

**EFFECTS OF PRE-INSTRUCTIONAL WORD-CLEARING AND
MATHEMATICS PRE-TEACHING ON SENIOR SCHOOL STUDENTS'
ACHIEVEMENT IN GENETICS IN ILORIN METROPOLIS, NIGERIA**

Ph.D. ORAL DEFENCE

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CERTIFICATION

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DEDICATION

I dedicate this research work to Almighty Allah, the beneficent and the most merciful and my Father Alhaji Gbigbadua Buhari Abdulraheem.

ACKNOWLEDGEMENTS

Glory is to Almighty Allah for His mercy and grace towards the completion of this research project. I thank Allah for sparing my life and giving me the opportunity and wisdom which had helped me throughout my stay on this programme.

I sincerely express my profound gratitude to my supervisor, Dr. G. Bello, and my internal-external supervisor, Prof. A. A. Adegoke, for their constructive criticisms, suggestions, and corrections while reading through the manuscript. May God continue to bless you all (Ameen). My special appreciation goes to my former supervisor, Prof. I. O. Abimbola, who thoroughly tutored me right from my undergraduate days through my master's degree and up to the Ph.D. level. Thank you, sir, I will forever be grateful to you.

I am equally grateful to the Head of the Department of Science Education, Dr. A. O. Akanbi, and to all lecturers in the Department of Science Education, University of Ilorin, Ilorin for their constructive criticisms, suggestions, and corrections. I sincerely want to appreciate Prof. A. S. Olorundare; Prof. Esther O. Omosewo; Prof. Medinat F. Salman; Dr. Mulkah A. Ahmed; Dr. M. A. Akanmu; Dr. Khadijah S. Ameen; Dr. K. O. Afolabi; Dr. J. E. Upahi; Dr. R. Mohammed; Dr. Hafusat I. Alabi; Mr. S. B Jimoh; Dr. Florence O. Abidoye; Mrs Saidat M. Adeniji; Dr. Aduke R. Ahmed; Mrs Bashirat T. Imam; Mr. S. B. Shuaib; Mr. S. A. Adesanya; Mr. M. M. Sulaiman; Mr. O. T. Badmus and Mrs Yusuf

My special appreciation goes to my loving father, Alhaji Gbigbadua Buhari T. my Mother, Alhaja Afusat A. Gbigbadua. Thank you for being my parents, I would forever be grateful for your moral and financial support all through my life. My appreciation also goes to Prof. Medinat F. Salman who despite her tight schedule tutored, encouraged and gave me motherly supports which help greatly towards the completion of this research. Thank you ma, Allah continues to bless you. I also appreciate the principal and Biology Teachers of the schools where this study was carried out for their support and cooperation.

To my darling wife, Ashiat Adenike Gbigbadua. my Boys, Mohammed Buhari, Abdulquyum Olayimika and Ridwanllah Kayode Gbigbadua. Thank you for your understanding and prayers. To my Siblings Hajia Memunat A. Bushari, Engineer Abdulazeez Gbigbadua, Engineer Ahmed Gbigbadua, Usthman Oladimeji Gbigbadua for their prayers and moral support. My sincere appreciation also goes to my Mother-in-law Mrs. Saadat Abdulkadir, also grateful to Dr. S. Ottan, Dr. Mohammed Lawal, Mrs. Bashirat T. Imam Mr. M. M. Sulaiman, Mrs. Gbadamosi, Ahamatullahi, Sheik Abdulrazaq Attani, Mallam Nurudeen Adebisi, and Mr. Badmos their encouragements, prayers and support all through this challenging race.

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ABSTRACT

Genetics, the study of heredity unifies all the sub-disciplines of Bio-Sciences. Literature is replete with evidence that it is a hard-to-teach and hard-to-learn Biology topic. Advance organizers strategies had been widely reported to be effective in teaching and learning difficult topics but this needs further verification in relation to pre-instructional word clearing and mathematics pre-teaching. Therefore, the study investigated the effects of pre-instructional word-clearing and mathematics pre-teaching on senior school students' achievement in genetics. The objective of the study were to determine the: (i) effects of pre-instructional word-clearing on students' achievement in genetics; (ii) effects of the use of mathematics pre-teaching on students' achievement in genetics; (iii) difference in the achievement of students based on gender when taught genetics with pre-instructional word-clearing; (iv) difference in the achievement of students based on gender when taught genetics with mathematics pre-teaching of genetics; (v) difference in students' achievement based on study habits when taught genetics using pre-instructional word-clearing; and (vii) difference in students' achievement based on study habits when taught genetics using mathematics pre-teaching.

The study adopted a quasi-experimental design involving pre-test, post-test control groups with a 3 x 2 x 2 x 3 matrix. The target population was all senior school III students offering Biology in Ilorin metropolis. Purposive sampling technique was employed to select three co-educational schools. The sample consisted of 172 senior school III students from three intact classes. The instruments used were the Genetics Achievement Test (GAT) and an adapted Questionnaire on Biology Students' Study Habits (QBSSH). The reliability coefficient of GAT and QBSSH were 0.98 and 0.83 respectively. Hypotheses were tested using the *t*-test and Analysis of Covariance (ANCOVA) at 0.05 level of significance.

The findings of the study were that:

- i. a significant difference exists in the achievement of students taught genetics using pre-instructional word-clearing and those taught with conventional strategy in favour of those taught with pre-instructional word-clearing ($t_{(118)}=3.38$; $p<0.05$);
- ii. a significant difference exists in the achievement of students taught genetics using mathematics pre-teaching and those taught with the conventional strategy in favour of those taught with mathematics pre-teaching ($t_{(120)}=-0.99$; $p<0.05$);

- iii. there was no significant difference in the achievement of male and female students taught genetics using pre-instructional word-clearing;
- iv. there was no significant difference in the achievement of male and female students taught genetics using mathematics pre-teaching;
- v. there was a significant difference in the achievement of students with positive and negative study habits when taught genetics using pre-instructional word-clearing in favour of students with positive study habits ($t_{(50)} = -10.96$; $p < 0.05$); and
- vi. a significant difference exists in the achievement of students with positive and negative study habits when taught genetics using mathematics pre-teaching in favour of students with positive study habits ($t_{(48)} = -8.98$; $p < 0.05$).

The study concluded that the use of pre-instructional word-clearing and mathematics pre-teaching enhanced students' achievement in genetics. This implies that these strategies enhance meaningful learning of difficult concepts in Genetics. The study recommended that Biology students and teachers should clarify the genetics terminologies and review the mathematics concepts related to genetics concepts prior to instruction to boost students' Achievement.

CHAPTER ONE

INTRODUCTION

Background to the Problem

The level of scientific attainment of any nation is an important key for measuring its level of development. This is why every nation should pay adequate attention to the teaching and learning of science. Science has been defined in many diverse ways by many researchers in the field of Education. For instance, Abimbola (2013) defined science as a body of knowledge, a way or method of investigating and a way of thinking in the pursuit of an understanding of nature. Olorundare (2014) viewed “science as a multidisciplinary human activity which involves a planned systemic investigation and understanding of the world, nature and the universe” (p. 7). Science is a field of study that utilises the process of observing and experimenting to discover and describe the world around us (www.vocabulary.com/dictionary/science). It can be deduced from the above definitions that science is an integral field of study which seeks to understand the natural phenomenon through a systematic procedure.

Science is categorized into three broad areas: the earth science, physical science, and life science. The earth science is a branch of science that deals with the physical constitution of the earth and its atmosphere. This branch of science consists of sub-disciplines such as climatology, glaciology, and hydrology, among others. The physical science is another branch of science which deals

with the study of inanimate natural objects. This branch of science consists of sub-disciplines such as Physics, Chemistry, Astronomy, e.t.c. Life science is a branch of science that deals with the scientific study of life and organisms. This branch of science consists of sub-disciplines such as biology, botany, microbiology, and so on (Himesh, 2019).

Biology is a branch of science that deals with the study of living things. It deals with the existence, structure, function, and relationship of living organisms with their environment (William, 2015). Biology is defined as a science subject that is concerned with the study of living organisms including their growth, structure, functions, distribution, taxonomy and evolutionary trends.

Biology is divided into two major fields which are functional biology and historical biology. Functional biology is a division of biology that deals with all the physiological processes in living things and does not require knowledge of history for its explanation. Historical Biology, on the other hand, provides a sound knowledge of history and explanation needed in all aspects of the living world; this aspect is also known as evolutionary biology (Bello, 2017).

As a school subject, biology occupies a very unique position in the secondary school curriculum. The major aim of the Biology Curriculum is to provide a biology-related learning experience for students to develop science literacy in order that they can participate actively in a rapidly changing knowledge-based society, prepare for further studies or career in the fields

related to life science and become life-long learners in science and technology (Abimbola, 2017).

The knowledge of biology in secondary schools is significant by allowing the students to know the major differences that exist among living beings. Such knowledge helps learners to have a better understanding of themselves. Bello, Ahmed, Alabi, Bello, and Bello (2016) submitted that without the study of Biology, epidemic diseases caused by viruses and bacteria such as Lassa fever, Zika fever, Ebola, Bubonic plague and HIV/AIDS could have wiped out humankind. The study of biology also enhanced the growth of some industries such as silk, pearl, fishing, apiculture and so forth; it has also assisted in the production of pest and diseases-resistant varieties of plants and animals, thereby improving agricultural practices (Abimbola, 2017). Therefore, the impact of Biology and its importance on the life of every society and individual globally cannot be compared with other science subjects.

The foregoing has stressed the relevance of Biology knowledge to individuals and society at large. The Federal Government of Nigeria (FGN, 2013) in the National Policy on Education regards Biology as an elective subject restricted to science students only, and it is no longer a core subject. This would be of great disadvantage to the students as well as the society in general as this may lead to a reduction in life science literacy among school-age adolescents.

The new Biology curriculum according to the Nigerian Educational Research and Development Council (NERDC, 2013), consists of four themes, which are: organization of life; organisms at work; organisms and their environment; and, continuity of life. Genetics, a topic in Biology, is subsumed under theme four (4) “continuity of life”. It is a branch of biology concerned with the study of inheritance, characters and related phenomena (Abimbola, 2017).

Genetics is one of the fields of Biology which basically deals with the study of genes, genetic variation, and heredity in living organisms. Knowledge of genetics enables students to learn about genes and their mode of transmission from generation to generation. Such knowledge helps students to understand problems of genetic nature rather than relying on superstition and other mystical explanations. Also, students learn accurate scientific ways of explaining the genetic defects that may be found in their families and communities (Paul, 2018).

Genetics is regarded as an important topic in the Nigerian Secondary School Biology (SS III) curriculum. This is why global collaboration on the human genome project emphasized the need for the international community to place a premium on the teaching and learning of Genetics in secondary schools. Among the primary objective of the human genome project is the analysis of human genes in which mutation will lead to disease. The recommendations

from the human genome project could promote advances in prevention, diagnosis, and provision of therapy of genetic disorders (Ishaku, 2015).

Despite the importance of Genetics, it is considered to be one of the most difficult Biology topics to teach and to learn by teachers and students in many parts of the world (Chifwa, 2015). It is noted that students have a lot of misconceptions about genetics terminologies act as barriers to the understanding the topic. Also, the concept of genetics has many interrelated ideas and facts. Thus, for students to achieve a meaningful understanding of genetics they must actually relate the ideas and facts that make up the concept while teachers endeavor to use relevant teaching methods (Paul, 2018). Moreover, the West African Examinations Council Chief Examiners' Report (WAEC, 2010, 2011, 2013, 2014, 2015 & 2016) revealed that candidates showed a poor understanding of concepts of genetics; that majority of candidates did not attempt questions raised on genetics concepts, and those who attempted the questions performed poorly.

To this end, factors such as poor mathematical knowledge and too many terminologies were considered to influence students' understanding of genetics (Haambokoma, 2007). Adelana (2018) posited that lack of practical activities, lack of learning resources, discouragement from the teachers, students' negative attitudes, schedule of the topic in the curriculum, unfriendly teachers' teaching methods, among others was identified to have contributed to learning difficulties in genetics.

Danjuma (2015) noted that for any meaningful learning and teaching to take place, there should be suitable means of presenting content to learners at all levels of education. The strategies of presenting the content to learners depend on familiarity with the basic principle of effective teaching methods in science. Thus, in a way to improve the performance of students in genetics, there is the need for a shift from traditional teaching strategies to innovative teaching strategies that would strengthen the teaching of genetics and facilitate proper understanding of the concepts therein and Biology in general. Therefore, using innovative strategies like pre-instructional word-clearing and mathematics pre-teaching may be appropriate.

Pre-instructional Word-Clearing is a system of backtracking which can be done with a student with other students or by a professional word-clearer on a student. L. Ron Hubbard is an American author, the postulator of an innovative method of study called study technology noted that a misunderstood word will remain misunderstood until one clears the meaning of the word. Once the word is clearly understood by the students, it is said to be cleared. The step taken to locate and clear up words that students misunderstood is called Word-Clearing (Hubbard, 1998).

Abimbola (2015) itemized the following as the main steps involved in clearing any word or symbol;

1. The learner needs to search for the misunderstood word from the earlier part of the reading material;

2. The students now look up the word in a standard dictionary;
3. Quickly read through all the definitions and find the one that fits;
4. Read out the definitions that fit;
5. Make several sentences with the definition until a proper understanding of the meaning of the word is achieved;
6. Learn each of the remaining definitions of the same word the same way;
7. The learner re-reads the passage from where the earliest misunderstood word was found;
8. At this stage, reading should normally proceed well if all the misunderstood words had been identified; if otherwise, other misunderstood words are searched and cleared using a standard dictionary (Abimbola, 2015).

As a remedy to misunderstood word, Pre-instructional Word-Clearing Strategy is considered in this present study as a method of finding terminologies that were misunderstood by students in the genetics concept. Aside from misunderstood words, Haambokoma (2007) identified poor mathematical knowledge as one of the factors that influence students' performance in genetics.

Mathematics Pre-teaching of genetics refers to an act of pre-teaching of the mathematics aspect of genetics earlier before the actual teaching of the main content of genetics to students. This strategy will provide a prerequisite knowledge that would assist students to understand the concepts perceived

difficult to comprehend. Pre-teaching, according to Autism Hub (2017), involves teaching students concepts or skills prior to a lesson. It requires explaining new vocabulary or new mathematical concepts prior to actual teaching. To this end, the functional role of mathematics in teaching genetics is enormous.

Adigun, onihunwa, Irunokhai, Sada, and Adesina (2015) reported that gender is a factor that has a considerable effect on the teaching and learning of science. It is the range of physical, biological, mental and behavioral characteristics pertaining to being a male or female. Several types of research have been conducted on whether or not gender influences the academic achievement of students in Biology. Abdulkadir (2011), Gbigbadua, Ahmed and Abimbola (2014), and Umoke and Nwafor (2014) found there was no significant difference in the achievements of male and female students in biology. Conversely, Nwagbo and Okoro's (2014) study revealed that the average scores for boys were higher than that of girls in Biology achievement tests based on students' interest due to interaction patterns. The study concluded that gender was a significant factor for students' achievement in Biology.

Score levels have been considered to be one of the factors that can influence students' achievement in Science. Akanmu (2013) conducted a study on the effects of guided-discovery learning on senior school students' cognitive styles and performance in mathematics. It was revealed that students classified as high scorers benefited most, followed by medium scorers while the low scorers

benefited the least when they were taught mathematics using a guided-discovery teaching strategy. However, a study conducted by Gbigbadua (2014) on the effects of pre-instructional word-clearing strategy on the achievement of senior secondary school Biology students revealed a significant difference in the achievement of high, medium and low scorers in favour of low and medium scorers. This implies that high scorers benefited the least.

Mendezabal (2013) noted that academic performance is affected by non-cognitive factors which include study skills, study motivations, study behaviours, study habits and attitudes. Student's study habit is one of the intervening variables explored in this study, and this is considered because it is an important aspect of the learning process. Mahwish, Naima, Hira, and Wajiha (2017) described study habits as of carving out a dedicated scheduled and continuous-time to apply one's self to the task of learning. Studies have been carried out by researchers on the influence of study habits on students' performance in biology. Ebele and Olofu (2017) carried out a study on study habits and their impacts on secondary school student's academic performance in Biology. The study shows that there was a significant relationship between study habits and students' academic performance. Also, Nateiyin and Moses (2018) revealed in their research on study habits and students' achievement in science among secondary that students have good study habits but without a good corresponding achievement in science subjects.

Statement of the Problem

Genetics is one of the fields of Biology that deals with the study of genes, genetic variation, and heredity in living organisms. Genetics provides conceptual threads across all fields of biological sciences. Studies have indicated that it is one of the concepts that is perceived hard-to-teach and hard-to-learn for teachers and students, respectively (Paul, 2018; Chifwa, 2015). These difficulties could hinder meaningful learning and encourage rote learning of the concept. Reports from the West African Examinations Council Chief Examiners' Reports (WAEC, 2015, 2016, 2017, 2018 and 2019) also indicated that students performed very poorly in genetics questions.

Several attempts have been made by researchers (Paul, 2018; Alabi, 2016; Busari, 2014; Manda, 2012) through studies employing different strategies to provide solutions to students' difficulties in learning genetics and improving the performance of students in Biology. For instance, Paul (2018) carried out research on dealing with Biology students' fear of genetics using a Computer Assisted Instructional Strategy. Furthermore, as Alabi (2016) investigated the comparative effects of text structures on students' achievement in genetics among senior secondary biology students in Ilorin, Nigeria, Busari (2014) examined the effect of pre-teaching the mathematical components of genetics on students' achievement in Oyo, Nigeria. Beside, Manda (2012) studied the nature and causes of learning difficulties students experienced in Biology in high school.

Interestingly, the findings and efforts of these researchers indicated that the achievement of students in genetics aspects has improved, but students' performance on this aspect of Biology is still not encouraging. Therefore, there is still the need to explore innovative teaching strategies that could help to further strengthen the teaching and learning of genetics concepts in order to improve students' performance in genetics. Therefore, the present study examined the effect of pre-instructional word-clearing and mathematics pre-teaching on senior school students' achievement in genetics. More so, the variables considered in the present study were not adequately reported in the early researches. For instance, none of these aforementioned researchers actually compared the effect of pre-instructional word-clearing and mathematics pre-teaching on the teaching and learning of genetics concepts with special focuses on the influence of gender, score levels, and study habits.

Purpose of the Study

The main purpose of this study was to investigate the effects of pre-instructional word-clearing and mathematics pre-teaching on senior school students' achievement in genetics. Specifically, the study examined the:

1. effect of pre-instructional word-clearing strategy on senior secondary school students' achievement in genetics;
2. effect of the use of mathematics pre-teaching genetics on senior secondary school students' achievement in genetics;

3. difference in the achievement of male and female senior school students when taught genetics with pre-instructional word-clearing strategy;
4. difference in the achievement of male and female senior school Biology students when taught genetics with mathematics pre-teaching of genetics;
5. difference in the achievement of high, medium and low scoring students when taught genetics using pre-instructional word-clearing strategy;
6. difference in the achievement of high, medium and low scoring students when taught genetics using mathematics pre-teaching strategy;
7. difference in students' achievement based on study habits when taught genetics using pre-instructional word-clearing strategy;
8. difference in students' achievement based on study habits when taught genetics using mathematics pre-teaching strategy;
9. interaction effects of treatments and gender on senior school students' achievement in genetics.
10. interaction effects of treatments and score levels on senior school students' achievement in genetics.
11. Interaction effects of treatments and study habits on senior school students' achievement in genetics.

Research Questions

On the basis of the purposes raised above, the following research questions were raised and answered in this study.

1. What effects does the use of the pre-instructional word-clearing strategy have on senior secondary school students' achievement in genetics?
2. What effect does the use of mathematics pre-teaching strategy have on students' achievement in genetics?
3. Do male and female students achieve differently when taught genetics using the pre-instructional word-clearing strategy?
4. Do male and female students achieve differently when taught genetics using mathematics pre-teaching strategy?
5. Does the achievement of students with different score levels differ when taught genetics using the pre-instructional word-clearing strategy?
6. Does the achievement of students with different score levels differ when taught genetics using mathematics pre-teaching strategy?
7. Does the achievement of students differ based on study habits when taught genetics using the pre-instructional word-clearing strategy?
8. Does the achievement of students differ based on study habits when taught genetics using mathematics pre-teaching strategy?
9. Will there be any interaction effects of treatments and gender on senior school students' achievement when taught genetics?

10. Will there be any interaction effects of treatments and score levels on students' achievement when taught genetics?
11. Will there be any interaction effects of treatments and study habits on students' achievement when taught genetics?

Research Hypotheses

The following null hypotheses were tested in this study:

H₀₁: There is no statistically significant difference in the achievement of students taught genetics using pre-instructional word-clearing and those taught with conventional strategy.

H₀₂: There is no statistically significant difference in the achievement of students taught genetics using mathematics pre-teaching and those taught with conventional strategy.

H₀₃: There is no statistically significant difference in the achievement of male and female students taught genetics using pre-instructional word-clearing strategy.

H₀₄: There is no statistically significant difference in the achievement of male and female students taught genetics using pre-teaching mathematics strategy.

H₀₅: There is no statistically significant difference in the achievement of high, medium and low scoring students taught genetics using pre-instructional word-clearing strategy.

H₀₆: There is no statistically significant difference in the achievement of high, medium and low scoring students taught genetics using mathematics pre-teaching strategy.

H₀₇: There is no statistically significant difference in the achievement of students based on study habits when taught genetics using a pre-instructional word-clearing strategy.

H₀₈: There is no statistically significant differences in the achievements of students based on study habits when taught genetics using mathematics pre-teaching strategy.

H₀₉: There is no statistically significant interaction effects of treatments and gender on students' achievement when taught genetics.

H₀₁₀: There is no statistically significant interaction effects of treatments and score levels on students' achievement when taught genetics.

H₀₁₁: There is no statistically significant interaction effects of treatments and study habits on students' achievement when taught genetics.

Scope of the Study

This study was conducted in Ilorin, Nigeria; it was limited to all the senior secondary schools in Ilorin. It involved all senior secondary school three (SSSIII) students' offering Biology in Ilorin, Nigeria. The topic "introduction to genetics" was the content scope. This is because genetics is important in the reproduction and health of living organisms and it is one of the perceived

difficult topics in Biology. Gender, score levels, and study habits were the moderating variables considered in this study.

Significance of the Study

The findings from this study might be of great assistance to students, Biology teachers, educational researchers, curriculum planners, policymakers and various educational bodies.

The findings from this will enhance Biology students' understanding of Biology concepts which are usually perceived difficult, and thus encourage them to make use of the Biology dictionary to clear up those terms. This strengthens their cognitive skills and interest in genetics and other related perceived difficult concepts. More so, Biology students that are lacking the knowledge of appropriate skills in tackling the problem in genetics might learn problem-solving skills using mathematics pre-teaching method. This will improve their performance in Biology.

The outcome of this study will provide teachers with insights to adopt innovative teaching strategies that are suitable for teaching genetics to facilitate students' understanding of the concepts and to bring about effective teaching of genetics and other related perceived difficult topics in Biology. Also, the outcome will help the classroom teachers whose duties include translation of government policies into reality. They would find the result useful to change their mode of teaching from old to modern innovative strategies that will aid easy understanding and assimilation of genetics.

Curriculum planners will benefit from the outcome of this study by assisting them to suggest strategies such as pre-instructional word-clearing and mathematics pre-teaching at the secondary school level for better understanding and assimilation of genetic concepts and principles. Also, the outcome will equally correct the anomalies as well as review the position of genetics in the curriculum in the development of the senior school Biology curriculum.

Furthermore, the outcome of the study might also be of benefit to educational researchers generally as this would serve as the searchlight for them to carry out further research in the field of Biology that would assist the students to improve their study habits and performance in Biology. Also, the findings of the study will provide information to the Education policymakers when taking a concrete decision on the integration of a new method of teaching genetic. And to the importance of knowledge of genetics concepts to the everyday life of every member of the society at large which would help them to make policies that would benefit human existence and solve the problem of poor performance in Biology.

The results of this study would also be of great assistance to various educational bodies at local, state and federal levels such as the Nigerian Educational Research and Development Council (NERDC), the West African Examination Council (WAEC), National Examinations Council of Nigeria (NECO) and professional bodies such as the Science Teachers' Association of Nigeria (STAN). They can use their results to organize conferences, workshops,

and seminars for secondary schools' Biology teachers on the use of new methods of teaching to enhance better performance in biology and to improve better understanding among students. They can also use these to improve the professional competence of practicing Biology teachers

Clarification of Major Terms and Variables

The following terms and variables were operationally defined with respect to the study:

Effects: Expected changes in genetics' achievement after exposure to the pre-instructional word-clearing and mathematics pre-teaching strategies

Pre-Instructional Word-clearing: This is the procedure used to clear up genetics terminologies using Biology dictionary, Biology textbook and materials with the students before the teaching of genetics.

Mathematics Pre-Teaching: This is the act of teaching the mathematics components of genetics prior to the teaching of genetics to students.

Achievement: This refers to grades obtained from the Genetics Achievement Test which measure students' understanding of Genetics.

Gender: this refers to a student's gender which could be male or female.

Score Levels: Categorizing students based on scores obtained in the genetics Achievement Test (GAT). Students who scored 65% and above are high scores; those with 50-64% are medium scores; while those that scored 0-49% are regarded as low scores.

Study Habits: This refers to Biology students' habits which could be positive (Good) or negative (poor). Students who scored 50% and above are considered to possess positive (Good) study habits, while students with less than 50% are regarded as having negative (Poor) study habits.

Interaction Effect: The collective effect that could be applied by two or more variables, i.e. joint effects of treatments* on gender, score levels, and study habits.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter review existing studies related to this study. The review was discussed under the following sub-headings:

- Theoretical Framework for the Study
- Objectives and Contents of the Nigerian Senior School Biology Curriculum
- Effects of Word-Clearing as an Instructional Strategy in Teaching and Learning of Science
- Empirical Studies on the Effects of Mathematics Pre-teaching strategy on Biology Teaching and Learning
- Empirical Studies on Students' Understanding of Genetics and Students' Achievement
- Factors Influencing Senior School Students' Achievement in Biology
- Empirical Studies on the Influence of Gender on Students' Achievement in Biology Teaching and Learning
- Empirical Studies on the Influence of Study Habits on Biology Students' Achievement in Biology
- Empirical Studies on the Influence of Score Levels on Students' Achievement in Biology.
- Appraisal of the Reviewed Literature

Theoretical Framework for the Study

This study is based on Ausubel's theory of meaningful learning and advance organizer. Ausubel was an American psychologist that had a significant contribution to the fields of educational psychology, cognitive science, and science education. Ausubel believed in deductive reasoning. This implies that understanding concepts, principles, and ideas are achieved through deductive reasoning. Furthermore, he believed in the idea of meaningful learning as opposed to rote memorization.

Ausubel (1963) in his theory on meaningful learning, noted that learning of new knowledge relies on what is already known. Ausubel's theory also focuses on meaningful learning. According to this theory, to learn meaningfully, individuals must relate new knowledge to relevant concepts they already know. New knowledge must interact with the learner's knowledge structure. Meaningful learning can be contrasted with rote learning. The latter can also incorporate new information into the pre-existing knowledge structure but without interaction. Rote memory is used to recall sequences of objects, such as phone numbers. However, it is of no use to the learner in understanding the relationships between or among the concepts.

Ausubel also advocates the use of advance organizers (prior knowledge) as a mechanism to help the learners to link new learning material with existing related ideas. Prior knowledge is helpful in the way that they help in the process of learning when difficult and complex materials are introduced. For advance

organizers to increase the effectiveness of students, the student must process and understand the information presented in the organizer, and the organizer must indicate the relations among the basic concepts and terms that will be used (Ausubel, 1960). Ausubel's theory of advance organizers is categorized into two areas: comparative and expository. The main goal of comparative organizers is to activate existing schemas and is used as a reminder to bring into the working memory of what the student may not realize is relevant. A comparative organizer is also used both to integrate as well as discriminate. It integrates new ideas with basically similar concepts in cognitive structure as well as increases discriminability between new and existing ideas which are essentially different but confusable similar. Expository Organizers, however, provide new knowledge that students will need to understand upcoming information. Expository organizers are often used when new learning materials are unfamiliar to the learner. They often relate what the learner already knows with the new and unfamiliar material, and this, in turn, is aimed at making the unfamiliar material more plausible to the learner. This study is basically linked to the expository type of advance organizers, because both mathematics pre-teaching and pre-instructional word-clearing aimed at providing new information to the students that will help them to understand the upcoming information.

Objectives and Contents of the Senior Secondary School Biology Curriculum

The curriculum has been defined in various ways by different authors depending on the area from which the scholar is coming from and, as such, there are many definitions of the curriculum as there are many scholars.

Alade (2011) defined curriculum as a medium through which educational institution seeks to translate the societal values into concrete reality. Adegoke (2005) pointed out that for a curriculum to be effective, it must have a definite and dynamic purpose based on the value of the society and the views of the child as a citizen and a skilled individual. Biology curriculum is the totality of learning experiences prepared for the students in order that the students can acquire general skills in Biology (Ahmed, 2017). The development of current senior secondary biology curriculum was as a result of the dissatisfaction with the existing curriculum, which eventually called for a change and the reasons for the changes was to make the curriculum more relevant to the needs and culture of the society and also to make up for the failure of the old curriculum in order to achieve the objective expected by the society among others.

However, following the Federal Government of Nigeria reform in education and the need to attain the Millennium Development Goals (MDGs) and the critical target of the National Economic Empowerment Development Strategy (NEEDS), which can be summarized as value-orientation, poverty eradication, job creation, wealth generation and using education to empower the

people, it became imperative that the existing curricula for senior secondary schools should be reviewed and re-aligned to fit this reform programme. In light of this, the Nigerian Educational Research and Development Council (NERDC), between 2007 and 2008 organized several workshops, which culminated in the design and production of new curricula (NERDC, 2009). The objectives of the Biology curriculum as derived from the National Policy on Education, 2004, are to prepare the students to acquire:

- i.) Adequate laboratory and field skills in biology,
- ii.) Meaningful and relevant knowledge in biology,
- iii.) Apply scientific knowledge to everyday life in matters of personal and community health and agriculture,
- iv.) Reasonable and functional scientific attitude,

In pursuance of the stated objectives, the contents and context of the curriculum place emphasis on field studies, guided discovery, laboratory techniques and skill along with conceptual thinking in handling the themes, which are spelled out in the curriculum.

The 2009 edition of the senior secondary school science curriculum, which was an outgrowth of the one developed earlier by Comparative Education Study and Adaptation Center (CESAC), was developed in 1985 (Federal Ministry of Education, FME, 1985b) to include Agricultural Science, Biology, Chemistry, and Physics. The biology section was organized under seven

themes. Which are the Concept of living, Basic ecological concepts, Plant and animals Nutrition, Conversion of matter and energy, Variation and variability, Evolution and lastly Genetics.

The 2009 edition of the Biology Curriculum ¹⁰(NERDC, 2009) now organized into six sections which are topics, performance objectives, contents, students and teachers' activities, learning and teaching materials, and evaluation guide.

The curriculum is centered on four themes. These four themes include:

Theme 1: Organization of life

2: Organization at work

3: The organisms and their environment

4: Continuity of life

Science subjects have lost out in the new senior secondary school curriculum because it is no longer a requirement for senior secondary school students to offer one science subject as a part of the core subjects. The new core subjects are: English studies, General Mathematics, Civic Education, Computer Science, and One Trade/ Entrepreneurship subject (NECO, 2007; Abimbola, 2013).

In planning the new biology curriculum, the spiral approach to sequencing a science course was adopted. In the approach, the concepts to be taught are arranged in such a way that they run throughout the three- year post basic course, with the concepts being discussed in greater depth as the course progresses.

The West African Examinations Council (WAEC) syllabus is an examination syllabus developed from the curricula of the member countries of the West African Examinations Council. The syllabus is divided into three sections: Section A, B, and C. Section A is for all candidates, Section B for the candidates in Ghana only, and Section C is for the candidates in Nigeria, Sierra Leone, Gambia, and Liberia.

According to West African Senior School Certificate Examinations Syllabus (2004-2008), the inclusion of biology in the secondary school curriculum is aimed at achieving the following objectives:

1. Understanding of the structure and functions of living organisms as well as the appreciation of nature;
2. Acquisition of adequate laboratory and field skills so as to perform and assess experiments and projects in Biology;
3. Acquisition of necessary scientific skills, for example, observing, classifying and interpreting biological data;
4. Acquisition of basic relevant knowledge in biology needed for future advanced studies in biological sciences;
5. Acquisition of scientific attitudes for problem-solving;
6. Ability to apply biological principles in everyday life in matters that affect personal, social, environmental, community health and economic problems
7. Awareness of the existence of interrelationships between biology and other scientific disciplines.

According to the National Examinations Council (SSCE) Syllabus (2004-2006), the aims and objectives of biology as derived from the ⁹National policy of Education (2013) are as follows:

1. Mastery of the structure and function of living organisms
2. Appreciation of nature and needs of its conservation.
3. Acquisition of adequate laboratory and field skills in biology necessary to carry out and evaluate experiments and projects in biology.
4. Ability to observe, classify, and interpret biological data (the Scientific Skills)
5. Acquisition of meaningful and relevant knowledge in biology as a pre-requisite for the pursuit of careers in biological science and related discipline.
6. Acquisition of acceptable scientific attitude for solving problems and;
7. Ability to apply biological knowledge/thoughts to everyday life in matters of personal, social, economic, environmental, and community health (p.39)

The Biology curriculum has topics that are organized into instructional units in order to enable the concepts and skills to be treated throughout the three years duration of the Senior Secondary School. The topics are arranged in segmental and concentric forms to create room for the recurrence of the concepts taught in previous years.

Genetics, unlike other concepts, is not approached using a concentric method. This is because of the fact that genetics does not surface at all in SS1 and SS 2 but until SS 3 when the examination is around the corner. In the 2009 curriculum edition, a concentric approach to sequencing was adopted as was

found in 1985 Edition. This approach ensures that each of the themes runs through the three years but at a greater depth or level of complexity as the course progresses. This is, however, not the case except for genetics, which is discussed only in SS3.

The concepts of genetics just like other concepts are organized into six sections these are topics, performance objectives, contents, teachers-students' activities, teaching and learning materials, and evaluation guide. This arrangement gives a sense of direction to the teacher, the teachers though have the power to incorporate into the performance objectives those examples and illustration found within the geographical location of the learner and to encourage easy assimilation of new knowledge with the existing knowledge as explained by ³⁵Ausubel (1963).

Senior Secondary school 1 (SS1)

Theme 1: Organization of life

Topics: Recognizing living things

1. Classification of living things (1) kingdoms: Monera, Protista, Fungi, Plantae, and Animalia
2. The cell
3. The cell and its environment
4. Some properties and function of the cell

Theme 2: The organisms at work

Topics:

1. Tissues and supporting systems
2. Nutrition in Animals

Theme 3: The organisms and their environment

Topics:

1. Basic ecological concepts
2. Functioning Ecosystem, Autotrophy, and Heterotrophy - Food Webs and Tropic Levels
3. Energy Transformation in Nature
4. The relevance of Biology to Agriculture
5. Micro-organisms around us
6. Micro-organisms in action
7. Towards better health
8. Aquatic habitat (Marine Habitat)
9. Aquatic habitat (Estuarine Habitat)
10. Aquatic habitat (Fresh Water Habitat)
11. Terrestrial Habitat (Marsh)
12. Terrestrial Habitat (Forest)
13. Unicellular organisms and Invertebrates (FME, 2009, pp. 1-32)

Senior Secondary 2 (SS2)

Theme 1: Organization of Life

Topics: Classification of plants

Theme 2: The Organism at Work

Topics: Digestive System

3. Transport System

4. Respiratory System

5. Excretory System

Theme 3: The organisms and their environment

Topics:

1. Nutrient cycling in nature

2. Ecological management: Association, Tolerance, Adaptation, and
Pollution

3. Conservation of natural resources

4. Pests and Diseases of crops

Theme 4: Continuity of life

Topics:

1. The reproductive system in Vertebrates

2. Reproductive systems in plants

3. Pollination in plants (FME, 2009, pp. 33-49)

Senior Secondary School 3 (SS3)

Theme 2: The organisms at work

Topics:

1. Regulation of Internal Environment

2. Nervous Co-ordination

3. Sense Organs

Theme 3: The organisms and its Environment

Topics:

1. Ecology of population
2. Balance in Nature

Theme 4: Continuity of life

Topics

1. Reproductive System and Reproduction in Humans
2. Development of New Seeds
3. Fruits
4. Reproductive Behaviours
5. Biology of Heredity (Genetics)
6. Variation and Evolution

Evolution (FME, 2009, pp.50-66).

Effect of Word-Clearing as an Instructional Strategy on the teaching and learning

Study Technology comprises devices and methods teachers can use to enhance the rates of learning of students. Abimbola (2011) noted that Study technology is an innovative strategy that consists of tools and techniques teachers can use to improve the learning rates of students. And students can also use the techniques of study techniques to improve their ability to understand and help them to use the materials they read and study. The principle of study

technology is based on the understanding of three main principles, which are also known as the barriers to study. Student's awareness of these three barriers can make students recognize when they encounter problems in the cause of study and then proceed to overcome these problems and these three barriers are identified by Applied Scholastics International as follows;

- I. Absence or lack of mass
- II. Too steep (skipped) a gradient
- III. The misunderstood word

According to Abimbola (2013) a misunderstood word, concept, symbol, or situation is a word, concept, symbol, or situation, that is not understood, or a word, concept, symbol, or situation, which is wrongly understood. The author also noted that, this third barrier to study is the most important barrier because it is capable of making the students quit what they are studying about or drop out of school completely and also affects our thinking processes. Ten principal types of misunderstood words are identified by Applied Scholastics International this includes;

1. A false definition: This is when a students or learners give a definition that has no relationship to the actual meaning of the word.
2. An invented definition: An invented definition is a type of a false definition. The person made it up himself or he was given

somebody else's made-up idea. This can be difficult to find as he is certain he knows it - after all he invented it himself. But usually, it does read on a Meter.

3. An incorrect definition: A definition that is not right but may have something to do with the word or symbol.
4. An incomplete definition: A definition that just isn't precise enough or is insufficient.
5. An unsuitable definition: A definition by itself is correct, but does not fit the context in which it is used. It causes the student not to be able to understand the sentence correctly.
6. A homonymic definition: One word which has two or more clearly different meanings. A homonym can also be two (or more) words that sound the same ("piece" and "peace" for example). This can cause the student not to understand the text right.
7. A Substitute Definition: A substitute definition occurs when a person uses a synonym for the definition of a word. A synonym is not a definition. A synonym is a word having a meaning similar to that of another word.
8. An omitted (missing) definition: An omitted definition is a definition of a word that the person is missing; it can be omitted from the dictionary he is using. In other words, the word is used in meaning the student doesn't know, but he thinks he does.

9. A No-definition: A no-definition is a "not-understood" word or symbol.

10. A rejected definition: A rejected definition is a definition of a word which the person will not accept. This can be based on emotional reactions to it. The person finds the definition degrading to himself or his group, etc. He may have a total misunderstanding on the word and still refuse to have it explained or to look it up (Applied Scholastics International, n.d.).

However, Abimbola (2015) noted that when a student has a misunderstood word, may exhibit some of these reactions which include; Blank, sort of nervous hysteria, students do the wrong thing, doodling daydreaming, worried, and even students may stop studying among others reactions. Therefore, in a way to find a solution to misunderstood word encounters by students in the course of study, study technology suggested +a word-clearing method of instruction.

Word-clearing is a system of backtracking which can be done with a student with other students or by a professional word clearer on a student. Abimbola (2015), recognized the following as the main steps involved in clearing any word or symbol, which students may not understand during studying as follows;

1. The learner needs to search for the misunderstood word from the earlier part of the reading material
2. The students now look up the word in a standard dictionary

3. Quickly read through all the definitions and find the one that fits
4. Read out the definitions that fit
5. Make several sentences with the definition until a proper understanding of the meaning of the word is achieved
6. Learn each of the remaining definitions of the same word the same way
7. The learner re-reads the passage from where the earliest misunderstood word was found
8. At this stage, reading should normally proceed well if all the misunderstood words had been identified, if otherwise, other misunderstood words are searched and cleared using a standard dictionary.

Meanwhile, studies have shown that study technology has a significant influence on teaching and learning. For instance, Peter, Adewale, Adetayo, and Yusuf (2019) carried out research on the use of demo kits as a strategy for enhancing senior secondary school students' achievement in computer studies in Nigeria. The study adopted a pre-test and post-test comparison group quasi-experimental research design with a 2 x 2 factorial matrix. The population for the study was made up of all senior secondary (SS 2) students in Ijebu-North Local Government Area, Ogun State. The sample for the study was drawn from two public co-educational senior secondary schools with the use of intact classes. The schools were randomly assigned to experimental or comparison groups. The gathered data from the research were analyzed using both

descriptive and inferential statistics. The finding of the study shows a significant main effect of the strategy that the students exposed to the use of demo kits performed significantly better than those in the comparison group which learned using the conventional method of teaching.

Ahmed (2018) carried out an experimental study on the effects of study technology learning strategies on senior school students' achievement in Ecology in Ilorin. The study adopted a quasi-experimental design that involved a pre-test, post-test control group the sample for the study consist of 399 biology students who were purposively selected from five schools. The data collected were analyzed using ANCOVA. The results show that students taught Ecology using components of study technology (word-clearing, Demo kits, and learning on a gradient) performed better than their counterparts in the control group. The study concluded that study technology learning strategies are useful in improving students' achievement in ecology.

Similarly, Gbigbadua, Abimbola and Ahmed (2014) investigated the effect of word-clearing strategy on the achievement of senior school biology students in Kwara State, Nigeria. The study was an experimental type using the quasi-experimental design, non-randomized and non-equivalent pretest and posttest control group design. A total of one hundred and fifty-eight (158) students were involved in the study. Analysis of Co-variance (ANCOVA) was used to test the generated hypotheses while pre-test and post-test scores were analyzed using the mean scores. The findings of the study indicated that the

utilization of pre-instructional word clearing as an instructional technique upgraded the better accomplishment of students in Biology.

Another similar study conducted by Obioha and Danjuma (2021) on the impact of subsumers of biology terminologies on secondary school students' achievement in Jalingo education zone. Taraba State, Nigeria. The study adopted Quasi-experimental research design with a population of 184 students randomly sampled out of 366 Secondary School drawn from two intact classes. The research questions were answered using mean and standard deviation while the hypotheses were tested at 0.05 level of significance using ANCOVA. The reliability of the instrument "Biology Achievement Test (BAT)" was found to be 0.77 with Spearman Brown correlation coefficient. Results showed that the use of subsumers improves students' achievement among others.

In another related study, Adeoye and Abimbola (2016) carried out research on the effects of senior secondary students' use of demo kits on the achievement in Biology in Omu-Aran, Nigeria. The study employed a quasi-experimental design of 2x2x3 factorial matrix. The data for the study was collected from four intact classes in four purposively selected secondary schools in Omu-Aran, Kwara State, Nigeria. Analysis of Covariance (ANCOVA) was used to test the corresponding null hypotheses. Findings from the study showed that there was a significant difference in the achievement of students who learned Biology utilizing the demo kit and those who learned it without utilizing the demo kit.

Abimbola (2013) remarked that teachers who know how to use study technology methodologies become new teachers who know how to teach students how to learn, and they became lifelong learners and teachers who are capable of learning anything and teaching anything and any type of learner. Study technology has been described as a tool which can be used by students, teachers, children and parents alike as it can be applied to anything: homework, homeschooling, teaching, tutoring, sports, work, reading, etc. (Association for Better Living and Education International, n.d.).

Empirical Studies on the Effects of Mathematics Pre-teaching on the Teaching and Learning of Biology

Mathematics Education is one of the most important things in our life and that information technology has a strong impact on many aspects of our life. Mathematics plays a vital role in education since it is derived from the cultural, utilitarian and interdisciplinary value which the subject seeks to inculcate in the learners. Mathematics education is important to every nation because it serves as a basis for understanding and application of science and technology (Oduval, 2013).

Many topics in the science subjects cannot be understood without the sound knowledge of mathematics. For example, students required knowledge on change of subject in mathematics to understand density which appears under the major topic in Ecology, Diffusion in chemistry and floatation in physics.

However, several topics in the science (Biology, Chemistry, and Physics) are interrelated and this means that there are overlaps in the content areas of the subjects. Therefore, students need basic mathematics knowledge to perform excellently in other science subjects (Hamza, Muntari, and Ahmed, 2015).

Severer studies have been carried out on effects and relationships between mathematics teachings on Biology learning. For example, ³³Busari (2014) on the effects of pre-teaching the mathematics component of genetics on senior school students' genetics achievement, the study was carried out in Oyo State, Nigeria. A quasi-experimental, non-randomized, non-equivalent, pre-test, post-test control group design was used for the study. One hundred and seventy-six (176) biology students from four secondary schools were purposively selected for the study. Data were collected and analyzed using descriptive statistics; mean standard deviation and mean gain score was used to answer research questions. The t-test and Analysis of Covariance (ANCOVA) were used to test the hypotheses. The findings of the study revealed that students that were pre-taught the mathematics component of genetics achieved significantly better than those that were not pre-taught the mathematics components of genetics.

Another study by Badmus, Akanmu, and Akanbi (2015) carried out research on the predictive effects of mathematical concepts pre-teaching on physics students' performance in Ilorin. The study was an experimental type of quasi-experimental design. A total of 62 students drawn from intact classes of

two purposively selected schools were used. The data collected was analyzed using t-Test and Analyses of Variance. The result shows that, the students who exposed to the pre-teaching of mathematical concepts performed significantly than their counterparts in the control group. Kurumeh, Igyu, and Mohammed (2013) investigated the correlation that existed between mathematics achievement and the achievement in Chemistry, Physics, and Biology in WASSCE. The study emphasize the importance of mathematics to science and that mathematics achievement can be used to predict the achievement of students in other science subjects. The ex-post facto research design was used to carrying out the study. The study consists of four hundred and eighty students selected from six secondary schools in Makurdi Local Government Area of Benue State. The result of the study indicated that there was a significant relationship that existed between Mathematics and each of Chemistry, Physics, and Biology at 0.05 level of significance.

Oluwatuse and Dele (2017) investigated the effects of further mathematics curriculum on students' performance on science-based subjects in senior secondary certificate examination in ikere local government, Ekiti. The study was an experimental type adopted ex-post-facto research design. A stratified random sampling technique was used to select the sample. An inventory was used to collect data from four schools. The data were analysed using descriptive and inferential statistics. The result shows a significant difference between further mathematics and biology, chemistry and physics.

Today mathematics is made compulsory for all students in Nigerian Secondary Schools. Its importance hinges on the fact that credit or pass in the subject serves as a basic requirement for a candidate seeking admission into various departments in the institution of higher learning especially, in the faculties of Social science and Science oriented courses.

Awofala, Fatade, and Nneji (2012) investigated the effects of test response mode and locus of control on Students' Achievement in Senior Secondary School Mathematics and Sciences within the blueprint of casual-comparative research of an ex-post-facto type. The sample consisted of 240 Senior Secondary School year two students drawn from seven randomly selected Senior Secondary Schools in Epe Local Government Area of Lagos State, Nigeria. Five instruments were used for data collection. Mean standard deviation and t-test were used to analyze the data.

The result indicated that there was a significant effect of test response mode on students' achievement in (a) Mathematics (b) Biology (c) Chemistry (d) Physics. Students performed better in the multiple-choice objective test than in constructed-response tests in each of the school subjects investigated. It was also revealed that there was a significant effect of locus of control on students' achievement in mathematics, Biology, Chemistry, and Physics in favour of the internals who recorded higher mean scores than the externals.

Empirical Studies on Students' Understanding of Genetics and students' achievement

Genetics is a fundamental part of biology but is also relevant to everyday life. The applications and implications of genomics require better 'genetic literacy' through biology education. However, genetics is also one of the most difficult topics for both students and their teachers (Paul, 2018; Agboghorm and Oyovwi, 2015; WAEC, 2013, 2014, 2015 and 2016).

Several studies have been conducted using different strategies on students' understanding of genetics at secondary school levels. For instance, Friday, Abdullahi, Bashir and Bashir (2018) investigated the effect of concept mapping and demonstration on senior secondary two Biology students' achievement in genetics in a secondary school in Jos. The study was an experimental type with a total number of 60 Biology students comprising of 32 male and 28 female students who were randomly selected from the sample. The instrument used to collect data was a genetics achievement test. The data collected were analyzed using mean, standard deviation and t-test. The result revealed that there is a significant difference between the posttest scores of students taught genetics using concept mapping and those taught demonstration methods.

Similar to this is a study carried out by Jibrin and Zayum (2012) on the effect of concept mapping teaching strategy on the academic achievement of senior secondary school students in Genetics. The study adopted a pre-test and

post-test control group of quasi-experimental design. All the 20 senior secondary schools in Dengi metropolis constituted the population for the study. Two senior secondary schools were randomly selected and grouped into experimental and control groups. The instrument used to collect data was Genetics Achievement Test (GAT) which was prepared by the researchers. The data collected were analysed using z- test statistics. The results of the findings revealed that students taught Genetics using concept mapped instructional strategy achieved higher than those taught using the expository method.

Another study conducted by Busari (2014) on the effects of pre-teaching the mathematics component of genetics on senior school students' genetics achievement, the study was carried out in Oyo State, Nigeria. A quasi-experimental, non-randomized, non-equivalent, pre-test, post-test control group design was used for the study. One hundred and seventy-six (176) biology students from four secondary schools were purposively selected for the study. Data were collected and analyzed using descriptive statistics; mean standard deviation and mean gain score was used to answer research questions. The t-test and Analysis of Covariance (ANCOVA) were used to test the hypotheses. The findings of the study revealed that students that were pre-taught the mathematics component of genetics achieved significantly better than those that were not pre-taught the mathematics components of genetics.

Manda (2012) investigated the nature and causes of learning difficulties pupils experience in Biology in high schools in Samfya District. A descriptive

sample survey design was used. The research instruments used were interview guides and self-completion questionnaires. The study revealed that one of the topics that teachers and pupils found difficult to teach and learn respectively was genetics.

Similar study was carried out by Danmole and Lameed (2014) on the effect of annotated drawing on the understanding of genetics by secondary school biology students. The study employed 110 secondary school students drawn from two intact classes which constituted the sample. Quantitative and qualitative methods were used to collect data using the research questions raised and hypotheses formulated for the study. A Genetics Achievement Test (GAT) and a 50-item multiple-choice test were used to collect quantitative data and an Interview Schedule (IS) was employed to elicit responses that constitute data for the qualitative method. A reliability coefficient of 0.82 was obtained for the GAT using the split-half method.

Findings revealed that the annotated drawing strategy had a significant positive effect on students' understanding and achievement in genetics. The analysis of data also showed that students had some misconceptions in biology, which hitherto, hindered their understanding of genetics concepts.

Factors influencing Senior School Students Achievements in Biology

Biology is a branch of science that deals with the study of living organisms. Biology is majorly concerned with the nature of organisms and their

relationships to each other and to their environment. The subject establishes a framework for professions in health, agriculture, education, and the environment. In addition, Biology as a subject equips the students with an understanding of the major biological process such as digestion, respiration, excretion among others that takes place within their body system (Dinah, 2013). Knowledge of Biology, according to Abimbola (2017), enables students with the ability to plan, interpret and report the field works, experiments and observation and also with the ability to handle materials and equipment. In view of this, the teaching of Biology requires that teachers should have the knowledge and appropriate method of teaching Biology while students should be given proper orientation for the conceptualization of subject matter.

Despite the importance of Biology in society, Students' achievement in Biology subject in Senior Secondary Certificates Examination (SSCE) has been unsatisfactory over many years, different reasons have been attached to this problem by scholars. Dinah (2013) noted that the availability of textbooks, laboratory apparatus, and other learning resources contributes significantly to the performance of students in Biology examination. The researcher added that students with a positive attitude towards the subject register better performance than those who had a negative attitude. Those with a positive attitude are motivating to work hard and this is reflected in the good marks scored in the examination.

Suman (2011) conducted a research on the influence of parents' education and parental occupation on the academic achievement of students. The researcher concluded that Education and occupation of parents positively influence the academic achievement of children. Femi (2012) inferred that the education qualification of parents and the healthiness of students are critical variables that influence the academic performance of students.

According to Akinsanya (2014), parents' education has the highest significant influence on the academic achievement of students. This is because the child from an educated family has a lot of opportunities to study hard due to his/her access to the internet, newspaper, television. They can also be taught extra lessons at home. Students raised from an illiterate family have limited access to that. It has been observed that the falling academic standard and the influencing factors include the economic status of the parents. Just having a look at the present economic situation of the country, many poor parents do send their children to go and do pity household work before going to school. These children were confused about what they can help their family through that. However, the destitution of parents affects their children's academic adventures as they lack sufficient assets and capital to support their children's education and good school, good housing facilities, medical care, and social welfare services.

Femi (2012) in his research submitted that parents' socioeconomic and literacy levels are not noteworthy factors in students' academic ability. Osuafor

(2013) in their research on the influence of family background on academic achievement of secondary school Biology students revealed that family structure, parents' occupation and educational level of parents did not have a significant influence on students' achievement in biology. Memon (2010) in his study revealed that the majority of students whose parents were well educated perform better in matriculation examination as compared to those students whose parents were less educated or illiterate.

The studies have been carried out by many researchers on the problems of student's underachievement in Biology and their opinion varies. Owino (2014) attached the problem with an inadequate supply of teaching and learning resources such as chemicals, charts, apparatus, models, local specimens, laboratories, textbooks, and libraries led to poor performance in Biology. The researcher added that irregularities related to the teacher of Biology such as irregularity in administration of practical, class discussion, teachers not allowing students to ask questions, teachers not giving prompt feedback on assignments or exams, by not making the Biology subject interesting and teachers not conducting demonstration during practical.

Empirical Studies on the Influence of Gender on Biology Teaching and Learning

Gender issues in educational research have been very controversial. This is because the conclusion of researchers on the influence of gender on students'

academic performance and achievement differs. One of the millennium development goals (MDGs) is gender equality. Fatokun and Odagboyi (2011) submitted that most societies; the female child has been completely neglected, preventing women from participating in, and benefitting from the development efforts of the society. Even disciplines such as science, technology and mathematics have been tagged masculine, while others like home economics, secretarial studies are branded feminine.

Many studies established that no significant differences exist between male and female. For instance, in a study conducted by Ahmed, Shittu, Yahaya and Dada (2021), on the effects of Concept-mapping instructional strategy on senior secondary school students' achievement and retention in biology in Lagos, Nigeria. The study is a Quasi-experimental of research design. The population for the study comprised all senior secondary school two biology students. Two intact classes of SS II students were involved in the study. The research instruments used for the collection of data were the Biology Achievement Test (BAT) and Concept-Mapping Based Lesson Plan (CMBLP). The reliability of the instruments was 0.75 and 0.82 respectively. The data collected was analyzed using Analysis of Co-variance (ANCOVA) all the hypotheses were tested at 0.05 level of significance. The results of the study showed among other that there was no gender influence on students' achievement.

Ikide and Edet (2013), investigated the influence of learning styles (active/reflective, sensing/intuitive, visual/verbal, and sequential/ global) and teaching strategies (guided inquiry, demonstration and lecture) on students' achievement in Biology.

The study explored Two hundred and forty (240) Senior Secondary Two (SSII) biology students, which comprises one hundred and thirty-six (136) females and one hundred and four (104) males and they were randomly drawn from six (6) Secondary Schools in Uyo Metropolis. A non-randomized control group pretest-posttest design was used for the study. Two research instruments used in gathering data for the study include: Biology Achievement Test (BAT) and Index of Learning Style Questionnaire (ILSQ). Pearson Product Moment Correlation was used to establish the reliability coefficient for Biology Achievement Test, which stood at 0.86. Analysis of covariance (ANCOVA), Multiple Classification Analysis (MCA) and Scheffe multiple comparison test were the statistics used to analyse the data.

The result of the findings revealed there is no significant influence of gender on students' achievement when taught using guided-inquiry, demonstration, and lecture teaching strategies based on their learning style.

Also, Gbigbadua, Abimbola and Ahmed (2014) recorded no significant difference among gender when investigated the effect of word-clearing strategy on the achievement of senior school biology students in Kwara state, Nigeria. The study was an experimental type using the quasi-experimental design, non-

randomized and non-equivalent pre-test and posttest control group design. A total of one hundred and fifty eight (158) students were involved in the study. Analysis of Co-variance (ANCOVA) was used to test the generated hypotheses while pre-test and post-test scores were analyzed using the mean scores.

Similarly, Odagboyi (2015) investigated the effect of gender on the achievement of students in biology using the jigsaw method. The sample comprised of 87 students in SS1 in a secondary school. The study utilized an intact class because the study took place in a normal school term. There were 39 males and 49 females. The Biology Achievement Test (BAT) was constructed from past WAEC questions.

The students administered the BAT as pretest, and the results were collated by gender. A t- test analysis showed that there was no significant difference between the mean scores of boys and girls. The class was taught, topics in microorganisms for 12 weeks. At the end of the 12 weeks, the BAT was administered as posttest. The results were analysed using the t-test at 0.05 level of significance. Results showed that there was a significant difference between the mean scores in favour of the males. This showed that the males gained more from the jigsaw method compared with the females.

Oludipe (2012) investigated gender difference on junior secondary students' academic achievement in basic science using cooperative learning teaching strategy. One hundred and twenty students drawn from intact classes of

the three selected junior secondary schools in the three-selected Local Government Area of Ogun state, South West Nigeria, participated in the study.

The study employed a quasi-experimental design. Lesson note based on Jigsaw II cooperative learning strategy and achievement test for Basic Science students were the instruments used to collect relevant data. The findings of the study revealed that there was no significant difference in the academic achievement of male and female students in the pretest, posttest and delayed posttest levels respectively.

Awodun, Oni, and Oyeniyi (2015), conducted a study to examine the influence of teacher's gender in secondary school students' performance in Physics in Ekiti State, Nigeria. Two hundred (200) SS II Physics students form the samples, which were randomly drawn from ten secondary schools in Ikere Local Government Area of Ekiti State.

The research design adopted was descriptive survey of the expos-facto research type. ANOVA statistical analysis was used to analyze the tree null hypotheses formulated for the study. The findings showed that there was a significant difference in the performance mean scores of boys taught by male and that of those taught by female Physics teachers, there is significant difference in the performance mean scores of girls taught by male and that of those taught by female teachers and there is significant difference in the performance mean scores of students taught by male and that of those taught by female Physics teachers.

In another related study, carried out by Jibrin and Zayum (2012) on the comparative analysis of senior secondary school students' achievement among gender using concept map instructional method in genetics in Zaria local Government Area, Pretest and posttest control groups design method was employed. Samples of 96 SSII students were involved in the study. The instrument for data collection was Genetics Achievement Test (GAT) with reliability $r=0.65$. Data collected were analyzed using student t-test statistics. The result indicated that male students taught genetics using concept map instructional method performed better than their female counterpart.

Empirical Studies on the Effects of Study Habits on Biology Students' Achievement

Learning involves the development of proper study habits and skills. The problem of study habits is one of the universe's important problems both from the theoretical and practical points of view. Theoretically, efficient learning depends upon the development of efficient study habits and skills. ⁶⁶(Nadeem, Puja, Bhat, 2014).

Crede and Kuncel (2008) defined study habits as study routines, including, but not restricted to, frequency of studying sessions, review of the material, self-testing, rehearsal of learned material, and studying in a conducive environment. Omotere (2011) described study habit as the adopted way and manner a student plans his private readings, after classroom learning so as to attain mastery of the subject. According to the author, good study habits are

good assets to learners because they (habits) assist students to attain mastery in areas of specialization and consequent excellent performance, while the opposite constitutes constraints to learning and achievement and leads to failure. Omotere (2011) defined study habits as a behaviour style that is systematically formed by students towards learning and achievement.

Ogbodo, (2010) noted that there is a need to guide the students about meaningful learning so that they are able to memorize things in a better way. Students improve their performance because they can learn most of the concepts clearly through proper study habits. Study habits refer to learning which leads to the achievement of a learner's goal, through a prescribed pattern of steady behaviour. A student must know the learning method and study habits, which help him to achieve the goals of education. Learning through good study habits is the key process in human behavior. Parents and teachers always show concern for learning of the child because learning through good study habits influences our language, our skills, attitudes, interests, and even our goals.

Marc (2011) submitted that students with learning problems are equally known to have inefficient and ineffective study habits and skills. The student that is conscious of his learning habits or styles will equally understand why sometimes get frustrated with common study methods. The researcher also observed that good study habits are essential to educational success; as they contribute to a successful academic future. Good study habits lead to good

grades while good grades lead to admissions to better colleges and universities, possibly with a scholarship thrown in. This in turn, will lead to a great career.

Study habits are generally classified into two areas, that is, the good study habits, and the bad study habits. Good study habits are also referred to as positive or productive study habits, which means, they are those pleasant study habits that have the tendency to improve the academic performance of students or that seem to produce good results. This type of study habits make the students successful in their studies after developing and applying them throughout their academic career. Bad study habits on the other hand, are those negative or non-productive study habits which are undesirable and counter-productive to students' academic performance. Whenever the students developed and utilized the bad study habits, this hamper the students' academic progress and performance at all levels. (Katelyn, 2013; John, 2010).

Researchers have carried out studies on the effectiveness of study habits. For instance, Albert and joy (2013) carried out a study on the assessment of the study habits of secondary school science students in northwest Nigeria, a zone that is considered educationally less advantaged. Consequently, 1,796 students who were offering the basic science subjects (Biology, Chemistry, and Physics) in 22 secondary schools in four northwest states (Kaduna, Kano, Katsina, and Zamfara) of Nigeria during the 2011/2012-school session were selected using stratified random sampling. The students' study habits were assessed by

administering the Bakare (1977) Study Habit Inventory on them and their science scores (academic performance) were obtained from their first term's school results. The independent t-test and one-way Analysis of Variance (ANOVA) statistics were employed for data analyses that were used to test five null hypotheses stated for the study at the alpha value of 0.05. All the null hypotheses were significant, indicating that difference exists between the study habits of male and female, older and younger, private and public schools', low and high academic performing, and among the students in the four states.

It was therefore recommended that school counselors, teachers, administrators, examination bodies and governments should, among other things, do the following so as to improve students' study habits - carry out routine study needs assessment of secondary school science students, teach students how to study, and how to prepare and use personal time-table ineffective study.

Also, on the same note Odiri, (2015) examined the relationship between study habits of students and their achievement in mathematics. The study was a correlational type, and a sample of 500 students was randomly selected from 25 public secondary schools in Delta Central Senatorial District, Delta State, Nigeria. Questionnaires were drawn to gather data on students' study habits. Students' results in mathematics were also collected from their various schools to gather data on their achievement in mathematics. Two research questions were formulated to guide the study. Regression and ANOVA were used to

analyse the data. The result shows that there was a significant relationship between students' study habits and mathematics achievement. There was a significant difference in mathematics achievement between good study habits and poor study habits.

Similarly, Babu and Govindharajan (2014) conducted a study to investigate the level of students' attitude towards Biology and their study habits. The study also examines the relationship between the study habits and attitude towards the Biology of the higher secondary students. 735 higher secondary students in Thiruvannamalai, Trichy and Dhindukal Districts were randomly sampled in the study. The instruments used in the study were the Study Habits Scale Standardized by Gopal (1985) and the students' attitude of biology scale constructed by the investigator. The study revealed that the level of study habits and attitude towards biology at high are favorable. Furthermore, it is also noted that there is a negligible correlation between study habits and attitude towards Biology among higher secondary students.

Finally, on this note, Kambiz and Varsha (2014) examined the relationship of achievement motivation and study habits to academic performance in high school students in Hyderabad. A sample of 400 students consisting of boys and girls were selected from 7th and 8th grade. The tools used in the study to collect data were study habits inventory by Palsane (1989) and achievement motivation scale by Deo.mohan (1992). The data were

collected in small groups. Later the data were analyzed by using the mean score, standard deviation, Pearson's correlation, and regression.

The result indicated that there was a significant positive relationship between achievement motivation and study habits to academic performance. The result also showed the extent of contribution of achievement motivation and study habits to academic performance. It is also concluded that achievement motivation and study habits have proved to be effective on the academic performance of students and helped them for better performance and academic achievement.

Empirical Studies on the Influence of Score Levels on Students' Achievement in Biology

Students' scoring academic ability level has been discovered as important factors influencing students' achievement in science. Many studies have been carried out to determine how the differences in scoring level and academic ability can affect students; knowledge of science concepts. Lawal (2018) investigated the effects of learning together and jigsaw learning strategies on senior school students' achievement in Biology and their science literacy in Offa, Nigeria. The study adopted a quasi experimental design of 3X2X3. Purposive sampling technique was used to select six schools that participated in the study, a total number of 253 biology students forms. Biology achievement Test and Science literacy Test was used to as instrument to collect data. Inferential statistics of ANCOVA was used to analysed the data. The results

shows a significant difference in the achievement of students based on their score levels when exposed to learning together in favour of the high scorers

In a study carried out by Onijamowo (2010) on senior school chemistry students' misconceptions and alternative conceptions of selected chemistry concepts in Kogi State, Nigeria. It was discovered from the study that the scoring level of students does not actually influence the number of misconceptions and alternative conceptions students hold. High scorers held the least number of misconceptions and alternative conceptions.

Scoring level and effectiveness of the problem-solving approach of physics students in Kwara State were examined by Adeniran (2011), the study employed a 3x3x2 pretest, posttest quasi-experimental design. A total of 60 students randomly selected from three schools constituted the sample and the data were gathered using Optics Performance Test (OPT). The result showed that all the levels benefited from the study and that low scoring level students performed best with the posttest mean scores of 20.68. This was followed by the average (18.16) and high scoring levels (14.25). The study also revealed that there was a significant difference in the post-test means a score of students exposed to PPSA. Therefore it was recommended that teachers should expose the students to the heuristics of physics problem-solving approaches.

Gbigbadua, Abimbola and Ahmed (2014) investigated the effect of word-clearing strategy on the achievement of senior school Biology students in Kwara State, Nigeria. The study was an experimental type using the quasi-

experimental design, non-randomized and non-equivalent pre-test, and posttest control group design. A total of one hundred and fifty-eight (158) students were involved in the study. Analysis of Co-variance (ANCOVA) was used to test the generated hypotheses while pre-test and post-test scores were analyzed using the mean scores. The result from the study revealed that the use of pre-instructional word-clearing strategy had a greater influence on students classified as low and medium scorers than the high scorers.

Appraisal of the Reviewed Literature

The literature reviewed on the effects of word-clearing strategy as an instructional strategy for the teaching and learning of Biology revealed that word-clearing strategy could be used in tackling the problems of barriers to study. Available literature shows that all the components of study technology such as the use of word-clearing, Demo kits, learning on a gradient among others improved students' performance, for instance, Gbigbadua, Abimbola and Ahmed (2014), Adeoye and Abimbola and Ahmed (2016). The work of the above researchers differed to the present study because they explored only experimental design while this study explored both the experimental and the descriptive research designs. Further still, the present study also combined word-clearing with mathematics pre-teaching.

The review on the effects of mathematics pre-teaching strategy on the teaching and learning of Biology revealed that students' understanding of mathematics predicts their performance in other science subjects. Studies such

as Busari (2014), Badmus et al. (2015) and Kurumeh et al (2013) were reviewed. Busari (2014) carried out a study on the effect of pre-teaching of mathematics components of genetics among Biology students in Oyo state. Badmus et al. (2015) examined the effects of mathematical concepts pre-teaching on physics students' performance in Ilorin. These studies differ from this present study because this one among the study was carried out in Oyo state while this present study was carried out in Ilorin, Kwara state. Also, the second study was carried out in physics. More so, two instructional strategies (pre-instructional word-clearing and mathematics pre-teaching) were considered. Variables such as study habits and gender were also considered in this study.

Some of the reviewed studies concerning students' understanding of genetics were carried out using different types of instructional strategies such as concept mapping, problem-solving, pre-teaching mathematics components of genetics. These studies were carried out by Friday et al. (2018), Busari (2014) Jubrin and Zayum (2012), and Manda (2012), respectively. Most of these studies differed from this present study because they were carried out in descriptive forms with no treatment applied. However, the present study explored study technology tools, specifically the word-clearing method combined with mathematics pre-teaching of genetic concepts as strategies to promote students' learning of genetics in secondary school.

Having reviewed the literature on students' achievement in Biology, it can be deduced that there were certain factors responsible for the low

performance of students in Biology. Studies indicated that poor performance of students in Biology is due to non-availability of textbooks, laboratory apparatus, attitudes of students to learning, lack of teaching resources and incompetence on the part of teacher (Dinah, 2013) Meanwhile, Suman (2011), Femi (2012) and Akinsanya (2014) ascribed these problems to parental level of education and socioeconomic status. However, this present study will examine mathematics pre-teaching together with pre-instructional word-clearing as strategies to improve the poor performance of secondary school students in genetics.

In addition, studies on gender influence and student achievement were also reviewed; some of the studies reviewed concluded that gender had no effects on students' achievement (Ikide and Edet 2013; Gbigbadua, et al., 2014; and Odaboyi, 2015 and Oludipe, 2012). Others such as (Awodun, Oni, and Samuel 2015; Jubrin & Zayum 2012) concluded that gender had a significant effect on students' achievement. The present study will also investigate the influence of gender on students' achievement in biology when they are exposed to the treatment.

Finally, on the review of the influence of study habits on students' achievement, results from the studies affirmed that study habits had strong relationship with the academic achievement of students (Kambiz & Varsha, 2014; Odiri, 2015; Albert & joy, 2013 and Babu & Govindharajan 2014). Therefore, this study under investigation also investigated the influence of biology students' study habits in relation to their achievement when both pre-

instructional word-clearing and mathematics pre-teaching of genetics strategies were used.

CHAPTER THREE

RESEARCH METHOD

This chapter presents the methodology employed in carrying out this study. It was presented under the following sub-headings: research design, population, sample and sampling techniques, research instrument, validation of research instrument, procedure for data collection and data analysis techniques.

Research Design

This study adopted the quasi-experimental research design of the pre-test, post-test, non-randomized, control group design. Specifically, the study employed a 3 x 2 x 2 x 3 factorial design. The first “3” indicates the three types of strategies (pre-instructional word-clearing, mathematics pre-teaching and conventional). The first and second “2” represents students’ gender (male and female) and study habits (positive and negative), respectively, while the last “3” represents the low, medium and high score levels.

The pre-instructional word-clearing, mathematics pre-teaching and conventional strategies of teaching constituted the independent variables while the dependent variable was students’ achievement. The moderating variables in this study were students’ gender, score levels, and study habits.

The schematic representation of the research design is as follows:

Groups	Pretest	Treatment	Posttest
Experimental Group 1	O ₁	X ₁	O ₂
Experimental Group 2	O ₁	X ₂	O ₂
Control Group	O ₁		O ₂

Where:

O_1 = Pre-test administered to the three groups

O_2 = Post-test administered to the three groups

X_1 = Treatment (Pre-instructional Word-clearing) for Experimental Group

X_2 = Treatment (Mathematics Pre-teaching) for Experimental Group Two

Population, Sample, and Sampling Techniques

The population for this study was all the Senior Secondary School Students offering Biology in Ilorin, Nigeria. The target population consisted of all senior secondary school three (SSS III) students offering Biology in Ilorin. The sample for this study consisted of 172 (73 male and 99 female) senior secondary school three (SSS III) students from three intact classes. Senior Secondary School three (SSS III) students were considered appropriate for this study because the content area for the study was scheduled to be taught at this level in the Senior Secondary School Biology curriculum.

The participants were drawn from three co-educational schools that were purposively selected from a total of 75 senior secondary schools in Ilorin Metropolis. The choice of co-educational schools was because gender is one of the variables considered in this study. The three co-educational schools were designated to experimental group one, experimental group two and control group, respectively.

Research Instrument

Five research instruments that comprised response and stimulus instruments were used in this study. The response instruments include Genetics Achievement Test (GAT) and Questionnaire on Biology Students' Study Habits (QBSSH) while the stimulus instrument was the Manual for Word Clearing (MWC), Instructional Module for Mathematics Pre-teaching (IMMP) and Lesson Plans for experimental and control groups.

The Genetics Achievement Test (GAT) was a researcher designed multiple-choice items that consisted of two sections (A and B). Section A contained the bio-data of students while Section B consisted of sixty (60) multiple-choice test items on Genetics with four (4) options (A-D) where one is the correct option. Details of GAT and its Marking Scheme can be found in Appendices III and IV. Bloom's taxonomy of educational objectives was used to prepare the GAT items to cover the lower-order cognitive skills namely; knowledge, comprehension, and application (See Appendix V)

The Questionnaire on Biology Students' Study Habits (QBSSH) was adapted from Bakare (1977) study habits inventory. The QBSSH was used to test students' reading speed, writing skills, time management, concentration, note-taking, and test anxiety management. The main modification to the original instrument was the reframing of the inventory questions to elicit information about Biology students' study habits. The QBSSH was divided into two

sections; A and B. Section A contained the bio-data of the students while Section B consisted of the items on study habits.

The “Manual for Word Clearing (MWC)” was a researcher designed instrument which served as an instructional guide for the research assistant in experimental group one. The MWC consisted of words that were defined using Biology Dictionaries, English Dictionaries and Biology Textbooks. In addition, the “Instructional Module for Pre-teaching of Mathematics (IMPM)” served as the instructional guide for a research assistant in experimental group two. Lesson Plans were prepared by the researcher to guide the research assistants in the three groups on each of the strategies used in the study.

Validation of the Research Instrument

The Genetics Achievement Test (GAT) and Questionnaire on Biology Students’ Study Habits (QBSSH) were validated by three seasoned Biology teachers from three secondary schools in Ilorin, Nigeria, and two Biology Education lecturers from the Department of Science Education, University of Ilorin, Ilorin, Nigeria. The validators checked the content coverage, structure, language, and face value of the instruments. All the corrections suggested by the validators were effected in producing the final copies of the instruments used for this study.

In addition, to improve the validity of the GAT, item analysis was conducted to determine the difficulty index and discrimination index of each GAT items using the item analysis formula proposed by Sabri (2013).

$$p = \frac{R}{T} \times 100$$

Where:

p = difficulty index

R = Number of students in the upper and lower thirds who got the item right.

T = Total number of students in the upper and lower thirds combined

The discrimination index, on the other hand, was computed using the formula;

$$D = \frac{R_U - R_L}{\frac{1}{2}T}$$

Where:

D = Discrimination index

R_u = Number of students in the upper third who got the item right

R_L = number of students in the lower third who got the item right

T = total number of students in the upper and lower thirds

The test items in which 70% and above of the respondents scored above 80 marks were considered very easy, while those items in which 70% and above of the respondents scored less than 30 marks were considered very difficult. 14 items were removed altogether with 7 each for “very difficult and very easy” respectively. Items 54 to 60 were removed for “very easy” as they fell within the range of 30 marks and below, while items 1 to 7 were removed as they were considered “very difficult” from the instruments. The total items retained were 44 with a range of 31 to 69 marks. However, the average difficulty index and

discrimination power of Genetics Achievement Test (GAT) items were 0.3 and 0.46 respectively. See Appendix (V).

The reliability of the GAT and QBSSH were achieved by trial testing the test items using a test-retest method in an intact class of students from a school in Ilorin that were not part of the sample. The scores obtained were analyzed using Cronbach Alpha. A reliability coefficient of 0.98 and 0.83 was obtained for the GAT and QBSSH, respectively.

Procedure for Data Collection

The researcher presented a letter of introduction obtained from the Head of Department of Science Education, University of Ilorin, Ilorin, Nigeria, to the principals of the sampled schools to seek permission to conduct the research and to involve their students and teachers in the study. Thereafter, the consent of the teachers who served as research assistants and those of the participating students were sought through informed consent forms given to each of the teachers and students to indicate their willingness to participate in the study.

The study lasted for four weeks. In week one, the research assistants (Biology teachers) from the experimental schools were trained by the researcher on how to implement the treatments using pre-instructional word-clearing and mathematics pre-teaching. The training was held in one of the experimental schools while the researcher provided refreshments for the research assistants during the period of the training. In addition, the GAT was administered as a pretest during the first week so as to determine the prior knowledge of

participants in Genetics before the commencement of the experiment and the scores emanated were used to group the students into the low, medium and high score levels. The QBSSH was also administered during the first week across the groups to determine the study habit of the students.

The administration of treatments was conducted during the second and third week by the trained research assistants using two periods of 80 minutes each week. Students in experimental groups one were taught using Manual for Word Clearing (MWC) while those in experimental group two were taught using Instructional Module for Mathematics Pre-teaching (IMMP). The lesson plans were used by the research assistants in experimental groups one and two as well as the control group as guides during the implementation of the treatment using Pre-instructional Word-clearing, Mathematics Pre-teaching and Conventional strategies of teaching, respectively.

During the fourth week, the GAT previously administered as a pretest was reshuffled to avoid students getting familiar with the questions. This was administered as a posttest to all the groups so as to determine the achievement of students' in genetics.

In line with research ethics, all the information provided by the participants were treated with the utmost confidentiality and used solely for the purpose of the research. The participants were not compelled to participate in the research; hence, they can withdraw from the study at any point in time. In addition, all participants were informed that no risk is envisaged to their

personality since the lessons will take place during their normal Biology periods rather, participants will benefit from the research in terms of improving their performance in Biology.

Data Analysis Techniques

The data collected in this study were analyzed using descriptive and inferential statistics. The mean and standard deviation was used to answer all the 11 research questions while the *t*-test and Analysis of Covariance (ANCOVA) were used to test the null hypotheses at 0.05 level of significance. Specifically, hypotheses 1, 2, 3, 4, 7 and 8 were tested using the *t*-test because they consisted of one categorical and one continuous variable. Hypotheses 5, 6, 9, 10 and 11 were tested using Analysis of Covariance. The Statistical Package for Social Sciences (SPSS) Version 23.0 software was used for the data analysis.

CHAPTER FOUR

DATA ANALYSIS AND RESULTS

This chapter presents the data that was gathered, analyzed and the results obtained. The descriptive and inferential statistical analyses were carried out the data. Statistical Package for Social Sciences (SPSS) Version 23.0 software was used for the data analysis. All the twelve (12) research questions had corresponding twelve (12) research hypotheses that were tested using the *t*-test and Analysis of Covariance (ANCOVA) statistics at 0.05 Alpha level of significance. Specifically, hypotheses 1, 2, 3, 4, 5, 8 and 9 were tested using the *t*-test while hypotheses 6, 7, 10, 11 and 12 were tested using Analysis of Covariance (ANCOVA).

Demographics of the Groups

Table 1 presents the demographic characteristics of the senior school students that were involved in the study. A total of 172 students participated in the study, out of which 73(42.4%) were males while 99(57.6%) were females. This implies that majority of the respondents were female students. Also, 40(23.3%) were low scorer students, 54(31.4%) were medium scorer students while 78(45.4%) were high scorer students. It, therefore, means that most of the respondents are high scorers. Finally, the majority of respondents had positive study habits 118(66.28%) while 58(33.72%) of the respondents had negative study habits.

Table 1

Demographic Representation of the Respondents with Descriptive Statistics

Variables	Pre-Instructional		Pre-Teaching		Control		Total	
Gender	F	%	F	%	F	%	F	%
Male	23	44.23	22	44.00	28	40.00	73	42.44
Female	29	55.77	28	56.00	42	60.00	99	57.56
Total	52	100.00	50	100.00	70	100.00	172	100.00
Score level	F	%	F	%	F	%	F	%
Low	11	21.15	15	30.00	14	20.00	40	23.26
Medium	17	32.69	11	22.00	26	37.14	54	31.40
High	24	46.15	24	48.00	30	42.86	78	45.35
Total	52	100.00	50	100.00	70	100.00	172	100.00
Study habit	F	%	F	%	F	%	F	%
Negative	20	38.46	20	40	18	25.71	58	33.72
Positive	32	61.54	30	60	52	74.29	114	66.28
Total	52	100	52	100.00	70	100.00	172	100.00

Research Question 1: What effect does pre-instructional word-clearing have on senior school students' achievement in genetics?

Table 2 reveals the achievement of Biology students taught genetics using pre-instructional word-clearing (experimental) and conventional (control) strategies. The pretest mean scores of students taught genetics using pre-instructional word-clearing and conventional methods were (21.10 and 18.68) respectively, while the posttest mean scores were (41.94 and 37.74) respectively. The mean gain scores for experimental and control groups were (20.84 and 19.06), respectively. It is apparent that there was a difference between the mean gain score of experimental and control groups with the group

taught using pre-instructional word-clearing having a higher mean gain score and a mean gain score difference of 1.78 in favour of the experimental group.

Table 2

Mean Gain Difference of Students Achievement in Genetics for Pre-Instructional Word-Clearing and Control Groups

Group	No. of Respondents	Pre-test		Post-test		Mean Gain
		Mean	Std.	Mean	Std.	Mean Diff.
Control	70	18.68	5.58	37.74	6.07	19.06
Experimental 1	50	21.10	8.47	41.94	8.55	20.84

H0₁: There is no statistically significant difference in the achievement of students taught genetics using pre-instructional word-clearing and those taught using conventional strategy.

The result of the *t*-test analysis presented in Table 3 indicates that the *t*-value ($t_{(118)}=3.38$; $p<0.05$) was significant because the *p*-value 0.01 is less than 0.05 alpha level. This suggested that there was a significant difference between the achievements of students taught genetics using the pre-instructional word-clearing strategy and the control group with the result being in favour of the pre-instructional word clearing group and it provided the answer to research question one. Hence, hypothesis 1 was rejected. This implies that pre-instructional word-clearing improves students' achievement in genetics.

Table 3

The t-test Results of Significant Difference between the Achievement of Pre-instructional Word-clearing and Control Groups

Group	N	Mean	Std.	Df	T	Sig.	Remark
Control	70	37.74	6.07	118	3.38	.001	S
Experimental 1	50	41.94	8.55				

$p < 0.05$

Research Question 2: What effect does mathematics pre-teaching strategy have on senior school students' achievement in genetics?

Table 4 reveals the achievement of Biology students taught genetics in the experimental and control groups. The pretest mean scores of students taught genetics using mathematics pre-teaching and control groups were (19.96 and 18.56) respectively, while the posttest mean scores were (39.19 and 37.56) respectively. The mean gain scores for experimental and control groups were (19.23 and 19.00), respectively. It is apparent that there was a difference between the mean gain score of experimental and control groups with the group taught using mathematics pre-teaching having a higher mean gain score and a mean gain score difference of 0.23 in favour of the experimental group two.

Table 4

Mean Gain Difference of Students taught with Mathematics pre-teaching (Experimental 2) and Conventional (Control) Strategies

Group	No. of Respondents	Pre-test		Post-test		Mean Gain
	N	Mean	SD	Mean	SD	Mean Gain
Control	70	18.56	5.57	37.56	6.03	19.00
Experimental 2	52	19.96	9.27	39.19	9.36	19.23

H0₂: There is no statistically significant difference in the achievement of students taught genetics using mathematics pre-teaching of genetics and those taught without using mathematics pre-teaching of genetics.

The result of the *t*-test analysis presented in Table 5 indicates that the *t*-value ($t_{(120)}=-0.99$; $p<0.05$) was significant because the *p*-value 0.03 is less than 0.05 alpha level. This suggested that there was a significant difference between the achievements of students taught genetics using the mathematics pre-teaching strategy and the control group with the result being in of favour of mathematics pre-teaching strategy group and it provided the answer to the research question two. Hence, hypothesis 2 was rejected. This implies that the pre-teaching of mathematics components of genetics improves students' achievement in genetics.

Table 5

The t-test Results of Significant Difference between the Achievement of pre-teaching strategy and Control Groups

Group	N	Mean	SD	df	T	Sig.	Remark
Control	70	37.56	6.03	120	-.99	.03	S
Experimental 2	52	39.19	9.36				

$p<0.05$

Research Question 3: Do male and female students achieve differently when taught genetics using pre-instructional word-clearing?

Table 6 reveals the achievement of male and female students taught genetics using pre-instructional word-clearing. The mean score for male students was 38.78 while the female students had 39.52. It is apparent that the mean score of female students was higher than that of the male students with a marginal mean score difference of 0.74 in favour of the female students.

Table 6

Mean Scores of Male and Female Students' Achievement in Genetics using Pre-instructional Word-clearing

Treatment	Gender	N	Mean	SD
Pre-instructional	Male	23	38.78	9.42
	Female	29	39.52	9.46

H0₃: There is no statistically significant difference in the achievement of male and female students' taught genetics using pre-instructional word-clearing.

The result of the *t*-test analysis presented in Table 7 indicates that the *t*-value ($t_{(50)} = -0.28$; $p > 0.05$) was not significant because the *p*-value 0.78 is greater than 0.05 alpha level. This suggested that there was no significant difference between the achievements of male and female students taught genetics using a pre-instructional word-clearing strategy and it provided the answer to research question four. Hence, hypothesis 3 was not rejected. This means that students, irrespective of their gender, achieve significantly when taught using a pre-instructional word-clearing strategy.

Table 7

The t-test Results of Significant Difference between the Achievement of Male and Female Students in Pre-instructional Word-clearing Group

Treatment	Gender	N	Mean	SD	df	t	Sig.	Remark
Pre-instructional	Male	23	38.78	9.42	50	-.28	.78	NS
	Female	29	39.52	9.46				

$p > 0.05$

Research Question 4: Do male and female students achieve differently when taught genetics using mathematics pre-teaching strategy?

Table 8 reveals the achievement of male and female students taught genetics using mathematics pre-teaching strategy. The mean score for male students was 41.59 while the female students had 42.21. It is apparent that the mean score of female students was higher than that of the male students with a marginal mean score difference of 0.62 in favour of the female students.

Table 8

Mean Scores of Male and Female Students' Achievement in Genetics using Mathematics Pre-teaching strategy

Treatment	Gender	N	Mean	SD
Pre-teaching	Male	22	41.59	8.57
	Female	28	42.21	8.68

H0₄: There is no statistically significant difference in the achievement of male and female students' taught genetics using mathematics pre-teaching strategy.

The result of the *t*-test analysis presented in Table 9 indicates that the *t*-value ($t_{(48)}=0.25$; $p > 0.05$) was not significant because the *p*-value 0.80 is greater

than 0.05 alpha level. This suggested that there was no significant difference between the achievements of male and female students taught genetics using mathematics pre-teaching strategy and it provided the answer to research question five. Hence, hypothesis 4 was not rejected. This means that students, irrespective of their gender achieve, significantly when taught using mathematics pre-teaching strategy.

Table 9

The t-test Results of Significant Difference between the Achievement of Male and Female Students in mathematics pre-teaching of genetics Group

Treatment	Gender	N	Mean	SD	df	t	Sig.	Remark
Pre-teaching	Male	22	41.59	8.57	48	-.25	.80	NS
	Female	28	42.21	8.68				

p>0.05

Research Question 5: Does the achievement of students with different score levels differ when taught genetics using pre-instructional word-clearing?

The mean score of students' achievement presented in Table 10 clearly indicates that the low scorers' students have 33.36 followed by the medium scorers' students with a 38.47 mean score, while the high scorers' students had 42.38 when taught genetics using pre-instructional word-clearing strategy. It is apparent that the mean score of high scorers' students was higher than that of the medium and low scorers. This entailed that high scorers' students benefitted most from the teaching of genetics using a pre-instructional word-clearing strategy since they had the highest mean score.

Table 10

Post-Test Mean and Standard Deviation of Score Levels of Achievement of Students' in Pre-instructional Word-clearing Group

Score levels	N	Mean	Std.
Low	11	33.36	6.454
Medium	17	38.47	9.566
High	24	42.38	9.226

H0₅: There is no statistically significant difference in the achievement of high, medium and low scoring students taught genetics using pre-instructional word-clearing.

The result of the Analysis of Covariance (ANCOVA) analysis presented in Table 10 indicates that the F -value ($F_{(2,48)}=4.72$; $p<0.05$) was significant because the p -value 0.01 is less than 0.05 alpha level. The result suggested that there was a significant difference in the achievement of low, medium and high scorer students taught genetics using pre-instructional word-clearing strategy. The outcome is in favour of the high scorer students and it provided the answer to research question six. Hence, hypothesis 5 was rejected. This implies that the use of a pre-instructional word-clearing strategy improved the achievement of high scorer students greatly in genetics than the medium and low scorer.

Table 11

Summary of One-way Analysis of Covariance of Significant Difference among the Achievement of Low, Medium and High Scorer Students' in Pre-instructional Word-clearing Group

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected model	893.39a	3	297.80	4.00	.01
Intercept	9424.72	1	9424.72	126.70	.00
Pre-test	267.72	1	267.72	3.60	.06
Score level	702.08	2	351.04	4.72	.01
Error	3570.69	48	74.39		
Total	84338.00	52			

a. R Squared = .16 (Adjusted R Squared = .150)

Table 12

Pos-hoc Analysis of Mean Differences of Students taught Genetics with Pre-instructional Word-clearing based on their Score levels Using Bonferroni

(I)Score level	(I)Score level	Mean difference (I-J)	Std. Error	Sig. ^b
Low	Medium	-5.424	3.342	.333
	High	-9.590*	3.155	.011
Medium	Low	5.424	3.342	.333
	High	-4.166	2.738	.404
High	Low	9.590*	3.155	.011
	Medium	4.166	2.738	.404

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Research Question 6: Does the achievement of students with different score levels differ when taught genetics using mathematics pre-teaching strategy?

The mean score of students achievement presented in Table 12 clearly indicates that the low scorers' students have 46.80 followed by the medium

scorers' students with 42.45 mean scores while the high scorers' students had 38.67 when taught genetics using mathematics pre-teaching strategy. It is apparent that the mean score of low scorers' students was higher than that of the medium and high scorers. This entailed that low scorers' students benefitted most from the teaching of genetics using mathematics pre-teaching strategy since they had the highest mean score.

Table 13

Post-Test Mean and Standard Deviation of Score Levels of Achievement of Students' in Mathematics Pre-teaching strategy

Score levels	N	Mean	Std.
Low	15	46.80	6.505
Medium	11	42.45	9.822
High	24	38.67	7.833

H0₆: There is no statistically significant difference in the achievement of high, medium and low scoring students taught genetics using mathematics pre-teaching strategy.

The result of the Analysis of Covariance (ANCOVA) analysis presented in Table 13 indicates that the F -value ($F_{(2,46)}=9.77$; $p<0.05$) was significant because the p -value 0.001 is less than 0.05 alpha level. The result suggested that there was a significant difference in the achievement of low, medium and high scorer students taught genetics using mathematics pre-teaching strategy. This outcome is in favour of low and medium scorer students and it provided the answer to research question seven. Hence, hypothesis 7 was rejected. This

implies that the use of mathematics pre-teaching strategy improved the achievement of low and medium scorer students greatly in genetics than high scorer.

Table 14

Summary of One-way Analysis of Covariance of Significant Difference among the Achievement of Low, Medium and High Scorer Students' in Mathematics Pre-teaching strategy Group

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected model	1543.82a	3	514.61	11.61	.001
Intercept	6378.91	1	6378.91	143.91	.001
Pre-test	929.46	1	929.46	20.97	.001
Score level	866.02	2	433.01	9.77	.001
Error	2039.00	46	44.33		
Total	91531.00	50			

a. R Squared = .16 (Adjusted R Squared = .15)

Table 15

Pos-hoc Analysis of Mean Differences of Students taught Genetics with Mathematics Pre-teaching strategy based on their Score levels Using Bonferroni

(I)Score level	(I)Score level	Mean difference (I-J)	Std. Error	Sig. ^b
Low	Medium	6.839*	2.698	.044
	High	9.804*	2.221	.000
Medium	Low	-6.839*	2.698	.044
	High	2.965	2.431	.686
High	Low	-9.804*	2.221	.000
	Medium	-2.965	2.431	.686

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Research Question 7: Does the achievement of students differ based on study habits when taught genetics using pre-instructional word-clearing?

Table 16 reveals the achievement of students' with positive and negative study habits taught genetics using pre-instructional word-clearing. The mean score for positive study habits was 74.63 while the negative study habit was 53.55. It is apparent that the mean score of students with positive study habits was higher than that of the students with negative study habits with a marginal mean score difference of 21.08. this outcome is in favour of the students with positive study habits.

Table 16

Mean Scores of Students' Achievement in Genetics Based on Study Habits using Pre-instructional Word-clearing

Treatment	Study Habit	N	Mean	Mean Difference	Standard Deviation
Pre-instructional	Negative	20	53.55	21.08	4.90
	Positive	32	74.63		8.93
	Total	52	64.09		6.92

H₀₇: There is no statistically significant difference in the achievement of students based on study habits when taught genetics using pre-instructional word-clearing.

The result of the *t*-test analysis presented in Table 17 indicates that the *t*-value ($t_{(50)} = -10.96$; $p < 0.05$) was significant because the *p*-value 0.00 is less than 0.05 alpha level. This suggested that there was a significant difference

between the achievements of students with positive and negative study habits taught genetics using pre-instructional word-clearing. This outcome was in favour of students with positive study habit and it provided the answer to research question eight. Hence, hypothesis 7 was rejected. This means that the use of pre-instructional word-clearing improved the achievement of students with positive study habits greatly in genetics.

Table 17

The t-test Results of Significant Difference between the Achievements of Students Based on Study Habits using Pre-instructional Word-clearing

Treatment	Study habit	<i>M</i>	<i>t</i>	<i>df</i>	Sig.
Pre-teaching	Positive	53.55	-10.96	50	.00
	Negative	74.63			

$P < 0.05$

Research Question 8: Does the achievement of students differ based on study habits when taught genetics using mathematics pre-teaching strategy?

Table 18 reveals the achievement of students with positive and negative study habits taught genetics using mathematics pre-teaching of genetics. The mean score for positive study habits was 72.40 while the negative study habit was 54.25. It is apparent that the mean score of students with positive study habit was higher than that of the students' with negative study habit with a marginal mean score difference of 18.15 which was in favour of the students with positive study habit.

Table 18

Mean Scores of Students' Achievement in Genetics Based on Study Habits using Mathematics Pre-teaching strategy

Treatment	Study Habit	N	Mean	Mean Difference	Standard Deviation
Pre-teaching	Positive	20	54.25		4.09
	Negative	30	72.40	18.15	8.38
	Total	50	63.33		6.24

H0₈: There is no statistically significant difference in the achievement of students based on study habits when taught genetics using mathematics pre-teaching strategy.

The result of the *t*-test analysis presented in Table 19 indicates that the *t*-value ($t_{(48)} = -8.98$; $p < 0.05$) was significant because the *p*-value 0.00 is less than 0.05 alpha level. This suggested that there was a significant difference between the achievements of students with positive and negative study habits taught genetics using mathematics pre-teaching strategy. This outcome was in favour of students with positive study habit and it provided answer to research question nine. Hence, hypothesis 9 was rejected. This means that the use of mathematics pre-teaching strategy improved the students with positive study habit greatly in genetics.

Table 19

The t-test Results of Significant Difference between the Achievements of Students Based on Study Habits using Mathematics Pre-teaching strategy

Treatment	Study habit	<i>M</i>	<i>t</i>	<i>df</i>	Sig.
Pre-teaching	Negative	54.25	-8.98	48	.00
	Positive	72.4			

$P < 0.05$

Research Question 9: Will there be any interaction effects of treatments and gender on students' achievement when taught genetics?

Table 20 reveals the interaction effects of mathematics pre-teaching strategy, pre-instructional word-clearing, conventional methods and gender on students' achievement when taught genetics. The mean score of male and female students in mathematics pre-teaching strategy group were 41.59 and 42.21 respectively, while the mean score of male and female students in pre-instructional word-clearing group were 38.78 and 39.52 respectively. Also, the mean scores of male and female students in the conventional strategy group were 37.07 and 35.55 respectively. Each mean score of male and female students in mathematics pre-teaching strategy, pre-instructional word-clearing and conventional strategy groups respectively were almost the same. However, the male and female students in mathematics pre-teaching strategy group had the highest mean score.

Table 20

*Description of Interaction Effects of Treatments and Gender on Students'**Achievement in Genetics*

Treatment	Gender	N	Mean	Std. Deviation
Pre-teaching	Male	22	41.59	8.573
	Female	28	42.21	8.681
	Total	50	41.94	8.551
Pre-instructional	Male	23	38.78	9.419
	Female	29	39.52	9.459
	Total	52	39.19	9.356
Control	Male	28	37.07	5.981
	Female	42	35.55	8.276
	Total	70	36.16	7.434
Total	Male	73	38.97	8.091
	Female	99	38.60	9.108
	Total	172	38.76	8.669

H0₉: There is no statistically significant interaction effects of treatments and gender on students' achievement when taught genetics.

The result of Analysis of Covariance (ANCOVA) presented in Table 21 indicates that the F -value ($F_{(2, 166)}=0.32$; $p>0.05$) was not significant because the p -value 0.71 was greater than 0.05 alpha level. The result suggested that there was no influence of gender on treatments. Therefore, mathematics pre-teaching of genetics and pre-instructional word-clearing had an effect on students' achievement.

Table 21

*ANCOVA Analysis of Interaction Effects of Treatments and Gender on Students'**Achievement in Genetics*

Source	Type III Sum of Squares	df	Mean Square	<i>F</i>	Sig.	Partial Eta Squared
Corrected Model	1040.30 ^a	5	208.06	2.93	.02	.08
Intercept	251975.66	1	251975.66	3541.91	.00	.96
Treatments	897.39	2	448.70	6.31	.00	.07
Gender	.13	1	.13	.00	.97	.00
Treatments * Gender	48.99	2	24.50	.34	.71	.00
Error	11809.45	166	71.14			
Total	271196.00	172				
Corrected Total	12849.74	171				

a. R Squared = .08 (Adjusted R Squared = .05)

Figure 1 shows the interaction effects of treatments and gender on students' achievement. It can be revealed on the graph that despite the presence of interception in the line-graph, it did not amount to significance as the interception was only between the control group and gender. This implies that pre-teaching and pre-instructional strategies were very effective in teaching genetics without or with little influence of gender.

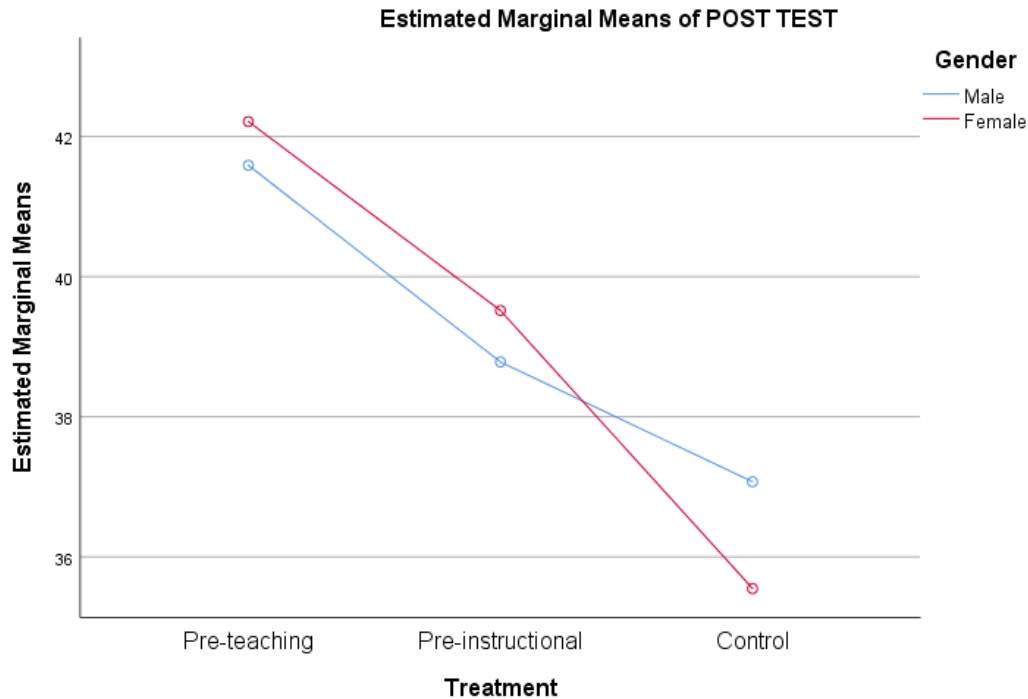


Figure 1: Interaction graph between treatments and gender

Research Question 10: Will there be interaction effects of treatments and score levels on students' achievement when taught genetics?

Table 22 revealed the interaction effects of the mathematics pre-teaching, pre-instructional word-clearing, conventional strategy and score levels on students' achievement when taught genetics. The mean scores of low, medium and high scorer students in the mathematics pre-teaching group were 46.80, 42.45 and 38.67 respectively, while the mean scores of low, medium and high scorer students in the pre-instructional word-clearing group were 33.36, 38.47 and 42.38, respectively. Also, the mean scores of low, medium and high scorer students in the conventional methods group were 32.50, 37.35 and 36.83, respectively. Each mean score of low, medium and high scorer students in pre-teaching of mathematics components of genetics, pre-instructional word-

clearing, and conventional strategy groups respectively, were almost the same. However, the low and medium scorer students in the mathematics pre-teaching strategy group had the highest achievement.

Table 22

Description of Interaction Effects of Treatments and Score Levels on Students'

Achievement in Genetics

Treatment	Score level	N	Mean	Std. Deviation
Pre-teaching	Low	15	46.80	6.51
	Medium	11	42.45	9.82
	High	24	38.67	7.83
	Total	50	41.94	8.55
Pre-instructional	Low	11	33.36	6.45
	Medium	17	38.47	9.57
	High	24	42.38	9.23
	Total	52	39.19	9.36
Control	Low	14	32.50	7.52
	Medium	26	37.35	8.37
	High	30	36.83	6.13
	Total	70	36.16	7.43

H0₁₀: There is no statistically significant interaction effects of treatments and score levels on students' achievement when taught genetics.

The result of the Analysis of Covariance (ANCOVA) presented in Table 23 indicates that the F -value ($F_{(2, 166)}=5.56$; $p < 0.05$) was significant because the p -value 0.00 was less than 0.05 alpha level. The result suggested that there was an influence of score levels on treatments. Therefore, the mathematics pre-

teaching of genetics and pre-instructional word-clearing had great effects on students' achievement based on score levels of students.

Table 23

ANCOVA Analysis of Interaction Effect of Treatment and Score Levels on Students' Achievement in Genetics

Source	Type III Sum of Squares	df	Mean Square	<i>F</i>	Sig.
Corrected Model	2467.33 ^a	8	308.42	4.84	.00
Intercept	227900.93	1	227900.93	3577.96	.00
Treatments	1324.21	2	662.10	10.40	.00
Score level	96.06	2	48.03	.75	.47
Treatments * Score level	1416.78	4	354.19	5.56	.00
Error	10382.42	166	63.70		
Total	271196.00	172			
Corrected Total	12849.74	171			

a. R Squared = .19 (Adjusted R Squared = .15)

Also, Table 24 shows the Bonferroni Post-hoc analysis of mean difference which revealed that differences existed among the treatments (mathematics pre-teaching of genetics and pre-instructional word-clearing) and the control.

Table 24

Pos-hoc Analysis of Mean Differences of Students taught Genetics based on their Score levels Using Bonferroni

(I) Treatment	(J) Treatment	Mean	Std. Error	Sig.
		Difference (I-J)		
Pre-teaching	Pre-instructional	2.75	1.581	.252
	Control	5.78*	1.478	.000
Pre-instructional	Pre-teaching	-2.75	1.581	.252
	Control	3.04	1.461	.118
Control	Pre-teaching	-5.78*	1.478	.000
	Pre-instructional	-3.04	1.461	.118

Based on observed means. The error term is Mean Square (Error) = 63.696.

*. The mean difference is significant at the .05 level.

In addition, Figure 2 further indicates the existence of the interception of line-graphs of treatments and score levels, which implies some form of influence of score levels on the treatments. The implication is that pre-instructional word-clearing is more effective than mathematics pre-teaching of genetics as there was no significant interaction between pre-teaching and control as shown in Table 24.

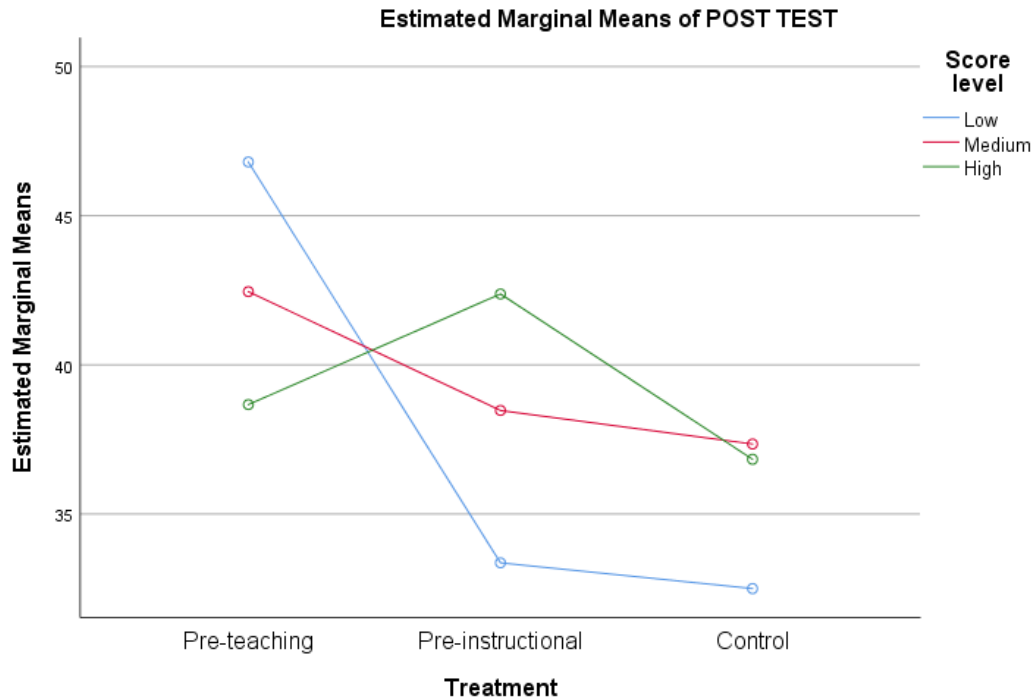


Figure 2: Interaction graph between treatment and score levels

Research Question 11: Will there be interaction effects of treatments and study habits on students' achievement when taught genetics?

Table 25 reveals the interaction effects of mathematics pre-teaching, pre-instructional word-clearing, conventional strategies and study habits on students' achievement when taught genetics. The mean score of positive and negative study habits students in mathematics pre-teaching group were 41.77 and 42.20 respectively, while the mean score of positive and negative study habits students in the pre-instructional word-clearing group were 40.31 and 37.40 respectively. Also, the mean scores of positive and negative study habits' students in the conventional methods group were 35.89 and 36.25 respectively. Each mean score of positive and negative study habits' students in mathematics pre-teaching, pre-instructional word-clearing and conventional strategies groups

respectively, were almost the same. However, the positive and negative study habits' students in the mathematics pre-teaching group had the highest achievement.

Table 25

Description of Interaction Effects of Treatments and Study Habits on Students' Achievement in Genetics

Treatment	Study habit	N	Mean	Std. Deviation
Pre-teaching	Negative	20	42.20	9.790
	Positive	30	41.77	7.789
	Total	50	41.94	8.551
Pre-instructional	Negative	20	37.40	7.549
	Positive	32	40.31	10.281
	Total	52	39.19	9.356
Control	Bad	18	35.89	7.522
	Negative	52	36.25	7.475
	Positive	70	36.16	7.434
Total	Negative	58	38.59	8.671
	Positive	114	38.84	8.704
	Total	172	38.76	8.669

H0₁₂: There is no statistically significant interaction effects of treatments and study habits on students' achievement when taught genetics.

The result of the Analysis of Covariance (ANCOVA) presented in Table 26 indicates that the F -value ($F_{(2, 166)}=0.53$; $p>0.05$) was not significant because the p -value 0.59 was greater than 0.05 alpha level. The result suggested that there was no influence of study habits (Negative and Positive) on treatments. Therefore, the mathematics pre-teaching and the pre-instructional word-clearing strategies had great effects on students' achievement.

Table 26

ANCOVA Analysis of Interaction Effect of Treatment and Study Habits on Students' Achievement in Genetics

Source	Type III Sum of Squares	df	Mean Square	<i>F</i>	Sig.
Corrected Model	1097.98 ^a	5	219.60	3.10	.01
Intercept	228395.21	1	228395.21	3226.20	.00
Treatments	884.75	2	442.38	6.25	.00
Study habit	33.70	1	33.70	.48	.49
Treatments *	75.00	2	37.50	.53	.59
Study habit					
Error	11751.77	166	70.79		
Total	271196.00	172			
Corrected Total	12849.74	171			

a. R Squared = .09 (Adjusted R Squared = .06)

Also, Figure 3 shows that despite the presence of interception, the line-graphs were not significant as the interception was very weak. This implies that mathematics pre-teaching and the pre-instructional word-clearing strategies were very effective in teaching genetics without the influence of study habits.

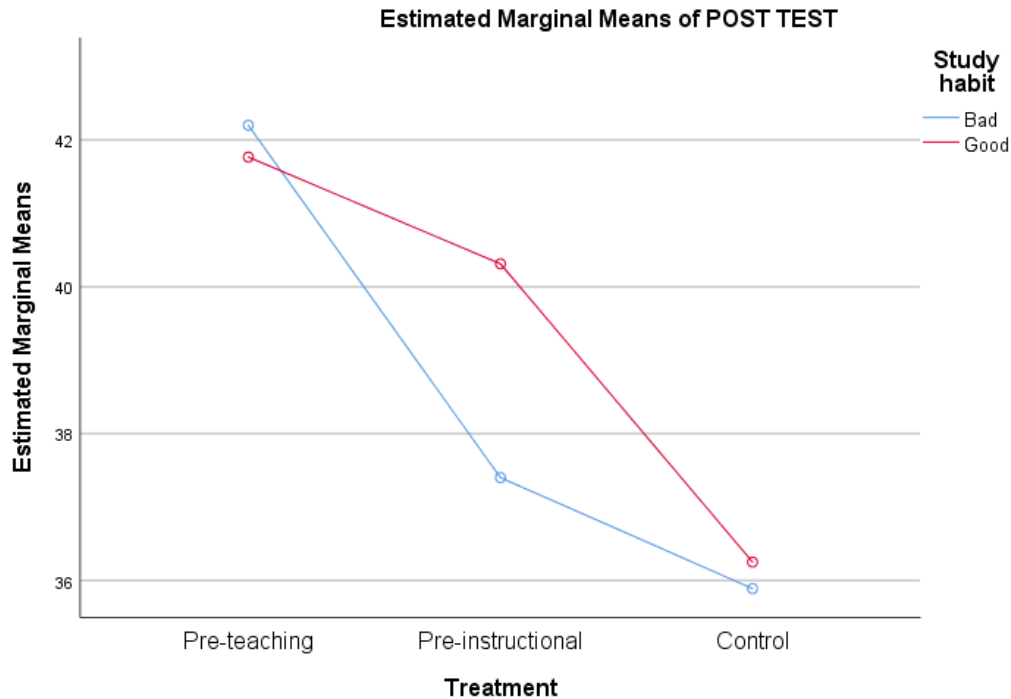


Figure 3: Interaction graph between treatment and Study habits

Summary of the Findings

The following are the major findings of the study:

- i. There was a significant difference in the achievement of students taught genetics using pre-Instructional word-clearing and those taught using conventional strategy. The outcome was in favour of those taught using a pre-Instructional word-clearing strategy. ($t_{(118)}=3.38$; $p<0.05$);
- ii. There was a significant difference in the achievement of students taught genetics using mathematics pre-teaching of Genetics and those taught using conventional strategy. The outcome was in favour of those taught using mathematics pre-teaching strategy. ($t_{(120)}=-0.99$; $p<0.05$);

- iii. There was no significant difference in the achievement of male and female students taught genetics using a pre-instructional word-clearing strategy. ($t_{(50)}=-0.28$; $p>0.05$);
- iv. There was no significant difference in the achievement of male and female students taught genetics using mathematics pre-teaching strategy. ($t_{(48)}=0.25$; $p>0.05$);
- v. There was a significant difference in the achievement of low, medium and high scoring students taught genetics using pre-instructional word-clearing strategy. The outcome favours the high scorers. ($F_{(2,48)}=4.72$; $p<0.05$);
- vi. There was a significant difference in the achievement of low, medium and high scoring students taught genetics using mathematics pre-teaching strategy. The outcome was in favours of the low and medium scorers. ($F_{(2,46)}=9.77$; $p<0.05$);
- vii. There was a significant difference in the achievement of students with positive and negative study habits when taught genetics using pre-instructional word-clearing strategy. The outcome being in favour of students with positive study habits. ($t_{(50)} = -10.96$; $p < 0.05$);
- viii. There was a significant difference in the achievement of students with positive and negative study habits when taught genetics using mathematics pre-teaching strategy. The outcome was in favour of students with positive study habits ($t_{(48)}= -8.98$; $p < 0.05$);

- ix. There was no interaction effects of gender on treatments when taught genetics ($F_{(2, 166)}=0.32$; $p>0.05$);
- x. There was interaction effects of score levels on treatments when taught genetics ($F_{(2, 166)}=5.56$; $p< 0.05$); and
- xi. There was no interaction effects of study habits on treatments when taught genetics ($F_{(2, 166)}=0.53$; $p>0.05$).

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

This chapter presents the discussion of the findings, the conclusion from the findings and recommendations were made as related to the findings.

Discussion

Finding from this study revealed that students taught genetics using pre-instructional word-clearing strategy achieved better than those that were taught genetics using conventional strategy. This could be as a result of the fact that the genetics terms which could have been difficult for students to understand were already cleared and understood by the students before the main lesson was presented, giving the students the opportunity to link those terms and make meaningful learning. Thus, this implies that the pre-instructional word-clearing strategy improved students' achievement in genetics as it assists students to understand the concept related to genetics before they are exposed to teaching. It also provides students with the ability to synthesis the piece of information which eventually leads to improved achievement.

This finding, therefore, agreed with the submission of Ahmed (2018) who reported that students at whatever levels would be more efficient when teacher adopted the use of word-clearing strategy in teaching any concepts, where the difficult terms and their various misconceptions would be cleared to aid improvement of their understanding. This outcome also corroborates with the findings of Obioha and Danjuma (2021) whose result from their findings

revealed that the use of subsumers of Biology terminologies on secondary school students improved the students' achievement in Biology. Also, in line with the findings of Gbigbadua, Abimbola and Ahmed (2014) who found out that utilization of pre-instructional word-clearing strategy as an instructional strategy enhances better grades in students' performance in Biology.

Another finding from this study showed that students taught genetics using mathematics pre-teaching strategy achieved better than those that were taught genetics using the conventional strategy. Perhaps, the Mathematics aspects of genetics have been simplified before the main lesson was presented which probably helped the students to understand the content effortlessly and meaningfully. It also implies that the use of mathematics pre-teaching strategy serves as the foundation on which the new information that is the content of genetics was built, Therefore, the use of mathematics pre-teaching strategy was able to simplify the mathematical aspect of genetics which students perceived difficult to comprehend, thereby making the understanding of genetics easy. Their understanding was glaring in the improved performance of the group exposed to it. This, therefore, implies that mathematics pre-teaching strategy had enriched the students' understanding of genetics and consequently improved their achievement. This is in agreement with the results of Busari (2014), and Badmus, Akanmu and Akanbi (2015) where the researchers in their separate findings affirmed that students' prior deep understanding of mathematics can influence their performance in other science subjects.

It was found in this study that no significant difference existed in the achievement of male and female students taught genetics using pre-instructional word-clearing. This implies that the use of a pre-instructional word-clearing strategy can be used to teach biology students irrespective of their gender; it, therefore, can be adopted in any co-educational schools. This finding corroborates with the finding of Gbigbadua, Abimbola and Ahmed (2014) who reported that there is no significant difference in the achievement of students when taught genetics using pre-instructional word-clearing strategy. However, it opposed the finding of Ahmed (2018) who recorded that male students outperformed female students in the interaction effect of learning Ecology with a demo kit, learning on a gradient and word-clearing strategy.

It was also revealed from the findings that there was no significant difference in the achievement of male and female students taught genetics using mathematics pre-teaching strategy. Arguably, both male and female students were taught the same tasks and the content of genetics does not contain gender bias statements and activities. Thus, both male and female students were exposed to the same experience when taught using mathematics pre-teaching strategy.

This finding is in agreement with the finding of Ikide and Edet (2013). Their study showed that gender has no significant effect on students' achievement when taught Biology using guided-inquiry demonstration and lecture teaching strategy. This outcome is in support of the finding of Busari

(2014) who also reported that gender had no significant difference when students were taught genetics using mathematics pre-teaching as an instructional strategy. Conversely, the finding is not in support of the finding of Jibrin and Zayum (2012) whose result indicated that male students taught genetics using concept mapping as an instructional method performed better than their female counterparts. Also against the result of Odagboyi (2015) which shows that there was a significant difference between the mean score in favour of male students, and this indicated that male students benefited most from the jigsaw method of instruction when compared with their female students' counterpart.

Furthermore, the result indicated that there was a significant difference in the achievement of students taught genetics using the pre-instructional word-clearing strategy on the basis of their score levels with high scorers benefitting most. This means that, even though the three levels had improved generally, but the outcome was in favour of the high scorers significantly. It can be said that the high scorers were able to grasp the terms related to genetics and as such retained it. This, in turn, led to a significant influence in their results against the low and medium scoring students. The implication of this finding is that the pre-instructional word clearing strategy should be used in classrooms dominated by high scoring students. This is also similar to the findings of Adeniran (2011) whose result shows that all students irrespective of their ability levels benefited from the study. And Onijamowo (2010) who noted that the scoring level of

students does not actually influence the number of misconceptions and alternative conceptions students hold. Thus, the high scorers held the least number of misconceptions and alternative conceptions. But against the finding of Gbigbadua, Abimbola and Ahmed (2014) whose result indicated that the use of pre-instructional word-clearing strategy had a greater influence on the students classified as low and medium scorers than the high scorers.

Similarly, it was revealed that there was a significant difference in the achievement of low, medium and high scoring students when taught genetics using mathematics pre-teaching strategy. The outcome was in favour of the low and medium scorers. Perhaps, the mathematics pre-teaching strategy was simple enough for low and medium scoring students. The result implies that mathematics pre-teaching strategy can be used to improve the academic achievement of academically weak and average students (low and medium scoring level learners). This finding agreed with those of Gbigbadua, Abimbola and Ahmed (2014), and Adeniran (2011). Their individual findings revealed that scoring level had a significant influence on the achievement of students with a specific note that low scoring students and medium scoring students achieved better than the high scorers.

In addition, the finding from this study revealed that there was a significant difference in the achievement of students with positive and negative study habits when taught genetics using a pre-instructional word-clearing strategy. The outcome was in favour of students with positive study habits.

This implies that the use of the treatment improved the understanding of students with positive study habits in genetics. This could be that the pre-instructional word-clearing strategy fosters positive and independent thinking ability of these sets of students to enable them to integrate already clear genetics terminologies during the actual teaching of the genetics concepts. Therefore, these enhance their understanding as reflected in their achievement scores. This finding corroborates the opinion of Mac (2011) who observed that good (positive) study habits contribute to a successful academic future of students and also boost students' ability to be self-disciplined and self-directed thereby leading to good grades in their academic. Also in agreement with the finding of Ebele and Ofolu (2017) which revealed that there was a significant relationship between study habits and academics performance of secondary school Biology students.

It was also revealed from the finding of this study that there was a significant difference in the achievement of students with positive and negative study habits when taught genetics using mathematics pre-teaching strategy. The outcome was in favour of students with positive study habits. This also means that the teaching strategy employed by the teacher in teaching genetics enhances the understanding of students with positive (good) study habits. This finding agreed with that of Odiri (2015) whose result shows that there was a significant difference between students with positive study habits and students with poor study habits.

Furthermore, no interaction effect of gender on treatments (pre-instructional word-clearing strategy and mathematics pre-teaching strategy) when taught genetics. Possibly, pre-instructional word-clearing and mathematics pre-teaching strategy used as treatments were not proscribed by the interaction effects of gender; it, however, somewhat improved students' achievement in genetics in spite of the moderating variable.

Another finding revealed that there was an interaction effect of score levels on treatments (pre-instructional word-clearing and mathematics pre-teaching strategies) when taught genetics. Possibly, pre-instructional word-clearing and mathematics pre-teaching strategies used for treatments were proscribed by the interaction effects of score levels.

Also in this study, there was no interaction effect of study habits on treatments when taught genetics. Possibly, pre-instructional word-clearing and mathematics pre-teaching strategies used as treatments were not proscribed by the interaction effect of study habits. Nevertheless, its somewhat improved students' achievement in genetics in spite of the moderating variable. This is in agreement with the findings of Babu and Govindharajan (2014) that revealed that there is a negligible correlation between study habits towards Biology among higher secondary students.

Conclusion

It was concluded that pre-instructional word-clearing strategy and mathematics pre-teaching strategy enhance students' achievement in Genetics

specifically among the low and medium scorer and between students with positive and negative study habits, irrespective of gender.

Recommendations

The study recommends the following based on the findings:

1. Government at all levels and school administrators should encourage the Biology Teacher on the use of innovative instructional strategies such as pre-instructional word-clearing and mathematics pre-teaching to teach genetics and other biology-mathematics related topics to improve performance in biology so as to ensure that students learning progress from known to unknown for meaningful learning to take place.
2. Biology teachers should always make uses of Biology Dictionary to clarify those genetics terminologies that could lead to misunderstood words and deep knowledge of basic mathematics especially the aspect of probability in their lessons to spicy up their Biology lesson so as to foster understanding as well as enhance their students' performance in genetics.
3. Curriculum planners should embark on public sensitization in various secondary schools on the use of innovative teaching strategies such as pre-instructional word-clearing and mathematics pre-teaching as it has proved to be effective in the teaching of genetics.
4. Classroom teachers and instructors should always take cognizance of the genetics terminologies commonly used by their students during and after

the lessons so as to the clear misconception of those words with the use of word-clearing strategy.

5. Policymakers should develop flexible documents that can accommodate a series of innovative strategies that can help students to excel in biology.
6. Science educational researchers, particularly in Biology should endeavour to conduct similar research in furtherance to improving students' performance in other difficult concepts in Biology.

Suggestion for Further Studies

A replica of this study should be carried out on other difficult Biology topics in different sampled locations and academic levels such as colleges of education and universities. In addition, researchers can determine the influence or effect of other variables different from the ones investigated in this study such as; retention, attitude, and perceptions of students toward pre-instructional word-clearing and mathematics pre-teaching strategies employed in teaching the of genetics in prospective studies.

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APPENDIX I
UNIVERSITY OF ILORIN, ILORIN, NIGERIA
DEPARTMENT OF SCIENCE EDUCATION
PRINCIPAL'S CONSENT FORM

The principal,

Name of School.

I am a postgraduate student of the above named University conducting a Ph.D. research entitled Effect of Pre-instructional Word-clearing and Mathematics Pre-teaching on Senior School Students' Achievement in Genetics in Ilorin, Nigeria. The results of this research work will help the students to improve on their achievement in genetics, which has been identified as one of difficult topics in Biology to learn and also, exposes the Biology teachers to an innovative teaching strategy which will help them in the teaching of genetics to students.. Thus, I am seeking your consent for the participation of your students and teachers in the study, which will be conducted during school hours only. I am assuring you that the data obtained during the course of research will be treated with utmost confidentiality and used for research purpose only.

Thanks for your anticipated cooperation.

Yours Faithfully,

GBIGBADUA, D. A.

Principal's Respondent Agreement: I _____, hereby voluntarily give my consent to the request of the researcher. Moreover, I understand that if I have questions about the research, I may contact the Department of Science Education, University of Ilorin, Ilorin, Nigeria or the researcher no 08038109639 and through gbigbaduadare1176@gmail.com

Signature

Date

APPENDIX II

UNIVERSITY OF ILORIN, ILORIN, NIGERIA

DEPARTMENT OF SCIENCE EDUCATION

INFORMED CONSENT FORM

Dear Student,

Pleased be informed that you are selected to participate in a research study. Your consent is needed to take part in the study. Detail information about the research is provided below. After reading this document, kindly read through and endorse the consent form if you volunteer to participate in the study.

Purpose of the Research: The purpose of the research is to examine the effect of pre-instructional word-clearing and mathematics pre-teaching on senior school students' genetics achievement in Ilorin, Nigeria.

Procedure: Students will be taught genetics through the help of research Assistants who are the Biology teachers in the selected schools. The students will be required to attend class regularly and attempt questions in achievement test designed by the Researcher. The time allocated for Biology on the timetable will be used for the exercise.

Confidentiality: All information collected from you will be strictly used for the purpose of research and handed with utmost confidentiality.

Risk: You would be required to freely participate in the study and all the activities will be conducted in your regular classroom hours, hence, no risk envisage to your person during the research.

Benefit: With your involvement in this study, you will be exposed to innovative teaching strategy like word-clearing and mathematics pre-teaching which would enable you to have meaningful learning of genetics concepts and other related concepts. Also, students stand to obtain good grade in the West African Senior School Certificate Examination (WASSCE) and other public examinations.

Rights of Volunteers: Students' participation is voluntary. This means that you are free to withdraw from participating in the study at any point without losing anything. If you have any question about this research, you may contact the Department of Science Education, University of Ilorin, Ilorin, Nigeria or call the researcher on the cell phone number 08038109639

Student Respondent Agreement: I hereby willingly consent to participate in the research. I know that I can withdraw my participation in the research at any time. I also understand my right to contact Department of Science Education, University of Ilorin, Ilorin, Nigeria or call the researcher on the cell phone number 08038109639 in case I have question(s).

..... Student participant	 Sign	 Date
..... Parent/Guardian	 Sign	 Date
..... Researcher	 Sign	 Date

APPENDIX III

GENETIC ACHIEVEMENT TEST

UNIVERSITY OF ILORIN

FACULTY OF EDUCATION

DEPARTMENT OF SCIENCE EDUCATION

Dear Students,

This test items intend to investigate the effects of pre-instructional word clearing and mathematics pre-teaching on senior school students' achievement in genetics in Kwara state, Nigeria. The study would concentrate on the introduction to genetics, Ratio, percentage, probability and transmission of characters. This instrument consists of two sections, which are as follows:

SECTION A

This section consists of personal data of the students

Class.....

School.....

Gender: Male Female

SECTION B

GENETICS ACHIEVEMENT TEST (GAT)

Attempt all questions in this section and choose the correct answer for each question by shading the correct letter.

1. Genetic make-up of an individual is referred to as:
A. Anatomy B. Genotype C. Phenotype D. Physiology
2. The transmission of characters from parents to their offspring is termed:
A. Cloning B. Evolution C. Heredity D. Resemblances
3. What will be the genotypic ratio when two heterozygous red peas are crossed?
A. 1:0 B. 1:2:1 C. 2:1 D. 3:1
4. The probability that two consecutive children of the same parents will be male is:
A. $\frac{1}{2}$ B. 1 C. $\frac{1}{4}$ D. $\frac{3}{4}$
5. How many chromosomes will be present in a gamete if the somatic cell has eight (8) chromosomes?
A. 4 B. 6 C. 8 D. 16
6. What will be the phenotypic ratio when tall plant (T t) is crossed with short plant (t t):
A. 0:4 B. 2:2 C. 3:1 D. 4:0
7. In a cross between two heterozygous parents (T t), what is the probability of having an F1 heterozygous (T t) offspring?

- A. $\frac{1}{4}$ B. $\frac{1}{2}$ C. $\frac{3}{4}$ D. 1

8. A tall man (T T) married to a short woman (t t) gave birth to four children.

What is the phenotypic ratio (Tall: short of the children)?

- A. 2:2 B. 4:0 C. 3:1 D. 0:4

9. At the end of mitosis, the number of daughter cells produced from a parent cell is:

- A. Four B. Six C. Eight D. Two

10. What is the genotype of the gains in F1 generation?

- A. YY B. Yy C. yy D. YYyy

11. The name given to a sudden change in a gene or chromosome the can be passed on to offspring is:

- A. Mutation B. Linkage C. Alleles D. Inheritance

12. In humans, sex is determined by:

- A. Two homologous chromosomes
B. A dominant gene for maleness present in a male
C. Two similar sex chromosomes in the male and dissimilar in the female
D. The differences in the nature of the X and Y chromosomes in the male

13. A man with heterozygous genotype for blood group B marries a woman with heterozygous A, what percentage (%) of their children would be universal donor?

- A. 50% B. 25% C. 15% D. 10%

14. A sudden loss of black pigment from the of an African can be attributed to:

- A. Blending of black and white genes
 - B. Recombination of genes
 - C. Loss of the epidermis
 - D. Mutation in the skin cells
15. Heterozygous tall plants were crossed with pure-breeding dwarf plants of the same species. What were the approximate percentages of the offspring?
- A. 100% tall 0% dwarf
 - B. 75% tall 25dwarf
 - C. 50% tall 50% dwarf
 - D. 25% tall 75% dwarf
16. Which of the following traits in humans can be affected by environmental factors?
- A. Skin colour
 - B. Eye colour
 - C. Baldness
 - D. Tongue rolling
17. Which of the following is used to test for heterozygous?
- A. Backcross
 - B. Test cross
 - C. XY Chromosome
 - D. A and B
18. Which of the following is a major cause of variation among organisms?
- A. Inbreeding
 - B. Backcrossing
 - C. Sexual reproduction
 - D. Gene dominance
19. Which disease is sex–linked and mainly afflicts male offspring?
- A. Sickle Cell Anaemia
 - B. Haemophilia
 - C. Diabetes
 - D. Malaria
20. The appeared gene in an organism is called:
- A. Recessive
 - B. Chromosome
 - C. Dominant
 - D. Allele

Use the following information to answer questions 21 and 22.

In an experiment, a red-flowered plant was crossed with another white-flowered plant and the following results were obtained; 448 red flowers and 154 white flowers in the F1 generation.

21. Which of the following represent the genotype of the parent if R is for red gene and r is for white gene?

- A. $RR \times Rr$ B. $RR \times rr$ C. $Rr \times Rr$ D. $rr \times rr$

22. Which of the following represent the phenotypic ratio of the above genetic cross?

- A. 3:1 B. 1: 2: 1 C. 4:1 D. 2:2

23. The heterozygous normal person AS married a sickle cell anemia patient SS, what is the probability of having sickle cell anemia patient among their children? A. $\frac{1}{4}$ B. $\frac{1}{2}$ C. $\frac{3}{4}$ D. 1

24. The unit of inheritance in an organism is called:

- A. Chromosome B. Gene C. Trait D. Character

25. Which of the following genotype cause Klinefelter syndrome?

- A. XO B. XX C. XXY D. OXY

26. The offspring of two parents that are heterozygous for a given trait have a _____ percent chance of being homozygous for that trait.

- A. 0 B. 25 C. 50 D. 100

27. Which of the following diseases is transmitted through genes?

- A. HIV/AIDS B. Sickle cell anemia C. Diabetes D. Presbyopia

28. In a case of complete dominance, what is the phenotypic ratio of the cross

$Bb \times Bb$, where B= black and b white

- A. 1 black : 1 grey : 2 whites B. 1 black : 3 whites
C. 1 black : 2 blues : 1 white D. 3 blacks : 1 white

29. Which of the following is a function of the chromosome?

- A. Transmission of hereditary traits B. Protein synthesis
C. Excretion D. Energy production

30. Which of these is not a hereditary variation?

- A. Infant paralysis B. Blood group
C. Sickle cell D. Shape of face and nose

31. Which of the following is the carrier of hereditary materials?

- A. Centriole B. Cytoplasm C. Nucleolus D. Chromosomes

32. In Mendel's experiments, it was discovered the F₁ generation of a cross between a brown cock and a white hen were all brown because the gene for the:

- A. Brown colour was recessive B. White colour was dominant
C. Brown colour was dominant D. White colour did not combine

33. If the pink colour of a petal is dominant over white, what would be the colour of the flower of the F₁ generation when a pure pink flowered plant is crossed with a white flowered plant?

- A. Purple B. Pink C. White D. Yellow

34. A cross between an albino female and a genetically normal male will result in offspring that are:
- A. All albinos B. All phenotypically normal
 - C. A and B D. Half albinos and half normal
35. A feature associated with Y-chromosome in humans is:
- A. Long eyelashes B. Prominent Fingernails
 - C. Facial hairs D. Enlarged breast
36. A tall plant crossed with a dwarf one produces offspring of which half are tall and half are dwarf. What are the genotypes of the parents?
- A. Tt, tt B. Tt, Tt C. TT, tt D. TT, TT
37. The phenotype of an individual can be summed up as the:
- A. Totality of the expressed traits
 - B. Individual's physical appearance
 - C. Individual's entire genetic make-up
 - D. Physiological traits of the individual.
38. A man with normal Haemoglobin (AA) marries a woman who has sickle cell haemoglobin (SS). They have a child who has sickle-cell trait. Which of the following genotypes could be associated with the child's haemoglobin?
- A. AA B. OO C. AO D. AS
39. Y chromosome is found only in: A. Male B. Female
- C. All of the above D. None of the above

40. The tendency of two or more genes to segregate together in a cross is known as:
A. Co dominance B. Incomplete dominance
C. Polygenic-inheritance D. Sex linkage
41. If a baby is female, her mother's ovum must have been fertilized by a sperm carrying the chromosome:
A. X B. XY C. YY D. Y
42. Out of four children produced by a couple the probability of having male child is:
A. 1 B. $\frac{1}{2}$ C. $\frac{3}{4}$ D. $\frac{1}{4}$
43. The hereditary material in eukaryotic cell is known as:
A. ADP B. CNS C. RNA D. DNA
44. If parents' blood groups AB and OO produce six children:
A. Three of them will have group B
B. All of them will have group O
C. Two of them will have group A
D. Four of them will have group A
45. When two heterozygous mates, the dominant trait will appear in:
A. The F1 Generation only
B. F2 Generation
C. Both the F1 and F2 generations
D. F1 generation if the gene is strong

46. Which of the following is true of the children of a haemophilic man who marries a woman that is not haemophilic and does not carry the trait?
- A. All their daughters will be carriers
 - B. All their daughters will be haemophilic
 - C. All their sons will be carrier
 - D. All their sons will be haemophilic
47. Which of the following characters is sex linked?
- A. Albinism B. Baldness C. Haemophilia D. Colour blindness
48. The F₁ of a cross between a tall and dwarf plant was tall. The F₁ was advanced to F₂. How many of 120 F₂ plant will be dwarf?
- A. 30 B. 60 C. 90 D. 120
49. The following are characters that could be transmitted in human beings EXCEPT:
- A. Intelligence B. Body structure
 - C. Human Height D. Structure of the seed
50. The following are the reasons for Mendel's choice of pea plant EXCEPT:
- A. Short life span B. Position of Flowers
 - C. Self-pollinating plant D. Very common to come by
51. In determining the sex of a baby, a male baby is formed if:
- A. A sperm with X chromosome combined with an egg having X chromosome
 - B. A sperm with Y chromosome combined with an egg with X chromosome

- C. If X chromosome in egg combines with both X and Y chromosome in sperm
- D. A sperm with Y chromosome combined with an egg having Y chromosome
52. If R and r, denotes the genes for a character, the offspring of a cross between RR and rr are:
- A. RR, 2Rr, rr B. 2RR, 2rr C. 2RR, 2Rr D. 4Rr
53. Which of the following disease or disorders can be prevented by the application of the knowledge of heredity through marriage counseling?
- A. Sickle cell anaemia B. Haemophilia
- C. Diabetes mellitus D. River blindness
54. Identical twins inherit their genes from:
- A. The same ovum and different sperms
- B. The same sperm and different ova
- C. Different sperms and many ova
- D. The same ovum and the same sperm
55. One of the following is not a use of genetics to medicine:
- A. Prevention of hereditary diseases
- B. Determination of paternity of a child by use of DNA and blood group
- C. Blood transfusion
- D. Tongue rolling ability

56. Which of the following represents Mendel's second law of inheritance? The factors of two pairs of contrasting characters are: A. Dependent on each other
- B. On homologous chromosomes
- C. Allelomorphic
- D. Inherited independently of each other
57. A farmer's assumption that the seed from a good harvest will produce a good yield is explained by the theory of:
- A. Evolution B. Adaptation C. Variation D. Heredity
58. The point of location of a gene on a chromosome is known as:
- A. Diploid B. Locus C. Haploid D. Phenotype
59. Hassan and Hussain are identical twins but Hassan grows taller and faster than Hussain. This is probably because:
- A. Hassan inherits genes for tallness and fatness from the father
- B. They have dissimilar genotypes
- C. Hussain is endowed with genes for shortness and thinness
- D. They are raised in different environments
60. The following are the reasons for Mendel's choice of Pea plant EXCEPT;
- A. Short life span
- B. they have several of their traits exist in one or two forms
- C. the plant could self-pollinate itself
- D. very common to buy

APPENDIX IV

Instructional module for mathematics pre-teaching (IMMP)

Probability

Probability of a particular outcome is defined as:

$$\frac{\text{The number of equiprobable favourable outcomes}}{\text{Total number of equiprobable outcomes.}}$$

Therefore, probability can be viewed under four major division namely; experimental theoretical, mutually exclusive and independent events.

Experimental Probability

Experimental probability bases its result on the actual test (experimental) carried out. The outcome will therefore be based on the number of trials (experiment) carried out.

Therefore, experimental probability is defined as:

Number of required outcome

Number of possible outcome

Examples:

1. Outcome of 500 fruits bought in a market, it is known from experience that 25 will be bad. What is the probability that a fruit picked from the lot will be good?

Solution

Total fruit bought = 500

The expected number of good fruits = 500 – 25

= 475

Hence, n = 500

Bad fruits = x = 25

Good fruits = 500 – x = 500 – 25

$$= 475$$

$$\text{Probability of picking good fruits} = \frac{475}{500} = \frac{19}{20}$$

The table below shows the marks scored by a number of pupils in a mathematics test

Mark%	30	40	50	60	80
No of frequency	11	8	4	5	2

(a) How many pupils are there?

(b) What is the probability that a pupil chosen at random from the class will score

(i) 40% (ii) below 60%

Solution

(a) Total number of pupils = $11 + 8 + 4 + 5 + 2 = 30$ pupils

(bi) Probability of a pupil scoring 40% will be

Number of pupils that score 40

The total

$$= \frac{8}{30} = \frac{4}{15}$$

(bii) Probability of pupils scoring below 60% = $\frac{23}{30}$

Theoretical Probability

Theoretical probability in its cases based its results as occurrence on exact values that can depend on the physical nature of the conditions or situation that are being considered.

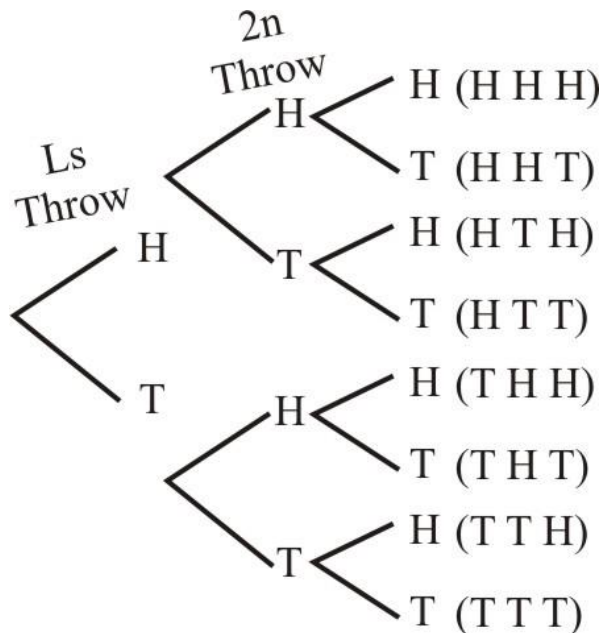
Example

(1) Three coins are thrown together. Find the probability of:

i. Two heads and one tail

ii. Three heads

Solution



(a) Probability of two head has a tail =

$$\frac{\text{Number of places with 2 head and 1 tail}}{\text{The total number of outcomes}} = \frac{3}{8}$$

(b) Probability of three head = (H H H) = $\frac{1}{8}$

(2) A bag contains 2 black balls, 3 red balls and 6 white balls. A ball is picked from the bag at random. What is the probability that it is:

(A) Black (B) Red (C) Not Red

Solution

$$\text{Total ball in the bag} = 2 + 3 + 6$$

$$= 11 \text{ balls}$$

$$\text{(a) Probability of a Black ball} = \frac{\text{Number of Black}}{\text{Total number of balls}}$$

$$= \frac{2}{11}$$

$$(b) \quad \text{Probability of Red ball} = \frac{\text{Number of red}}{\text{Total number of ball}}$$

$$= \frac{3}{11}$$

$$(c) \quad \text{Probability of Not red} = 1 - \text{Prob of Red}$$

$$= 1 - \frac{3}{11}$$

$$= \frac{11-3}{11}$$

$$= \frac{8}{11}$$

Mutually Exclusive Events

Can you whiz with your mouth and blow your Nose at the same time? Throw a dice to score a three and a four at the same throw with the dice. From the experience, it will be discovered that each of those events cannot happen at the same time. The performance of the whizzing will prevent that of blowing the nose.

Example:

A fair dice is tossed once, what is the probability of scoring a:

- i. 3 or 6 ii. 4 or 5 iii. Neither 6 nor 1

Solution

(a) Probability of 3 or 6 will be probability (3) + probability (6)

$$= \frac{1}{6} + \frac{1}{6}$$

$$= \frac{1+1}{6} = \frac{2}{6} = \frac{1}{3}$$

6

(b) Probability of 4 or 5 = probability (4) + probability (5)

$$= \frac{1}{6} + \frac{1}{6}$$

$$= \frac{2}{6}$$

$$= \frac{1}{3}$$

(c) Probability of neither 6 or 1

= probability (2)

= p (2) or p (3) or p(4) or p(5)

= p (2) + p (3) + p(4) + p(5)

$$= \frac{1}{6} + \frac{1}{6} + \frac{1}{6} + \frac{1}{6}$$

$$= \frac{4}{6}$$

$$= \frac{2}{3}$$

➤ INDEPENDENT EVENTS (MULTIPLICATION OF PROBABILITY)

Can you clap your hands and sing at the same time? Jump up and clap your hands at the same time? From these two actions you will discover that it is possible to do each of the two events at the same time.

Therefore, if two events can occur without affecting each other then, the two events are independent events.

Example (1)

Two dice are thrown once, what is the probability of getting

(a) 2 six?

(b) Two prime numbers?

(c) One odd, one even number?

Solution

(a) Probability of six:

Probability of 6 on the first dice = $\frac{1}{6}$

Probability of 6 on the second dice = $\frac{1}{6}$

Probability of 6 on the two dice = $\frac{1}{6} \times \frac{1}{6}$
 $= \frac{1}{36}$

(b) Probability of two prime number.

Probability of prime number on the first dice = $\frac{3}{6}$

Probability of prime number on the second dice = $\frac{3}{6}$

Therefore probability of prime nos. on both dice = $\frac{3}{6} \times \frac{3}{6}$

$$= \frac{9}{36} = \frac{1}{4}$$

(c) Probability of one odd, one even:

The occurrence of this can be: either odd on first die, even on second dice of even on first die, odd on second dice.

The suggest that there is the idea of addition rule in this type of probability can therefore occur like this

$\frac{3}{6}$ and $\frac{3}{6}$ of $\frac{3}{6}$ and $\frac{3}{6}$

$$= \frac{3}{6} + \frac{3}{6}$$

$$= \frac{6}{6}$$

$$= 1$$

Example (2)

The chances of three independent events P, Q, R, occurring are $\frac{1}{2}$, $\frac{2}{3}$, $\frac{1}{4}$ respectively. What are the chances of?

- (a) Q and R only occurring
- (b) P only occurring
- (c) None occurring

Solution

(a) Probability (Q and R only occurring) is the probability of Q and R occurring.

Therefore probability (Q and R only occurring)

$$= \frac{2}{3} \times \frac{1}{4} \times \frac{1}{2}$$

$$= \frac{2}{24}$$

$$= \frac{1}{12}$$

(b) Probability of P only occurring means P will occur but Q and R will not occur

Therefore (p only occurring)

$$= \frac{1}{2} \times \frac{1}{3} \times \frac{3}{4}$$

$$= \frac{3}{24}$$

$$= \frac{1}{8}$$

(c) Probability (none occurring) = $\frac{1}{2} \times \frac{1}{3} \times \frac{3}{4}$

$$= \frac{3}{24}$$

$$= \frac{1}{8}$$

APPENDIX V

TABLE OF SPECIFICATION FOR GENETICS ACHIEVEMENT TEST

Contents	Cognitive domain						Total No. items	Percentage
	Remember	Understand	Apply	Analyze	Evaluate	Create		
Introduction to genetics	3	2	3	3			11	18.3
Transmission of characters	5	3		1	1	1	11	18.3
Mendel's work in Genetics	3	7	3	4		1	18	30.0
Probability in Genetics	3	2	3	1	1		10	16.7
Application of Genetics	3	2	3		2		10	16.7
Total	17	16	12	9	4	2	60	100
Percentage	28.3	26.7	20.0	15.0	6.7	3.3	100	

APPENDIX VI

ITEM ANALYSIS FOR GENETICS ACHIEVEMENT TEST

S/N	Score	Discriminating Index	Difficulty Index				
ITEM 60	6	0.1	0.1	10	1	VE	7
ITEM 59	7	0.12	0.12	12	1	AVERAGE	46
ITEM 58	8	0.13	0.13	13	1	VD	7
ITEM 57	10	0.17	0.17	17	1	AVERAGE SCORE	46.22
ITEM 56	12	0.2	0.2	20	1		
ITEM 55	13	0.22	0.22	22	1		
ITEM 54	18	0.3	0.3	30	1		
ITEM 53	20	0.33	0.33	33	2		
ITEM 52	23	0.38	0.38	38	2		
ITEM 46	24	0.4	0.4	40	2		
ITEM 47	24	0.4	0.4	40	2		
ITEM 48	24	0.4	0.4	40	2		
ITEM 49	24	0.4	0.4	40	2		
ITEM 50	24	0.4	0.4	40	2		
ITEM 51	24	0.4	0.4	40	2		
ITEM 37	25	0.42	0.42	42	2		
ITEM 38	25	0.42	0.42	42	2		
ITEM 39	25	0.42	0.42	42	2		

ITEM 40	25	0.42	0.42	42	2		
ITEM 41	25	0.42	0.42	42	2		
ITEM 42	25	0.42	0.42	42	2		
ITEM 43	25	0.42	0.42	42	2		
ITEM 44	25	0.42	0.42	42	2		
ITEM 45	25	0.42	0.42	42	2		
ITEM 32	26	0.43	0.43	43	2		
ITEM 33	26	0.43	0.43	43	2		
ITEM 34	26	0.43	0.43	43	2		
ITEM 35	26	0.43	0.43	43	2		
ITEM 36	26	0.43	0.43	43	2		
ITEM 27	27	0.28	0.45	45	2		
ITEM 28	27	0.32	0.45	45	2		
ITEM 29	27	0.33	0.45	45	2		
ITEM 30	27	0.35	0.45	45	2		
ITEM 31	27	-0.02	0.45	45	2		
ITEM 26	28	0.27	0.47	47	2		
ITEM 23	29	0.15	0.48	48	2		
ITEM 24	29	0.18	0.48	48	2		
ITEM 25	29	0.27	0.48	48	2		
ITEM 21	31	0.12	0.52	52	2		

ITEM 22	31	0.13	0.52	52	2		
ITEM 20	32	0.13	0.53	53	2		
ITEM 19	33	0.15	0.55	55	2		
ITEM 15	34	0.15	0.57	57	2		
ITEM 16	34	0.17	0.57	57	2		
ITEM 17	34	0.17	0.57	57	2		
ITEM 18	34	0.17	0.57	57	2		
ITEM 14	35	0.17	0.58	58	2		
ITEM 12	36	0.18	0.6	60	2		
ITEM 13	36	0.18	0.6	60	2		
ITEM 11	37	0.2	0.62	62	2		
ITEM 10	38	0.22	0.63	63	2		
ITEM 8	39	0.23	0.65	65	2		
ITEM 9	39	0.23	0.65	65	2		
ITEM 6	42	0.27	0.7	70	3		
ITEM 7	42	0.28	0.7	70	3		
ITEM 5	43	0.28	0.72	72	3		
ITEM 4	44	0.3	0.73	73	3		
ITEM 3	45	0.32	0.75	75	3		
ITEM 1	50	0.38	0.83	83	3		
ITEM 2	50	0.4	0.83	83	3		

Average	28	0.30	0.5	50			
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Reliability Statistics for Questionnaire

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.823	.828	36

Reliability Statistics for Achievement Test

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.998	1.000	60

APPENDIX VI

Marking scheme

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

27.B
28.D
29.A
30.A
31.D
32.D
33.B
34.C
35.C
36.A
37.B
38.D
39.B
40.D
41.B
42.B
43.D
44.B
45.C
46.A
47.C
48.A
49.C
50.D
51.B
52.D
53.A
54.D
55.D

56.D

57.D

58.B

59.D

APPENDIX VII

QUESTIONNAIRE ON BIOLOGY STUDENTS' STUDY HABITS (QBSSH)

SECTION A

Name of school:

Class:

Gender: Male ()

 Female ()

Section B

Instruction: This Section consists of questions concerning students' habits and methods of study. Read and consider each statement and then indicate how it applies to you. Please answer all questions. After each statement, you will find columns 1, 2, 3, and 4. Place a check mark (✓) in the column that you feel best describes your study habits. Check it in accordance with the following key: 1 (almost never), 2 (less than half of the time), 3 (more than half of the time), and 4 (almost always).

items	Statements	1	2	3	4
	Homework and assignments				
1	Do you complete your assignments on time?				
2	Do you begin your assignment as soon as the teacher gives them to you?				
3	Do you write down all assignments for each lesson in a special section of the notebook?				
4	When you read and attempt to answer your homework, do you have in mind area where your answer will be gotten from?				
5	Do you contact people to help you with your assignment?				
6	Do you review your assignment before writing Biology test?				
7	Do you complete and submit your assignments on time?				
8	Does homework given, makes you read more facts about the				

	topic taught by your teacher?				
	Time allocation				
9	Do you waste too much time listening to the radio or watching T.V. for the good of your studies?				
10	Do you find that having many other things to do cause you to get behind in your school work?				
11	Do problems outside of the classroom—with other students or at home—cause you to neglect your school works?				
12	Do you study Biology for at least 30 min each day after classes?				
13	Do you spend more time reading other subjects than Biology?				
14	Do you spend time involving in other activities that will improve your understanding of Biology?				
15	Reading and Note Taking				
16	After reading several pages of an assignment, do you find yourself unable to remember what you have just read?				
17	Do you find it hard to pick out the important points of a Biology assignment?				
18	Do you have to re-read material several times because the solutions don't have much meaning the first time you go over them?				
19	Do you have trouble picking out the important point in the Biology exercises you solved?				
20	Do you go back and check solution to exercises you have studied, rechecking any points you find doubtful?				
21	When you are having issues with Biology exercises, do you try talking it over with the teacher?				
	Study period procedures/test preparation				
22	Do you need a long time to get warmed up when you want to start studying?				
23	Are you unable to study well because you get restless and unable to sit for long?				

24	When you sit down to study, do you find yourself too tired, bored, or sleepy to study well?				
25	Do you prefer to solve Biology exercises alone rather than with others or maybe groups?				
26	Do you seem to get very little done for the amount of time you spend solving Biology exercises?				
27	Do you find yourself beset by too many health problems to study efficiently?				
28	Do you find it hard to keep your mind on what you are studying for any length of time?				
29	Do outside interruptions disturb you while studying?				
	Examinations/Test taking				
30	Do you do poorly on Biology tests because of time?				
31	Do you get worried and confused when you did not do a Biology test to your ability?				
32	When getting ready for a test, do you plan the way you will attempt your questions?				
33	Are you careless about spelling, botanical names and orderings when attempting Biology Examinations?				
34	Are you unable to finish test within the time allowed?				
35	Do you find out that you did not do well in test because of careless mistakes?				
36	Do you finish your mathematics examination/test before time?				

APPENDIX VIII

Word list and their meanings

Genes: Genes are hereditary units or basic units of inheritance. They are located in chromosomes and are responsible for the transmission of characters from parents to offspring.

Chromosomes: These are rod or thread-like bodies found in the nucleus of a cell. The chromosomes house or contain the genes.

Characters or Traits: These are the inheritable attributes or features possessed by an organism, e.g. seed colour, seed size, plant height etc

Gamete: Gamete is a matured sex cell which takes part in sexual reproduction. There are two types: male gamete or spermatozoon (in animals) and pollen grains (in plants) and Female gamete, egg or ovum (in animals) and ovules (in plants). Gametes are usually haploid.

Zygote: Zygote is a single cell formed as a result of the union of a male gamete with a female gamete. Gamete is usually diploid.

Allelomorphs: Allelomorphs are pairs of genes on the position of a chromosome (i.e. locus) that control contrasting characters. Pair of allelomorphs is called allelic pair. While each member of the pair is the allele of the other.

Phenotype: Phenotype is the sum total of all observable feature of an organism, i.e. the physical, physiological and behavioral traits, e.g. height, weight, skin colour etc.

Genotype: This term is used to describe those traits of sum total of the genes inherited from both parents. In other words, the genotype of an individual is his genetic make-up or constitution. Genotype includes both the dominant and recessive traits that form the genetic make-up of an individual.

Dominant character: This is a trait or character that is expressed in an offspring when two individuals with contrasting characters or trait are crossed.

Dominant genes: These are genes which control dominant characters. For instance, in a very tall plant, there may be the gene for shortness but the gene has no influence on the gene for tallness.

Recessive character: This is the character or trait from one parent which is masked or does not produce the effect in the presence of dominant character. From the illustration above, shortness is the recessive character while the tallness is the dominant character.

Recessive gene: Are genes which control recessive characters.

Homozygous: An individual is said to be homozygous if it has two similar genes for the same character, i.e. it has two identical alleles at the same position on a pair of chromosomes.

Heterozygous: An individual is said to be heterozygous if the two members of a pair of genes controlling a pair of contrasting characters are different. i.e. it has two different or contrasting alleles located on the same position on a pair of chromosomes.

Filial generation: The offspring of parents make up the filial generation. The first, second and third generations of offspring are known as the first, second and third filial generation respectively, and are denoted by the symbols F_1 , F_2 and F_3 respectively

Hybrid: Hybrid is an offspring from a cross between parents that are genetically different but of the same species.

Hybridization: Hybridization is the crossing of plants with contrasting characters.

Monohybridization: This involves the crossing of two pure traits

Dihybridization: It is the crossing of plants with two pairs of contrasting characters.

Locus: Locus is the site for location of a gene in a chromosome.

Haploid: Haploid is when an organism has one set of chromosomes in the gamete. Gametes at certain stages in the life cycle of plants are haploid. It is represented by small letter (n).

Diploid: Diploid is when an organism has two sets of chromosomes in the body cell. The bodies of animals and plants are diploids. Diploid numbers is double the haploid number of chromosomes and is represented by (2n).

Mutation: Mutation is a change in the genetic make-up of an organism resulting in a new characteristic that is inheritable.

APPENDIX IX

LESSON PLAN ON GENETICS

(PRE-INSTRUCTIONAL WORD CLEARING GROUP)

WEEK ONE: 1st & 2nd Period

CLASS: SS3

CLASS AVERAGE AGE: 15-18yrs

SUBJECT: Biology

TOPIC: Genetics

SUB-TOPIC: Genetics Terms

DURATION: 40mins

LEARNING OBJECTIVE: At the end of the lesson, learners' should be able to:-

define the term genetics?

spell the genetics terms

list the genetics terms

(iv) use the terms in a sentence

RATIONALE: To

INSTRUCTIONAL MATERIALS: Cardboard showing list of words and their meanings, Biology Dictionaries, Standard Dictionaries and Biology Textbook.

REFERENCE: (i) Senior Secondary School Biology 2 (New Edition) by: J. O., Aina, F. O. C., & Ndu P. Asun.

(ii) Essential of Senior School Certificate Biology by: J. O. Oladele. Published by Tonad limited, Ibafo, Ogun State.

LESSON DEVELOPMENT

STAGE	TEACHERS' ACTIVITIES	LEARNERS' ACTIVITIES	LEARNING POINT
I	The teacher starts the	Learners' answer	Linking prior

	lesson by reviewing the previous lesson by asking relevant questions on the last lesson. Examples of such questions are: What is variation? Mention two types of variation with examples	questions relating to prior lesson	lesson to the present knowledge
II	The teacher explaining the meaning of genetics. The teacher further write down the genetics words that is going to be cleared such as; Genes, Chromosomes, Characters or traits, Gamete, Zygote, Allelomorphs, Allelic pair, Phenotype, Genotype Dominant character, Dominant genes, Recessive character, Recessive genes, Homozygous, Heterozygous, Filial generation, Hybrid.	Listen to the teacher and write	Lesson introduction
III	The teacher asks the students to spell each of these terms one after the other and corrects any misconception based on his cleared list.	Students' respond to the teacher's questions and also notes their mistakes. The students also, responds to these terms based on what they found out and listen to correct all their misconceptions.	Lesson buildup
IV	The Teacher discuss the meanings of the genetics terms: Genes: Genes are hereditary units or basic units of inheritance. They are located in	Write down relevant information and use the genetics terms in a sentence	Lesson buildup

	chromosomes and are responsible for the transmission of characters from parents to offspring. Chromosomes: These are rod or thread-like bodies found in the nucleus of a cell. The chromosomes house or contain the genes. Characters or Traits: These are the inheritable attributes or features possessed by an organism, e.g. seed colour, seed size, plant height etc. Gamete: Gamete is a matured sex cell which takes part in sexual reproduction. There are two types: male gamete or spermatozoon (in animals) and pollen grains (in plants) and Female gamete, egg or ovum (in animals) and ovules (in plants). Gametes are usually haploid. Zygote: Zygote is a single cell formed as a result of the union of a male gamete with a female gamete. Gamete is usually diploid. Allelomorphs: Allelomorphs are pairs of genes on the position of a chromosome (i.e. locus) that control contrasting characters. A pair of allelomorphs is called allelic pair. While each member of the pair is the allele of the other. Phenotype: Phenotype is		
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	the sum total of all observable feature of an organism, i.e. the physical, physiological and behavioral traits, e.g. height, weight, skin colour etc. Genotype: This term is used to describe those traits of sum total of the genes inherited from both parents. In other words, the genotype of an individual is his genetic make-up or constitution. Genotype includes both the dominant and recessive traits that form the genetic make-up of an individual. Dominant character: This is a trait or character that is expressed in an offspring when two individuals with contrasting characters or trait are crossed. Dominant genes: These are genes which control dominant characters. For instance, in a very tall plant, there may be the gene for shortness but the gene has no influence on the gene for tallness. Recessive character: This is the character or trait from one parent which is masked or does not produce the effect in the presence of dominant character. From the illustration above, shortness is the recessive character while the tallness		
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	is the dominant character.		
Evaluation	What is Genetics? Give the meaning of the following terms; Genes, Chromosomes, Characters or traits, Gamete, Zygote, Allelomorphs, Allelic pair, Phenotype, Genotype Dominant character		
Conclusion	The teacher goes through the lesson briefly and round off		
Assignment	Using a Biology Dictionary, Biology Textbook and other available materials, find out the meaning of the following words: Recessive genes, Homozygous, Heterozygous, Filial generation, Hybrid, Hybridization, Monohybridization, Dihybridization, locus, Haploid, Diploid and Mutation.		

APPENDIX X

LESSON PLAN ON GENETICS

(PRE-INSTRUCTIONAL WORD CLEARING GROUP)

WEEK ONE: 3rd & 4th Period

CLASS: SS3

CLASS AVERAGE AGE: 15-18yrs

SUBJECT: Biology

TOPIC: Genetics

SUB-TOPIC: Genetics Terms

DURATION: 40mins

LEARNING OBJECTIVE: At the end of the lesson, learners' should be able to:-

define the term genetics?

spell the genetics terms

list the genetics terms

(iv) use the terms in a sentence

RATIONALE: To

INSTRUCTIONAL MATERIALS: Cardboard showing list of words and their meanings, Biology Dictionaries, Standard Dictionaries and Biology Textbook.

REFERENCE: (i) Senior Secondary School Biology 2 (New Edition) by: J. O., Aina, F. O. C., & Ndu P. Asun.

(ii) Essential of Senior School Certificate Biology by: J. O. Oladele. Published by Tonad limited, Ibafo, Ogun State.

LESSON DEVELOPMENT

STAGE	TEACHERS' ACTIVITIES	LEARNERS' ACTIVITIES	LEARNING POINT
I	The teacher starts the lesson by reviewing the previous lesson by asking relevant questions on the last lesson. Examples of such questions are: What are the meaning of the following terms Genes, Chromosomes, Characters or traits and Gamete.	Learners' answer questions relating to prior lesson	Linking prior lesson to the present knowledge
II	The teacher explaining the meaning of genetics. The teacher further write down the genetics words that is going to be cleared such as; Recessive genes, Homozygous, Heterozygous, Filial generation, Hybrid, Hybridization, Monohybridization, Dihybridization, locus, Haploid, Diploid and Mutation.	Listen to the teacher and write	Lesson introduction
III	The teacher asks the students to spell each of these terms one after the other and corrects any misconception based on his cleared list.	Students' respond to the teacher's questions and also notes their mistakes. The students also, responds to these terms based on what they found out and listen to correct all their misconceptions.	Lesson buildup
IV	The Teacher discuss the meanings of the genetics	Write down relevant information and use	Lesson buildup

	terms: Recessive Gene: Are genes which control recessive characters. Homozygous: An individual is said to be homozygous if it has two similar genes for the same character, i.e. it has two identical alleles at the same position on a pair of chromosomes. Heterozygous: An individual is said to be heterozygous if the two members of a pair of genes controlling a pair of contrasting characters are different. i.e. it has two different or contrasting alleles located on the same position on a pair of chromosomes. Filial Generation: The offspring of parents make up the filial generation. The first, second and third generations of offspring are known as the first, second and third filial generation respectively, and are denoted by the symbols F_1, F_2 and F_3 respectively. Hybrid: Hybrid is an offspring from a cross between parents that are genetically different but of the same species. Hybridization: Hybridization is the crossing of plants with contrasting characters. Monohybridization: This	the genetics terms in a sentence	
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	involves the crossing of two pure traits. Dihybridization: It is the crossing of plants with two pairs of contrasting characters. Locus: Locus is the site for location of a gene in a chromosome. Haploid: Haploid is when an organism has one set of chromosomes in the gamete. Gametes at certain stages in the life cycle of plants are haploid. It is represented by small letter (n). Diploid: Diploid is when an organism has two sets of chromosomes in the body cell. The bodies of animals and plants are diploids. Diploid numbers is double the haploid number of chromosomes and is represented by (2n). Mutation: Mutation is a change in the genetic make-up of an organism resulting in a new characteristic that is inheritable.		
Evaluation	What is Genetics? Give the meaning of the following terms; Recessive genes, Homozygous, Heterozygous, Filial generation, Hybrid, Hybridization.		
Conclusion	The teacher goes through the lesson briefly and round off		

Assignment	Explain and list out transmittable character in both human beings and in plants.		
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APPENDIX XI

LESSON PLAN ON GENETICS

(PRE-MATHEMATICS TEACHING OF GENETICS GROUP)

WEEK ONE: 1st & 2nd Period

CLASS: SS3

CLASS AVERAGE AGE: 15-18yrs

SUBJECT: Biology

TOPIC: Genetics

SUB-TOPIC: Probability

DURATION: 40mins

LEARNING OBJECTIVE: At the end of the lesson, learners' should be able to:-

define probability?

describe the experimental and theoretical probability?

knowledge on mutual exclusive events

explain probability rules?

work exercises on probability?

RATIONALE: To

INSTRUCTIONAL MATERIALS: Balls, Coins, Dice and Ludo.

REFERENCE: (i) Macrae, M. F., Kalejaye, A. O., Chima, Z.I., ademosu, M. O. (2008). New General mathematics for senior schools. Longman, Pp 137-141.

LESSON DEVELOPMENT

STAGE	TEACHERS' ACTIVITIES	LEARNERS' ACTIVITIES	LEARNING POINT
I	The teacher starts the lesson by reviewing the	Learners' answer questions relating to	Linking prior lesson to the

	previous lesson by asking relevant questions on the last lesson. Examples of such questions are: What are the meaning of the following terms Genes, Chromosomes, Characters or traits and Gamete.	prior lesson	present knowledge
II	The teacher explains the meaning of probability as the likelihood of something happening, or the chance occurrences in everyday life. I.e. the probability of particular events is the ratio of the number of the required outcomes to the total number of possible outcome or probability. It is usually given as a fraction: Probability = $\frac{\text{Number of required outcomes}}{\text{Number of possible outcomes}}$ For example, the probability of throwing the head of a coin is $\frac{1}{2}$, i.e. number of required outcome is 1, number of possible outcome is 2. If we are certain that something will happen, the probability is 1 but if we are sure that something cannot happen, the probability is 0. Hence, if the probability of something will happen is X, then the probability of something not occurring is	Listen to the teacher and write	Lesson introduction

	1-X.		
III	the teacher explain the experimental and theoretical probability A farmer asks, will it rain this month? The answer to the farmer's question is based on; the month, the place where the farmer is and what has happened in the past in that month at that place. Experimental probability is the likelihood of an events based on the past records. For example. A girl writes down the number of male and female children of her mother and father, she also writes down the number of male and female children of her parent's brothers and sisters. The table below shows is result.		Lesson buildup

R e l a t i o n s h i p	M	a	l	e	F	e	m	a	l	e
Mother and father	2				5					
Mother's brothers	6				8					
Mother's sisters	4				8					
Father's brothers	5				8					
Father's sisters	7				7					
T o t a l	2			4	3					6

Find the experimental probability that when the girl has children of her own her first born will be a girl

If the girl eventually has 5 children, how many are likely to be male.

Solution:

A. In the girl's family, there is total of 60 children, 36 of these are female, if the girls own children follow the pattern of family, then the experimental probability that her first born will be a girl is $36/60 = 3/5$

B. Following the family pattern, $3/5$ of the girl's children will be female and $2/5$ of the girl's children would be male. Therefore, the number of male children that the girls likely to have $= 2/5$ of $5 = 2$.

The teacher gave another example, that when a fair die is thrown, the possible chances are (1,2,3,4,5,6). The probability of getting 4 is $1/6$. This is theoretical probability as exactly one throw out of every 6 is expected to produce 4.

STEP: IV	the teacher explains mutually exclusive events as two events are mutually exclusive or disjoint, if they cannot both be true (occur) i.e. they have nothing in common. For example, the set of outcomes of a single coin toss, which can result in either heads or tails but not both. In probability theory, events $E_1, E_2, \dots, E_n$ are said to be mutually exclusive. If the occurrence of one implies the non-occurrence of the other $n-1$ events. The intersection of both of them is empty (the null even) i.e. $A \cap B = \emptyset$ Example1: What is the probability of rolling a 5 and a 3 on a toss of a single die. Solution: Probability of throwing a five and a three on a single toss of a die is 0 because it cannot occur. Example 2: There are 7 red balls, 8 white and 5 blue balls in a box. 1 pick a ball at random from the box. Find the probability that the ball is a. White b. Red c. Blue or red d. Neither red nor white e. Green. Solution: a. Total number of balls = $7+8+5=20$ Number of white balls =8 Probability of selecting a white ball = $8/20=2/5$ B. Number of red balls =7 P (of selecting a red ball) = $7/20$	Write down relevant information	Lesson buildup
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	C. Number of blue and red balls = $5+7=12$ P (of selecting a blue or red ball) is $12/20=3/5$ D. if the ball is neither red nor white; then it must be blue P (of selecting neither red nor white) is the same as P (of selecting a blue ball) $=5/20=1/4$ E. There are no green balls, hence Pr (of selecting a green ball) $=0$		
V	The teacher states and explains the probability rules thus. There are two rules governing probability, they are: (i) Product rule of probability Addition rule of probability If the probabilities of two independent outcomes A and B are P (A) and P (B) respectively, then the probability that outcomes A and B will occur is the product of P (A) and P (B). That is $P(A \cap B) = P(A) \cdot P(B)$. Example: (i) if a fair die is thrown twice. What is the probability that 1 and 6 will appear. Solution The two outcomes are independent $P(1 \text{ and } 6) = P(1) \cdot P(6)$ $= 1/6 \times 1/6 = 1/36$ A bag containing 7 blue balls, 5 red and 8 white, all identical. Two balls are to be drawn at random one after the other. What is the probability that they are both white? With replacement Without replacement Solution The two outcomes are independent i.e. with replacement. $P(\text{white})$ and $P(\text{white})$ $P(w) \cdot P(w)$ $8/20 \times 8/20 = 4/25$ The two outcomes are dependent i.e. without replacement $P(\text{white})$ and $P(\text{white})$, $P(\text{white first})$, $P(\text{white-white first})$ $8/20 \times 7/19 = 14/95$		
VI	The teacher explains addition rule of probability thus:		

	If A and B are two mutually exclusive outcomes of a random experiment, the probability that A and B will occur is the sum of their probabilities i.e. $P(A \text{ or } B) = P(A) + P(B)$ Or $P(A \cup B) = P(A) + P(B)$. However, if two outcomes A and B of a random process are not mutually exclusive, the probability that A or B or both will occur is $P(A \text{ or } B \text{ or Both}) = P(A) + P(B) - P(A \text{ and } B)$. For example, two fair coins are tossed together. Find the probability that they are: a. both heads and both tails. b. Head and tail. Solution A. $P(\text{both heads and both tails}) = P(\text{both head}) + P(\text{both tails})$ because the two outcomes are mutually exclusive $= \frac{1}{2} \times \frac{1}{2} + \frac{1}{2} \times \frac{1}{2} = \frac{1}{4} + \frac{1}{4} = \frac{1}{2}$ B $P(\text{Head and Tail}) = P(\text{Head on coin A and tail on coin B}) + P(\text{Tail on coin A and Head on coin B})$ because these are two mutually exclusive outcomes $(\frac{1}{2} \times \frac{1}{2}) + \frac{1}{2} \times \frac{1}{2} = \frac{1}{2}$.		
VII	The teacher gives exercises to students to work on thus: If two fair dice are thrown together, find the probability of obtaining two sixes Solution The two outcomes are independent $P(6 \text{ and } 6) = (6).P(6) = \frac{1}{6} \times \frac{1}{6} = \frac{1}{36}$ Find the probability of throwing a number a number greater than 2 with a fair die. Solution Possible outcomes are 1, 2, 3, 4, 5, 6, those greater than 2 are 3, 4, 5, 6, $= \frac{4}{6} = \frac{2}{3}$		
Evaluation	(i) Define probability. (ii) Describe experimental exclusive events (iii) Explain mutually exclusive rule.		

	(iv) Explain probability rule.		
Conclusion	The teacher goes through the lesson briefly and round off		
Assignment	A. Find the probability that a number selected at random from 51-56 is a multiple of 9. B. Two numbers are chosen at random from three numbers 3, 5, 8. Find the probability that the sum of the two is not odd.		

WEEK ONE: 1st & 2nd Period

CLASS: SS3

CLASS AVERAGE AGE: 15-18yrs

SUBJECT: Biology

TOPIC: Genetics

SUB-TOPIC: Meaning of Genetics and Transmission of Characters

DURATION: 40mins

LEARNING OBJECTIVE: At the end of the lesson, learners' should be able to:-

define genetics

define heredity

describe how characters are transmitted from parents to their offspring

give examples of transmittable characters in human beings

give examples of transmittable characters in plants

RATIONALE: To

INSTRUCTIONAL MATERIALS: Cardboard showing list of words and their meanings, Biology Dictionaries, Standard Dictionaries and Biology Textbook.

REFERENCE: (i) Michael, M. C. (2015). Essential Biology for Senior Secondary Schools. 6th Edition. Tonad Publishers Limited.

LESSON DEVELOPMENT

STAGE	TEACHERS' ACTIVITIES	LEARNERS' ACTIVITIES	LEARNING POINT
I	The teacher starts the lesson by reviewing the previous lesson by asking relevant question on the last lesson. Example of	Learners' answer questions relating to prior lesson	Linking prior lesson to the present knowledge

	such question is: What is Genetics?		
II	The teacher defines Heredity as the transmission and expression of characters or traits in organisms from parents to offspring. The teacher went further to describes genetic variation as the differences among individuals, which can be passed from parents to their offspring.	Listen to the teacher and write	Lesson introduction
III	The teacher describes how characters are transmitted from parents to offspring. Characters are transmitted from parents to offspring are controlled by genes. A diploid organism has two sets of chromosomes known as homologues. Organisms produce gametes by meiosis in their reproductive organs. Males produce the male gametes known as sperms and females produce the female gametes known as ova or egg cells. During sexual reproduction, the two gametes will fuse together to form the zygote. A zygote contains a set of chromosomes and a copy of gene from the gamete of each parent. Characters determined by genes are thereby transmitted from parents to offspring		Lesson buildup

	through genes.		
IV	The Teacher gives examples of characters transmitted in Human beings Body stature Shape of head, nose and ear Colour of the skin, hair and eye Intelligence Height Baldness etc.	Write down relevant information.	Lesson buildup
V	The teacher gives examples of transmittable characters in Plants Height of plant Size of leaf and fruit Taste of fruit Shape of leaf, fruit and flower etc		
Evaluation	Define Genetics Define Heredity Describe how characters are transmitted from parents to their offspring Give examples of transmittable characters in human beings Give examples of transmittable characters in plants		
Conclusion	The teacher goes through the lesson briefly and round off		
Assignment	Briefly describe how characters are inherited by offspring from parents.		

WEEK ONE: 1st & 2nd Period

CLASS: SS3

CLASS AVERAGE AGE: 15-18yrs

SUBJECT: Biology

TOPIC: Genetics

SUB-TOPIC: Mendel's work in Genetics, Codominance, Incomplete Dominance and Sex Determination in Human.

DURATION: 40mins

LEARNING OBJECTIVE: At the end of the lesson, learners' should be able to:-

describe Mendel's experiments in Genetics?

state the two Mendel's Laws of Genetics?

explain Dihybrid and Monohybrid Inheritance?

make genetic crossings for Dihybrid and Monohybrid Inheritance?

describe Test cross and Back cross?

RATIONALE: To

INSTRUCTIONAL MATERIALS: Cardboard showing list of words and their meanings, Biology Dictionaries, Standard Dictionaries and Biology Textbook.

REFERENCE: (i) Michael, M. C. (2015). Essential Biology for Senior Secondary Schools. 6th Edition. Tonad Publishers Limited.

LESSON DEVELOPMENT

STAGE	TEACHERS' ACTIVITIES	LEARNERS' ACTIVITIES	LEARNING POINT
I	The teacher starts the lesson by reviewing the previous lesson by asking relevant questions on the	Learners' answer questions relating to prior lesson	Linking prior lesson to the present knowledge

	last lesson. Examples of such questions are: What is sexual reproduction and transmission of characters in human?		
II	The teacher introduces the topic by explaining Mendel's role. Mendel is often regarded as the father of genetics because his work forms the basis on which the foundation is set for heredity and variation. The teacher further describes Mendel's experiments Mendel carried out several experiments on how hereditary characters were transmitted from generation to generation. He carried out the experiment using Garden pea(<i>Pisum sativum</i>). Mendel chose Garden pea because of the following reasons: 1. It is a self pollinating 2. It is an annual crop 3. It has several contrasting characters.	Listen to the teacher and write	Lesson introduction
III	The teacher describes Mendel's experiments Mendel used two methods in conducting his experiments. These methods were grouped into monohybrid and dihybrid inheritance. He planted tall plants for several generations and		Lesson buildup

	discovered that the plants were all tall plants. He did the same with short plants. He proceeded to plant tall plants and short plants. By the time the flowers were produced, he collected the pollen grains of the tall plants tagged male and pollinated them with the stigma of the short plants tagged female. He also collected the pollen grains of the short plant and placed them on the stigma of the tall plant. He then covered the artificially pollinated flowers with small paper bags to prevent the change of natural pollination by insects. Mendel once again picked the seeds formed after the cross. When he planted the seeds, the plants obtained were all tall plants. This he referred to as First filial generation F1 generation He then crossed the F1 plants, collected their seeds and sowed them. He got from these were tall and short plants in a ratio of 3:1. He then called these stage the Second Filial generation F2 The outcome of this experiment led to Mendel's first law of genetics Parents TT X tt Gametes TT X tt F1 generation		
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	Tt Tt Tt Tt		
IV	The Teacher states Mendel's first law of genetics The law is also called law of segregation of gene, it states that genes are responsible for the development of the individual and are transmitted independently from one generation to another without undergoing any alteration. The teacher further describes Dihybrid Inheritance, which led to Mendel's second law of Genetics. Mendel also carried out various experiments in which he crossed plants which differed in two pairs of contrasting characters such as seed shape and seed colour. This he called dihybrid inheritance.	Write down relevant information and use the genetics terms in a sentence	Lesson buildup
V	The teacher states Mendel's second law of Genetics The law states that each character behaves as a separate unit and is inherited independently of each other. This can be represented by letters and is explained below: Parents: RRYY X		

	rryy (round and yellow) (wrinkled and green) Parent gametes RY RY X ry ry F1 generation Ryry Ryry Ryry Ryry		
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PUNNET SQUARE

	R	Y	R	y	R	y	R	y	
R	Y	R	Y	R	Y	R	y	r	y
R	y	R	y	R	Y	R	y	r	Y
R	Y	r	y	R	Y	r	Y	r	Y
R	y	r	y	R	Y	r	y	r	Y

VI	The teacher describes Test cross and Back cross Test cross is the crossing of organism with the homozygous recessive organism. Backcross is the crossing of an organism with the homozygous recessive organism from the original parental generation.		
Evaluation	Describe Mendel's experiments in Genetics State the two Mendel's Laws of Genetics Explain Dihybrid and Monohybrid Inheritance Make genetic crossings for Dihybrid and Monohybrid		

	Inheritance Describe Test cross and Back cross		
Conclusion	The teacher goes through the lesson briefly and round off		
Assignment			

WEEK ONE: 1st & 2nd Period

CLASS: SS3

CLASS AVERAGE AGE: 15-18yrs

SUBJECT: Biology

TOPIC: Genetics

SUB-TOPIC: Incomplete Dominance and Sex Determination in Human and Probability in Genetics

DURATION: 40mins

LEARNING OBJECTIVE: At the end of the lesson, learners' should be able to:-

describe Incomplete dominance?

describe how sex is determined in Human beings?

define probability in Genetics?

explain how probability can be applied to the formation of gametes?

describe application of probability to the formation of offspring in Humans?

RATIONALE: To

INSTRUCTIONAL MATERIALS: Cardboard showing list of words and their meanings, Biology Dictionaries, Standard Dictionaries and Biology Textbook.

REFERENCE: (i) Michael, M. C. (2015). Essential Biology for Senior Secondary Schools. 6th Edition. Tonad Publishers Limited.

LESSON DEVELOPMENT

STAGE	TEACHERS' ACTIVITIES	LEARNERS' ACTIVITIES	LEARNING POINT
I	The teacher starts the lesson by reviewing the previous lesson by asking the students to define	Learners' answer questions relating to prior lesson	Linking prior lesson to the present knowledge

	genetics and state the Mendel's laws of genetics?		
II	The teacher defines the concept "incomplete dominance" this is ability of two contrasting alleles to interact and produce a heterozygous phenotype that is different from the two homozygous phenotypes. Example is found in four 'o' clock plant and Mirabilis Jalapa.	Listen to the teacher and write	Lesson introduction
III	The teacher explains sex determination in Human beings. In human beings, there are 23 pairs of chromosomes in each body cell. Of these, 22 pairs are called autosomes and have no direct effect on the sex of the individual. One pair is directly concerned with sex determination. This one pair is referred to as sex chromosomes. In the male, the two sex chromosomes in each body cell are called X and Y-chromosomes. Each male gamete carries either an X or a Y chromosome. In the female, all the cells of the body contain one X chromosome each. At fertilization, the combination of an egg with a sperm carrying either an X or a Y chromosome occurs by chance. The chances of an egg	Students' respond to the teacher's questions and also notes their mistakes.	Lesson buildup

	combining with either of the two types of sperms are equal. When a sperm with an X chromosome combines with an egg having X chromosome, the zygote has two X chromosomes and forms a female baby. But if a sperm with a Y chromosome with an egg, the zygote has X and Y-chromosomes and form a male baby.		
IV	The teacher defines probability in Genetics Probability is a branch of mathematics, which can be applied to those events that depend entirely on chance. Probability is usually expressed in units ranging from 0-1. Mendel's works are based on probability.	Write down relevant information.	Lesson buildup
V	The teacher explains the application of probability to the formation of gametes. Suppose an organism with genotype AA, what kinds of gametes will it produce and in what proportion? Since only one of the pairs of chromosomes get segregated during meiosis, the probable gamete produced from the AA parent is A $\frac{1}{2}$ and $\frac{1}{2}$ A. If the parent is heterozygous (A) (a), the probable gamete will be $\frac{1}{2}$ A and $\frac{1}{2}$		

	a.		
	The teacher explains the application of probability to the formation of offspring in Humans. Suppose a male carrier of the albino gene marries a female albino, what is the probability of them having an albino? The male is heterozygous (Aa), and the female is homozygous recessive (aa) Parents Aa aa Gamete Aa aa Offspring Aa Aa aa aa The probability is that $\frac{1}{2}$ of the offspring will be albino while $\frac{1}{2}$ of them will be heterozygous		
Evaluation	The teacher asks the students the following questions. Describe Incomplete dominance Describe how sex is determined in Human beings Define probability in Genetics		
Conclusion	The teacher goes through the lesson briefly and round off		
Assignment	What is the probability that		

	an individual with genotype Tt will produce a gamete with T gene?		
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WEEK ONE: 1st & 2nd Period

CLASS: SS3

CLASS AVERAGE AGE: 15-18yrs

SUBJECT: Biology

TOPIC: Genetics

SUB-TOPIC: Sex linkage in Human and Application of Genetics

DURATION: 40mins

LEARNING OBJECTIVE: At the end of the lesson, learners' should be able to:-

define sex link gene?

give examples of sex linked traits?

define Pedigree?

state importance of Pedigrees?

state application of principles of genetics?

RATIONALE: To

INSTRUCTIONAL MATERIALS: Cardboard showing list of words and their meanings, Biology Dictionaries, Standard Dictionaries and Biology Textbook.

REFERENCE: (i) Michael, M. C. (2015). Essential Biology for Senior Secondary Schools. 6th Edition. Tonad Publishers Limited.

LESSON DEVELOPMENT

STAGE	TEACHERS' ACTIVITIES	LEARNERS' ACTIVITIES	LEARNING POINT
I	The teacher starts the lesson by reviewing the previous lesson by asking by the students to explain how traits are transmitted	Learners' answer questions relating to prior lesson	Linking prior lesson to the present knowledge

	from parents to their offspring.		
II	The teacher describes sex-linked traits as traits that are carried by the X chromosomes. Genes on the same chromosome are said to be linked because they are inherited together. A sex-linked gene is a gene located on the X chromosome.	Listen to the teacher and write	Lesson introduction
III	The teacher gives examples of sex linked traits These include; Colour blindness, Haemophilia, Baldness, Sickle cell anemia and Albinism		Lesson buildup
IV	The teacher define family trees or Pedigree A family tree is an illustration or chart showing the lines of generation of parents and their offspring.	Write down relevant information.	Lesson buildup
V	The teacher explains the importance of pedigree 1. It can be used to study a particular trait in a family, whether such trait is inherited or transmitted from one generation to another 2. It helps to easily detect diseases that run in some families		
VI	The teacher explains the application of principles of Genetics which include: (i) In cross and self-		

	fertilization (ii) In sexual and asexual reproduction (iii) In out breeding and in breeding (iv) In agriculture (v) In Medicine - To determine paternity of children - In blood transfusion - In marriage counseling - In the diagnosis of diseases - In crime detection Etc.		
Evaluation	- Define sex link gene - Give examples of sex linked traits - Define Pedigree - State importance of Pedigrees - State application of principles of genetics		
Conclusion	The teacher goes through the lesson briefly and round off		
Assignment	- State five ways in which genetics has contributed to the improvement of agriculture - Explain the term “sex linked traits”/ - State three areas in which the principle of genetics has improved medicine.		

APPENDIX XII

BUDGET PROPOSAL

1.0 Personnel Cost/Allowances	180,000:00
1.1 Research assistant(6)	50.00
1.2 Research information	30,000:00
1.3Technical assistant	210,000:00
Subtotal (not>20% of budget)	
2.0 Equipment (list & specify)	
2.1 Laptop	150,000:00
2.2 printers	85,000:00
(1 color and 2 black and white)	
2.3 Flash/modem	15,000:00
2.4 Generators	40,000.00
(Alternative power supply)	
Subtotal(not>20%of budget)	295,000:00
3.0Supplied consumables	
3.1 papers/Toners	120,000:00
3.2 Purchase of textbooks and pen	5,000:00
3.3 Monthly subscription of	75,000:00
Modem at 2500 per month x30	
Subtotal	200,000:00
4.0 Data collection & analysis	
Workshop	300,000.00
4.1Analysis	100,000:00
4.2 Cost of administering the	100,000:00
the questionnaire	

Subtotal	500,000:00
5.0 Travels	
5.1 Researcher	120,000:00
Sub total	
6.0 Dissemination	
6.1 Seminar 1 (proposal)	40,000:00
6.2 Seminar 2 (Protocol)	25,000:00
6.3 Seminar 3 (Mock Defence)	20,000:00
6.4 Seminar 4 (Oral Defence)	260,000:00
Subtotal	335,000:00
7.0 Others/ Miscellaneous	
7.1 Accommodation on research trip	135,000:00
7.2 Miscellaneous	120,000:00
Subtotal	250,000:00
GRAND TOTAL	2,480,000:00

APPENDIX XIII

Postgraduate Research Plan

	11/01/16	11/02/16	11/03/16	11/04/16	11/05/16	11/06/16	11/07/16	11/08/16	11/09/16	11/10/16	11/11/16	11/12/16	11/01/17	11/02/17	11/03/17	11/04/17	11/05/17	11/06/17	11/07/17	11/08/17	11/03/18	11/04/18	11/05/18	11/06/18	05/07/18	05/08/18	05/09/18	27/11/18	13/02/2020
M O N T H	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
T A S K																													
Survey of Literature																													
Write Proposal (Programmes Without Coursework)																													
Write Proposal (Programmes With Coursework)																													
Gather Data (Programmes with Coursework)																													
Thesis Writing																													
Write Introduction																													
Revise Introduction																													
Write Methodology																													
Revise Methodology																													
Approval for proposal S e m i n a r																													
Awaiting schedule for proposal seminar																													
Proposal presentation																													
Effecting proposal corrections for protocol																													
Protocol presentation																													
Analyses, Results and Discussion																													
Write Conclusions																													
Revise conclusions																													
Acknowledgements, Appendices, etc.																													
Preliminary Defense																													
Proof reading																													
Printing and Binding																													