributory factor at SSS for the poor performances and hence SSS Students dislike genetics concepts. They further reported that students who usually have much analytical abilities are attracted to physical science and mathematics. Also, many of the students who took Biology as a science subject, do not take Chemistry serious upon which much of genetics and indeed modern Biology is heavily dependent.

A base line study conducted by the State Ministry of Education Kaduna (MOE) stated that genetics is one of the topics students regarded as difficult to learn in Biology (MOE 2005). The study probes into the learners' cognitive structures of Biology, what they harbour about genetics that hinders their proper understanding of genetic concepts. This study intends to use the comparative impact of two constructivist teaching strategies to teach these selected topics or areas where the students are believed to have problems. Several studies such as the study conducted by Tambaya (2004), Awodeyi, 2005 have shown that constructivist teaching strategy has an advantage of increasing the students knowledge in relation to generating more active participation in science activities leading to their greater understanding of science subjects.

From the foregoing, the factors responsible for poor performance in genetics study at SSS could be attributed to the nature of genetics concepts such a gene, chromosome, cell structure which cannot be easily observed and comprehended. Others are the lack of effective practical work, not using effective instructional strategies, teachers and students attitude towards the genetic concepts among others. (Mahmud, 2009) Therefore in this study, there is a need to employ activity-based teaching strategy such as Discovery as well as Problem Solving strategies to find out whether it will enhance the teaching and learning of genetics at Senior Secondary School.

2.3 Science Teaching Instructional Strategies

Effective teaching and learning in any subject at post primary and tertiary level depends on instructional strategies used by the teachers such as the use of instructional materials, practical activities among others and other variables (Jegede, 1996). Instructional strategy is the major factor responsible for the level of performance in any subject by the students Adamu (2014). There are several strategies of teaching which can

be employed for teaching science (Danazumi, 2008 & Mamuda 2009). Prominent among the instructional strategies used in teaching and learning are problem-solving, discovery, laboratory, demonstration, inquiry, project, field trip, lecture, cooperative learning, simulation, concept mapping among others. Findings of some researchers such as Lawal (2009) and Muhammad (2014) reveals that the teaching method that are activity oriented involves the learner taking active role in teaching and learning process which results in better learning and understanding of science concepts on the part of the learner. However, teachers of Biology resort to the use of the popular "talk and chalk", method to teach in the class-rooms, which more or less results into memorisation of facts and does not promote meaningful learning. (Okebukola, 2002)

Research findings of Okebukola (2002), Tsui and Treagust (2002), revealed that those teaching strategies that are activity oriented and involves the learner taking active role in the teaching and learning process results in better learning and understanding of science concepts on the part of the learners.Olarewaju (1998) described traditional strategy of teaching as a one way type of classroom interaction. Here, the teacher talks and writes notes on the board while the students listen and copy down notes. The teacher talks directly to the students and the students are not given little chance to ask questions or give feedback to the teacher. Learning difficulties can be solved by using appropriate teaching strategies and also different approaches have been adapted for instruction in order to promote learning. The teachers can impact knowledge by lecture method, team teaching, discussion, audio-visual instruction, activity-based strategy among others (Jegede, 1996).

The teacher comes to class to deliver the lesson while the learner listens and writes down the point dictated by the teacher. In fact, Okebukola (2002) contended that eighty percent (80%) of scientific information that students receive from their teachers come through lecture method. Thus, Okebukola said this is as a result of the emphasis the

educational system lays on paper qualification, which is obtained through public examinations, Science teachers thus use lecture method since it leads to easy coverage of the school syllabus, which unfortunately is the main concern of science teachers and the society in generally. The instructional strategies proposed to improve science instruction are those which follow the constructivist view to enhance the students' performance in genetics concept. The role of students' personal experiences in their construction of knowledge has been largely neglected in the previous learning strategies. There is need to have a shift from teacher-centred to student-centred strategy which recognizes the role of personal construction in the development of scientific knowledge (Lakpini, 2006). The purpose of teaching is to make the students learn or know what they were taught, that is teachers are to impart knowledge and skills to students. Knowledge, is a complex issue which can be convieniently broken down in to three areas or domains according to the Bloom's Taxonomy of educational objectives namely:

1. Cognitive domain: This deals with the recall and remembering of information, understanding and re-organization of information, the use and application of learnt information to other situations, and finally, the analysis, synthesis and evaluation of a given piece of information.

2 Psychomotor domain: This deals with the skills of manipulation, the use of the hands, especially in practical work, e.g. the ability to use a Burette to measure volume, a Microscope to observe micro-organism or an electrical bell to set up an electric circuit.

3. Affective domain: This deals with attitudes and feelings for instance honesty, co-operation, neatness and openness are positive attitude which fall into this area of knowledge in the teaching of science.The thinking skills should be tailored in such a way that they start from concrete to the abstract taking note of the following:

a. Knowledge

b. Comprehension

c. Application

d. Analysis

e. Synthesis

f. Evaluation

Also, with reference to teaching methods, there exist today many approaches to the teaching of science in schools. Some of these include:

i. Laboratory activity method
ii. Lecture method
iii. Discussion method
iv. Guided discovery method
v. Concept mapping method
vi. Problem solving
vii. Field trip method
viii. Project method

This study is designed to investigate the impacts of discovery and problem solving teaching strategies on academic performance in genetics of Senior Secondary School students.

2.4 Constructivist Teaching Strategy

Several authors have different views on Teaching Strategies such as problem solving, discovery strategies. Awodeyi (2005) who explained that, the constructivist school of thought views learning as process in which students actively construct their own

knowledge of the situation at hand based on the existing previous knowledge. According to the theory,students engage their minds very actively in constructing meaning out of their interaction with the environment. They make their own connections between experiences. What they are been taught and create their own network of relationships and patterns of thinking. Okebukola (2002) sees learning under problem-solving and discoverymodel as being comprised of a process of adjusting one's own mental models to accommodate new experiences. The model is not a model that transmits knowledge rather it is a model that involves the organization of situation in the class-room and designing of a task materials and resources from which students construct their own knowledge. The problem-solving and discovery model sees the learner as not completely blank slate upon which knowledge is written, but rather sees the learner as coming into learning environment within a formulated knowledge, ideas and understanding. This previous knowledge becomes the raw materials for the new knowledge to be created. As such learning in the model says that the learner compares new information taught to him to the knowledge and understanding he/she already has.

Ogunkule and Gbamanja (2006), Igboko and Ibeneme, (2006) regarded problem-solving and discoverymodel as learner-centred, in which the science teacher is an organizer, facilitator and manager of science teaching and learning rather than an authority or a dictator. They went further to observe that instead of being passive observers of scientific information, students participate actively in the teaching and learning process. In addition, they are introduced to the inquisitiveness and curiosity in the world of science.

Students are also encouraged to ask questions, to be critical, to investigate and to seek answers to scientific questions. Ogunkule, 2006 reported that science teaching approach is characterized by discussion, questions, arguments, agreements, disagreements, exchange of ideas, discovering, problem solving leading to what may be regarded as

science classroom. The research observed that this has the potential of creating a conducive and encouraging science classroom that could lead to effective science teaching and high performance among students. This mode of teaching is also known to promote cognitive growth and acquisition of critical thinking skills in learners, Mari (2001).

Foster (2008) identified the following characteristic of learner-centred teaching strategy namely:

i. Classroom set up, desks and chairs not fixed in rows rather, they are in groups, or stations
ii. Learners talk and do activities most of the time, with the teacher serving as facilitator only.
iii. Content and Activities: Learners Initiate Content and or Activities.
iv. Experience and knowledge: Learners experiences and knowledge are used in instruction.
v. Learners creativity: The teacher encourage learners activities most of the time
vi. Peer group work: Learners learn and carry out activities in peers or small groups the teacher serves as a guide.
vii. Teachers position in class: Teacher walks around and checks learners work/activities
viii. Questioning technique: The teacher mostly asks open ended and higher order questions (evaluates, reasoning, judgment and abilities)
ix. Assessment method: Learners are continuously assessed and assisted by the teacher from beginning to the end of the lesson
x. Report: The teacher talks to learners both inside and outside the class, inquires how learners are doing.

2.4.1. Nature of Problem-solving and DiscoveryApproach in Science

Social constructivists suggested that knowledge is first constructed in a social context and is then appropriated by individuals, (Eggan&Kauchak, 2004). According to social constructivist such as Meter& Stevens (2000), the process of sharing individual perspectives called collaborative elaboration, results in learners constructing understanding together that will not be possible alone. Social constructivist scholars view learning as an active process where learners learn to discover principles, concepts and facts for themselves: hence, the importance of encouraging guess work and intuitive thinking in learners. In fact, for the social problem-solving and discovery, reality is not something that we can discover. It exists prior to our social invention. Other constructivist scholars agreed with this and emphasized that individual makes meaning through interaction with each other and with the environment they live in. Knowledge of this kind is a product of humans and socially and culturally constructed. Mcmahon (1997) agreed that leaving is a social process, learning is not a process that only takes place inside our minds, nor is it a passive development of our behaviours that is shaped by external forces and that meaningful learning occurs when individuals are engaged in social activities. In this study, some learning approaches that could harbour this interactive learning include problem-solving and discovery field trip and others are going to be discussed. Eggan & Kanchak (2004) also highlighted the convergence of the social and practical elements in learning by saying that the most significant moment in the course of intellectual development occurs when speech and practical activity, two previous completely independent lines of development, coverage. Through practical activity a child constructs meaning on an intrapersonal level, while speech connects this meaning with the interpersonal world shared by the child and his/her culture,

A further characteristic of the role of the facilitators in the social viewpoint is that instructor and the learners are equally involved in learning from each other as well (Holt &Willard-holt, 2000). This means that the learning experience is both subjective and objective and requires that the instructor's culture, values and background become an essential part of the interplay between learners and tasks in the shaping of meaning. Learners compare their version of the truth with that of the instructor and fellow learners to get to a new socially tested version of truth (Kukla 2000). The task or problem is thus the interface between the instructor and the learner. This research intends to use two problem-solving and discovery strategies because most of the researchers are used one experimental with control but fill this gap so that will enhance effective teaching and learning of genetics concepts.

2.4.2 Problem-Solving Teaching Strategy

Problem-solving teaching strategy is not only that new knowledge that is acquired but also the skills of problem-solving are retained for use in new problems, new situations and new context. Skills learned in one context can be transferred and used in another one. Skills acquired in schools are therefore, useful for solving more general problems in the outside world and transfer of learning can be useful. Problem-solving tasks are set as a regular part of the course work on most courses in mathematics, science, as well as technology and some social science courses as well (Laurilliad, 2000). They are seen as an important part of the students work because they require the application of knowledge and principles to new situations, thus testing and reinforcing the students' real understanding of what they have learned. Any knowledge without the ability to apply it is rightly seen as a very poor commodity, and teachers therefore regard problem-solving exercises as an important part of learning (Chia, 2003).

On the effectiveness of problem solving in science and learning, Nott (1987), Kurfiss (1988), Eze (2001) and Bichi (2002) were of the opinion that problem solving encourages good learning habit as well as putting into account children'sinterest, which lead to logical thinking. It promotes development in the area of academic. This is an activity-based teaching method and therefore, encourages group work. Danjuma (2005) opined that there are three things involved in a problem. For a goal or an objective to be a problem, it must be a challenge to the solver, secondly the solver must be willing to accept the challenges. Thirdly, the solver has no readily accessible ways for confronting the question for obtaining solution. As such the above three conditions have to be satisfied for a situation to be regarded as a problem.

However in this study, a task or problem is considered as a challenging situation acceptable to an individual or group that cannot be solved directly by means of regular routine procedure. Problem-solving strategy is one of the imparting scientific knowledge and communicating science to students in schools. Problem-solving approach is based on several cognitive theories. Scoiellos and Malotidi (2004) are identified as the most prominent attribute of problem-solving teaching strategies. Olaniyi (2002) conducted an experimental research on relative effect of value clarification and problem-solving instructional strategies on students learning outcomes in Integrated Science. The result indicated that there was a significance effect of treatment on student's performance in selected environmental concept.

Research and education association REAS(1992) and Powell (1995) find out that science has been taught in schools and students have found this subject difficult to understand and learn because of the usually number of principles & their complex intralations REA'S (1992) affirmed that despite the publication of hundred of textbooks in this field, each one intended to provide an improvement. In science textbooks, (Biology

inclusive) concept remains particularly perplexing and the subject is often taken only to meet certain requirement for selected courses of study, it has been observed that some teachers failed to state the problems and to present the solution, instead, they pass through a general discussion, never revealing what is to be solved for example some textbooks do not always include diagrams/graph, whenever appropriate and therefore students do not obtain training to draw diagrams or graphs to simplify and organise their thinking.

Selvaratram (1990) also observed that students can learn the subject only by doing the exercises themselves and reviewing them in class to obtain experience in applying the principles with different – ramification in doing problem-solving exercise. Problem – solving strategy is one of the strategies of imparting scientific knowledge and communicating science to students in school. Problem solving approach is based on several cognitive theories (Scrorelles & Malofidi, 2004) identified two points as the most prominent.

- learners should work on "real problem" perceived as meaningful or relevant.
- People try to fill "gaps" when presented with a situation they do not in reality understand.

Consequently engaging people in working on real life, problem is also involved in the transition from a traditional education social centred approach to more learners approach. Literature shows that problem – solving as a process involved five major procedures which are as follows

i. Problem definition identification and understanding.

ii. Searching for and identifying alternatives to solve that problem.

iii. Feasibility assessment leading to a proposed solution.

iv. Implementing an action generated towards the solution.

v. Evaluating the progress and success of solution.

The procedures highlighted above can be further reduced to the following steps:

Step 1: The teacher helps the students to identify a problem either by himself or chosen by themselves.

Step 2: Students need to discuss and define the topic as well as collect information to determine the causes of the problem so that they will be able to know where to focus the effect in order to solve it.

This step calls for answer to the following questions:

i. What is the cause of the problem?

ii. For how long has the problem existed?

iii. Who is affected by the problem?

iv. How frequently does the problem occur?

v. How does those affected by the problems feel?

vi. How do you feel about the problem?

Problem-solving is the process of finding an appropriate response to a situation that is truly unique and new for problem –solvers students. Ayesha (2007) explained problem-solving strategy for teaching as a teaching guide that theoretically or conceptually teach students to solve problems using various strategies and problem solving steps. Sanjaya (2005) suggested several advantages of learning with problem solving strategy which are as follows:

a. Solving problem can challenge students' skills and provide satisfaction to discover new knowledge for students.

b. It also helps students to transfer their knowledge to understand the problem in real life

c. Problem solving strategy encourages students to evaluate both outcome and process of learning.

d. Solving problem can develop students' ability to adjust to new knowledge.

The illustration of the flow chart of problem-solving used in this is presented in figure 3.3

2.4.3 Discovery Teaching Strategy

This is another discoveryteaching strategy which is activity-based. This strategy of science teaching was postulated by Bruner (1961). The strategy enables students to get experience using facts, concepts, principles, laws, theories as well as processes by using mental processes and manipulating scientific equipment and materials. Bruner believes that a child who is exposed to the heuristic of discovery benefits a lot. Discovery strategy is one of the activity-based instructional procedures for science teaching, as teachers cannot teach science effectively without employing activity-based strategy among others, (James &Usman, 2000). Therefore, this strategy will form one of the constructivist teaching strategies namely, problem-solving and discovery strategies to find out whether it will improve students' academic performance in genetics in secondary schools. Discovery strategy on the other hand is one of the constructivists teaching strategy that involves mental skills for learning by students who play around with objects, while observing, measuring, classifying, formulating hypothesis, experimenting, collecting data,

analysing data and making conclusions. (Mohammed & Njelita, 2007). This activity based instructional strategy can boost creativity and self-confidence in science students. Adamu, (2014) and Piaget (1968) believes that individuals construct their own knowledge as a result of their interaction with specific phenomena as in the case of discovery concepts. Such constructivist knowledge usually forms the basis upon which new knowledge is anchored around the concept a learner has already found faulty. Studies have shown that, such erroneous conceptions or unscientific views do pose serious threat to learners' understanding of scientific concepts (Osbore & Wittrock, 2000& Haslam & Treagus, 2001, Kikas 2004).

The use of activity-based instructional strategies such as discovery strategy is being advocated for by some science educators to help shift such erroneous conceptions (Hawson, 2001, Okebukola, 2002 & Kikas, 2004). This activity strategy makes use of theories of psychological learning. The Discovery strategy is one of the science teaching strategy that can be used for any content to be taught. This leads itself to exploration using concrete materials. According to Ajewole (2005), Discovery is an approach to investigate on/inquiring teaching whereby students are assisted in a way in their learning activities so that they can arrive at finding out new/additional knowledge. Any lesson prepared by the teacher using discovery strategy has to be moderately structured.

Discovery strategy has been defined in different ways. Bruner (1961) viewsdiscovery as mental processes to medicate (discovery) some concept or principles. Cronberch (1963) sees it as mental assimilation by which the individual gain a concept or principle resulting from physical and mental activity. The teacher ensures that the students have a chance to form concept by studying subjects before leading the students to form the generalization. In the discovery strategy teaching concepts formation is the main purpose.

Discovery strategy has the following steps (Nacino, 2005):

i. The teacher describes the performance expected of the students after they have learned the concept.

ii. The teacher provides positive and negative examples in close succession or simultenously.

iii. The teacher reduces the number of simple concepts or attributes.

iv. The teacher assesses the learning of the students.

The discovery strategy has been strongly advocated for by Bruner (1961) in his statement.

v. To instruct some students in a discipline is not a matter of getting them to commit results to mind. Rather, it is to teach them to participate in the process that makes possible the establishment of knowledge . We teach a subject not to produce little living libraries in the subjects, but rather to get a students to think mathematically for themselves to consider matters as a historian does. To take part in the process of knowledge getting, knowing is a process not a product.

According to Gajere (2002), the Discovery strategy of teaching involves problems, finding out, investigating, analyzing, thinking, searching, experimenting, collecting or validating knowledge and finding information. From the above it is clear that discovery strategy means finding out teaching by discovery in which the students find answers to questions and problems. In other words, instead of telling the learners the answers, the teacher possess a leading question which will help them to find the solution to these problems. Uhumuavbi (2006), conducted an experimental study on the relative effects of discovery and expository strategies of teaching in learning physics concepts and performance at SSS level. The purpose of the study was to compare the relative effectiveness of the discovery and lecture strategies of teaching difficult physics concepts

and performance of students in SSS level. The results obtained indicated that students' active participation in science lesson develops positive gain.Busari (2001), conducted an experimental study on comparative effects of four instructional strategies on student's performance and retention in Chemistry in some selected schools in Lagos State. The purpose of the study was to compare the effects of instructional strategies. The results obtained indicated that there was no gain, in post-instruction in all the groups except the lecture method group.

Discovery strategy is one of the teaching strategies that involve mental skills for learning by students such as observing, measuring, classifying, formulating hypothesis experimenting, data collection, data analysis making conclusion. James (2000) & Usman (2000) discovery strategy will be employed in this study find its effectiveness in teaching of genetic concepts in relation to academic performance at secondary school leave compare to lecture methods. Finally, the strategy is one of the activity - based strategies of science teaching of the teacher cannot teach science effectively without employing activity base strategy among others Usman (2000), James (2000) & Mahmud (2009), who states that the discovery strategy is the of the main variable investigated in this study the impact of constructivist strategies on attitude retention & academic performance in genetic concepts among senior secondary school students was conducted find out to its effectiveness.

Adigun (2003),however said it does not allow students to develop manipulative skills demand for carrying out activities on their own. The adoptions of lecture strategy by most teachers to overcome the bulky Chemistry syllabus before the SSCE affect students' performance. Researchers believe that in the lecture strategy, theory is taught as an absolute knowledge, hence students centred activities for developing scientific reasoning skills and processes are lacking. The lecture strategy is also known to cause lack of

interest and poor performance in science as opined by Njoku (2007) and Aghadinano (2007) contended that science teaching is limited exclusively to telling, reciting and testing of information and sterile as it does not convey either the meaning or intent of science.

Recent researches in science education have been gathered towards improving the method of teaching science so as to improve students' performance in science subjects. Paul (2012) also carried out a study to determine the effects of lecture and demonstration methods on academic performance in Chemistry in Nassarawa Local Government Area of Kano State. The boys and girls are better in academic performance when taught using demonstration method than lecture method.Results obtained revealed that students perform better in Chemistry when taught using demonstration strategy as compared to the lecture method.

The illustration of the flow chart of discovery strategy used in this is presented in figure 3.4

2.5 Instructional Strategies and Students' Attitude to Science

Attitude is viewed as a set of affective reactions towards an object; it is derived from the concepts and beliefs that the individual has concerning the object and predisposition the individual has in a certain manner towards the object (Ibrahim, 2000). Attitude is built up largely as a product of unique experiences and each individual will interpret evidence, anticipated events and make decisions in the light of attitude possessed.Attitude which is an expression of likeness plays significant role in the learning subjects (Situ, 2008). Students' attitude towards science subject is influenced by the instructional strategies employed in the process of teaching (Timothy, 2005).

Many factors could contribute to students' attitude towards studying science. Knough (2000) concluded that a number of factors have been identified as related to the

students attitude to science, such factors are teaching strategies, teachers attitude, influence of parents, gender, age, students career, societal view of science, and students interest. On social implication of science and scientists, Kola and Dube (2005) worked on the influence of comparative impact of instructional strategies on student's attitude towards science subjects. The result obtained was that attitudes become more positive after instruction.Ibrahim (2000) also concluded, that groups that score significantly high in science performance test also score significantly high in attitude test after instruction. Gazi, Oluruntegbe andTunde (2010) reported that several factors can work to influence students' attitude and behaviour towards quantitative aspect of the practical Chemistry. Instructional strategy is one of such factors, and the result obtained indicated that these factors actually influence the attitude of the subjects towards volumetric analysis.

Adesoji (2008) reported that students exposed to programmed instruction recorded higher and more favourable attitude toward mathematics. Liza (2010) asserted that there was a positive significant relationship between the student's attitude towards Chemistry and the instructional strategy employed which lead to better performances in Chemistry. While students attitude after instruction seems to greatly influence their performances in Chemistry, in this study the student's positive attitude towards Genetic as observed by the impact of the instructional strategies such as problem solving and discovery was employed to determine whether there was a change in students' attitude towards genetic concepts.

2.5.1 Students' Attitude and Academic Performance in Science

Attitude toward science denotes interest in studying science. It is the students' disposition towards "like" or "dislike", while attitude in science means scientific approach assumed by an individual for solving problems, assessing ideas and making decision (Yara, 2009). However, recent research has reported that students' performance also

depends on academic enablers such as attitude and behaviour that allow the students to participate in and ultimately benefit from academic interaction in the classroom (Liza, 2010). Students attitude about the value of learning service may be considered as both an input and outcome variable because their attitude towards the subject can be related to academic performance in ways that reinforce higher performance (Bunkure 2012).

Several research reports indicate that students' attitude were poor in secondary school science subjects especially Biology (Aghadinuno, 2005; Olarewaju, 2006). These researchers express the view that teachers shy away from activity-oriented teaching methods which is known to be effective and rely on teaching methods that are easy but most often inadequate and inappropriate. Based on such findings, several attempts have been made to investigate the effectiveness of teaching methods on achievement in Biology (James 2000; Akubuilo, 2005; Adewole, 2007). Results from these investigations indicated that innovative teaching methods such as Outdoor laboratory approach, guided discovery, co-operative learning and inquiry methods were more effective than the lecture method in enhancing students cognitive performance in Biology.

Since attitude is a concept which arises from the attempt to account for the observed regularities in the behaviour of individual, the quality is judged from the observed evaluative response one tends to make. An individual can show positive or negative attitude towards a particular object, subject or idea (Kalu 2007).Olatoye (2001) reported that students' attitude towards science has significant and direct effect on students' performance in the subjects.Children who are academically successful hold positive attitude in schools as well as adjusted emotionally and socially according to (Jaynes, 2005). It was opined by Ogunsola andBandele (2000) that in most of the Nigerian societies, science is seen as a male activity and no go area for the females. Some activities are considered abnormal to female but normal to male. These societal perceptions of

normal and abnormal sex roles influence female participation.In this respect, measuring the attitude and knowing the level of attitude of individuals related to objects are in demand in many fields (Erkus, 2003).

Adnan in Ahmed (2006), however revealed that attitude of students towards Mathematics and science courses have significant relations to the scores of subsets of mathematics & science test. It has also been suggested that having negative attitude towards these courses might be taken as an important factor for the students' performance in Mathematics & sciencewhich has not improved by the years as expected. (Carkir & Sabin, 2000), in their research on the 6^{th} grade students have found out that the students'attitudes have effect on academic performance indirectly via other variables.

Attitude is a major factor in learning science subjects because students thinking or behaviour towards it will determine the level of their diligence and performance (Situ, 2008). Muhammad (2014) asserted that attitude towards science subjects are known to decrease as students' progress through their schooling years. The implication of Muhammad's findings is that attention should be given to science teaching early, so as to enable students have favourable disposition toward science later in life. Therefore, attitude is a significant factor that can enhance students' academic performance when positively inculcated in the students as a result of different factors (Gibbons & Oshea, 1997). Fostering positive science attitude in students living in technological society mean, that science educators and classroom teachers must be able to measure students attitude as a result of quantitatively and qualitatively assessing the opinions and attitude of students towards the learning activities in which they are participating in, it may be possible to improve the quality of instructional procedures which could lead to better leading.

Academic performance according to Obeka (2009), is the quality of results produced by students which reflects in the quality of their examination scores. Students' attitudes are set of attributes that an individual should possess in the pursuance of knowledge and some researchers acknowledged that activity-based teaching approaches can enhance students' attitude along with academic performance in science. Funke (2002) conducted a study in Nigeria, and her findings revealed that there is no significant relationship between students' academic performance and students' attitude, and many young students in Nigeria are superstitious in their belief.

Sekar (2013) determined the students' attitude and reasoning ability to Biology and Computer group students in India and the findings showed that the students' attitude remains more or less the same for boys and girls of Biology group and computer group of students. However, the reasoning ability for boys and girls of computer group and biology group students significantly differ. Ademola (2014) determine the relationship between students attitude towards science and academic performance of secondary school students and found that students attitude towards science do not significantly predict academic performance in science, and students attitude toward science has positive but no significant relation with science performance mean scores by gender. It is in line with this, that the study intends to investigated the impact of constructivist teaching strategies to find their impact on students attitude, retention and academic performance in genetic concepts among SSS students

2.6 Instructional Strategies and Students Retention Ability in Science

Permanent and meaningful learning is the ultimate goal of any educational endeavour. Understanding and retention are products of meaningful learning when teaching is effective and meaningful to the students (Bichi, 2002). Retention is the ability

to retain and consequently remember things experienced or learned by an individual at a time. It takes place when learning is coded into memory. Thus, appropriate coding of incoming information provides the index that may be consulted without an elaborate search in the memory line Bichi (2002). The nature of the material to be coded contributes to the level of retention; materials are related to the quality of retention in terms of their meaningfulness.

Several factors are known to influence retention. Bichi (2002) reported that learning could improve retention, while things that lead to confusion or interference among learned materials decrease the speed and efficiency of learning and accelerates forgetting. Retention levels in relation to age have been investigated by several researchers and have attracted the attention of many scholars in recent years. For instance, Ezema and Dung (2003), compared the effectiveness of concepts mapping and guided discovery teaching strategies on student's retention of some Chemistry concepts. Results showed a significant difference between the concept mapping and guided discovery in favour of guided discovery method. Akinbola (2009), compared the effectiveness of constructivist teaching strategy and the conventional method with reference to performance, retention and attitude.

Akinbola (2009) also investigated that students exposed to constructivist teaching strategy have higher cognitive performance, more positive attitude and higher retention level than their counterparts taught using the conventional teaching strategy. Okebukola (1998) studied the relative effectiveness of discovery and expository instructional methods on retention of biology concepts, and come out with the following result. The experimental group was significantly better than the control group in the retention of learned materials. They explained that the students in the experimental group did better because they actively participated in the learning process. To them this is because the

conditions that permitted the learner to interact directly with the learning materials and making use of the processes of science will be more facilitative to the mastery and retention of biological concepts than the condition where learners because passive listeners to teachers.

Analysis of scores according to ability level revealed that high ability students were significantly better in retention of learned materials then the average ability level, which in turn, retained more of the learned biological concepts than the low ability students. Their finding did not examine the extent of retention on the different ability groups. This study aspired to find out the extent to which learning of the selected concept are enhanced and retained by the various groups when compared with group subjects. Oyedokun (1998) in her study on the effect of a conceptual and attitude model in students' achievement, retention and attitude to biology concepts reported that the experimental group was significantly better than the control group in retention of learned material. Samba (1998) in her study on the efficacy of a conceptual change strategy in remediating identified misconception in biology reported high correlation between retention and performance scores of the experimental group while a low correlation was recorded for control group. Oluwaiye (2001) observed that students undertake much of discovery and practical work when exposed of the problem-solving activities. Problem-solving is a situation in which an individual is called upon to perform a task not previously encountered. Danjuma (2005) suggested that problem-solving is a request for certifiable outcome to a situation. Problem-solving is a strategy of organizing given information and using that information along with the knowledge you possess, to obtain the desired outcome or solution.

James (2000) went further to explain that the improved retention of concepts may be due to the fact that concept mapping strategy enables the students to have concepts

organised by providing linkage and summarised in such way they are easily remembered at a later time, and also it could be that concept mapping makes knowledge of concepts clear and meaningful students. In the case of genetics, studies have shown that the poor performance of the students in genetics is responsible for their poor performance inbiology generally.(Njoku, 2005, Omolade 2005, WAEC examiner 2010).

From the literature reviewed on the aspects of impact of problem-solving and discovery strategy on students' performance in genetics is relatively few as most of them used problem-solving or discovery strategy.Therefore, this study intended to investigate impact of problem-solving and discovery strategies on attitude, retention and performance in genetics of secondary schools.

From the literature reviewed, it has been shown that improved instruction could enhance retention. This study therefore sought to use two strategies find solution to problems confronting students together with the aim of finding out if the two strategies can impact on attitude, retention and academic performance in genetic concepts among secondary school students.

2.7 Gender and Academic Performance in Science

The concept "gender" has attracted the attention of many psychologists and researchers as a result of which a lot of literature exist on different aspects of the concept Bichi (2002) defined gender as the amount of masculinity and femininity found in a person and there are mixtures of both in most human being. The normal male has a preponderance of masculinity and the normal female has a preponderance of femininity. The concept gender, refers to the amount of masculinity or femininity found in an individual. Many research works carried out on gender effects on academic performance have described the proportionately low performance of female students in science

education programmes and careers (Bandele, 2000), this gave the male a greater dominance than their female counterparts. The under representation of women in science has led many feminist scholars to postulate that science as practiced today is gendered and use to the benefits of the male world. Okeke (2001), gender difference has become a current issue locally, nationally and internationally. Girls generally, remained and were encouraged to remain at home due to cultural reasons and their feminine roles as wives and mothers (Aluko,2005) while Okeke (2010) agreed that this may have also contributed to poor enrolment and performance of girls in science and technology in tertiary institutions. Bennie (2001), states that gender stereo typing which assign science as male domain is a major cause of female low participation in sciences. A normal man has a preponderance of masculinity while a normal female has preponderance of femininity (Bichi 2002).

The influence of gender on students' performance has for a long time been a concern to many educational researchers. But surprisingly no consistent results have been obtained (Francis&Babatunde, 2008). Philips (2006), had opined that girls excel consistently in arithmetic computation and are superior in reading and hand writing, while boys are slightly better in arithmetic reasoning, History, Geography and Geometry. Ogunboyede (2003) found out that boys are not better than girls in terms of educational performance. The results obtained for researches in gender is not consistent, some favour males while others are in favour of females and sometimes there is no gender difference in the performance of students. It is based on this that gender difference was investigated in this study by using impact of problem-solving and discoveryteaching strategy to see if it is gender friendly or otherwise.

Abayomi (2004) has provided report in respect to gender, that is there is no distinguishing in the cognitive affective and psychomotor skills performance of students in

respect of gender. Other researchers have reported differently on this issue. For example in the studies carried out by Eria and Seugh (2006), Onekatu and Onekatu (2002), they found out that boys outperform girls in science. Teachers play a vital role in addressing the problem of gender equality in science education. According to Levi (2000), there are three main roles a teacher must play namely:

a. To ensure provision of equal opportunities and respect for difference in the class room

b. To ensure that both males and females have the same experience by treating them equally and

c. Compensate for gender differences in the society.

In this study, impact of problem-solving and discovery strategy are investigated to determine whether those strategiesare gender related or not.According to Yusuf (2012) and Adamu (2014),the attitude and beliefs of teachers about the male and female students' academic performance have been studied. From their results,teachers appear to be more aware of their male students than female students. Teachers attribute the success to hardwork and hold many of the same perception as their students by viewing science as masculine subjects. Based on their findings of the research on different in attitude and classroom experience, many educational programmes have developed and implemented in various levels of schooling. Therefore, this study intended to investigate the impactconstructivist strategies on attitude, retention and performance in genetics concepts. Most of the researchers conducted the studies on one constructivist teaching strategy. In this study,none of them was able to use two teaching strategies. This study intended to fill these gaps to see which one is more effective.

2.8 Overview of Similar Studies

A number of researches have been carried out on impact of two instructional strategies on students' learning outcomes. Usman and Ebuta (2006) carried out a study in secondary school entitled "Enhancement of Students' Performance in Geometry using Problem-Solving Model" in Secondary School. Experimental research design was used with the sample size of 214 SS I students. Geometry Performance Test (GPT) was employed for data collection and the statistical tool used was Analysis of Covariance (ANCOVA) at $P \leq 0.05$. The study revealed that there was no significant difference between experimental and control groups. However, the present study differs from Usman and Ebuta (2006) by adding other variables in the study such as, Discovery and Discussion teaching strategies. In a similar study, Baja (2007) investigated the effect of problem-solving and discovery method instructional strategies on Chemistry students using experimental research design and used a sample of 138 SS1 students. The data were analyzed using analysis of covariance and t – test. The result showed that there was no significant difference between students exposed to problem solving strategy and those exposed to lecture method. This study is similar to the present research in the following aspects, both include problem-solving and discovery methods. The study carried out was in Chemistry while this study was in Biology to see whether the results will be the same or different.

A study in Biology was carried out by researchers on the comparative effectiveness of two instructional approaches (Inquiry & Traditional methods) on science students' achievement and attitude at secondary school by Okeke (2006), experimental research design was used where 570 SSII students were sampled. The instrument used was Biology Achievement Test (BAT). Statistical tools used for analysis was ANCOVA and ANOVA. The results showed that inquiry-based classroom was superior to the traditional lecture

approach.Based on this finding, a similar study is needed in genetic concepts among senior secondary school students and also the researcher used ANOVA and Kruskal Wallis test.

Paul (2012) studied the effects of lecture and discovery method on the academic performance of students in Senior Secondary School. Experimental research design was used and the researcher sampled 58 SS1 students in Chemistry, the instrument used was Chemistry Achievement Test (CAT) and results obtained were analyzed using t-test at $P \leq 0.05$. Result shows that there is significant difference in learning Chemistry using discovery method than lecture method. In other case it was gender friendly. The above study is similar in the following aspects: both students used discovery strategies on performance. However it differs in the following ways, the first researcher used two variables while in the present study two variables were will be use by adding attitude and retention t-test and ANOVA as statistical tools at $P \leq 0.05$ and in the present study ANOVA and Kruskal Wallis would be used. The findings of the first study showed that both male and female performed better when taught using discovery method and shows equality in their performance in Chemistry while in the present study recommendation made emphasis on the use of discovery and problem solving strategy.

In another study, Adewole (2007) used experimental research design and studied the effect of discovery and expository instructional methods on the academic performance of students in 'O' level Biology. The instrument use Biology Achieve Test (BAT) 240 students sampled t-test statistics was used ANCOVA was employed at $P \leq 0.05$. At the end of this study, it shows that discovery method leads to difference between students exposed to discovery and expository in favour of discovery method, while in the present study, two teaching strategies namely problem-solving and discoverywere used on attitude and retention ability of Biology students at Senior Secondary School. The present study would

focus on problem-solving and discovery strategies on attitude, retention and academic performance in genetics among secondary school students.

In a similar study, Busari (2001), conducted experimental research design and used a study on comparative effects of four instructional strategies problem solving, discovery, demonstration and laboratory on students' performance and retention in Chemistry whereby 218 SSII students were sampled in secondary schools. The design of the study was randomized of the learner task.The researcher made use of Chemistry Achievement Test (CAT), Chemistry Performance Test was used to collect data. ANOVA statistics increased on $P\leq 0.05$. Results show that, there was no significant difference in performance in the learning of Chemistry concepts in form of Problem Solving Strategy use. This study is similar to the present one in the following aspects: both studies used experimental research design with four groups. And differ in the following ways: the first study was on performance and retention while the present study added attitude, and retention in addition to performance. Statistical tool used in the study was ANOVA while in the present study is ANOVA, Kruskal Wallis statistics were used.

Awodi in Bichi (2002) studies the effect of gender on academic achievement in evolution concepts among secondary school students using problem – solving instructional strategy. The researcher used experimental research design and sampled 289 SS II students in evolution, the instrument used was Evolution Concepts Test (ECT) was used to collect data and the result obtained were analysed using t test at $p\leq 0.05$. The result shows there is no significant differences between the posttest mean scores of male subjects and female subject taught evolution concepts test using problem – solving strategy. The instrument was use evolution concept test. Arbogast (1997) reported that boys performed significantly better than girls in SSCE physics examination. Based on this finding, a similar study is

needed in genetic concepts among senior secondary school students. In this studies the aspect of using discovery strategy to determine which of them is the best was no done.

Obeka (2010) studied the effects of inquiry and lecture methods on performance and retention among SSI students in Geography 225 samples were used experimental research design was used in Geography Performance and Retention Tests (GART) were the instruments used for data collection. ANCOVA was used for statistical analysis. The researcher discovered that, there was no significant difference in performance between inquiry and discovery teaching methods. The first researcher's work was on Geography while the present study was in Biology. The first researcher used inquiry and lecture methods while this study would use problem-solving, discovery teaching strategies. Beside this, attitude, retention and performance were added. In this study, ANOVA was used while in the present study was used ANOVA and Kruskal Wallis test. The present researcher findings revealed that inquiry and lecture methods had significant effect on students' performance.Based on this finding, a similar study is needed in genetic concepts among senior secondary school students to investigate of the strategies which is betteron academic performance among students.

Also, Bichi (2002) investigated the effects of problem-solving instructional strategy and enriched curriculum in secondary schools in Zaria, Kaduna state. The researcher used experimental design, sample size used was 156 SSII students. Biology Performance Test (BAT) was used as an instrument for data collection. Bichi used t-test as the statistical tool at $P \leq 0.05$. He discovered that, there was significant difference in the academic performance of students exposed to problem-solving with enriched curriculum and those exposed to the conventional methods. In a similar study Jibrin and Abba (2011) investigated the effect of enhancing problem-solving instructional method on self-efficacy of senior secondary school Biology using sample size of 50 students SSII and

experimental research design was used. Biology Performance Test (BAT) was employed for data collection and t-test statistical tool at $P \leq 0.05$ was used for analysis. The finding of the study revealed that there was significant difference in the students' academic performance of those exposed to problem solving. The findings reveal that student's performance in Biology can be enhanced when exposed to problem-solving teaching strategy.It was observed that if right instructional method such as problem-solving is employed, self-efficacy of senior secondary school students in biology can improved. Base on this finding, a similar study is needed in genetic concepts using problem-solving and discovery strategies to find out which of them is better needed in genetic concepts on senior secondary school students.

Tambaya (2015) conducted a research on the impacts of 5E-learning cycle of attitude, retention and performance in genetics among Pre-NCE students in North-West Zone. A sample of 110 students comprising 55 each for the control and experimental groups was subjected to Genetic Achievement Performance Test(GAPT) and analysed Using Analysis of Variance (ANOVA) and Kruskal Wallis test while studies attitude and retention, the present study is on the impact of problem solving and discovery strategies on the attitude, retention and academic performance in genetics concepts among secondary school students.

In a similar study, Alumba (2008) investigated effects of inquiry and traditional teaching strategy on academic performance in Integrated Science in junior secondary school in Kano state. The researcher used experimental design, and sample size of 239 JSSIII students. The researcher used Integrated Science Performance, as an instrument for data collection. The researcher used t-test statistical tool at $P \leq 0.05$. There is no significant difference in the performance of boys and girls in both control and experimental group. In another study, Adamu (2014) studied the effect of problem-solving

instructional strategy and self-efficiency and creativity and academic performance on Genetics at N.C.E level in north-west. The researcher used experimental design, 100 students were used Genetic Performance Test (GPT) the instrument used for data collection. The researcher used t-test statistical tool at $P \leq 0.05$. The Researcher found that; there was a significant difference on students' performance when exposed to Problem-solving and self-efficiency in favour of experimental group than those of lecture method. In a similar study, Lawal (2009) studied the effectiveness of conceptual change instructional strategy in Remediating Identified Misconception in Genetics in Secondary School in Kano state. The researcher used experimental research design, and sample size of 285 SSII Biology students. The instrument used is Biology Performance Test (BAT) for data collectiont-test statistical tool at $P \leq 0.05$ was used for analysis. The researcher discovered that there is no significant difference between male and female students exposed to the conceptual instructional strategy and those exposed to traditional instructional strategy. This study investigates the impact ofproblem-solving and discoverystrategies on attitude, retention and academic performance to see which of them would enhance effective teaching and learning of genetics concept. Therefore, the researcher used one strategy and control while this study has to filled the gap by using two problem-solving and discovery strategies in order to enhance effective teaching and learning genetic concepts among secondary school students.

Douglass (1997) in a research on the effect of explicitproblem solving instruction on high school students problem-solving performance and conceptual instruction in Physics, eight physics class with a total of 145 students were randomly selected to either treatment group. The four treatment–classes were taught how to use an explicit problem-solving strategy. Students' problem-solving performance and conceptual instruction were assessed both before and after the instruction. The result indicate that explicitstrategy

improved the quality and competence of students in physics representation more than the textbook strategy, but there was no difference between the two strategies on match of equations with representation, organization or mathematical execution. Therefore, this study is similar with the second researcher on problems solving discovery and performance but with deeper on the following aspect, two problem-solving and discoverystrategies but the first researcher used one strategy and control in physics and the second researcher used two experimental and control in genetics concepts at secondary schools. The first researcher used t-test and ANCOVA while thepresent researcher used ANOVA and Kruskal Wallis test at $P \leq 0.05$.

Akinbobola (2009) conducted a study to find out the attitude of students toward the use of cooperative, comparative and individualistic learning strategies in Nigeria in senior secondary school physics. The research made use of quasi-experimental design. A total 140 students consisting of 66 males and 77 females were selected by a random sampling techniques from a population of 680 senior secondary two (SS II) physics students drawn from all the 13 coeducational secondary school in Ife south local government area of Osun state Nigeria. The data collected were analyzed using analysis of variance (ANOVA) and the result of the findings effective in facilitating students' attitude toward physic. This was followed by competitive strategies will the insignificant gender difference in the attitude of students towards physics when taught with cooperative with competitive and individualistic strategies, many educational studies have explored the effectiveness of scientific inquiry teaching on learner performance. This study is on genetics as it affectsattitude, retention and performance using ANOVA andKruskal Wallisas statistical tools.

Bilgin (2009) investigated the effects of inquiry instruction incorporating with cooperative learning environment on university students achievement of acid base

concepts and attitude toward inquiry instruction. The researcher selected 55 first year university students from two intact classes of a chemistry course instructed by the same teacher. One of the classes was randomly assigned as the experimental group and the other was assigned as a control group. The experimental group cooperatively studied worksheets which were related to acid base concept in the group while the control group individually studied the worksheet in the class. The data collected were analyzed using multi variance analysis (MANOVA). The result showed that., students in the experimental group had better understanding of acid base concepts and a more positive attitude toward inquiry instruction. Therefore, this study was investigate the impact of problem-solving, discovery strategies on attitude, retention andacademic performance to see which one most effective in teaching and learning of genetics concept.

In another study, Boujaoud (2003), investigated the relationship between students' problem-solving strategies in stoichiometry and the conceptual performance to their learning approaches (deep approach, vs relating ideas vs intrinsic motivation). Based on the result that indicated a connection between sound conceptual and procedural knowledge and successful problem-solving, they administered a Learning Approach Questionnaire (L.A.Q.) and a stoichiometry test, partial followed by unstructured interviews to forty Lebanese students (Grade II age 16-20). The derived three main types from the test and the interviews:

i. Correct strategies which are subdivided into "algorithmic" efficient and "Messy" strategies.

ii. Incorrect strategies which were subdivided into "incorrect strategies – incorrect answers" and incorrect strategies-correct-answer"

iii. Incomplete strategies

As the authors state, the majority of students participating in that study used algorithmic problem-solving even when they do not have adequate of the relevant concepts. In construct to results in literature, they do not find a correlation between the factors learning approach and conceptual understanding. Furthermore, they did not find any partners in the problem-solving strategies used by students with different learning approaches.

Scott (2012) studies the effectiveness of discovery strategy in elementary mathematics classroom in Indian University the study was that of a repeated quasi experimented design using three second grade teachers. The pre-test and post-test results for each unit, as well as the aptitude test data and gender were collected and included in the descriptive analysis of sample data was analysed using dependent t-test. This quantitative study concluded that discovery did not have an overall effectiveness at significant level. Students with a high academic ability benefited significantly with opportunity to be challenged at a higher level while students of average ability did not. There was no significant different between the performance of males and females.In this case of this study used problem-solving and discovery strategies were used to see which one would enhance the academic performance of students in genetic concepts.

Esiolu and Soyibo (1995) investigated the effects of instructional strategies on students' performance. They used nine (9) experimental classes and nine (9) control classes. Both groups were exposed to the same curriculum making, the difference was that the experimental group were taught concept mapping while the control group were taught using the lecture method. Pre-test and post-test results were analysed on the basis of which the following conclusion were make:

- The experimental group achieved significantly better than the control group

- There was no significant difference between performance of males and that of female students. This study intended to use problem-solving and discovery strategies to see which one enhance the academic performance toward genetic concepts.

Bunkure (2012) investigated the effects of constructivist instructional strategy on the academic performance, retention and attitude in Physics among secondary school students in Kano state. The experimental research design was used. SSII students were used as sample size and Physics Performance Test (PAT) was applied for data collection. The researcher used t-test statistical tool at the level $P \leq 0.05$ to analyzed the data. The researcher found that there was no significant difference between the retention ability of males and females exposed to 5E constructivist instructional strategy and further confirms that 5E constructivist instructional strategy is gender friendly. This study is similar in the following aspects: the researcher worked on effects of a constructivist instructional strategy on the academic performance, retention and attitude to Physics while the present study is on impact of problem-solving, discovery, attitude, retention and academic performancein Genetics (Biology). Bunkure used two groups for the experiment, while in this study two groups will be used for the experiment. ANOVA and t-test are the statistical tools to be used. They also argue that science curriculum based on constructivist increase students self confidence in relation to science generate a more active participation in science activities and lead to greater interest in the subject. The study of Bunkure conducted only 5E problem-solving strategy but did not consider discovery strategy to see which of them is better than the other or none.

Problem-solving and discoverybased curriculum enables the students to become much involved in their own learning. It is recommended that science teachers and curriculum developers should initiate the development that would help learners to process of problem-solving and discoverybased curriculum that would help learners to actively

construct their own knowledge towards genetics concept in order to enhance effective teaching and learning of genetics concept among others.

2.9 Implications of Literature Reviewed For the Present Study

The literature reviewed on impact of problem-solving and discovery on attitude, retention and academic performance in genetics among senior secondary school students was reviewed. The literature so far reviewed has some implication for the present study. The study looks at the meaning of problem-solving and discoveryteaching strategies. Okebukola (2002), see learning under instructional model as being comprised of a process of adjusting ones' own mental models to accommodate new experiences. Paul (2012) carried out a study to determine the effects of discovery method on academic performance in Chemistry. The result obtained revealed that students perform better in Chemistry when taught using discovery method. Paul studied the effects of discovery method and lecture method only, but present study added problem-solving and discovery strategies. Paul used topics in Chemistry while in this study genetic in Biology was used. This study intended to useproblem-solving and discoverystrategies to see which one enhance better retention and positive attitude towards learning genetics.

Bichi (2002) and Nwafor (2007), used problem-solving instructional strategy in their studies. They did not specify which constructivist strategy was used but present study was categorical on problem solving. The present study also used problem-solving and discovery strategy which consist of two strategies. In addition, attitude and retention ability was examined. Galadima (2001) carried his study using problem-solving in mathematics. This study used problem-solving and discovery as teaching strategies, but, in Biology. Ugwanyi (1999) used guided discovery in his study, while this study added two more strategies problem-solving anddiscovery. Ugwanyi used random sampling

techniques in selecting the subjects, this study used intact-classes to avoid distractions of the school academic calendar.

In a similar study; Danjuma (2005) reported that problem-solving instructional strategy is superior to other teaching strategies. Eze (2001) opined that problem-solving encourage good learning habit, logical thinking and promote intellectual development on the area of academic performance. Bunkure (2012), investigated the constructivist instructional strategy on academic performance retention and attitude in Physics among secondary school students while the present researcher investigate the impacts of problem-solving and Discovery strategies constructivist strategies on attitude, retention and performance in genetics concepts among secondary school students to see which one will enhance effective teaching and learning of genetic concept.

Wakili (2007), study revealed that, the influences of discovery method on creativity of students at secondary school level are encouraged. The conclusion was that, students taught using guided discovery method performed better in terms of creative ideas generation. The present study was concerned with attitude and retention ability in Biology concepts (Genetics). Adamu (2014) used problem-solving to find out its effects of self-efficacy and creativity at NCE level. In a similar study, Tambaya (2015) conducted a research on impacts of 5E-learning cycle on attitude, retention and performance in genetics among Pre-NCE students were the researcher fund that 5E-learning improve more students' performance in genetics concept. While the present researcher used impact of problem-solving and discoverystrategies on attitude, retention and performance in genetic concepts among secondary school students to see which was more enhance teaching and learning of genetic concepts and also the researcher used the flow-chart of Polya models and Bruner for discussion of the two strategies.

From the studies review researchers conducted their study on a single teaching strategy for example; Okebukola (2009), Bunkure (2012), Adamu (2014), Sukola (2015) they did not use two teaching strategies as the case of this study.This study therefore filled this gap by investigating the impact of problem-solving and discovery strategies on attitude, retention on academic performance in genetic concepts among secondary school students.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The study investigated the impact of problem-solving and discoverystrategies on attitude, retention and academic performance in genetics concepts among senior Secondary School Students. It also investigated whether gender has any effect on students' performance in genetic concept using the problem-solving and discovery teaching strategies. The methodology was prepared under the following sub-headings:

3.2 Research Design;

3.3 Population of the Study;

3.4 Sample and Sampling Procedure;

3.5 Selection of Topics

3.6 Instrumentation;

3.6.1 Validation of Instruments;

3.6.2 Pilot Testing of the Instruments;

3.6.3 Reliability of the Research Instruments;

3.6.4 Item Analysis;

3.6.5 Administration of Treatments

3.6.6 Data Collection Procedure;

3.9 Procedure for Data Analysis.

3.2 Research Design

The research design for this study was pretest, posttest,postposttest, Quasi – experimental and control group design using intact classes which does not allow for randomisation of the subjects (Sambo 2008) Two (2) experimental groups, EG_1, EG_2, and one control group were used for the study.

The experimental groups were taughtgeneticsconcepts using problem solving and discovery strategies. While the control group was taught the same genetic concepts using lecture method. A pretest (O_1) was administered to determine equivalence of the groups before the commencement of the treatment. A posttest (O_2) was administered to both groups of studentsafter the treatment to see their performance. Two weeks after their post test and post posttestwas administered to the test of retention ability. The research design is presented in Figure 3.1.

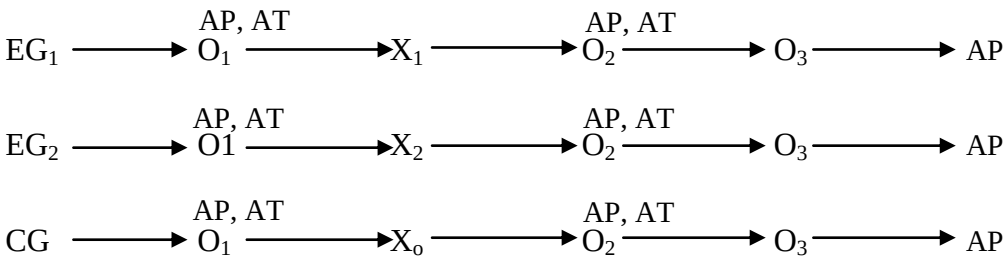


Figure 3.1 Research Design adapted from (Sambo 2008).

Key:

EG_1 = Experimental Group 1

EG_2 = Experimental Group 2

CG = Control Group

X_1 = Problem-Solving Teaching Strategy

X_2 = Discovery Teaching Strategy

X_0 = Traditional Teaching Strategy

0_1 = Pre test

AP = Academic performance

AT = Attitude

0_2 = Post test

0_3 = Postposttest

The design was suitable for this study because of the advantages as stated by Sambo (2008) which can be summarized as follows:

1. The superiority of any of instructional strategy over the others can easily be tested.
2. It gives indication of concept attainment and understanding gained by students after they have been exposed to a particular treatment.
3. The pre test scores give indication as to whether the two groups (2 experimental and 1 control) differ significantly in the concepts they have before instructions are given.
4. It allows for the assessment of retention ability of genetic concept taught.

3.3 Population of the Study

The population of the study comprises five (5) co-educational public secondary schools in Zaria Metropolis. All SS II students form the target populations. The reason for using co-educational school is because gender is involved in the study. The co-educational schools are located in the twolocal government areas, Sabon Gari local government and Zaria Local Government has four schools making a total of five co-educational schools. The number of students were 264 males and 263 females making a total of 527. The details of the population of the study is presented in Table 3:1

Table 3.1: Population of the Study

S/N0.	Names of Schools	Status Type	Enrolment of S.S. II Biology Students		
		L. G. A.	Male	Female	Total
1.	G.S.S. Magajiya (M)	Zaria	47	61	108
2.	G.S.S. K/Kuyanbana	,,	60	40	100
3.	G.S.S. Dakace (D)	,,	53	69	122
4.	G.S.S. TudunJukun (T)	,,	63	52	115
5.	G.S.S. Aminu	S/Gari	40	42	82
		Total	**263**	**264**	**527**

Source: Kaduna state Ministry of Education Zaria Zone (2015).

All the five (5) Schools that the population of the study have many features in common. These schools are similar in terms of conditions of service of the teachers. The teachers are trained and qualified. Most of the students have similar background, some other features are as follows:

i. The area has five co-educational schools.

ii. The schools are Kaduna State owned public Secondary Schools and the program of the schools are being supervised by Kaduna State Ministry of Education.

iii. The Schools have been presenting students for Senior Secondary School Certificate Examination (SSCE) for more than 10 years.

3.4 Sample and Sampling Procedure

The sample for the study was selected from the population of the study in the following ways; the 5 co-educational schools were given pre-test and Analysis Of Variance (ANOVA) was used to determine the schools that did not differ significantly in

their performance before the treatment. The results showed that there was significant difference in their performance. To determine which schools showed no significant difference Scheffe's test was carried out and the result of ANOVA and Scheffe's test is presented in Appendix K. From the result of a Scheffe's test three schools that showed no significant difference were chosen using simple random sampling technique in form of balloting: The first school picked was tagged experiment group 1 while the second school was picked as experimental group 2 and the third school was the control group. The students involved were182 males and 163 females. Making a total of 345.This sample size is viable for the study andinline with central limit theorem that recommends a minimum of 30 sample size for experimental study, (Tukman, 1975 Usman 2000, Sambo 2008).Intact class was used in all the three schools to avoid the disruption of the school time table and no randomization of the subjects. The detail of the sample selected is presented in Table 3.2.

The number of students in each of the three schools selected is shown in Table 3.2

Table 3.2: Sample for the Study

Schools	**Groups**	**Sample of Students (Male)**	**(Female)**	**Total**
G.S.S. (D)	Experimental (I)	61	47	**108**
G.S.S. (M)	Experimental (II)	69	53	**122**
G.S.S. (T)	Control	52	63	**115**
Total		**182**	**163**	**345**

3.5 Selection of Topics to be Taught

The following topics in genetics were taught to the subjects of the study due to some reasons.

- To maintain normal scheme of work for SS II school students.
- The topics of some areas perceive to difficult for students idea about phenomenon there in Johnstone & Mahmud (1980).
- The topics linked themselves to activity/base method that idea for the study.
- Cell, Types of cell in a living organism, Functions of cell in a living organism, Mitosis, Meiosis, Difference between mitosis and meiosis.

The choice of genetics concepts taught motivated the researcher becausegenetics is perceived by the students as one of the difficult topics in Biology as the students performed poorly in genetics area. Umeh (2002), Chief Examiner's Report (2012& 2015) noted that many teachers have phobia towards teaching genetics which might be another reason for the poor academic performance of students in the subject. The table of items of specification based on genetic concepts selected to be taught is presented in Table 3.3

3.6 Instrumentation

The instruments that were used for the study are Genetics Performance Test (GPT), and Student Attitude toward Genetics Questionnaire (SAGQ) which was adapted from (Lawal, 2009). The description of the two instruments are as follows:

3.6.1 Genetics Performance Test (GPT)

Genetics performance Test (GPT) was used to measure students' academic performance in genetics. It is 45 items multiple choice test and 5 short answer test was adapted from WAEC 2012 – 2015 past question papers. The test was developed by the researcher. GPT instrumentwas developed based on the following topics, types of cells,

function of cells, mitosis, and meiosis, different between mitosis and meiosis. Because they are the topics in ordinary level biology preparatory to the concept of Genetics.

Table 3.3:Table of Items Specification of Genetic Concepts Selected Based on Bloom Taxonomy of Cognitive Domain

S/No.	CONCEPTS Number chosen	Of items	TOTAL
1.	Cell 10, 34	16 58 1 30	7
2	Types of Cell 3	114 1232 40	6
3.	Function of cells 2	6,36 11 18 195	7
4.	Meiosis 23	371,38 4 13 16	7
5.	Mitosis 27	24,19 29 33 25 35	7
6.	Difference between Mitosis and Meiosis 20	17 15 37 22 31	6
TOTAL			**40**

Source: Researcher's Field Work (2015)

Table 3.4:Table of Items Specification of Genetic Concepts Selected and Genetic PerformanceTest (GPT) Based on Bloom Taxonomy of Cognitive Domain

S/No.	CONCEPTS	Know	Comp	App	Analy	Syn	Eval	TOTAL	%
1.	Cell21, 34		27	23	20	26	30	7	17.5
2	Types of Cell 9		3	16	8	32	40	6	15.0
3.	Function of cell	2	7,36	11	18	10	5	7	17.5
4.	Meiosis 28		39	6,38	12	4	1	7	17.5
5.	Mitosis13		24,19	29	33	25	35	7	17.5
6.	Difference between Mitosis and Meiosis 14		17	15	37	22	31	6	15.0
TOTAL								**40**	**100**

Source: Researcher's Field Work (2015)

3.6.2 Students' Attitude to Genetics Questionnaire

The Student Attitude to Genetics Questionnaire (SAGQ) was adapted from Lawal, (2009) and samba (1998). SAGQ was adopted because it was designed for testing students' attitude to genetics for ordinary level biology student similar to the subject of present study and they are using similar curriculum. The questionnaire comprises of 27 items to reflect on the overall attitude towards genetic. Students Attitude towards genetic questionnaire based on Likert – Five point Scales of Strongly Agreed (SA) Agreed (A) Undecided (UD), Disagreed (D), Strongly Disagree (SD), was used respectively the point in the questionnaire was scored as follows:

SA = 5, A = 4, UD = 3, DA = 2 SD = 1

The same Students' Attitude Genetics Questionnaire (SAGQ) was administered as pretest, and posttest to the subjects in order to determine if there is any significant change in the attitude of students towards genetic concepts.

3.6.3 Validation of the Instruments (GPT) and (SAGQ)

Genetics Performance Test (GPT) and Students Attitude Genetic Questionnaire were given to three (3) experts with minimum of Ph.D qualification in Science Education Department and Biological Science ABU Zaria to validate the instruments. They were requested to critically examine and assess all the items of the instrument paying attention to the following:

i. whether the test items test what they are meant to test or not.

ii. whether the questions are clear, precise and free from ambiguity.

iii. whether the questions matched the ability level of the students.

iv. whether the language of expression is simple and clear.

The experts made constructive criticisms in areas of language usage and content of (GPT) instrument. The corrections made led to the final selection of the items and corresponding marking scheme as presented in (Appendix A,G&H).Based on the corrections of the validated some of the items were reframed while some were deleted. For example questions one and twenty were corrected as follows:

Q1. A cell that is not dividing is described as a cell at rest, it is said to be at the stage of (a) Prophase (b) metaphase (c) Anaphase (d) interphase

Q20. At the end of mitosis, the number of chromosome in the cell is described as (a) diploid (b) haploid (c) polyloid (d) triploid.

Initially there were 47 questions but only 45 were retained after the validation, while some were reframed.

For the Students' Attitude towards Genetic Questionnaire (SAGQ), two experts with the minimum of PhD qualification in the Department of Psychology, and expert in science education of Biological science Ahmadu Bello University, Zaria to validate the instruments. Four questions were reframed. The total items for SAGQ are 37 but only 27 were retained.

3.6.4 Pilot Testing of the Instruments

The instruments for the study i.e. Genetics Performance Test (GPT), Students' Attitude in Genetic Questionnaire (SAGQ) were pilot tested using SS II students' in the Senior Secondary Schools in Zaria Metropolis. Thirty (30) SS II students from G.S.S. Aminu Sabon Gari which is not part of the study sample were used immediately after the validation of the instrument. The researcher taught the subjects in the pilot school the following concepts, cell, types of cell in a living organisms, function of cell in a living organism, mitosis, meiosis, different between meiosis and mitosis. The teaching for pilot

study was done for in two weeks and a test-retest method was used as recommended by Tuckman (1975) and Sambo (2008).

The pilot testing was done to:

i. find out the items analysis of Genetics Performance Test.
ii. determine the appropriateness of the length of time required to take the test.
iii. find the reliability of Genetics Performance Test (GPT) and the Students Attitude to Genetics Questionnaire (SAGQ).

3.6.5 Reliability of the Instruments (GPT & SAGQ)

Reliability is the degree to which a test on repeated measurement yields almost the same result when administered to subjects of similar characteristics (Bichi, 2002). To determine the reliability of the Genetics Performance Test (GPT), test-retest method was employed. The test was administered to SS II Biology students at GSS Aminu in Zaria Metropolis, Kaduna State, which is not part of the sample but is in the population of the study. The test was administered twice with the interval of 2 weeks as recommended by (Tuckman,1975& Sambo,2008). Pearson Product-Moment Correlation Coefficient Statistic was employed for analysis.

The reliability coefficient of Genetic Performance Test (GPT) was found to be r = 0.87, which indicates that the reliability of the instrument is suitable and can be used for data collection in this study.Split half method was used employing “odd and even” number method. Kuder – Richardson correlation coefficient statistics Kr = 21 was used for analysis. The reliability coefficient was found to be r = 0.79 which indicated that the instrument was reliable. From the reliable value calculated the two instruments (GPT) and (SAGQ) are reliability and were used for data collection in this study.

3.6.6 Items Analysis Index (FI) of (DI)

This is the percentage of students who obtained the correct answer on item. For computing the difficulty index for each item, the following steps were followed:

- The scores on the whole test scripts were ranked in order, from highest to lowest.
- One third of the scores of the high scoring students and one third of the scores of the bottom scoring students were selected.
- The percentage of the high scoring one third and the low scoring one third of the total test items was calculated.
- The items difficulty index was computed by adding the percentage of those that got the items correct in the bottom scoring and high scoring groups and then divide by two. The formula is:

$$F = \frac{Ru + RL}{N} \times 100$$

Where:

F = Facility Index

RU = Is the number among the high 27 percent of the respondents who scored the item correctly.

RL = Is the number among the lower 27 percent of the respondents who scored the item correctly.

N = Is the total number of respondents in each of the upper and lower groups (not the entire students that sat for the test) N.T.I (2010). Lawal (2009) and Adamu (2014) recommended facility indices between 0.30 - 0.70 as appropriate/acceptable for performance test. Satterly (1986) recommended 0.3 and 0.80 facility indices for selecting good test items for performance test. For this study items which fall between the range of 0.30 - 0.70 was finally selected. A difficulty index of 0.75 or higher is

regarded as easy in terms of difficulty level, where the index is 0.25 or less, that items are hard in terms of difficulty level. In the Genetic Performance Test (GPT) test items with difficulty index which range from 0.25 - 0.75 was retained which is in line with (Maduabum 2004 & Lawal 2009).

Discrimination Index (DI) of (GPT)

Discrimination index of a test refer to the capacity of such a test to discriminate or distinguish between high and low achievers among students in the sample if an item has positive discrimination index. Satterly, (1986) and Lawal (2009) recommended 0.30 and 0.80 discrimination indices for selecting good items for performance test. For this study items with discrimination indices between 0.30 and 0.70 were selected and those with very low indices were discarded and some reconstructed and finally selected (Appendix J). Discrimination Index (DI) is determined by the formula given by (Furst 1958 & Olorukooba, 2001) presented as follows:

$$D = \frac{Ru + RL}{\frac{1}{2}N} \times 100$$

Where:

D = Discrimination Index.

RU = The Number among the Upper 27% of the Respondents who Scored the Items Correctly.

RL = The Number among the Lower 27% of the Respondents who Scored the Items Correctly.

N = Number of respondents in each of the upper and lower groups.

According to Satterly(1986) and Lawal (2009) items with discrimination index which are terms as bad questions ranges between 0.29 too difficult and above 0.70 too simple. As earlier stated, the magnitude of discrimination indices which range from 0.30 – 0.70 are used in line in Lawal, (2009). The facility indices and discrimination indices

calculated from the initial tests which did not fall within the theoretically acceptable range suitable for use were rejected. Therefore, the instrument utilises range from 0.30 – 0.70 for the study. The discrimination index was calculated using the formula given by (James, 2000 & Lawal 2009) for the details of item selected based FI and DI see Appendix

3.7 Administration of Treatments

The treatment of the study involves exposing SS II students to genetic concepts using problem – solving instructional strategy, discovery strategy as well two experimental groups. The experimental groups weretaught for six (6) weeks 80 minutes per period by the researcher. The concepts taught are cell, types of cells in a living organisms, function of cell in a living organism, mitosis, meiosis, and differences between mitosis and meiosis in (Appendix A-C) while the control group taught the same concepts using lecture method for the same period of time. Treatment Administration was carried out under the following sub-sections:- Concepts of cell, cell structure, function of cell, mitosis and meiosis, difference between mitosis and meiosis, roles of mitosis and meiosis.

3.7.1 Problem Solving Strategy

Problem solving instructional strategy is one of the activity-based instructional strategies that could help develop certain skills such as manipulative skills, logical reasoning ability. They are seen as an important part of the students' work since they require the application of knowledge and principles to new situations, thus testing and reinforcing the students understanding of what they have learned with the ability to apply throughstudents' interaction with one another also with instructional materials and eventually construct of knowledge and the processes of science.

The steps of teaching

Step 1. **Introduction**: The teacher presents the lesson to the students on the previous Lesson;example: what is the body made up? Name the main type of cell.

Step 2. **Presentation**: The teacher presents the lesson to the students based on the topic taught example: define the term cell?

Step 3. **Student activities**: Students areallowed to think and solve the problem in groups and latter present their answers individually on a paper, for example: Identify life specimen mounted under the light microscope.

Step 4. **Discussion**: Students are to discuss some similarities and differences of their answers with their partner next to him/her.

Step 5. **Evaluation**: Students are asked question on what they have learnt using problem-solving.

3.7.2 Discovery Teaching Strategy

Discovery teaching strategy has been defined in different ways. Bruner (1961) views discovery as mental processes to mediate (discovery) some concept or principles. Alumba (2008) sees it as mental assimilation by which the individual learning of concept or principle resulted from physical and mental activity carried out by the learner. The teacher ensures that the students have a chance to form concept by studying subjects before leading them to form the generalization. Discovery strategy is applicable to virtually all area of teaching and the types of activities the students are involved is vary from topic to topic and the age and ability of the students. In the discovery strategy teaching concepts formation is the main purpose.

The steps of teaching

Step 1. Introduction of the lesson based on the previous knowledge.

Step 2. The students' activities using discovery strategy of student activities on the topic taught.

Step 3. **Discussion**: The teacher asks the studentsto present their findings based on their Observationof the results of the activity carryout in the topic of the lesson. The student discussion in the class what they have observed activity carryout and agree on a correct answer.

Step 4. **Evaluation**: The teacher evaluates the students by asking some questions based on the topic of the lesson taught.

3.7.4 Experimental Group One

The Problem-Solving Instructional Strategy (PSIS)

Problem-Solving Instructional Strategy (PSIS) was adopted from Jensen and Finley (1996) for the study. In problem-solving teaching strategy, the teacher explain the concept for a short period of time and then presents a problem for the class to solve. Students are required to solve the problem individually and discuss similarities and differences in groups. The strategy is presented as follows:

Step 1:Introduction: The teacher presents a problem to the students with relevant concept of genetics.The objective of the step is to make students become familiar with some genetics concepts.

Step 2:StudentsActivities: Students are allowed to think and solve the problem presented individually on paper. The objective of this step is to assist the students to make use of some manipulative skills in genetics lesson.

Step 3: Discussion: Students discuss some similarities and differences of their answers with a partner sitting next to him/her. The objective of this step is to encourage all members that are involved in the study to participate actively in class room activities. It encourages the students to accept the views of others while doing group work.

Step 4:Students'Activities: Students share their ideas and findings together. The objective of this step is to assist the learners to listen to the view of others for a valid and reliable conclusion several times during the lesson to enhance students' understanding.

Step 5: Evaluation: Students were asked questions on what they have learned using problem solving.

The flow chart of problem – solving teaching strategy is presented in Figure 3.3

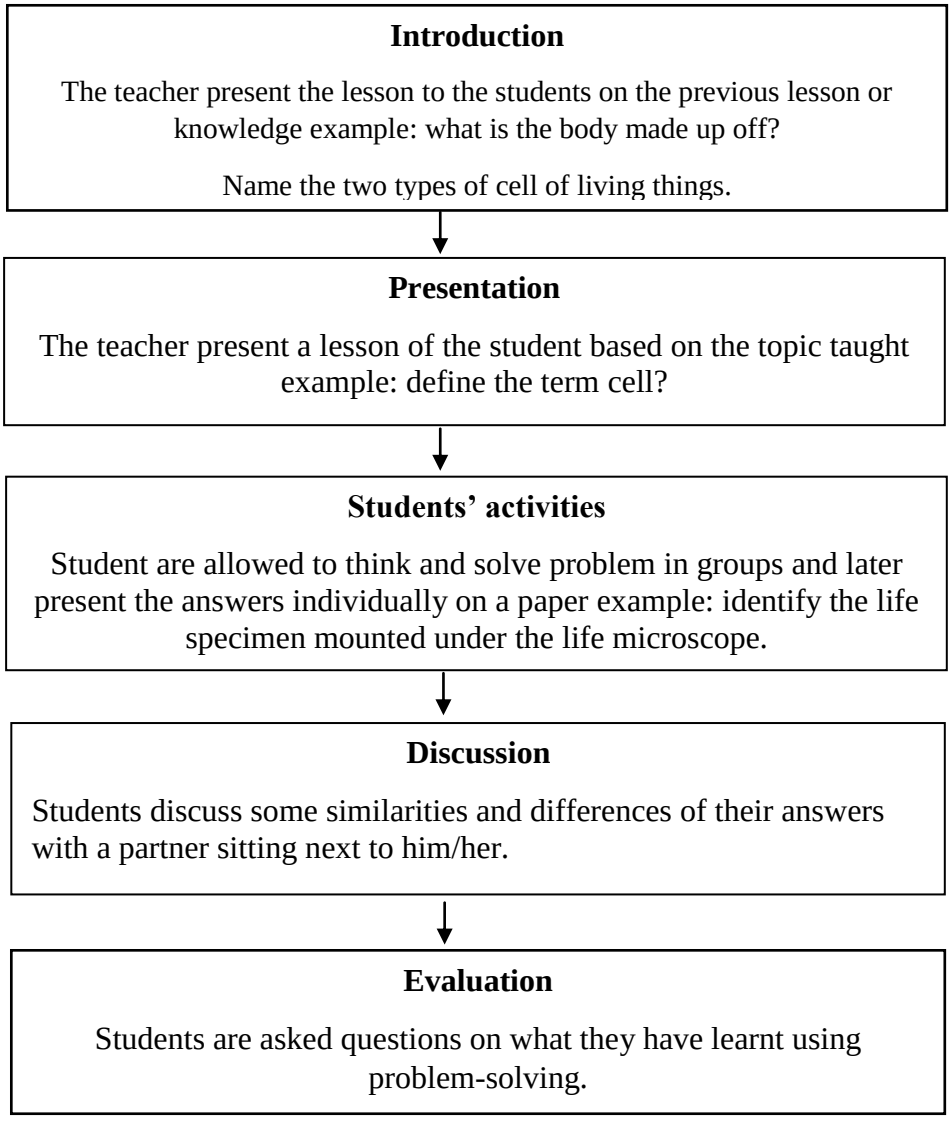


Fig. 3.3: Flowchart of Problem – Solving Strategy Adapted from Jensen and Finley (1996) and Adamu (2014).

3.8.2 Experimental Group Two

Discovery Teaching Strategy

Discovery Teaching Strategy is another treatment presented in Appendix (B) in this study. Ogunsanya (2001) states that discovery is search oriented technique in which the teacher motivates the students to use his/her past experiences and knowledge in and outside his/her environment to find solution to the problem. Discovery teaching strategy process is adapted from Martin (1994) for

this study. In this discovery strategy, the teacher was introduce a concept for a short period of time and give students some activities to carry out by themselves to discover concepts on their own.

The discovery teaching strategy has the following steps:

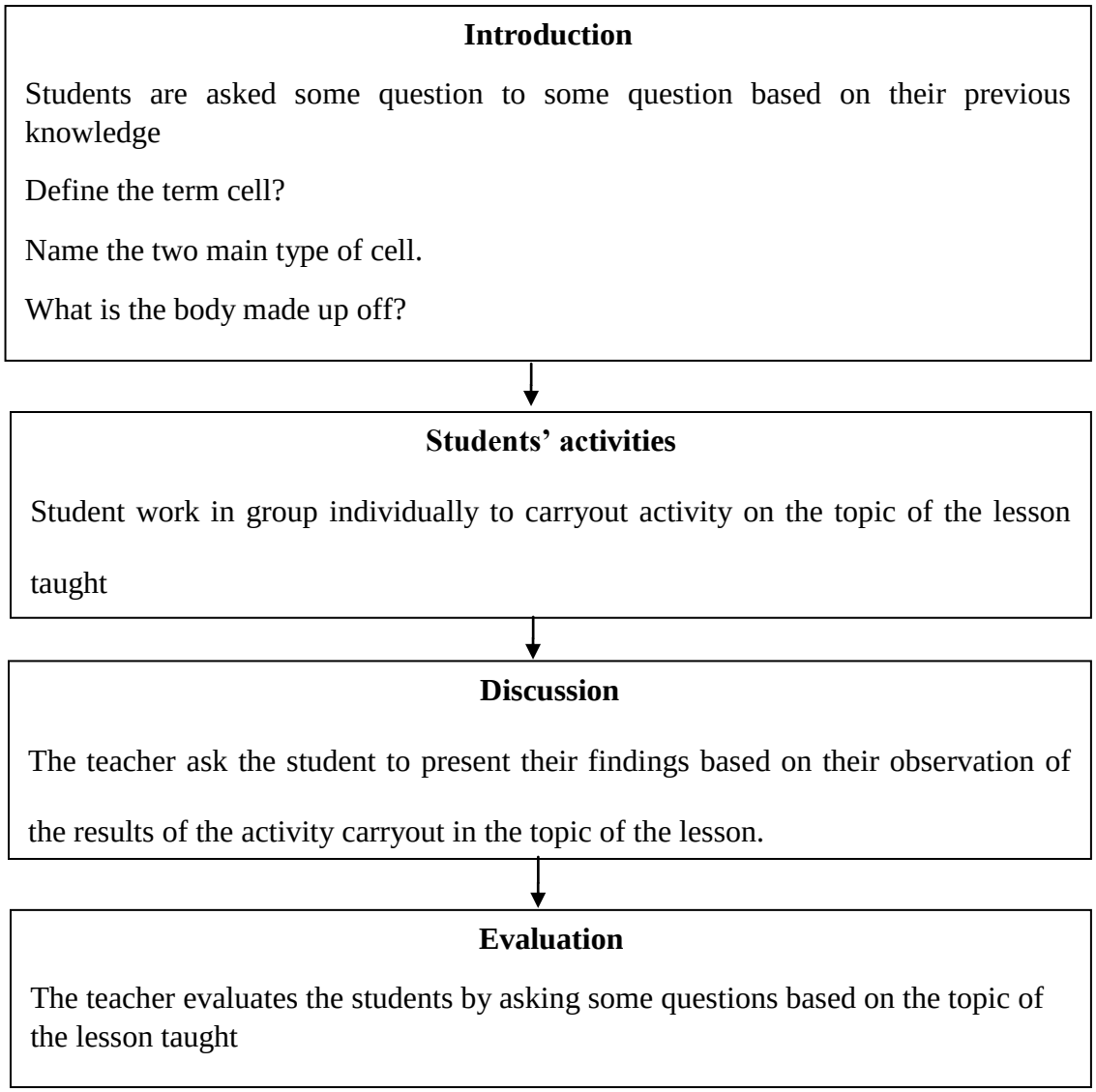


Fig. 3.4: Flow Chart of Discovery Teaching Strategy Adapted from Bruner (1961) and Martins (2000)

3.8.4 Teaching the Control Group

Teaching control group using lecture method. The Control Group taught the same genetic concepts by the researcher using the usual lecture method. This involved the use of the lecture method which is basically verbal presentation of ideas about the topics. During the session the students listen and take notes as the teaching progresses. The teacher

explains genetic concepts taught found to be difficult to the subjects in the control group was presented in Appendix (C).

3.9 Data Collection Procedure

The data collected for this study involves using the following instruments: Genetics Performance Test (GPT) Students Attitude to Genetic Questionnaire (SAGQ) A pre and post-tests was given using GPT and SAGQ. The data was collected after marking the students' scripts of academic performance, attitude and retention ability for both experimental and control groups. The scores were divided into the two experimental and one control groups. Also, the scores were further divided based on gender i.e. male and female. After sorting out the scores, the data subjected to analyses as described in section 3.8

3.10 Procedure for Data Analyses

The data collected for the purpose of the study was analysed as follows:

Research questions 1 and 2 were analysed using mean scores, standard deviation, sum of mean rank mean difference was analysed and also deals with academic performance and retention ability. Research questions 3, 4 were analysed using mean rank, sum of mean rank and mean rank difference with attitude.

3.10.1 Hypotheses Testing:

The following hyptheses were formulated for testing at $p \leq 0.05$.

Null Hypothesis One: There is no significant difference in the post test mean scores of SS II students taught genetics concepts using problem-solving and discovery teaching strategies compared to their counterparts taught using lecture method.

Null Hypothesis Two: There is no significant difference in the post post test mean scores of SS II students taught genetic concepts using problem solving and discovery teaching strategies compared to their counterparts taught using lecture method. One-way analysis of variance (ANOVA) statistics was used to test the hypothesis.

Null Hypothesis Three: There is no significant difference in attitudinal change between students taught using problem-solving, discovery strategies and those taught genetics with lecture method at SS II students. Kruskal Wallis test statistics was used for analysis.

Null Hypothesis Four: There is no significant difference in the post test means scores among male and female SS II students taught genetic concepts using problem-solving and discovery strategies. One-way analysis of variance statistics was used to test hypothesis four.

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

The study investigated the impact of problem-solving and discovery strategies on attitude, retention and academic performance in genetics concepts among secondary school students in Zaria metropolis of Kaduna State. The focus of this chapter is to analyse the data generated in relation to the research questions and null hypotheses stated in chapter one. The chapter is presented under the following sub-headings:

4.2 Data Analysis and Presentation of Results

4.2.1 Answering the Research Questions

4.2.2 Testing the Null Hypotheses

4.3 Summary of Findings

4.4 Discussion of Results

4.2 Data Analysis and Presentation of Results

Four types of data were generated as follows:

i. Pretest data generated via Genetic Performance Test (GPT) to establish group equivalence before the experiment.

ii. Posttest data generated via Genetic Performance Test (GPT) to establish performance after treatment.

iii. Postpost test data to measure retention of learned concepts generated via Genetic Performance Test (GPT)

iv. Students' attitude data generated via Students' Attitude to Genetics Questionniare (SAGQ) to meaure their attitude towards genetic concepts before and after treatment.

The data generated were used to answer the research question and test the null hypotheses.

4.2.1 Answering the Research Questions

Research Question One: What is the difference in the posttest mean scores of SS II students taught genetic concepts using problem-solving and discovery teaching strategies compared to their counterparts taught using lecture method?

To answer this research question, posttest mean scores of EG1, EG2 and CG students were subjected todescriptive statistics, meansand standard deviations were calculated and used to draw Table 4.1.

Table 4.1: Posttest Mean Scores and Standard Deviation of Students Exposed to Problem-solving, Discovery Strategies and Lecture Method

Groups	N	$\overline{X}$	SD	MD
EG I (Problem-Solving)	108	24.74	3.28	
EG II (Discovery)	122	25.78	3.11	- 1.04
EG I(Problem-Solving)	108	24.74	3.28	
CG (Lecture)	115	21.83	3.24	3.91
EG II (Discovery)	122	25.78	3.11	
CG (Lecture)	115	21.83	3.24	3.95

*Significant at P<0.05

Table 4.1 shows the performance mean scores of students taught using problem solving strategy, discovery strategy and lecture method to be 24.74, 25.78 and 21.83 respectively. The performance mean score of discovery strategy was the highest while that of lecture method was the lowest. The mean difference between problem solving and discovery strategies was 1.04; between problem solving and lecture method was 3.91 and discovery strategy and lecture method was 3.95.to show which of the strategy is the best can be seen in their mean scores. From the Table 4.1 the problem-solving has the mean score of 24.74 while discovery strategy has mean score of 25.78 which is the highest. This shows that discovery strategy is the best as indicated in the result of this study.

Null Hypothesis One: There is no significant difference in the post testmean scores of SS II students taught genetic concepts using problem-solving and discovery teaching strategies compared to their counterparts taught using lecture method.

To test this hypothesis, posttest means scores of EG1, EG2 and CG were subjected to ANOVA statistics at P≤0.05. Summary of analysis are shown in Table 4.2a.

Table 4.2a: ANOVA Result ofPosttest means scores on Academic Performance ofProblem-Solving, Discovery,and Lecture Method of Genetics Students

Variable	Sum of Square	Df	Mean Square	F	P	Remark
Between group	980.980	2	490.49	47.560	0.001	*S
Within groups	3527.061	343	10.313			

*Significant at P<0.05

In Table 4.2a the results of the ANOVA statistical analysis show that there is a significant difference in the academic performance mean scores of students in EG1, EG 2 and CG. The P-valuerecorded is 0.001 which is lower than 0.05 level of significance set for the study. Therefore, the null hypothesis is rejected, this implies that there is significant

difference in mean score between experimental and control group. To find out where the difference lies between the three groups, Scheffe's Post Hoc test was conducted and presented in Table 4.2b

Table 4.2b: Results of Scheffe's Post Hoc Test Between Students in Experimental and Control Groups

Groups	MD	SD	Sig	Remark
EG I (Problem-Solving)	-.9053	.40676	0.86	NS
CG	5.5024	.41253	.001	S
EG II (Discovery)	.9053	.40676	.086	NS
CG	6.4077	.40014	.001	S
Control EG I (Problem-solving)	-5.5024	.41253	.001	S
EG II (Discovery Strategy)	-6.4077	.40014	.001	S

*Significant at P<0.05

Results from Table 4.2b show that there is no significant difference in the academic performance mean scores between students in the experimental groups I and II with P=0.086 which is greater than 0.05. However, significant difference was found between the control group and EG 1 with P-value of 0.001 which is less than 0.05.Similarly, no significant difference was found in the control group and EG II with P-value of 0.01 which is less than the statistically p-value of 0.05 while experimental group II and control group show p-value of 0.01 which indicate significant difference because the p-value observed is less than the P≤0.05. It can be concluded that both discovery teaching strategy and problem-solving were effective in improving the performance of students in genetic concepts compared to the control group.

Answering Research Question Two: What is the difference in the retention ability mean scores of SS II students taught genetic concepts using problem-

solving and discovery teaching strategies compared to their counterparts taught using lecture method?

The data collected to answer the research question, post test scores of EG1, EG2, and CG students were subjected to descriptive statistic means and standard deviations were computed and used to draw Table 4.1.

Table 4.3a: Retention Mean Scores of Problem-solving, Discovery Strategies and Lecture Method of Genetic Students

Groups	N	Mean	Std	Meandifference
EG 1 (Problem-solving)	108	26.93	26.31167	
				0.79
EG II (Discovery Strategy)	122	26.14	3.01147	
				6.00
Control	115	20.14	3.34361	

*Significant at P<0.05

Table 4.3a shows the academic retention scores of students taught using the problem solving strategy, discovery strategy and lecture method to be 26.93, 26.14 and 20.14 respectively, with mean difference of EGI 0.79 and EG II 6.00. This shows that the students taught using the problem solving (EG I) and discovery strategy (EG II) retained the learned genetic concepts better than their counterparts in the control group (LM). However the test for significance difference was done by testing null hypotheses two.

Null Hypothesis Two: There is no significant difference in the post post testmean scores of SS II students taught genetic concepts using problem solving and discovery teaching strategies compared to their counterparts taught using lecture method.

To test this hypothesis, post post test scores of EG1, EG2, and CG were subjected to ANOVA at P≤0.05. The summary of analysis is shown in Table 4.4.

Table 4.4a: One-Way ANOVA Mean Score ResultsofRetention of Problem Solving, Discovery Strategies and Lecture Method

Variables	Sum of Squares	Df	Mean of Squares	F	P	remark
Between group	3146.011	2	1573.008			
				7.037	0.001	*S
Within group	764488.378	343	223.533			
Total	79504.380	344				

*Significant at P<0.05

From Table 4.4, the results of the ANOVA shows that P-0.001 which is less than p= 0.05; as such the difference in retention between experimental and control is significant. Hence the hypothesis which states that there is no significant difference in the retention ability of students taught genetic concepts using problem solving, discovery strategy and lecture method is rejected at 0.05 level of significance.

Table 4.4b: Sheffe's Post Hoc Test of Mean Score of Students Exposed to Problem-Solving, Discovery Strategies and Lecture Method on Academic Performance in Genetics.

Groups		MD	SD	Sig	Remark
EG I (Problem-Solving)	(EG II Discovery	078764	1.97535	.924	NS
CG		6.78736	2.00338	.004	S
EG II (Discovery)	(EG I Problem Solving	-.78764	1.97535	.924	NS
CG		5.99971	1.94320	.009	NS
Control EG I (Problem-solving)		-6.78736	2.00338	.004	S
EG II (Discovery Strategy)		-5.99971	1.94320	.009	NS

*Significant at P<0.05

From the result in Table 4.4b, the significant value of 0.92 was recorded for the students exposed to problem solving on those exposed to discovery strategy. Since the P-value of 0.92 is greater than P=0.05 it means that there is no significant difference on

retention ability of students exposed to problem-solving and discovery strategies. Therefore, the null hypothesis which states there is no significant difference in mean retention ability of those exposed to problem-solving (EG 1) compared to control group with observed P-value of 0.04 which is less than P=0.05. Also, there is significant difference in the mean retention scores of students exposed to discovery strategy (EG 2) compared to the control group since the P-value observed is 0.009 which is less than P=0.05.

Answering Research Question Three: What is the difference in theAttitudinal change of senior secondary school SS II students towards Genetic Concepts when exposed to Problem-solving, Discovery strategies and those taught with lecture method?

To answer the research question 3, the mean rank ofEG1, EG2 and CG were computed using Kruskal Wallis statistic and result is presented in Table 4.5.

Table 4.5: Mean Rank Scores of Attitude of Students Exposed to Problem-Solving, Discovery Strategies and Lecture Method in Genetics

Groups	Attitude	N	Mean Rank	Mean Rank Gain
EG I	Pretest	108	359.93	
EG I	Posttest	108	404.91	44.98
EG II	Pretest	122	436.15	
EG II	Posttest	122	449.94	13.79
Control	Pretest	115	165.51	
Control	Posttest	115	169.58	4.07

*Significant at P<0.05

In Table 4.5 the result revealed that the mean rank of students attitude before exposure to problem-solving was 359.93 while after exposure to problem-solving it was 404.91 with mean rank gain of 44.98. For those exposed to discovery strategy the mean rank before exposure was 346.15 after exposure it was 449.94 with mean rank gain of 13.79. While those in the control group recorded the mean rank of 165.51 before, and after was 169.58 with mean rank gain of 4.07. This shows that students exposed to problem-solving retain more than those exposed to discovery strategy while those is the control group retain very little. To test for significant difference, null hypotheses was tested.

Null HypothesisThree: There is no significant difference in attitudinal change between SS II students taught genetic concepts using problem-solving, discovery strategies and those taught genetics with lecture method.

To test the hypothesis, post test data EG1, EG2 and CG were subjected to Kruskal Wallis summary of analysis and the result is shown in Table 4.6.

Table 4.6a: Non-Parametric Test of Kruskal Wallis Test of Problem-Solving , Discovery Strategies and Lecture Method

Variables	Attitudinal	N	Mean Rank	Df	Chi-square	P	Remarks
Experimental I	Pretest	108	359.93				
Experimental I	Posttest	108	404.91				
Experimental II	Pretest	122	436.15	5	101.085	0.001	*S
Experimental II	Posttest	122	449.94				
Control	Pretest	115	165.51				
Control	Posttest	115	169.58				

*Significant at P<0.05

The results from Table 4.6 show chi-square value P=0.001 at df=5 and Hoc test of 101.085.The obtained p=0.001 which is less than P≤0.05in favour of experimental groups. This implies that the difference was significant. The null hypothesis which stated that there is no significant difference is therefore rejected.

Table 4.6b: DunnBonferrari Post Hoc Test of Attitude of Genetic Students Exposed to Problem-Solving, Discovery Strategy and Lecture Method

Variables	Attitude	N	Mean Rank	Sig.	Remarks
Experimental I	Pretest	108	359.93		
Experimental I	Posttest	108	404.91	0.001	S
Experimental II	Pretest	122	436.15		
Experimental II	Posttest	122	449.94	0.032	S
Control	Pretest	115	165.51		
Control	Posttest	115	169.58	0.065	NS

*Significant at P<0.05

In Table 4.6b, the result revealed that for experimental group I (Problem-solving) the P-value recorded is 0.001 which is less than P≤0.05 meaning that there is significance difference between attitude of genetic students before and after exposure to problem-solving. Also, those exposed to discovery strategy, the P-value recorded is 0.032 which is less than P≤0.05 showing that there is significant difference in the attitude after exposure to treatment. This shows that both problem-solving and discovery strategies enhance genetic students attitude in their learning of genetics as observed from their mean scores. The P-value recorded was P≤0.065 which is greater than P≤0.05 meaning that there is no significant difference with attitude of genetic students before and after exposure to lecture method. This implies that problem-solving and discovery strategies equally enhance attitude of students towards learning of genetics at the senior secondary school.

Research Question Four: What is the difference in post test means scores of male and female SS II students in genetic concepts when taught using problem-solving and discovery strategies?

The data collected to answer the research question were post test scores of EG1, EG2 and CG students were subjected to descriptive statistics mean and standard deviation were computed and used to draw Table 4.7.

Table 4.7a: Posttest Mean Scores of Problem-solving and Discovery Strategies of Male and Female Students on Academic Performance in Genetics

Groups	Sex	N	Mean	Std	Meandifference
Problem-solving strategy	M	47	25.85	2.95	
					1.31
	F	61	24.54	3.18	
Discovery strategy	M	53	26.16	3.56	
					0.27
	F	69	25.89	3.05	

*Significant at P<0.05

Table 4.7a The mean difference between male and female was 1:31 in problem-solving; 0.27 in discovery group. This implies that there is difference in mean performance between male and female in experimental groups. For significant difference null hypotheses four was tested.

Null Hypothesis Four: There is no significant difference in the post test means scores among male and female SS II students taught genetic concepts using problem-solving, discovery strategies.

To test this hypothesis is post test data of EG 1, EG 2 and CG were subjected to ANOVA summary of analysis in the Table 4.8.

Table 4.8: One-Way ANOVAof Mean Scores of Male and Female StudentsExposed to Problem-Solving and those Exposed to Discovery Strategy

Variables	Sum of Squares	Df	Mean square	F	Sig	Remark
Between Groups	2247.09	1	1582.550			
Within Groups	46749.378	229	143.533	1.102	0.44	NS
Total		**230**				

*Significant at P<0.05

In Table 4.8 the result shows the F value of 1.102 at df=1,229 while the P-value recorded is 0.44 which is less than P≤0.05. Since the P-value observed is less than P≤0.05 there is no significant difference in the performance of genetics students exposed to problem-solvingand those exposed to discovery strategy. The null hypothesis which says there is no significant difference is retained. Therefore, the two constructivist teaching strategies are gender friendly.

4.3 Summary of Findings

The followings are findings of the study:

1. Significant differencesexist in academic performance among students taught using problem solving and lecture method; discovery strategy and lecture method in favour of students taught using problem solving and discovery strategy; but there was no significant difference between the academic performance mean scores of students taught using problem solving and discovery strategies.
2. Significant edifference exist in retention ability among students taught using problem solving and lecture, problem solving and discovery strategy in favour of problem solving strategy. Also significant difference in retention ability exists between students taught using discovery strategy and lecture method in favour of discovery strategy and problem-solving.

3. There is a positive change in the attitude of the students taught genetic concepts using problem solving and discovery strategies which led to their high performance in the posttest and also high retention in the postpost test compared with their counterpart in the lecture method which have low performance and retention abilities.
4. There is no significant difference in the academic performance mean scores of male and female students taught genetic concepts using discovery strategy and problem-solving showing that these two methods are gender friendly.

4.4 Discussion of Results

This study investigated the impact of problem-solving and discovery strategieson attitude, retention and academic performance in genetic concepts among secondary school students in Zaria metropolis, Nigeria. The findings of the study are discussed as follows:

In Table 4.2 the result of testing hypothesis one shows that there is significant difference in the academic performance mean scores among students taught genetic concepts using problem-solving, discovery strategies and those taught with lecture method. The significant difference found between the three groups was due to the use of problem-solving and discovery strategies (an activity oriented method) on the experimental groups. Since the two experimental groups performed significantly better than the control group, it implies that using problem-solving and discovery strategies have significant impact on academic performance in genetic concepts among secondary school students improves their performance which agreed with Bichi (2002) findings that problem-solving is an active process take into account children interest lead to logical thinking in enjoyable. Challenge and motivation is an activity based therefore encourage group work. The results also disagree with the findings of Musa (2010) where his result showed gender difference.

Based on this finding, in Table 4.2a, there is a significant difference in the academic performance of problem solving and discovery strategies compared to their counterpart in the lecture method. This finding agreed with that of Jensen and Finley (1996) who found that problem solving instructional strategy is more effective in teaching of the Darwinian Evolution concepts than the lecture method of teaching. Furthermore, Deproux (2007) found out that the discovery instructional strategies is also more effective in enhancing the academic performance of students when taught some biological concepts. The finding is in disagreement with that of James (2001) Thedifference with this findings may be attributed to the level of education which is secondary school education.

The result from Table 4.2b showed that there is no significant difference in the academic performance mean scores between students in the experimental groups I and II. It can be concluded that both discovery teaching and problem solving strategies are effective in improving the academic performance of students in genetic concepts compared to the control group (LM)

In Table 4.4 the result shows that there is significant difference in retention ability between the students taught genetic concepts using discovery strategy and problem-solving strategy compared to the lecture method. The students taught genetic concepts using the problem solving and discovery strategies retained the learnt concepts higher than those in the lecture method. This might be due to the fact that students taught using problem-solving and discovery strategies performed better than those taught using lecture method which can lead to better retention of the concept learnt.

The findings of the result Table 4.6showed that there are significant differences between the experimental groups and control group. Also, from the Table it can be seen that the experimental groups I and II gained from the treatment as the post test scores of

the experimental I and II groups are higher than the pretest scores. While in the control group the posttest score was lower than that of EG I and EG II. Therefore, the researcher can conclude that the problem solving and discovery strategies impacted higher on students performance than the lecture method.This findings agreed with that of Okeke (2006, which found that the inquiry-based classroom was superior to the traditional lecture approach. This is in agreement with Runco (2001) and Crosser (2010) who found significant difference in originality of ideas in their various studies on gender. This has indicated that problem solving and discovery strategies is one of the strategies for effective teaching of genetics concept.

The result from Table 4.7 has shown the performance mean scores of male and female students taught using the problem solving, discovery strategies and lecture method and their mean differences. The result shows that there is no significant difference in the mean academic performance in genetic concepts among male and female exposed to problem-solving and discovery strategies. This indicates that both problem-solving and discovery strategies are gender friendly. This agreed with the findings of Paul (2012) who studied the effects of lecture method and discovery methods on the academic performance of students in senior secondary school and the finding showed that both methods are gender friendly. The finding is however in disagreement with Musa (2000), Ibrahim (2012) who reported a significant difference in the performance of male and female of experimental group, favouring male of the experimental.

The results from Table 4.8 shows that there is no significant difference in the academic performance mean scores between male and female students taught genetic concepts using problem-solving and discovery strategies. This implies that discovery and problem-solving strategies are gender friendly in teaching genetic concepts.The result agreed with the earlier findings of Bichi (2002) who reported the effectiveness of a

problem solving approach when he investigated the effects of instructional approach on academic achievement based on gender in Biology concept among senior secondary school students. The result disagrees with that of Wakili (2007) who reportedthat both male and female subjects exposed to integrated science using discovery method showed gender difference. The findingsof this study suggest that the impact of problem-solvingand discovery strategies on attitude, retention and academic performance led to better academic performance of students in genetic concepts at secondary school level.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The study investigated the impact of problem-solving and discovery strategies on attitude, retention and academic performance in genetic concepts among secondary school students. This chapter summarises the entire study as presented in the following sub-headings:

5.2 Summary

5.2.1 Summary of Major Findings

5.3 Conclusion

5.4 Contribution to Knowledge

5.5 Recommendations

5.6 Limitation of the Study

5.7 Suggestions for Further Studies

5.2 Summary

This study investigated the impact of problem solving and discovery strategies on attitude, retention and academic performance in genetic concepts among secondary school students.It also investigated the impact of gender related differences on students' academic performance in genetic concepts when exposed to problem solving and discovery strategies.

The sample comprised a total of 345 senior secondary school SS II students drawn from three schools in Zaria, Kaduna-Nigeria. This sample was chosen by using simple random sampling techniques. The two instruments used were Genetic Performance Test (GPT),a 40 item multiple choice, short answer test with a reliability coefficient of 0.87

which indicated that the instrument is reliable using test-retest methodaccording to Tuckman (1975) cited in Sambo (2008) and Students Attitude to Genetic Questionnaire (SAGQ) which was adapted from Lawal (2009). The questionnaire comprised 37 items. It was tested for reliability using Split half method, employing odd and even number. Kuder Richardson correlation coefficient statistics was used for the analysis. The reliability co-efficient was found to be r=0.79 which indicates that the instrument is reliable. Based on this, it can be used for data collection in this study. The data generated were analysed according to the domains of the four hypotheses formulated to guide the study and the design of the study as reported in Chapter Four. Data analysis was conducted using the Statistical Package for Social Science (SPSS) version 16.0. The discussion of the results and summary of finding were reported accordingly. Analysis of the results indicatedthatproblem solving and discovery strategieshave positive impact on the performance and retention overlecture method. In addition, the three instructional strategies (problem solving, discovery strategy and lecture method)werefound to be gender friendly and suitable for students in genetic concepts.

5.2.1 Summary of Major Findings

The findings of this study are summarised as follows:

1. Significant differencesexist in academic performance among students taught using problem solving and lecture method; discovery strategy and lecture method in favour of students taught using problem solving and discovery strategy; but there is no significant difference between the academic performance mean scores of students taught using problem solving and discovery strategies.
2. Significant difference exist in retention ability among students taught using problem solving and lecture, problem solving and discovery strategy in favour of problem

solving strategy. Also significant difference in retention ability exists between students taught using discovery strategy and lecture method in favour of discovery strategy and problem-solving.

3. There is a positive change in the attitude of the students taught genetic concepts using problem solving and discovery strategies which led to their high performance in the posttest and also high retention in the postpost test compared with their counterpart in the lecture method which have low performance and retention abilities.
4. There is no significant difference in the academic performance mean scores of male and female students taught genetic concepts using discovery strategy and problem-solving showing that these two methods are gender friendly.

5.3 Conclusions

From the findings of the study, the following conclusions are drawn:

1. Students taught using problem-solving and discovery strategies performed better in attitude, retention and academic performance in genetics concepts at secondary schools.
2. Use of problem-solving and discoverystrategies have potentiality of enhancing academic performance in genetic concepts as well as improving attitude.
3. The treatment also improved retention ability among secondary school students'.
4. Those exposed to problem-solving did better than those exposed to discovery method which may be due to activity-based involvement and learner centredness. Therefore, problem-solving allows students to think critically and learn manipulation of the object, while discovery strategy is similar where students are engaged to observe certain activities of the concepts by themselves.

5. Impact of problem solving and discovery strategies on attitude, retention and academic performance in genetics concepts among secondary schools students, since the strategy allows students to carry out activities on their own and arrive at a particular concepts, there is significant difference between the experimental I and experimental II groups over the control group. The finding further suggested that the impacts of problem solving and discovery strategies on attitude, retention and academic performance led to better performance and retention in experimental groups which is higher than the control group.

5.4 Contributions to Knowledge

i. Problem solving and discovery strategies and flowchart were used as treatment models for the experimental groups which was very effective. The flowchart was designed by the researcher and can be used by other researchers, therefore this has contributed to the existing knowledge.
ii. Problem solving and discovery strategies reduce the gap of gender difference in performance between male and female and thus gender friendly.
iii. The two strategies combined (Problem solving and discovery) strategies of teaching and learning genetic concepts had increased the retention ability of those exposed to problem-solving and discovery strategies. The researcher was able to use the two strategies in teaching genetic which wee done separately by othe researchers.
iv. The findings of the study have also added information to the existing literature on genetic concepts and classroom practices as they affect students' performance and retention and attitude to genetics.
v. Though many researchers have worked on some constructivism teaching strategy in this study the researcher employ the two strategies with different mode of lesson

plan and was able to find that problem-solving or discovery strategies which is better enhances students' performance, retention and attitude to learning genetics, but discovery strategies has more impact as revealed in the mean scores.

vi. The instruments - Genetic Performance Test (GPT) and Attitude of Students to Genetic Questionnaire (ASGQ) were developed by the researcher which other researchers can adopt or adapt for future study.

5.5 Recommendations

Based on the findings of the study, the following recommendations were made:

1. Biology teaching in general should be conducted in such a way that the students effectively learn and retain the concepts presented to them. The use of problem-solving and discovery strategy appear to be appropriate in achieving this goals. It should therefore be incorporated into the main strategies of teaching and learning of genetic concepts among secondary school students.
2. For positive attitudinal change of students, genetics concepts should be taught using theproblem-solving and discovery strategies.
3. Teachers should be encouraged to use problem-solving and discovery strategies in teaching of genetic concepts over lecture method to improved academic performance.
4. Professional associations like Science Teachers Association of Nigeria (STAN), Mathematics Association of Nigerian (MAN) and Nigeria Educational Research Development Council (NERDC) should organise workshop on training and retraining of teachers on the use of constructivist teaching strategies such as problem-solving.

5.6 Limitations of the Study

This study has some limitations that include the following:

1. insufficient materials in the schools used that made the researcher to look for more facilities from near by schoolswhich increase the number of days for the research.
2. the attendance of students was falling, that is irregular numbers in class some times.
3. attitude of students exhibited some times in the classes during lessons.

5.7 Suggestions for Further Studies

From the various studies reviewed in this work, very few researches were carried out using problem solving and discovery strategies and lecture method, most especially in genetic concepts. The following recommendations were made for further study:

i. A similar research should be carried out focusing on teaching Mathematics, Chemistry, Physics, Biology using problem solving and discoverystrategies with a view of finding out if similar or different results as in this study might be obtained.
ii. Problem solving and discoverystrategies can be used with other strategies notably, the science processes appraoch, the demonstration, project method, among others on the teaching and learning of genetic concepts.
iii. The study can be extended to the university students to investigate, if educational level has impacts on the variables that this study dealt with.
iv. There is a need to conduct further investigation on the role, if any, that gender differences play in the interactions between strategies and various types of curriculae as different studies seem to be showing different results.

REFERENCES

Abdel, El-Khalick, F. Boujaoude S. Dusch, R. Leaderman, N.G. Mamlok Naaman R, Hofstedn.A Niaz M. Treaquist, D. and Taun H., (2004). Inquiring in Science Education.*International Perspective Science Education,* 88(2), 378 – 419.

Abayomi, A & Miji, A (2004). Gender a Factors in Performance Among Nigeria Students.*Journal of Empirical Research,*2(1) 49 – 53.

Abdullahi U.A. (2006). Science Technology and Mathematics. A key note address presented at Annual Conference of Science Teachers Association of Nigeria (STAN) Kano State Branch on Thursday 4th, May, Kano Education Resources Centre Kano Nigeria.

Adamu, G.J. (2014). Effect of Problems-Solving Instructional Strategy on Self Efficacy, Creativity and Academic Performance in Genetic Among NCE Students. Unpublished PhD. Thesis Ahmadu Bello University, Zaria.

Ademola, O.R. & Olasehinde, K.J. (2014). Scientific Attitude to Science and Science Achievement of Senior Secondary School Students in Katsina State, Nigeria. *Journal of Education and Social Research,* 4(1), 445-452.

Adewole, A. (2007). The Challenge of Tertiary Education in the Next Millennium. A Guest Speech at Curriculum Organization of Nigeria (CON) Seminar and Fellowship Award University of Jos.

Adesokan, C.O. (2000). Students Attitude and Gender as Determination of Performance in JSS Integrated Science. Unpublished B.Ed Project University of Ado – Ekiti Nigeria.

Ajewole, G.A. & Okebukola, (1988). The Instructional methods on retention of biological concepts. *Nigeria Educational Forum* 11 (1) 77 – 82.

Adnan, K. & Ahmed, A. (2006). Affective Factors that Influence Chemistry Performance (Attitude & self efficiency) and the Power of these Factors to Predict Chemistry Performance. *Journal of Turkish Science Education,* 3(1),76 – 85.

Adesoji, F.A (2008), Students Ability Level and Effectiveness of Problem–Solving Instructional Strategy.*A Journal of Social Science,* 17(1), 5 – 8.

Adewumi, A., Auta, J. & Bako, S.O (2001).*Questions and Answers in Advanced Level Biology*. Ndali Press and Publisher Nigeria Ltd pp 70 – 80.

Adewole, U.A. (2003). Effects of Discovery and Expository Method on Performance of Students in O level Biology, Unpublished Ph.D Dissertation.Faculty of Education University of Ibadan, Nigeria.

Adesoji, F.A. (2008). Students'Ability Level and Effectiveness of Problem Solving Instructional Strategy. *Journal of Social Science* 17(1), 5 – 8

Adigun, A.O. (2003). *Introduction to Vocational and Technology Education*, Jos. February Aminchi Nigeria Limited.

Adnan, K. & Ahmed, A. (2006) Affective Factors that Influence Chemistry Achievement (Attitude and Self-Efficacy) and the Power of these factors to Predict Chemistry Achievement. *Journal of Turkish Science Education,* 3(1), 76-85.

Agboola, O. S, & Olayede, E.O. (2007). Effect of Project, Inquiry and Lecture Demonstration Teaching Method on Senior Students Performance in separation of mixture practical test. *www.academicjournals.org/err*

Agbadinuno, M.C.K. (1987). Analysis of the Enrolment and Performance in the Hard Science in West African School Certificate in the 1960s 28th Annual Conference Proceeding of Science Teaching Association of Nig. 1987 25 – 32.

Aigboman, D.O (2002). Science for All: Implication for the Teacher and National Development.Benin City:Anibik Press.

Ajewole C.A. (2000). Improving Socio-cultural Aspects of Classroom Learning Environment in Enhancing Students' Performance in Biology SGS 7AN.*www.academicjournals.org/err*

Ajewole, G.A. (2000). Effect of Guided Discovery and Expository Instructional Method on Student and Transfer of Learning. *Journal of Science Teachers Association of Nigeria (STAN),*26(2), 59 – 66.

Akanbi, A.O. (2002). Students Correlate as Function of Performance in theSchool Certificate Physics in Ilorin State. *Kontagora Journal Science and Technology*4 (1), 33 – 41.

Akanbi, A.O. (2004).Gender Sensitivity in Classroom. Teaching and Learning A paper Presented at ETF/NCCE The Frances Workshop, F.C.E Katsina States Nigeria.

Akinbobola, A, & Ikitde, G.A. (2008). Facilitating Student Attitude in the Concept A Heat Energy in Nigerian Secondary School Physics Using Models Realia and Instructions Chart Africa Research 2 (2) 56 – 68 retrieved on 15/4/2013 fromwww.com

Akinbobola, A, & Folashade, A. (2009). Constructivist Problem-based Learning Technique and the Academic Achievement of Physics Students in Nigeria Secondary School *Eurosian Journal of Physics and Chemistry Education,*1(1) 45-51.

Akubuilo, D.U. (1995).Effect of Problem Solving Instructional Strategies on Students Performance in Biology. An Unpublished PhD Dissertation, Faculty of Education, University of Nigeria Nsukka.

Akpan, E.U.U. (1999). Towards Evaluation Chemistry Laboratory Practice: A survey on Plateau State Secondary Schools in evaluating Science Technology&Mathematics Education (Ed) Olanitemi O. 40th Annual Conference Proceeding of *Science Teachers Association of Nigeria* 117 – 122.

Allen, O. (2003). Paper and Students Perception of Science Learning Environment and it Influence our Student Outcomes.Unpublished PhD Thesis Parth; Curtin University of Technology.

Aluko, A.Y. (2005). Social Factors Underlying Gender Variation of School Enrolment in Nigeria.*Ife Psychologist,*13(1), 74.

Alumba, E. (2008). Effects of Inquiry and Traditional Teaching Strategies on Academic Achievement in Integrated Science Among Junior Secondary School Students in Kano Metropolis. Unpublished M.Ed Thesis Faculty of Education, Ahmadu Bello Zaria.

American Association for the Advancement of Science (2006).*Science for All Americans*. New York.

Arbogast, E.D. (1997). Effects of Gender on the Choice of Physics in Tertiary Institution in Zaria. An unpublished Post Graduate Diploma in Education. Thesis Ahmadu Bello University, Zaria.

Awodeyi, R.F. (2005). The Constructivist Approach to the Teaching Relationship Between Volume and Capacity School Mathematics.*Journal of Science Teacher Association of Nigeria*, 50 (1 & 2) 22 – 27.

Ayuso, E, Bernet E. (2003).Teaching genetics at secondary school: strategy for teaching about the location of inheritance. Science education 84,313-351

Bajah, A.O. (2006). Under Performance in Academics. *Journal of Science Teachers Association of Nigeria,*4(1) 22-29

Bature, I.J. (2007). Students Perceived Difficulties in SSCE Mathematics Syllabus in Some Selected Secondary Schools in Plateau State. *Journal of Educational Studies,*13(1), 110-112.

Banet, E. &Ayuso,G.E. (2000).Teaching Genetics at Secondary School. A Strategy for Teaching about Location of Inheritances.*Science Education,*84(3), 313-351.

Banet E. &Ayuso,G.E. (2000). Teaching of Biological Inheritances and Evolution of Living beings in Secondary school. *International Journal of Science Education* 25(3), 373-407.

Bell, J.F. (2001). Investigating Gender Difference in the Science Performance of 16 Year Old Pupils in U.K. *International Journal of Science Education,*23(5), 469 – 486.

Benis, S.B. (2001). *Education Development in West African State, A Comparative Study*.Benin City: Peakers Publishers. 73 – 78.

Bichi, S.S (2002). The Effect of Gender on Academic Performance in Evolution Concepts Among Secondary School Students Using Problem – Solving Instructional Strategy, Zaria. *Journal of Studies in Education,*3(1) 133 – 138.

Bichi, S.S., (2002). The Effect of Problem Solving Strategy in Enhancing Curriculum on Students' Academic Performance in Evolution Concept among Secondary School Students. Unpublished Ph.D Dissertation, faculty of Education Ahmadu Bello University Zaria.

Bichi, S.S., (2012). Effects of Gender and Historical Enriched Curriculum on Academic Performance in Evolution Concept among Senior Secondary Schools Biology, Students in Kaduna State. *Journal of Educational Research and Development,* 1(1), 20 – 24.

Bilgin, I. (2009). The Effects of Inquiry Instruction in Cooperating andComparative Learning Approach on University Students Achievement of Acid and Base Concept and Attitude Toward Inquiry Instruction. *Academic Journals Scientific Research and Essay*,4(10) 1038-1046.

Bomide, G.S. (1986). The Nigeria Integrated Science Project How Conceptually Accessible to the Pupils.(ed)P.A. Okebukola *31st Annual Conference.Proceeding of Science Teachers Association of Nigeria* 174 – 178.).

Boujaoude & Barakat (2003). Students'Problem Solving Strategies in Stoichrometry and their Relationship to Conceptual Understanding and Learning Approaches.*Electronic Journal of Science and Education,* 7(3) 1 – 6.

Bransford, J. & Stein, B. (2001).*The Ideal Problem Solving. A Guide for Improving Thinking Learning and Creativity*. San Francisco: W.H Freeman.

Bruner, J.S. (1961). *Act of Discovery, Harvard Educational Review,* 31(21) 32– 38.

Bruner, J.; Goodnow, J.J. & Austin, G.A. (1961). A Study of Thinking: New York: Science Edition.

Bunkure, Y.I. (2012). Effect of Constructivist Instructional Strategy on the Academic Performance, Retention and Attitude to Physics among Senior Secondary School Students of Different Ability level unpublished PhD Thesis Ahmadu Bello University, Zaria.

Bunton,R. (2001).*New Genetics and Public Health.*London, U.K: Rutledge.

Busari, O.O. (2001). The College Review: *A multi-disciplinary Journal* 2(1), 20 – 24.

Cakir, O.S.; Sahin, T. & Sahun, B. (2000) Ikogretin t. Siniffen Bilgisi Dersine Iliskun Bazi Degiskenlerin Orgrencilerin Dayusal Ozellik lerini Aciklama Gucu. Itacetlepe, University. Egitim Faculties Dergisi V; 19, 43-49.

Chia, C (2003) *A Quasi-experimental Study researching how problem-solving teaching strategy impacts on learning Outcome for engineering students, world transactions on engineering andtechnology education (2003) 2(3) 391-394*

Cronbach, L.J. (1963). Educational Psychology, New York: Harcoul Brace Jovanurich

Damide, C.O. (2000).Enhancing the Transition from Concrete to Formal Cognitive Performance in Chemistry. An Unpublished M.Ed Thesis of ATBU University, Bauchi Pp51

Dana, G.B. (2006). Effects of Conception System and Instructional Methods on General Chemistry Laboratory Performance. *Journal of Research in Science Teaching,* 27(7), 699-709.

Danladi, S. (2003). Effects of Science Process on Students Performance in Chemistry. A Case Study of S.S. II in Gumel Educational Zone, Jigawa State Unpublished Ph.D Thesis. Ahmadu Bello University, Zaria.

Danjuma, I.M. (2005).An Investigation of Pre-service Teachers, Problem-Solving Behaviour in Solving Selected Numerical Problems in Chemistry, Unpublished M.Ed Thesis, Abubakar Tafawa Balewa University, Bauchi.

Dan'azumi, A.O. (2008).*Interactive Approach to Effective Learning of Practical Chemistry*. *A Hand Book for Chemistry Teachers*. Chemistry Panel Services 3 Science Teachers Association of Nigeria.

Derville, L.M.J. (1997).*The Use of Psychology in Teaching*,London:Longman Group Limited.

Dohn, H. Wagnes, K, (1999). Strategies and Method of Teaching Contemporary Higher or Education with Reference to Project Work Innovation in Education and Training 36 (4) 285 – 291.

Douglass, H. (1997). Effects of Explicit Problem Solving Instruction on Higher School Students' Problem Solving Performance Conceptual Understanding of Physics. *Journal of Research in Science Teaching,* 39(6), 551-557.

Driver, R. & Easaly, J.A. (2005). Pupils and Paradigms: A Review of Literature Related to Concept Development in Adolescent Science. *Journal of Studies in Science Education*, 5 (8) 78-85

Driver, R.& Erickson, (2002). Theories in Action Some Theoretical and Empirical Issues in the Study of Students Conceptual Framework in Science Studies.*Education,*10, 37 – 50.

Duke, L.I. (2005). Seven Cardinal Principle Problem Solving Thinking Higher Order Thing.*The Social Studies,* 76(3), 129 – 132.

Eriba, J.O.& Sesugh, A. (2006). Gender Difference in Achievement: In calculating Reaching Masses from Chemical Equations among Secondary School Students in Makurdi Metropolis: *Journal of Education Research,* 1(6), 170 – 173.

Esiolu, G.O.& Soyibo, K. (1995). Effects of Concepts of Mapping and Vee Mapping Under. Three Learning Modes of Students' Cognitive Achievement in Ecology and Genetics. *Journal of Research in Science Teaching.* 32(9), 197 – 995.

Ezenwa, V.I. (1993). A Comparative Study of the Effectiveness of Concept Mapping and Guided Discovery Teaching Strategies on Secondary School Students Understanding of Selected Chemistry Concepts. Unpublished PhD Thesis ABU Zaria.

Eggan, P. & Kanchek, S., (2004). *Educational Psychology*: *Windows on Classroom* 6th Edition.Prentice Hall.

Elsenkrat, A. (2003). Expanding the 5E model. *Science Teacher,* 70(6) 56 – 59.

Erkus, A. (2003). Psikometri Uzerire yazilar Turke Psikologlar Dernegi yajiloari No 24 Ankara.

Eze, J.D. (2001).Comparative Effects of Problem – Solving and Expository in Solving Word Problems in Mathematics, unpublished M.Ed Thesis,Department of Science ProgrammeAbubakar Tafawa Balewa University, Bauchi.

Ezema, M.A.& Dung, M.D. (2003). *Concept Mapping*.Abuja:Science Teachers Association of Nigeria (STAN). Integrated Science Education Series.Ed M.A.G. Akale.*N0.2,NCCE*.

Eta, F.E. (2000).Dimension of the Gender Crises in Nigeria Education. A View from Colleges of Educations. *Journal of the Nigeria Teacher Today,* 8(1&2) 157 – 169.

Federal Government of Nigeria. (2013). *National Policy on Education*, Lagos:Federal Government Press.

Fosnot, CT (1996). *Constructivist: Theory and Practice*. New York:

Fostar, Y. & Tamir, P. (2008). Kaduna State Education Sector Project. Teacher Professional Development Training Materials. Core module component 1.

Francis, & Babatunde (2008). InvestigatingGender Difficulties and Misconception in Inorganic Chemistry at Senior Secondary School Level. *International Journal of African-America Studies,* 7(11), 1 – 7.

Funke J. (2012) Relationship Between Scientific Attitude and Academic Performance among Demonstration Secondary School Junior Students of ABU, Kaduna State, Nigeria. *Postgraduate Seminar Series Journal* 1(1) 319 – 324.

Gabel, D.(2003*). Enhancing the Conceptual Understanding of Science Education*. Harrison, Winter 70-76.

Gajere, I.J. (2002). *Teaching is Learning to Nigeria Schools Innovative Approach*. Kaduna: Macmillan Publisher Limited. 100 – 103.

Gagne, R.M. (1970). *Learning Requirement for Enquiry, Reading in Science Education*.NewYork: Macmillan Company. 55 – 59.

Galadima, I. (2001). The Effect of Heuristics Problem-Solving Strategies in Senior Secondary School Students Achievement in Algebra. Unpublished Ph.D Dissertation, Ahmadu Bello University, Zaria.

Gazi, M.A, Olaruntegbe, K.O, & Tunde, O. (2010).Volumetric Analysis and Chemistry Student Performance: Combined Influence of Study Habit, Physiological and Psychological Factors Scientific Research and Essays. *Academic Journal* 5(11), 1325 – 1332.

Glasserfield, E. (1995). Radical Constructivist. A Way of Knowing and Learning.London & Washington D.C.:Planning Press. London and Washington DC.

Gibson, B. (2012) Differentiating Instruction and Practice; Practical Step for Implementation.

Gunstone, R.F., & Nothfield, J. (1992). Conceptual Change in Teacher Education. The Centrality of Meta – Cognition Paper Present at the Annual Meeting of the America Research.

Good, J.J. Woodizieka, J.A.& Winsfield, C.L. (2010). The Effect of Gender Stereotypic and Counter Stereotypic Textbook Images on Science Performance. *The Journal of Social Psychology* 150(2), 132 – 142.

Hanusin, D.L. & Lee M.H. (2007). Using a Leaning Cycle Approach to Teaching the Learning to Pre-Services Elementary Teacher. Papers Presented at the Annual Meeting of Association for Science Teacher Education Online http./web Missouriedie.

Haslam, F. & Treagust, D.F. (1987). Diagnosing Secondary Students Misconception of Photosynthesis and Respiration in Plant. Using a Two Tier *Multiple Choice Instrument and Technological Education* 4(2), 203 – 211.

Hischi, H. & Jen Chia, C., (2003). A Quasi-experimental Studies Teaching Strategy. Impacts on Outcomes for Engineering Students World *Transaction on Engineering and Technology Education*2(3), 2003.

Hewson, P. W. (2001). A Case Study Conceptual Change in Special Relativity. The Influence of Prior Knowledge in Leaning European. *Journal of Science Education* 4(3) 61 – 78.

Ibraheem, T.L (2004). An Investigation into Usefulness of Research Result Among Secondary Schools.Science Teachers (Ed)M.A.G. Akale4th*Edition. Science Teachers Association (STAN) Annual Conference Proceeding* 15 -25..

Ibraheem, A. (2008). An attitude Survey Towards Integrated Science. A Comparative Case Study of Pre-serviceTeaching. *The Nigeria Today,A Journal of Teacher Education,* 8 (1 & 2) 230 – 237.

Ibraheem, A.S. (2008). Comparison of Attitude of Students of Different Educational Level and Age-range. Towards Science. *A Journal of Educational Research and Development*, Zaria 3(3), 57 – 62.

Ibrahim, A. (2010). Core Subject for Primary School Teachers. A Paper Presentedat Training Workshop on Improving Teaching Organized by Gombe State University Consultancy Services, Gombe, Nigeria.

Igboko, K.O. & Ibeneme, O, T. (2006). Effect of Some Cognitive Constructivist Instructional Approach on Students Performance &Relation in the Study of Introduction. *Journal of Science Teachers Association of Nig*eria. 41 (1 & 2), 37 – 50.

James, T. (2000). Effect of Combining Reflective Writing with Concept Mapping and Lecture Method on Pre-Service N.C.E Teachers Attitude Performance in Biology.Unpublished Ph.D Thesis, Ahmadu Bello University, Zaria.

Jegede, S.A., (2010). Nigeria Students Perception of Technical Words in Senior Secondary School Chemistry Curriculum. *Pakistan Journal of Social Science,* 7(2) 109 – 111.

Jegede, O.J. (1996) Fostering Student understanding of Science Concepts. A Special Keynote paper for the 31th Annual conference proceedings of Science Teachers Association of Nigeria Uyo Akwa Ibon State 12-17 August.

Jensen, M.S. & Finley, F.N. (1996). Changes in Students Understanding of Evolution Resulting from Different Curricular & Instruction Strategy. *Journal of Research in Science Teaching*, 33(8), 879-900.

Jeynes, W.H. (2005). A MetaAnalysis of the Relationship of Parental Involvement to Urban Elementary School Students Achievement.*Urban Education*,40 (3) 237 – 269.

Jibrin A. G., Zayun, S.D.& Abba (2011). Effect of Enhanced Problem-Solving Instruction at Method from different Curriculum and Instructional Method on Self Efficacy of Senior Secondary School Biology Students in Bauchi Metropolis of *Technical and Educational Research,JOTER,* 4(3), 1 – 6.

Johnson, D.W & Johnson, R.T. (1984). Instructional Goal Structure Cooperative, Competitive Learning Individual's *Review of Educational Research* 44(2), 213 – 240.

John, S. (2000). Teaching Introductory Chemistry Using Concepts Development Interactive and Inductive Learning University Chemistry.*Education,* 4(1), 3.

Kala, M.D., (2012). The Effects of Enhance Cooperative Learning Strategy on Students Performance and Retention of Senior Secondary School Biology. Unpublished M.Ed Science Education, A.T.B.U Bauchi.

Kasim, A.G., (2007). The Effect of Visual Analysis Skills on Conceptual Understanding and Problem-Solving in Electricity 1995, Doctoral Dissertation Abstracts International, A57/03 umi, ACC 9622720.

Katcha, M.A. (2005) Effects of Vee-Diagram Instructional Strategy on Secondary School Academic Achievement and Attitude Change to Biology. Unpublished PhD (Science Education) Dissertation. A.B.U Zaria, Nigeria.

Krogh, L.B. & Thomasen, P.V. (2000). Gr Ii Repporten Dervsings Stil or Lareriagsud Bytes Cnd, Striffseries No University of Aahus Denmark (In Danish).

Kirschner, P.A., Swaller. J.S. & Clark, R.E. (2006). Why Minimal Guidance During Institution Does not Work: Analysis of the Failure of Constructivist Problems Based Teaching.*Educational Psychologist*, 41(21), 75–86.

Kikas, I. (2004). Teacher Conceptions and Misconception Concerning Three National Phenomena. *Journal of Research in Science Teaching, 41(5) 432 – 448.*

Kind, P.M., Jones, K. & Barmby, P. (2007). Developing Attitude Towards Science Measures. *International of Science Education*, 29(7), 871 – 893.

Kindfield, A.C.H. (1994) Understanding a basic biological process: Expert and novice models of meiosis. *Science Education 78(3): 255-283.*

Koran, S. & Baker, D.S. (2000). Teaching Biology Outside the Classroom; it Heading for Extension, for Occasional Publication 72 Share Westbury: Find Studies Council British Ecological Society.

Krejcie, R.J. &Morgan, D.W. (1975). Determining Sample Size for Research Activities.*Education Psychological Measurement*, 30, 302 – 310.

Lakpini, M. A., (2006).Effect of Conceptual Change Instrument Strategy on the Performance,Retention and Attitude of Secondary School Biology Students with Varied Abilities. Unpublished Ph.D Dissertation, Dept of Science Education, Ahmadu Bello University, Zaria.

Laurillard, D. (2000). Style and Approach in Problem-Solving. Harvard University Press.

Lawal, F.K., (2009).Effectiveness of Conceptual Change Instructional Strategy in Remediating Misconception in Genetics Concepts Among Senior Secondary School Students in Kano State. AnUnpublished PhD Thesis Faculty of Education Ahmadu Bello University, Zaria.

Levin, Y. (2000). The Moral Challenge of Modern Science. A Journal of Technology and Society Current Issue. Retrieved on 4 July, 2000 from http/www.therewatlentis.com

Liza, P.E. (2010). Attitude Towards Chemistry Performance; A Correlational Studies: Google Online Academic grade K-17 www.mercury.prep.com

Lorchugh, A.S. (2006). Influence of Cognitive Style, Cognitive Level and Gender on Students' Performance in Physics.Unpublished M.Ed Thesis, University of Nigeria Nsukka.

Mahmud, A.A. (2009). Study of Effect of Discovery and Lecture Method of Instruction on the Academic Performance in Genetics among NCE Students.Unpublished M.Ed Thesis, Ahmadu Bello University, Zaria.

Muhammad B. A. (2014). Influence of conceptual Instructional Method on students' performance and Attitude towards practical Chemistry among Secondary School Students in Zaria Educational Zone, Unpublished PhD thesis, A.B.U. Zaria.

Muhammed, S.A. (2011). Effects of Inquiry Teaching Method in Academic Performance, Retention as Attitude Towards Chemistry Among Diploma Students of Kano State Polytechnic. Unpublished M.Ed Thesis A.B. U. Zaria.

Mamuda, J. (2009). Responding the Science Teaching Methodology as Panacea for Sustainable National Development in the 21st century. *A Journal of Association Nigeria Educators*, 4(1), 230.

Maikano, S. (2006). A survey of Psychological Determinant for conductive Classroom/Laboratory Environment for Science, Technology and Mathematics Implication for Effective Teaching and Learning.

Martin, O.O. and Oyebanji, P.K., (2000).The Effect of Inquiry and Lecture Methodon the Cognitive Performance of Integrated Science Students. *Journal of Science Teachers Association of Nigeria* 3(1&2), 31 – 35.

Mari. J. S. (2001). The Effective of Process Skill Instruction on Formal Reasoning Ability Among SSS Students In Kaduna State. Unpublished PhD Thesis,Faculty of Education, Ahmadu Bello University, Zaria

Mari. J. S., (2001). Cognitive Function of Students Teachers: Challenges for Teacher Education. *Journal of Education Research & Development, 1(3), 90 -93.*

Mari, J.S. (1994). The Understanding of Science Processes and its Relationship to Performance in Integrated Science. M.Ed Thesis Ahmadu Bello University, Zaria.

Mathews, M. (1993) Constructivist on science Education: A Further Appraisal. *Journal of Science Education,* 11 (1) 121 – 134.

Michael, M.C (2002). *Biology for Senior Secondary School*. 1st Edition. Tonard Ltd. 120 – 123.

Mcmahon, J.Y. (1997). Effect of Cognitive Preference and Advance Verbal Organizers on the Retention of Ordinary Level Physics Textual Material. *Journal of Research in Science Teaching,* 1(3) 132 – 135.

Muhammad, B.A. (2007). Effects of Continuous Assessment in Academic Performance of New Chemistry Student in Kaduna State. Unpublished M.Ed Thesis Faculty Education, Ahmadu Bello University, Zaria.

National Teachers Institute. (2008). Manual for The Retraining of Primary School Teachers Basic Science and Technology. 60 – 65.

National Research Council. (2005). How Students Learn: Science in the Classroom Washington D.C: The National Academic Press.

Nacino B.R. (2005).*Curriculum and Instruction. An Introduction to Method of Teaching*. Macmillan Publishers. Pp 46-49.

Njelita C.B. (2007). Enhancing Science Skills Acquisition in Volumetric Analysis using co-operating Learning Strategy: Effective Method of Teaching Chemistry Practical. A Handbook for Chemistry Teachers. Teachers Chemistry penal serves 3 pp 30 – 35.

Njoku, Z. C., (2007). Comparison of students performance in the three categories of question in SSCE Practical Chemistry Examination. *Journal of Science Teachers Association of Nigeria* 42(1), 67 – 72.

Nwafor, O.M. (2007). *Educational Innovation, Process and Product*. Enugu: Magnet Business Enterprises. 97 – 103.

Nwosu, A.A. (2001). Gender and Science Process Skills among Secondary School Students: Implication for Science Teaching in O, O Basari (ed) 42nd*Proceeding of Science Teaching of Nigeria, 200 – 209. Heinemann Educational Books.*

Obeka, S. S. (2010). Effect of enquiry&demonstration method on Students Achievement 7 Relation in Some Enrolmental Concept of Geography.*Journal of Science & Mathematics Education,*Ahmadu Bello University, 1(1), 52 – 58.

Ogunboyede, M.O. (2003). Sex Difference and Students Performance at Primary level.*The Nigerian Academy Forum*,5(1), 152 – 155.

Ogunleye, A.O. (2001). Perception of Strategy for Improving Low Enrolment UnderPerformance and Attitude of Girls in Physics at SSS level. Proceeding of Science Teachers Association of Nigeria 42nd Annual Conference 344 – 351. Edited by Olanitemi O. Busari.

Ogunsola, B. M. F. (2000). General Science in a Male World. A paper Presented at the GASAT African Regional Conference, Abuja, Nigeria.

Ogunkule A,R & Gbamanja, T.S.P. (2006).Constructivists: An Instructional Strategy for Sustaining Students Self Concept in Secondary School Mathematics. *Journal of science Technology Association of Nigeria JSTAN* 41(1 & 2), 31- 36.

Ogunbayode, M.O. (2003). Sex Difference and Students Performance at Primary Level. *The Nigerian Academy Forum,* 5 (1), 152 – 155.

Okebukola, P.A.O (2000). The Relative Effects of Cooperative Instructional Strategy and Traditional Method of the Performance of Senior Secondary School Chemistry Students.Unpublished PhD Thesis,Ahmadu Bello University, Zaria.

Okebukola, P.A.O (2002) Attaining meaningful learning of concepts in Genetic and Ecology: An Examination of the potency or Concept Mapping Techniques. *Journal of Research in Science Teaching 27(5) 493-504*

Okebukola, P.A.O (2001).Attaining Meaningful Learning of Concept in Genetics and Ecology: An Examination of the Potency or Concept.

Okebukola, P.A.O(1997).Good concept mappers be good problem-solving Educating Psychology 12(2), 113 – 129.

Okeke E. A.C. (2010). Woman in Science Technologist and Mathematics in Nigeria key note address Woman in Science Technology in Nigeria (Ed) Nsikak-Abasi Udofia.

43rdAnnual Conference *Proceeding of the Science Teachers Association of Nigeria* 42 (1 & 2), 85 – 88.Okwo, F.A. &Jartiyus, I. (2006). Effect of Model of pictorial Adjust presentation and Cognitive style on students Performance in Biology Objective Test.*Journal of Science Teachers Association of Nigeria,* 41(1 & 2), 94 – 97.

Okwo, F. A. & Tarriyus. I. (2006). Effect 2 models of pictorial Adjunct presentation and Cognitive Style on Students Performance in Biology Association of Nigeria 41 (1-2) 94 – 97. Mapping Techniques. *Journal of Research in Science Teaching, 27*(5),493 – 504.

Okwo, F.A.& Otubah, (2007).Influence of Gender and Cognitive Style on Students Performance in Physics Essay Test. *Journal of Science Teachers Association of Nigeria,* 42(1-2) 85 – 88.

Okafor, E. N. & Okeke, O.C. (2006). Concept Mapping as Effective Techniques for Teaching Difficult Concepts in Biology in N. Uchenna, (Ed) Uchenna Nzewi. *Proceeding of the 47th Annual Conference of STAN*.

Olagunju, A.M. (2002). Modern Trends in Science School Biology Teaching in Samuel O, Ayodele (Ed) Teaching Strategies for Nigerian Secondary School.

Olaniyi, F.O. (2002). The College Review: *A multidisciplinary Journal* 2(2), 10-14.

Olarinoye, R.D (2001). Science Education as a Basis for Technological Development. A Paper Presented at 1st*National Conference* F.C.E (Tech) Gombe State.

Olatoye, R. A., (2001). A casual model of school factors as determines of Science. Performance in Lagos state Secondary Schools unpublished Ph.D thesis, Faculty of Education, University of Ibadan.

Olarewaju, A.O., (1998). *New Approaches to the Teaching of Integrated Science*. Alapas Nig. Company Ibadan.

Olarewaju, R.R (2000). Relationship of Gender and Related Differences in Learning of Biology Concepts Amongs Senior Secondary Students. A Research Seminar Presented at Department of Education Ahmadu Bello University, Zaria.

Oloyede, O.I. (2008). Problem of Teaching and Learning Science in Primary and Junior Secondary Schools. A workshop paper presented as SUBEB Teaching Training workshop Bauchi State 28th – 31st January a Lokatosian Interpretation Science Education 79, 19 – 36.

Olorukooba, S. B. (2001). The Relative Effects of Co-operative Instructional Strategy and Traditional of the Performance of Senior Secondary School Chemistry Students. Unpublished PhD Thesis, A.B.U. Zaria

Orion, G.B. (2003). Strategies for Teaching Science, Technology and Mathematics for Learners' Gain. Publication for Science Teachers Association of Nigeria. Pp 1-13.

Onekatu, A.& Onekatu ,P.O. (2002). Gender Difference in Achievement in JSS Examination in Integrated Science Implication for National Development.

Osborne, R. J. & Wittrock, M.C. (2000). A Technique for Exploring Students Views of the World.*Physics Education,*67(4) 489-508.

Osuala, E.C. (2002).*Principle and Methods of Business and Computer Education*. Enugu: God Jickson Publisher.

Otuka, J.E. (2006). The Teacher as a Key to National Development and Technological Breakthrough. A Paper Presented at a National Conference Organized by School of Science F.C.E Zaria, Kaduna State $4^{th} – 7^{th}$ April.

Oyetunde, T.O., (2000).*Writing Research Project.* Journal Article and Conference Paper Jos LECAPS Publisher.

Oyedokun, C.A. (1998). The Effects of a Conceptual Change Model on Students Achievement Retention and attitude to Biology Concepts. Unpublished Ph.DThesis, Faculty of Education,Ahmadu Bello University, Zaria.

Rateliff, R. (2006). Comparing Exemplar and Rule Based Theory of Categorization. *Journal of Current Direction In Physiological Science,*15,(9)13-17.

Paul, O.A. & Dantani, Y.S. (2012). Effects of Lecture and Demonstration Method on the Academic Performance of Students in Chemistry in Nasarawa L. G. Area Kano State. *International Journal of Modern Social Science,*1(1), 29 – 37.

Philip, E.O.A (2006). Gender Performance in Physics: A Case Study in Auchi Polytechnics. *Nigerian Journal of Professional Teachers,* 1 (2), 223 – 233.

Piaget, J. (1967). The Development of Thought. Translated by A. Rosin, Oxford Blackwell.

Samba, R. (1998). The Efficacy of Conceptual changings in Instructional Strategy in RemedyingIdentified Misconception on Photosynthesis and Respiration Among SSI Student Unpublished Ph. D thesis, Faculty of Education, Ahmadu Bello University Zaria.

Sambo, S. (2002).An Investigation into Effectives of Brainstorming Technique in for steering ideative Creativity among secondary School in Kaduna state unpublished PhD Thesis, Ahmadu Bello University, Zaria.

Sambo, A. A., (2008). *Research Methods in Education*. Ibadan, Sterling Hordan Publishers (Nig) Limited.

Sanjaye, A (2007). The problem Based Learning Process in Flow Innovations in Education and Teaching International. *Journal of Educational Psychology 47(2) 165-174.*

Satterly, I. (1980) ASSESSMENT IN Schools New York Basic/Black Will INT. 101 – 104.

Soyibo, K. (2007). A Critical Review of Some the Causes of Students Poor Performance in Science in P.A.O., Occebuloieded (Ed)Uchenna Nzewi. Proceeding of Annual Conference of Science Teachers Association of Nigeria, 80 – 85.

Situ, A.O. (2008). Attitude of Male and Female Students Toward Mathematics in Primary Education Studies Department in Colleges of Education. *Journal of Research in Education* 3(1), 31 – 38.

Tambaya, I. S. (2015). Impacts of 5 E-learning Cycle on Attitude, Retention and Performance in Genetics among Pre-NCE Students with Varied Abilities North West Zone, Nigeria. PhD unpublished Faculty of Eduaction, Ahmadu Bello University, Zaria.

Stein, M. (2000). Stimulating Creativity Vol. 1.Individual Procedures, New York Academic Press http/www.education.curtin.edu.cu/waire/forums/2002/tui.htm/

Suleiman, Z. (2015). Effectiveness of Problem Solving and Process Approach on Students Achievement and Retention in Basic Science Concepts in Zaria, Nigeria. Faculty of Education, Unpublished M.Ed Thesis A.B.U. Zaria.

Scocellos, M & Malotide, V (2004). A Hand Book on Methods Used in Environmental Education for Sustainable Development MID ESCOE A Charis.

Scolt, B.E. (2012). The Effectiveness of Differentiated Learning Style in the Elementary Mathematics Classroom. A Dissertation Submitted to the Graduate School Ball State University.

Sekar, P (2013). The Students' Attitude and Reasoning Ability of Biology and Computer Group Students in India. *Journal of Applied Research*, 3(8). 69 – 71.

Tambaya, I. S. (2004). Knowledge of Genetics among Senior Secondary School in Funtua Educational Zone of Katsina State. A seminar paper presented in Science Conference at Isa Kaita College of Education Dutsen ma.

Tsui, C.Y. & Treagust, D.F (2002).Learning Genetics with Multiple External Reposition: Preliminary Finding in a Laptop School *Proceeding of Australia of Western Australian Institute for Educational Research Forum*, 2002.

Tuckman, B.W (1975). Measuring Education outcomes. *Handout Huvawick*, New York.

Timothy, J. (2005). Secondary School Students AttitudeTowards Animal Conservation. ACase Study of Selected Junior Secondary School in Zaria Metropolis, *Nigeria Journal of Science Education Research,*1(2), 27 – 31.

Uche, N. (2002). *How to Approach the Teaching of Difficult Concepts in Biology*. Ibadan: University Press. 62 – 65.

Ugwuanyi, K.U. (1998). Effect of Guided Discovery and Export Tony Methods on Students Performance in Physics in Selected Secondary Schools in Nsukka, Enugu State, Nigeria. *Nigerian Journal of Teacher Education*, 15(1), 107 – 112.

Uhumuavbi, O.O. (2006). Relative Effects of Guided Inquiry and Expository Strategies on Learning Physics Concepts at senior Secondary Schools. *Nigerian Journal of Professional Teachers,* 1(3), 27-33.

Ukwungwu, J.O. (2000). A Comparative Study of the Effectiveness of Three Teaching Method on Students Performance, Interest and Retention in Physics. Unpublished Ph.D Abubakar Tafawa Balewa University, Bauchi.

Ukwunsu, J.O. (2002). Gender Difference Study of Performance in Integrated Science Summary of Studies Conducted in Nigeria. *Journal of Science Teachers Association of Nigeria* (STAN). 37(1&2) 55 – 59.

Ugwuanyi, I.U. (1998). Effects of Guided Discovery and Expository Teaching Methods on Students Performance in Physics in Secondary Schools in NSUKKA, Enugu State Nigeria. *Journal of Technical Education,* 15 (1), 10 – 14.

Umeh, M.O. (2002). Reducing Teacher Instructional Difficulties in Some Content Areas of Senior Secondary School Biology Curriculum for Sustainable Development Proceeding of the *43rd Annual Conference and Inaugural Conference of CASTME Africa.* Heinemann Educational Book, Nigeria 223 – 291.

Usman, I. A. (2000). The Relationship Between Students Performance in Practical Activities and their Academic Performance in Integrated Science, Using NISTEP Mode of Teaching.An Unpublished Ph.D Thesis, Facuklty of Education, Ahmadu Bello University, Zaria.

Usman K.O & Akor – Ebuta, A.P. (2006). Enhancement of Students Performance and Invest for Geometry Using Polya's Problem-Solving Model. *Journal of League of Researchers in Nigeria*, 7 (2 &4).

Viygotsky,L.S. (1997). Thought and language Newly Reversed by Kozulin of Cambridge University.

Wakili, L. A. (2007).The Influence of Guided Discovery Approach on Creative Traits of Integrated Science Student at Junior Secondary School Level. Unpublished M.Ed Thesis Ahmadu Bello University, Zaria.

Watts, D. N. (1991). *The Science of Problem-Solving*. Port-Smith USA:Heinemann Education and Books Inc., 35(2), 132-139.

Wassagu, M.A. (2007).Functional Science Technology and Mathematics Education for National Economic Empowerment and Development. A Lead Paper Presented at a School of Science Conference, F.C.E., Zaria, Kaduna State 2nd – 3rd April.

West Africa Examination Council. (2010). Senior Secondary Certificate Examination, Yaba Lagos Nigeria. Examiner Report.

West Africa Examination Council (2011). Senior Secondary Certificate Examination.

Webster, M. web-dictionary @ psycob .com Retrieval jan. 11th(2010).

Yara, P.O. (2009). Students Towards Mathematics Academy Achievement in Some in Selected Schools in South-West Nigeria. *European Journal of Scientific Research,*36 (3), 336 – 341.

Yusuf, A. (2012). Effects of Integrating Instructional Model with Lecture Methods on Academic Achievements and Retention on Students of Various Class Sizesin Some Biology Concepts. Unpublished M.Ed Thesis. Faculty of Education, Ahmadu Bello University, Zaria.

Zayun, S.D. (2008). Performance Enhancement skills for Teachers of Junior Secondary Schools. ASeminar PaperPresented at Bauchi State SUBEB Workshop 28th – 31st January.

APPENDIX A

Lesson plan for Experimental Group using Problem-solving Teaching Strategy

Lesson I

Class Level: **SS II**

Subject: **(Biology)**

Topic: **Living organism made of a cells**

Time and duration: 8am – 8:45am (45mins)

Instructional Materials: Light microscopes, slides/life specimens of various Organisms such as (a) Euglena (b) Chlamaydomonas, and (d) Paramecium. (e) Amoebadrawing plane sheet, ruler and reference books.

Behavioural Objectives At the end of the lesson, the students should be able to:

(1) Identify the various slides of organisms mounted under the light microscope.

(2) Draw and label the part of the organism.

(3) Name the type of shape passed by the specimen.

(4) Describe the mode of feeding and movement.

Previous Knowledge The students have already been taught about living things

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

a. Define a living things

b. State any three characteristics of living things

Presentation of the lesson:

Step I **Activity I**

The teacher goes on to ask the students to observed the following specimen mounted under the light microscope and give their names:

Step II Draw the diagram of Amoeba and Paramecium

Why do these animals have different shapes?

	Step III	Describe how amoeba moves
Evaluation		Based on the activities carried out; the teacher asks the students to: - Identify the various slide of organisms mounted under the light microscope. - Mention the shape of the amoeba and paramesium. - Describe their mode of feeding and movement.
Conclusion		The teacher highlights the lesson by following student views organisms observed and draw their shape mode of feeding and movement etc.
Home Work		The teacher gives the students the following questions to the answers: What is the difference between Euglena and Paramecium with regard to their structure, mode of feeding and movement. - State one economic importance of Euglena .

Lesson plan for Experimental Group using Problem-solving Teaching Strategy

Lesson II

Class Level: **SS II**

Subject: **(Biology)**

Topic: **Cells**

Time and duration: 8am – 8:45am (45mins)

Instructional Materials: Microscope slides, cover slips, pond water, drawing books, pencils, rulers, diagrams

Behavioural Objectives: At the end of the lesson the students should be able to:

1. Identify two examples of multicellular organisms mode of cells eg. Volvox colony and spirogyra.
2. What are the differences in the types of cells observed?
3. State the differences between the type of cella identified.

Previous knowledge The students have already come across organisms which exist in difference forms of a cell.

Thestudents were asked to carry out the following activities:

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

1. What is a cells?
2. Name two multicellular organisms

Presentation of the Lesson

Step II **Activity II**

Student activity: The students paired off to carry out the activity for the lesson. Answer the question and write out their answers individually on a plane sheet.

- Give the differences between the type of cells observed?

Step III	**Activity III** The students discuss their result by common together and then chose the correct answer to the activity of the lesson conducted.
Evaluation:	The teacher ask the students some questions based in the topic of the lesson: 1. Name any two multicellular organisms made of cell? 2. State the difference between the type of cell of the organism mentioned above 3. What the differences types of cells?
Conclusion:	The teacher highlights the lesson by stating the following points. - A single cell can be a free-livng organism capable of independent existance, eg. amoeba, Euglena, Paramecium,
Home work	Read and make short notes on the structures of each of the following: 1. Volvox. 2. Spirogyra. 3. Hydra.

Lesson plan for Experimental Group using problem-solving Teaching Strategy

Lesson III

Class Level: **SS II**

Subject: **(Biology)**

Topic: **Function of cell in living organism**

Timeand duration: 8am – 8:45am (45mins)

Instructional materials: Light microscope, slide, cover slip, biology text book, pencil, ruler.

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

i. Identify the organelles of cell
ii. State the function of each organelles identified in 1 above
iii. Explain the cell diversity.

Previous Knowledge: Students have known what a cell is and the different types of cells in organisms.

Introduction: The teacher introduces the lesson by asking the students some questions based on the previous lesson eg

1. Mention any two multicellular organism.
2. State any two different types of cells.

Presentation of the lesson

Step 2 students activity

Activity 3

Students pair up to carry out the activity and answer the questions asked on the activity.

1. Iedntify the organells of cell.
2. State the function of the organells. Eg nucleus, cytoplasm, ribosome, plasma etc

3. What is cell great diversity ?
4. State any three function of cell.

Students should present their answers individually on a paper.

Activity III

Step III Students present their answers compare and arrived to a common answers to the solution to the problem.

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

- Identify the organelles of a cell
- State the functions of each organelles identified in 1 above
- What is a cells great diversity?
- Mention any three functions of cell

Conclusion The teacher summarises the lesson as follows:

Nucleus:- It controls all the activities of the cell

Vacoule: - It contains cell sap which act as an osmoregulation by helping to remove excess water in cell

Ribosome:- They are responsible for protein synthesis

Lysosomes:- They are sites for respiratory enzymes

Home work: State the functions of the following:

Cell membrane, centrioles, golgibody

State the functions of cell membrane.

Lesson plan for Experimental Group using problem-solving Teaching Strategy

Lesson IV

Class Level: **SS II**

Subject: **(Biology)**

Topic: **Mitosis**

Time and duration: 8am – 8:45am (45mins)

Instructional Materials: Light microscope, cover slip, plane sheet, ruler, pencil, biology text book

Behavioural Objectives: At the end of the lesson, the students should be able to:

- Define cell division
- Name the main types of cell divisions in a living organism
- Draw a high power magnification of the process of cell division. (Mitosis)

Previous Knowledge: The students have already been taught about functions of each organelle in a cell.

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

1. Identify any two organelles of a cell
2. State any one function of the organelles identified in 1. above

Presentation of the lesson

Step I **Activity 4**

Students come in pairs and to carry out the activity, find answer to the problem and answer the questions. Students write out this

answers individually on paper by answering the questions;

1. How many stages did you observe of mitosis mounted under the light microscope.
2. What are the differences in the stages of mitosis mounted under the light microscope as observed.
3. From what have been observed in activity 1 How many stages did you observe
4. Draw and label the various stage involved

Activity II

Step II

The students discuss their answers and then choose the correct one to the problem given.

Evaluation

The teacher evaluates the lesson by asking the following questions based on the activity of the lesson or topic taught

- Define cell division
- Name the main types of cell division in a living organism
- Draw a high power magnification of the process of cell division. (mitosis)

Conclusion:

The teacher highlights the lesson by explaining the term mitosis as a cell or nucleus division of following duplication of chromosome where each daughter cell has exactly the same number of chromosome as a parent cell. The teacher will also state the stages of mitosis interphase, anaphase, prophase metaphase, telophase.

Home work:

State two important roles of matosis

Lesson plan for Experimental Group using problem-solving Teaching Strategy

Lesson V

Class Level: **SS II**

Subject: **(Biology)**

Topic: **Meiosis**

Time and duration: 8am – 8:45am (45mins)

Instructional Materials: Drawing book, pencil, cardboard paper, pins, ruler biology text book, light microscope, slide of root tip .

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

1. Explain the term meiosis.
2. Draw the various stages of meiosis
3. State the difference in the stages observed.

Previous knowledge The students have already been taught mitosis

Introduction

The teacher introduces the lesson by asking the students some questions based on the previous lesson

1. State the main type of cell division
2. Briefly explain mitosis

Activity 5

Presentation of the lesson

Step I The students paired up to carry out the activity and later report their answers individually on a plain sheet, on the following questions

1. Observe and draw the stages of meiosis as seen under the light microscope
2. How many stages does it have
3. What are the differences in the stage of the meiosis observed.

Discussion

Step II The students come together to discuss their answers and later choose the correct answer to the questions asked in the activity.

Evaluation The teacher evaluates the lesson by asking the following questions based on the activity of the lesson.

1. Define meiosis.
2. Name the various stages of meiosis.
3. State the differences between the stages drwan

Conclusion The teacher highlights the lesson by explaining the term meiosis as

1. A cell division that give rise to gametes and haploid spores, in flowering plant and animal.
2. It occurs only in the productive organs.

The teacher also states the stages of meiosis.

Home work State two important roles of meiosis to living things.

Lesson plan for Experimental Group using problem-solving Teaching Strategy

Lesson VI

Class Level: **SS II**

Subject: **(Biology)**

Topic: **Differences between Mitosis and Meiosis**

Time and duration: 8am – 8:45am (45mins)

Instructional Materials: Plain sheets, slide of root tip and animal cell, ruler, light microscope, biology text book.

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

1. Observe the slide of the animal cell and that of the root tip mounted under the light microscope and draw the various stages involved in both slides.
2. State the diffrences between the stages observed in animal cells and the root tip

Previous knowledge The students been taught Mitosis.

Introduction The teacher introduces the lesson by asking students questions based on their previous knowledge; eg

1. Define the term mitosis and meiosis

2. Mention a stage of mitosis and meiosis

Activity 6

Presentation of the lesson

Step I. Student's activity;

Students carry out the activity in pairs and later report the answer individually after answering the question asked eg

1. What are the stages of both mitosis and meiosis mounted under the light microscope observed
2. From what have been observed so far in activity I, Draw both stages of mitosis and meiosis

Activity II

Step II. Discussion

The students discuss the questions given to them in activity I to choose the correct answers to the problem/question given in the activity

Evaluation:

The teacher evaluates the lesson by asking the following questions based on the topics or the activity of the lesson taught

1. State the stages involved in the Animal cell and the root tip as observed under the light microscope
2. State any differences between the stages observed under then animak cell and the root tip

Conclusion

The teacher highlights the lesson by

1. Stating the staeges involved in the animal cell and the root tip
2. Summaris the differences between mitosis and meiosis.

Mitosis	Meitosis
Mitosis takes place during growth of the body	Takes place in the production of gametes
The number of chromosome parent and new cell are the same	Number of chromosome of new cell is half no of parent cell from offspring cell are found
Two offspring cell are formed	Four offspring cells are formed
Chromosomes are arranged in pairs in both parent and new cell	Chromosome are not arranged
There is no exchange of materials between the chromatids	There is exchange of materials that result in variation

Home work: State two important roles of mitosis.

State two important roles of meiosis

APPENDIX B

Lesson plan for Discovery Teaching Strategy

Lesson I

Class Level: **SS II**

Subject: **(Biology)**

Topic: Living organism made of cells

Time and duration: 8am – 8:45am (45mins)

Instructional Materials: Light microscopes, slides/life specimens of various Organisms eg (a) Euglena (b) Chlamaydomonas, and (d) Paramecium. Pins, Pencils, Drawing plain sheets, ruler and biology reference books.

Behavioural Objectives At the end of the lesson, the students should be able to:

1. Observe and identify the various slide of organisms mounted under the light microscope.
2. Draw and label their parts of the organism observed.
3. Identify the shapes of each organis.
4. Observe and describe their mode of feeding and movement.
5. List the characteristics of living things.

Previous Knowledge: The students were been taught living things.

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

1. Name any 2 organism made of cell studied in the last lesson.
2. Mention the types of shapes shown by these organisms.

Presentation of lesson:

Step I	**Activity I** Students filed into groups and assigned to carry out the Activity as outlined below; 1. Observe the live specimens of amoeba, euglena, paramecium 2. Draw and label the organism observed 3. Identify the shape of each organism drawn 4. Observe and describe the process of movement and feeding in amoeba, euglena and paramecium 5. Report your answer individually on a plane sheet
Step 2	**Activity II** **Discussion** Students come together to compare their answers and then choose the correct to answers to the question asked in the activity
Evaluation	The teacher asks the students some questions based on the topic taught or Activity carried out. 1a. Identify two organisms observed under the light microscope 1b. State the shape of each organism
Conclusion	The teacher highlights the correct answer or main points on the chalk board.
Home work	What are the differences between euglena, paramecium, with regards to their structures. - State one economic importance of euglena.

Lesson plan for Discovery Teaching Strategy

Lesson II

Class Level: **SS II**

Subject: **(Biology)**

Topic: **Cells**

Time and duration: 8am – 8:45am (45mins)

Instructional Materials: Light microscope, slides, ruler, pencil, plain sheets, slides of volvox colony and spirogyra filament.

Behavioural Objectives: At the end of the lesson the students should be able to:

1. Identify two examples of multicellular organisms eg. Volvox colony and spirogyra filament without labelling the structure.
2. Show the different types of cell by using high power under the microscope.
3. What are the differences between the types of cell you identify.

Previous Knowledge: The students have been taught cell as a living unit.

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

1. What is a cell
2. State any 2 organisms made of cells.

Presentation of Lesson

Activity I

Students Activity Step II The students are in groups to carry out the activity as outlined below;

1. Observe and identify the multicellular organism mounted under the light microscope

2. Draw the organisms without labelling the structure.
3. State the differences between the types of cells identified.
4. Write your answers individually on the plain sheet.

Step 3 **Discussion**.

The Students come together to discuss their answers to choose the correct answer to the question asked in the activity.

Evaluation

The teacher askes the students some questions based on the topic of the activity carried out eg.

1. State any 2 multicellular organism made of cells
2. State one difference between the multicellular organism mentioned in one above.

Conclusion:

The teacher summarises the correct answer given by the students on the chalk board for the students to copy in their notes.

Assignment/Home Work

Write short notes on the following volvox, spirogyra, hydra.

Lesson plan for Discovery Teaching Strategy

Lesson III

Class Level: **SS II**

Subject: **(Biology)**

Topic: Function of cell in a living organism

Time and duration: 8am – 8:45am (45mins)

Instructional Materials: Light Microscope, slide, ruler, plane sheet, pencil, biology text book.

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

1. Identify the organelles of a cell
2. Observe the functions of each organelles identified in (1) above.
3. Explain the functions of the following cell membrane, cytoplasm, nucleus.
4. Explain cell diversity in form and function.

Previous Knowledge: The students have been taught about cell as part of living organism.

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

1. Name any 2 multicellular organism
2. State any 2 differenttypes of cells

Presentation of lesson

Step 1. Students Activity **Activity 3**

Student filed into groups to carry out the activity but report their findings individually on a plane sheet. The questions of the activity include from what you have already taught about cell structure.

1. Explain cell membrane and cytoplasm
2. List cell structure that have been observed in a cell structure, draw and label.
3. Identify how the cell membrane look like? Mention the important of a cell membrane.
4. What are the functions of what you observed in cell organelles nucleus, cytoplasm, ribosome, plasma membrane.

Step 2 **Discussion**

Students would regroup and present their individual answers on the activity carried out. The student would go further to discuss the correct answers to the questions asked in the activity.

Evaluation

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

i. Identify the organelles of a cell.
ii. Mention the functions of each cell identified in (1) above.
iii. Explain the functions of the following (a) cell (b) membrane (c) cytoplasm, nucleus.
iv. Explain the great diversity of cell function.

Conclusion:

The teacher summarises the lesson by explaining some functions of organelles, nucleus, rebosome, lysosome, etc.

Assignment/Home work

State the functions of the following: (i) Golgibody (ii) centroles (iii) food vacuole.

Lesson plan for Discovery Teaching Strategy

Lesson IV

Class Level: SS II

Subject: **(Biology)**

Topic: **Mitosis**

Time and duration: 8am – 8:45am (45mins)

Instructional Materials: Light microscope,cover slip, plane sheets, ruler, pencil, biology text book

Behavioural Objectives: At the end of the lesson, the students should be able to:

1. Define cell division
2. Name the main types of cell division in a living organisms.
3. Draw a high power magnification of the process of cell division (mitosis).

Previous knowledge The students have been taught about function of each organelle in a cell.

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

1. Name any 2 organnelles of a cell
2. State any one function of the organelles identified in one above.

Presentation of lesson

Step 1 Students Activity **Activity 4**

The students form groups to carry out the activity and give answers to the following questions.

1. Identify the stage of mitosis mounted under the light microscope.

2. What are the differences in the stage of mitosis mounted under the light microscope?
3. From what you observed in activities II draw the stages of mitosis and labelled the various stages.
4. State the importance role of mitosis.
5. Write your answer individually on a plane sheet.

Step 2 **Discussion**

The Students file in their answers and discuss then choose the correct answers to the questions asked in the activity.

Evaluation

The teacher asks the students to answer these questions:

1. Define cell division
2. Name the main types of cell division
3. Draw under a high power magnifications the process of cell division.

Conclusion

The teacher highlights the lesson by explaining mitosis as a cell or nucleus division of the following duplications of chromosome where each daughter cell has exactly the same number of chromosome as a parent cell. They also state the stages of mitosis interphase, anaphase, metaphase, prophase, telophase.

Home Work:

State two important role of mitosis

Lesson plan for Discovery Teaching Strategy

Lesson V

Class Level: **SS II**

Subject: **(Biology)**

Topic: **Meiosis**

Time and duration: 8am – 8:45am (45mins)

Instructional Materials: Drawing book, Pencil, microscope, slide of root tip, ruler, pins, chart with diagrams.

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

1. Define cell division.
2. Name the main types of cell division in living organisms.
3. Draw a high power magnifications of the process cell division.

Previous knowledge The students have been taught about mitosis.

Introduction The teacher introduces the lesson by asking the studentsthe following questions

1. State the main types of cell division
2. Briefly explain mitosis

Presentation of the lesson

Step 1 Students Activity **Activity 5**

The students form a group to carry out the activity. The student file into their groups and carry out the activity based on the following questions

1. Identify the stages of meiosis mounted under light microscope.

2. How many stages of meiosis did you observe
3. What are the differences in the stages of meiosis mounted under light microscope observed.
4. Draw the different stages and label them fully.
5. State three roles of meiosis
6. Report your answers individually on plain sheet

Step 2

Discussion

The students come together to discuss their answers and later choose the correct one to the question asked in the activity of the topic.

Evaluation:

The teacher evaluates the lesson by asking the following questions.

i. Define meiosis
ii. Name the various stages of meiosis
iii. State the differences between the stages drawn.

Conclusion:

The teacher highlights the lesson by explaining the term meiosis as a cell division that give rise to gametes and haploid spores, in flowering plants and animal it occurs only in the reproductive organs. Then the teacher also states the stages of meiosis.

Home Work

- State two important roles of meiosis to living things.

Lesson plan for Discovery Teaching Strategy

Lesson VI

Class Level: **SS II**

Subject: **(Biology)**

Topic: **Differences between Mitosis and Meiosis**

Time and duration: 8am – 8:45am (45mins)

Instructional Materials: Plain sheet, slide of root tip and animal cell, light microscope, pencil, ruler, biology text book.

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

1. Observe the slide of the animal cell and that of the root tip mounted under light microscope and draw the various stages involved in both slides.
2. State the differences between the stages observed in animal and the root tip

Previous knowledge: The students have already been taught Mitosis and Meiosis
and Meiosis.

Introduction: The teacher introduces the lesson by asking the students these questions.

1. Define the term mitosis

2. Mention a stage of mitosis and meiosis

Presentation of the lesson

Step 1: Students Activity **Activity 6**

Students would carry out the activity in groups while they give answer to the following question

1. Describe what you have observed

2. State five functions of mitosis and meiosis in living organism
3. Write the significance of mitosis and meiosis
4. Report your answer individually in a plain sheet.

Step 2 **Discussion**

The students discuss their answers to the activity carried out. Choose the must correct answers to the questions asked in the activity.

Evaluation: The teacher evaluates the lesson as follows:

1. State the stages involved in the animal cell and root tip as observed under the light microscope.
2. State any 2 differences between the stages observed under the animal cell and the root tip.

Conclusion: The teacher highlights the lesson by

1. Stating the stages involved in the animal cell and root tip.

2. Summarisi the differences between meitosis and meiosis.

Mitosis	**Meiosis**
Mitosis take place during growth of the body	Take place in the production of gametes
The number of chromosome of parent and new cell are the same	Number of chromosome of new cell is half number of the parent cell.
Two offsipring cell are formed	Four offspring cell are formed
There is no exchange of materials between the chromatids	There is exchange of materials that result in variation.

Home work: i. State the two important role of mitosis

ii. State the two important role of meiosis

APPENDIX C

Lesson plan for Control Group

Lesson I

Subject: **Biology**

Topic: **Living organisms made of cells**

Class Level: **SS II**

Time and duration: 8am – 8:45am (45mins)

Instructional Materials: Light Microscope, diagrams, biology text book

Behavioural Objectives: At the end of the lesson, the students should be able to:

1. Identify the various slide of organisms
2. Draw and lbel the organism
3. Name their shapes
4. Describe their mode of feeding and movement

Previous Knowledge: Students were taught about living things.

Introduction: The teacher introduces the lesson by asking the students questions based on the previous knowledge with anthology on a building.

- Describe the term living things
- State the characteristics of living things
- State three differences between living and non living things

Presentations of the Lesson:

Step I The teacher shows the students diagram/chart of Paramecium/ Amoeba, Euglena, Chlamydomonas and explain to them

Step II The teacher draws the diagram of amoeba on the black board and labels the parts

Step III The teacher also explains the various shape of each organism.

Step IV The teacher explains the mode of feeding and movement of the organisms.

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

i. Name the organisms taught in this lesson
ii. State their shapes
iii. Describe their mode of feeding and movement

Conclusion: The teacher summarises the lesson by stating the main points.

Home Work:
- State two differences between amoeba and paramecium
- List one economic importance of amoeba.

Lesson plan for Control Group

Lesson II

Subject:	**Biology**
Topic:	**Cell**
Class Level:	**SS II**
Time:	8am – 8:45am (45mins)

Instructional Materials: Chalkboard, textbooks, charts/diagrams, drawing book

Behavioural Objectives: At the end of the lesson, the students should be able to:

1. Identify two examples of multicellular organism madee of cells eg volvox colony,spirogyra
2. State the differences in the types of cells
3. Mention the differences between the type of cell in the organism

Previous Knowledge: Students were taught about Cell as a living unit.

Introduction: The teacher introduces the lesson by asking the students questions based on the previous knowledge with anthology on a building.

1. Define a cell
2. Name any 2 organisms made of cell
3. State the shape of each organism mentioned in 2 above

Presentations of the Lesson:

Step I	The teacher names the multicellular organism made of cell and writethem on the chalk board eg Spirogyra, etc.
Step II	The teacher draws Spirogyra on the chalkboard and label the parts.
Step III	The teacher states some of the functions of Spirogyra etc.
Step IV	The teacher states the differences between the types of cells and of the organism eg volvox colony and spirogyra.
Evaluation	The teacher evaluates the lesson by asking students the following questions: 1. Name any 2 multicellular organism made of cells 2. What are difference types of cell have study? 3. Describe the structure of each organism 4. State any 2 differences between the organism
Conclusion:	The teacher concludes the lesson by summarising the main points.
Home Work:	Write short note on the following: - Valvox, spirogyra, hydra.

Lesson plan for Control Group

Lesson III

Subject: **Biology**

Topic: **Functions of cell in a living organism.**

Class Level: **SS II**

Time and duration: 8am – 8:45am (45mins)

Instructional Materials: Teaching aids with diagrams

Behavioural Objectives: At the end of the lesson, the students should be able to:

1. Identify the organelles of cell
2. State the function of each organelle eg cytoplasm,nucleus
3. Explain cellgreat diversity

Previous Knowledge: Students were already taught about cell as a part of living organisms.

Introduction: The teacher introduces the lesson by explaining the cell structure and functions unit of life, in other word the cell as the simplest, smallest and basic unit of life.

Presentations of the Lesson:

Step I The teacher indroduces the lesson by drawing the animal cell on the chalk board.

Step II The teacher labels the diagram and explains some of the function of the organelles on the chalk board.

Step III The teacher explains the great diversity of cell to the students.

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

i. Explain the functions of cell membrane.

ii. State the functions of cytoplasm, ribosome, nuclear membrane.

iii. Explain cell great diversity in form and function.

Conclusion: The teacher summarises the lesson by stating some functions of (i) organells (ii) nucleus (iii) ribosome (iv) lysosome.

Home Work: State the functions of the following:

- Golgibody, Centroles, food vacoule.

Lesson plan for Control Group

Lesson IV

Subject: **Biology**

Topic: **Mitosis**

Class Level: **SS II**

Time and duration: 8am – 8:45am (45mins)

Instructional Materials: Light Microscope, diagram, charts, biology text book.

Behavioural Objectives: At the end of the lesson, the students should be able to:

1. Define cell division.
2. State the main types of cell division in a living organism
3. Draw a high power magnification of the process of cell division (Mitosis)

Previous Knowledge: The students have already been taught about function of each organelle in a cell.

Introduction: The teacher introduces the lesson by explaining the term mitosis: Is the process of a cell or nuclear division of the following duplication of the chromosome where by each daughter cell or nuclear has exactly the same chromosome where by each daughter cell or nucleus has exactly the same chromosome as parent or content. Then teacher also state the stages of mitosis as interphase, anaphase, prophase metaphase, telophase.

Presentations of the Lesson:

Step I The teacher writes the stage of mitosis.

Step II The teacher explains the stages of mitosis one after the other.

Step III The teacher draws the stages on the black board.

Step IV The teacher also writes the importance of mitosis.

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

i. Define cell division

ii. State the main types of cell divisions in a living orgainsms.

iii. Draw a light power magnification the process of cell division. (Mitosis).

Conclusion: The teacher concludes the lesson by explaining the term mitosis as a cell or nuclear division of the following duplication of chromosome where each daughter cell has exactly the same number of chromosome as parent or contents and also state the stages of mitosis interphase, anaphase, prophase, metaphase, telophase.

Home Work: - State two importance role of mitosis.

Lesson plan for Control Group

Lesson V

Subject: **Biology**

Topic: **Meiosis**

Class Level: **SS II**

Time and duration: 8am – 8:45am (45mins)

Instructional Materials: Diagram, text books charts

Behavioural Objectives: At the end of the lesson, the students should be able to:

1. Explain the term meiosis
2. Draw the variuos stages of meiosis
3. State the differences in the stages of meiosis

Previous Knowledge: The students were already taught about mitosis.

Introduction: The teacher introduces the lesson by explaining that the cell division are two types mitosis and meiosis we should look at meiosis stages.

Presentations of the Lesson:

Step I The teacher explains the two stages of meosis on the chalk board.

Step II The teacher draws the stages of meiosis on the black board.

Step III The teacher labels the stages of meiosis drawn in stages II.

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

i. Define cell division.
ii. State the main types of cell division.
iii. Draw the stages of process meiosis.

Conclusion: The teacher concludes the lesson by explaining the term meiosis as a cell division that give rise to gamete and haploid spores, in flowering plant and animal, it occurs only on the reproductive organs. Then the teacher will also state the stages of meiosis.

Home Work: - State two important role of meiosis.

Lesson plan for Control Group

Lesson VI

Subject: **Biology**

Topic: **Differences between mitosis and meiosis**

Class Level: **SS II**

Time and duration: 8am – 8:45am (45mins)

Instructional Materials: Diagram, biology text books charts.

Behavioural Objectives: At the end of the lesson, the students should be able to:

1. Draw the various stages of meosis in a root tip and animal cell
2. State the differences between the stages of root tip and animal cell.

Previous Knowledge: The students were already been taught about mitosis and meiosis.

Introduction: The teacher will introduce the lesson by explaining the term mitosis and meiosis.

Presentations of the Lesson:

Step I The teacher explains the stages of mitosis.

Step II The teacher explains the stages of meiosis.

Step III The teacher draws both mitosis and meiosis the stages on the chalk board.

Step IV The teacher states the differences between stages in mitosis and meiosis.

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

i. Describe the differences between two types of cell division.

ii. State each of those differences between them.

Conclusion: The teacher concludes the lesson by summarising the differences between mitosis and meiosis.

S/No	Mitosis	Meiosis
1.	Mitosis takes place during growth of the body	Takes place in the production of gametes
2.	The number of chromosomes of parent and new cell are the same	The number of chromosomes of new cell in half no of parent cell
3.	Two offspring well cell are found	Four offspring well cell are found
4.	There is no exchange of materials between the chromatids	There is exchange of materials that result in variation

APPENDIX D

Department of Science Education,
Faculty of Education,
A.B.U Zaria.
21st Dec. 2012.

The Director,

Zaria Zonal Inspectorate Division,
Ministry of Education,
Kaduna State.
Sir,

REQUEST FOR PERMISSION TO VISIT SOME SCHOOLS TO GET DATA FOR MY RESEARCH

I write to apply for permission to visit some Secondary Schools under your division in order to get data for my research. The natures of the information are:

1. Population of science students in the selected schools.
2. To use two (mixed) schools for administration of the research instrument.
3. Two other (unisex) schools will be used for the experimental method, where I will interact with the students for a short-time teaching.

Attached here is the list of the some Secondary School for this regard.

Thanks for your usual co-operation.

Yours faithfully,

Mahmud A.

PhD/Educ/531/11-12

APPENDIX E

Dept. of Science Education,

Faculty of Education,

A.B.U Zaria.

21st Dec. 2012.

The Lecturer,

Dept. of Biological Science,

Faculty of Science

A.B.U Zaria.

Dear Sir,

VALIDATION OF A RESEARCH INSTRUMENT

I have developed a research instrument designed to generate data for my PhD thesis on Genetic concepts at Senior Secondary School level. The instrument titled Genetic Performance Test (GPT) Students Attitudes in Genetics Questionnaire (SAGQ). The draft of the instrument is enlisted here with. As a specialist in Biology and Research Methodology, I would like you to kindly examine the items with reference to the following:

1. Would these items test what they are meant to test?
2. What general criticisms and suggestions could you give to improve the instrument?

I very much appreciate your assistance.

Thanks.

Yours sincerely,

Mahmud A.
PhD/Educ/531/11-12

APPENDIX F

GENETICS PERFORMANCE TEST

Instructions: Please Tick [ ] the option chosen on your answer sheet. Time: 1½hrs

Sex: …….

School:..……..

1. A cell that is not dividing is described as a cell at rest. It is said to be at the stage of

(a) Prophase (b) Metaphase (c) Anaphase (d) Interphase

2. At the end of mitosis, the number of chromosome in the cell is described as

(a) Diploid (b) Haploid (c) Polyloid (d) Triploid

3. At the end of the second meiotic division, the number of daughter cells formed are:

(a) **2** (b) 4 (c) 8 (d) 1

4. Which of the following organelles is not common to plant and animal cell?

(a) Cell wall (b) Cytoplasm (c) Mitochondria (d) Golgi bodies

5. In a cell undergoing mitotic division, all of the following are happening except

(a) Nucleus enlarges nuclear membrane disappears.

(b) Chromatins becomes more visible with spindles showing

(c) Cytoplasmic content is visible and each chromatid moves in to the cytoplasm

(d) Centromere divides into two each moving to opposite ends of the poles.

6. In a living cell factors which are responsible for inheritance are located

(a) On the nuclear membrane

(b) In the nucleus

(c) On the chromosome

(d) In the nucleoplasm

7. The basis of growth involves the following processes except

(a) Cell reduction (b) Cell division (c) Cell differentiation (d) Cell enlargement

8. The cell membrane consists of

(a) Carbohydrate and Lipids (b) Vitamin and Protein (c) Lipids and Protein (d) Starch and cellulose

9. How many chromosomes are found in the human ovum?

(a) 23 (b) 40 (c) 13 (d) 33

10. In which of the following is the precise location of the gene?

(a) Chromosome (b) Centrosome (c) Centriole (d) endoplasmic reticulum

11. Which of the following is not likely to be in the cell of a ripe tomato fruit?

(a) Plastid (b) Mitochondrion (c) Chlorophyll (d) Mineral salts.

12. When a zygote of an organism continues to grow, it produces new cells by

(a) Meiosis (b) Crossing over (c) Gestation (d) Mitosis

13. The protoplasm consist ofcytoplasm and nucleus

(a) Vacuole (b) Cytoplasm (c) Cell wall (d) Cell sap

14. A cell is ----------

(a) The structural and functional unit of life

(b) The smallest unit of matter

(c) Made up of a living material called the protoplasm

(d) It is the building block of living organism

15. The first formal description of cell structure was by

(a) Robert Hooke in 1665

(b) TheodokeShwann 1839

(c) Rudoif Von Virchow 1858

(d) Aristotle 322Bc

16. The theory of spontaneous generation was destroyed by Louis Pasteur when he

(a) Demonstrated that heating would kill microbes

(b) Demonstrated that when sterile substance are protected from air, no microbes appear in the substance

(c) Demonstrated the processes of pasteurization

(d) All of the above

17. The bacteria cell differs from eukaryotic cell by having number

(a) Cell wall (b) nuclear membrane (c) nuclear material (d) Cell membrane

18. How many chromosomes will be present in a gamete if the somatic cell has eight (8) chromosome

(a) 4 (b) 6 (c) 8 (d) 16

19. At the end of the second meiotic telaphase in meiosis number of daughter cell are formed

(a) 2 (b)4 (c) 8 (d) 1

20. The part of the cell responsible for carrying hereditary materials is.

(a) Ribosome (b) Nucleus (c) Nuclear membrane (c) Cytoplasm

21. Hereditary characteristic are passed from parent to offspring through the

(a) Chromosome (b) Nucleus (c) RNA (d) DNA

22. A bacteria cell differs from eukaryotic cell having no

(a) Cell wall (b) Nuclear material (c) Nuclear membrane (d) Cell membrane

23. In a cell undergoing mitotic division all of the following are happening except?

(a) Nuclear enlarges nuclear membrane disappear.

(b) Chromatin becomes more visible with spindles showing.

(c) Cytoplasmic content is visible and each chromosatin moves into the cytoplasm.

(d) Centromere divides into two each movig opposite ends of the poles.

24. The cell division which is responsible for growth is

(a) Meiosis

(b) Binary fission

(c) Fragmentation

(d) Mitosis

25. An organism with two sets of chromosomes is said to

(a) Polypoid

(b) Diploid

(c) Haploid

(d) Hybrid

26. Which of the following is not likely to be in cell of a ripe tomato fruits

(a) Plastid

(b) Mitochondrion

(c) Chlorophyll

(d) Mineral salt

27. When the zygote of an organism continuous to growth, it produces new cells by ……

(a) Meiosis

(b) Crossing over

(c) Gestation

(d) Mitosis

28. The protoplasm of a living cell is made up of ……..

(a) Vacuole

(b) Cytoplasm

(c) Cell wall

(d) Cell sap

29. Mitochondria. It is describe as the power house of the cell

True/False

30. RNA identifies and assembles amino acid during protein synthesis True/False

31. Nucleic acid is the chemical basis of inheritance. True/False

32. There are two types of cell division. True/False

33. All living organisms are made of cell. True/False

34. All cells come from previously existing cell. True/False

35. Nucleus contains the DNA which store genetic traits. True/False

36. Ribosomes are sites for respiratory enzymes. True/False

37. Lysosomes are responsible for protein synthesis. True/False

38. Growth development or specialization takes place as a result of mitosis. True/False

39. Meiosis is a two successive cell division with only one duplication of DNA. True/False

40. Mitosis ensures exact copy of DNA. True/False

41. The term organelle is described as that sub-cellular unit which performs a specific job.

True/False

42. Mention two types of cell division. _____ and _____

43. The function of Nucleus _____

44. The function of cell wall _____

45. Mitochondria serve as _____

MAKING SCHEMES

1. D
2. A
3. B
4. A
5. C
6. C
7. A
8. C
9. A
10. A
11. B
12. D
13. B
14. A
15. C
16. D
17. B
18. A
19. B
20. B
21. A
22. C
23. C
24. C
25. B
26. B
27. D
28. C
29. True
30. True
31. True
32. True
33. True
34. True
35. False
36. False
37. False
38. True
39. True
40. True
41. True
42. Mitosis and Meiosis
43. It controls all activities of the cell
44. It provides protection and shape, mechanical support of the cell
45. It is the power house of the cell.

Total = 1mark x 45 = 45 mark

APPENDIX G

Department of Science Education
Faculty of Education
A.B.U Zaria

Student Attitude to Genetic Questionnaire

Section A Respondents Bio data:

Name of the school:…….

Gender: Male [ ] Female [ ]

Section B Please tick appropriate column using the following keys as: SA = Strongly agree, A = Agree, U = Undecided, D = Disagree and SD = Strongly Disagree respectively.

S/N	ITEMS	SA	A	U	D	SD
1.	I don't like Genetics concepts because they difficult to understand by me.					
2.	Poor performance in Genetic among Biology students at SSCE is because of its abstract nature.					
3.	I fear coming to Genetic class.					
4.	Genetics is easy for my understand					
5.	Genetics is enough to make me have self-reliant.					
6.	I study Biology because I know how useful it is					
7.	Study of Genetics helps me to know traits are transferred from parents to offspring.					
8.	I don't think I will need Biology for my future career because my teacher had never allowed me to understand genetics concepts.					
9.	I'm sure that I can learn genetics easily similar to 4 and 6.					
10.	My teacher has been interested in my progress more especially in genetics.					
11.	I find genetics difficult					
12.	I don't think I could read genetics at higher institution.					
13.	I cannot do well in genetics					
14.	I feel that Biology teachers ignore me when I try to talk about genetics concepts.					
15.	I can get good grades in Biology, if study genetics very well.					
16.	I'm good in genetics.					

17.	Femalescan do just as well as makes in Biology.					
18.	Biology is not important for my life.					
19.	I will get good grade in genetics if I am taught well.					
20.	I am afraid to study genetics.					
21.	Biology has been my worst subject because of genetics.					
22.	My teachers think I am the kind of person who would do well in Biology.					
23.	I have difficulty understanding the words and expressions used in genetics.					
24.	I often find Biology teachers' instruction difficult to follow when teaching genetic concepts.					
25.	The teaching strategy helped me to be more active in class.					
26.	There is too much to do in Biology and this is compounded by genetics.					
27.	Genetic topics make the lesson boring to me					

APPENDIX H

ITEMS FACILITY INDEX (FI) AND DIFFICULTY INDEX FOR GENETIC PERFORMANCE TEST

ITEMS	KEY	RU	RL	$F = \frac{RU + RL}{N}$	$D = \frac{RU + RL}{\frac{1}{2}N}$
1	26	27	21	0.68	1.05
2	18	28	22	0.70	1.10
3	20	20	23	0.50	1.15
4	29	29	21	0.73	1.05
5	24	24	20	0.60	1.01
6	26	25	19	0.63	0.95
7	22	22	24	0.55	1.20
8	23	23	22	0.57	1.10
9	21	27	21	0.68	1.05
10	27	28	20	0.70	1.00
11	26	30	21	0.75	1.05
12	28	32	19	0.80	0.45
13	24	33	22	0.57	1.10
14	28	28	21	0.83	1.05
15	25	29	23	0.73	1.15
16	29	30	20	0.75	1.00
17	30	29	22	0.73	1.10
18	26	27	22	0.68	1.10
19	28	25	20	0.63	1.00
20	26	27	21	0.68	1.05
21	27	28	22	0.70	1.10
22	26	27	20	0.68	1.00
23	19	30	21	0.75	1.05
24	16	29	23	0.73	1.15
25	17	28	21	0.70	1.05
26	29	29	22	0.73	1.10
27	28	30	21	0.75	1.05
28	26	26	18	0.65	0.90
29	27	27	20	0.68	1.00
30	23	24	19	0.58	0.95
31	25	25	17	0.63	0.85
32	27	27	23	0.68	1.15
33	30	30	22	0.75	1.10
34	29	31	20	0.78	1.00
35	31	28	21	0.70	1.05
36	28	29	23	0.73	1.15
37	27	27	21	0.68	1.05
38	29	29	21	0.73	1.10
39	20	20	23	0.50	1.15
40	22	22	21	0.55	1.05