IMPACT OF COGNITIVE CONFLICT INSTRUCTIONAL MODEL ON CONCEPTUAL CHANGE AND PERFORMANCE IN GENETICS AMONG SECONDARY SCHOOL BIOLOGY STUDENTS IN POTISKUM,

YOBE STATE, NIGERIA

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A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER DEGREE IN SCIENCE EDUCATION

DEPARTMENT OF SCIENCE EDUCATION,
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DEDICATION

This dissertation is dedicated to my Father, Alhaji Ahmad Jaji Saleh. To my Mother Hajiya Maryam Barau, my step mothers Haj. Hussaina and Haj. Aisha, my nephew Ahmed Aminun-kano Maude, my wife Aishatu Sani Dumbulwa, my son Ahmad (Mahbub) and to the entire Saleh Maude Family. Thank you all.

DECLARATION

I hereby declare that this dissertation entitled "Impact of Cognitive Conflict Instructional Model on Conceptual Change and Academic Performance in genetics among Secondary School Biology Students in Potiskum, Yobe State, Nigeria" has been written by me and it is a record of my own research work. It has not been presented in any previous institution and application for higher degree. All quotation marks or indentation and the sources of information are specifically acknowledged by means of references.

Abubakar Saleh JAJI Date

P16EDSC8075

CERTIFICATION

This dissertation entitled "Impact of Cognitive Conflict Instructional Model on Conceptual Change and Academic Performance in Genetics among Secondary School Biology Students in Potiskum, Yobe State, Nigeria" by Jaji Abubakar Saleh with Registration number P16EDSC8075, meets the regulations governing the award of the degree of Master of Education in Science Education of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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LIST OF ABBREVIATION

NERDC	National Educational Research and Development Council
ANOVA	Analysis of Variance
GPT	Genetic Performance Test
GCE	Genetic Concept Evaluation
PPMCC	Person Product Moment Correlation Coefficient
IVF	In Vitro Fertilization
DNA	Deoxyribonuclic Acid
SC	Scientific Conception
PC	Partial Conception
AC	Alternative Conception

OPERATIONAL DEFINITIONS OF TERMS

Academic Performance: Scores that students obtained after been subjected to tests or examinations at the end of a program or instruction.

Conception: Perception or understanding of a concept

Misconception: The prior knowledge that is in conflict with scientific knowledge

Conceptual change: Refers to what happens in the learner who has come to the learning environment with prior knowledge that might be a misconception that need to be changed or erased in order to accept a better conception

Lecture Method: Verbal means of presenting information to students dominated by the teacher.

Cognitive Conflict: This is a perceptual state in which one notices the discrepancy between one's cognitive structure and environment (external information) or between the components of one's cognitive structure (that is, one's conceptions, beliefs, substructures, among others, which are part of the cognitive structure)

ABSTRACT

This study investigates the Impact of Cognitive Conflict Instructional Model on Conceptual Change and Academic Performance in Genetics among Senior Secondary School III Biology students. A Quasi-experimental pretest and posttest research design was used for the study which featured two groups (Experimental and Control group). The experimental group was exposed to cognitive conflict instructional model (CCIM) while the control group was taught using lecture method. Sample sizes of 199 students selected from four secondary schools in Potiskum, Yobe State were used as the study sample, drawn from a population of 16 single sex (that is, either male or female) schools with a total of 1021 students. The Four schools randomly selected, were selected after matching them, to find their academic equivalence. The Instruments developed; Genetics Performance Test (GPT) and Genetics Concept Evaluation (GCE) with a reliability coefficient of 0.78 and 0.79 were used to collect data for pretest, posttest and gender equivalent. Four research questions and four null hypotheses guided the study.One of the research questions was: what is the difference in the mean conceptual change score of secondary school students taught genetics concept using cognitive conflict instructional model and those taught using lecture method?. One of the null hypothesis was : there is no significant difference between the mean conceptual change score among secondary school biology students in genetics taught using cognitive conflict instructional model and those taught using lecture method. The data collected were analyzed using t-test Statistic and Chi-square test at significance level of $P \leq 0.05$. Results indicated that; (i) the experimental group performed significantly better than the control group in their academic performance, showing there is a significant difference. (ii) the model was found to have promoted the experimental group students' scientific Conception (that is their level of conceptual change) as there was a significant shift of students from alternative or no conception to sound conception after treatment with CCIM. (iii) The treatment has no significant effect on gender which implied that the model is gender friendly. Based on these findings, it was recommended that;there is a need for training and retraining of science teachers towards effective use of CCIM in the teaching of science at SSS level as it promotes scientific thinking.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

Biology is one of the science subjects that occupies a significant position in the Senior Secondary School curriculum which when acquired and applied in any society can bring about rapid and sustainable national development (Ibrahim, 2015). It is a study of life and serves as an academic subject taught in senior secondary school and tertiary institutions in Nigeria. As one of the basic science subject, biology serves as a prerequisite to the study of Medicine, Pharmacy, Agricultural science, Veterinary medicine, Microbiology, Biochemistry, and Biotechnology among others.

Biology is meant to expose learners to scientific nature (facts, principles, and concepts), processes and attitudes. The objectives of Biology curriculum as provided in the National Policy on Education (FRN, 2013) include: Required for everyday life on matters of personal & community health; Meaningful and relevant knowledge.

Genetics as a branch of Biology is referred to as the science of genes, heredity and variation in living organisms. The knowledge of Genetics is very vital in all human endeavors. Through the knowledge of Genetics human life has improved effectively, ranging from improved variety of plant and animal species through selective breeding, inbreeding, out breeding, sex determination and prevention of heritable diseases in the family. Bailey (2013) defined Genetics as the study of heredity or inheritance. Genetics helps to explain how traits are passed from parents to their offspring. Although, a report from West African Examination Council (2016), said that students still perform poorly in the area of Genetics and only few candidates attempt questions on

Genetics. According to Araz (2007), Genetics has a lot of abstract concepts, terminologies that are hard to understand, to learn and to remember.

The problem of poor performance in science subjects including biology has persisted over the years (Jerome, 2006; & Enesi, 2007). According to Chief Examiners' reports (WAEC, 2015) regarding students' performance in biology in relation to other science subjects:

When compared with the May/June 2014 WASSCE, the trends in the candidates' performance are stated as follows:There was a decline in the performance of candidates in Agricultural Science1, Biology 1 and Chemistry 2;There was no significant difference in the performance of candidates in Biology 2.(May/June 2015 WAEC).

While candidates' performance were higher in Agric Science 2, Chemistry 1&2, Physics 2, Physical Education 2, candidates' performance dropped slightly in Physics 3, Agric Science 3, Biology 3, Biology 2, Physical Education 1 and Health Science 1&2.

(Nov/Dec 2015 WAEC).

The Chief examiners report(WAEC, 2015) pointed out some of weaknesses observed among Biology candidates that include:Poor knowledge of genetics and wrong spelling of technical words; Inability to distinguish between normal genetics crossing and sex-linked gene crossing; Poor knowledge of the application of genetics in marriage counseling(Nov/Dec 2015).

In addition, empirical studies such as those of Lakpini (2006), Lawal (2009), Lawal (2010), Timothy (2013) and Ibrahim (2015) have shown that students perform poorly in Biology at senior secondary school level.

Persistent low academic performance in science education is attributed to teacher instructional strategies among others (Atadoga, & Lakpini, 2013). Majority of science teachers teach students using lecture method. Science educators such as Danjuma (2005) reported that about 80-90% of the scientific information or principles students received from their teachers are through lecture method. A number of activity- oriented instructional strategies have been advocated for by curriculum designers and science educators to help improve on the failure rate among secondary school science students (Eniayeju, 2011). Thus, instructional strategies used by teachers in teaching and learning process have significant influence on learners' academic performance. According to Adesanya (2009), constructivists maintain that people actively construct new knowledge as they interact with environment. Everything one hears, sees, feels, reads and touch is tested against ones' prior knowledge and if it is viable within ones mental world, one may form new knowledge (Agiande, Williams, Dunnamah & Tumba, 2015).

Also, Lakpini (2006) reveals that when students are taught genetic concept using constructivist teaching strategies they achieved better than those taught with lecture method.A study by Lawal (2005) on genetic concept showed that students taught using concept mapping strategy performed better than those taught with lecture method.Therefore, the researcher investigated the impact of cognitive conflict instructional model on conceptual change and performance in genetics among secondary school Biology students.

It is accepted that students come to the classes with a range of informal ideas and most of them are different from scientific conceptions(Jaakkola &Nurmi, 2008; Treagust & Duit, 2008). Learners experience of the world, the influence of their peers, the media and pre-instruction would lead them to develop these conceptions (Chu,Treagust & Chandrasegaran, 2009; Fetherstonhaugh & Treagust, 1992; Reddish, Saul, & Steinberg, 1998). However misconceptions may occur, which may originate from category mistakes. Category mistakes occur when a learner mistakenly assigns concepts into wrong lateral or ontological categories (Chi, 2008). A lateral category is a category occupying different branches of the same tree, while an ontological category is a category between different trees. Category mistakes account for robust misconceptions (Chi, 2008). This implies that a category mistake once it gets registered into a learner's mental framework results in a wrong or flawed mental model. That is, students think of some concepts from different ontological categories from those assigned by scientists. This suggests that conceptual change must involve an ontological change in the student's cognitive structure. The structure of a conception may vary considerably from a relatively amorphous collection of ideas with no strong connection to one which is interrelated and possesses a large measure of internal consistency. Therefore, developing a solid base of knowledge about students' conceptions should be instrumental to providing a framework for considering the learning processes involved in changing students' conceptions, as well as providing a framework for designing instruction that facilitates the expected changes.

In science, learning of concepts can occur under three different conditions (Chi, 2008). First, a student may have no prior knowledge of the to-be-learned concepts, although they may have some related knowledge. In this case, prior knowledge is missing, and learning consists of adding new knowledge (Chi, 2008). Second, a student may have some correct prior knowledge about the to-be-learned concepts, but that knowledge is incomplete. In this incomplete knowledge case, learning can be conceived of as gap filling. In the third condition, a student may have acquired ideas, either in school or from everyday experience, that are "in conflict with" the to-be-learned concepts (Vosniadou, 1994). The prior knowledge that is in conflict with scientific knowledge is called misconception (Chi, 2008).

According to Baser (2006), studies show that since 1990s cognitive conflict-based instruction has been extensively used in science education where several studies concluded that cognitive conflict has an important/ positive effect on conceptual change. Most of the models proposed to explain conceptual change have emphasized the role of cognitive conflict as a central condition for conceptual change (Limon, 2001). Cognitive conflict has been defined as a perceptual state in which one notices the discrepancy between one's cognitive structure and environment (external information) or between the components of one's cognitive structure (that is, one's conceptions, beliefs, substructures, among others which are part of the cognitive structure) (Lee & Yi, 2013). In their 2012 article, Lee &Byun proposed an interesting and quite complete review of the available definitions. Most of them encompass the ideas of awareness, disequilibrium, not-confirmed expectations or predictions, logical conflicts between conceptions, among others (Lee & Byun, 2012).

There are different types of cognitive conflicts. Some occur between conceptions that exist within the same person, other conflicts occur between different people (socio-cognitive conflicts), but, most often, the models for cognitive conflict aim to trigger conflict by introducing new contradictory information (Limon, 2001). Contradictory information has been usually presented through texts, hands-on activities, experiments, simulations, and / or the opposing views of peers during group discussion. In this case, a contradiction occurs, for example, between student's conceptions or expectations and the crucial information that a knowledgeable teacher brings to the student's attention and which the students perceive to be discrepant. Thus, such a "discrepant event" can be defined as "the physical experience that provides students with novel evidence to contradict their existing conceptions" (Kang, Scharmann, & Noh, 2004).

Cognitive conflict in classical theory is a “revolutionary” process believed to make learners either accept the scientific conception by dissatisfying them with their alternative conception or retaining their conception if unable to satisfy the conditions for the scientific conception. Cognitive conflict occurs when a student’s mental balance is disturbed by experiences (referred to as “anomalous data”) that do not fit into their current understanding (Foster, 2011). The cognitive conflict strategy involves (a) identifying students’ current state of knowledge; (b) confronting students with contradictory information that is usually presented through texts and interviewers, thus making explicit the contradiction, or guide the debate with the student or among peers (small groups or the whole classroom); and (c) evaluating the degree of conceptual change between the students’ prior ideas or beliefs and a posttest measure after the instructional intervention (Hewson & Hewson, 1984). To understand cognitive conflict, knowledge of the cognitive conflict process model is imperative. The reason is because it explains the stages in which cognitive conflict occurs and how to resolve the generated conflict(s). Lee and Kwon (2001) developed a three-stage cognitive conflict process model, which includes preliminary, conflict, and resolution. The preliminary stage represents a process in which a student who has belief in preexisting conception accepts an anomalous situation (for example, experimental results obtained by a teacher) as genuine. If the students do not have a strong confidence in a well-formulated conception or if they consider the anomalous situation as deceptive, they do not experience cognitive conflict. Thus, the preliminary stage is the stage before cognitive conflict (Lee et al., 2003).

In this model, the cognitive conflict process occurs when a learner (a) recognizes an anomalous situation, (b) expresses interest or anxiety about resolving the cognitive conflict, and (c) engages in cognitive reappraisal of the situation. For instance, when learners recognize that a situation is incongruous with their conceptions, they become interested in or anxious about this situation (Lee et al., 2003). Relating this to genetics, where a student, who originally believes that skin color of a child, depends on the child's parents' complexion, now learn through anomalous example that skin color depends on inheriting the gene carrying the character. The student becomes interested or anxious to understand about the situation and how it cognitively reappraises his or her previous conception and accept the scientific conception of the use of inherited gene to predict a skin color. Also student may experience a cognitive conflict when asked to give genetic information of a cell collected from cheeks of two different individuals. For instance, if one of a child's cheek cell is removed and one of another child's cheek cell is also removed, will the genetic information in them be the same or different? Some might answer this question as different and the reason may be because they have different mommy and daddy, so they are genetically different. While some might answer it as same and the reason may be because all are cheeks cells, they are genetically identical or they have the same genetic structures. When such cognitive conflict was created, students will be allow to interact in their group and report their findings or answers, which will be use by the teacher to guide discussions between the groups and summarize the discussion at the end. Therefore, at the end of the lesson students will realize that it will be different because cells are only identical to only that person.

The resolution stage is an external response behavior (Lee, Kwon & Park 2003). Response behaviors include ignoring, rejection, uncertainty, exclusion, abeyance, reinterpretation, peripheral and theory change. The purpose of this study was to find the impact of Cognitive Conflict Instructional model on students' conceptual change in genetics. Specifically, the study intends to determine the effects of cognitive conflict instructional model on students' conceptual change and performance in genetics among secondary school biology students.

According to Ochonogor (2006), Biology as life science is expected to be humanistic and not gender-biased in nature. This implies that irrespective of natural gender differentiation , all learners (old or young) in any given science class are expected to be taught in a common learning environment, using non-stereo typed pedagogical approaches, contents and activities . With such foundation for all recipients of science knowledge content, their performance can, therefore, be evaluated and analyzed on a common platform. Hence, it will therefore be interesting to find out if there may be a link between cognitive conflict and gender differences in conceptual change and performance between male and female learners. In this study, the researcher investigates the impact of cognitive conflict instructional strategy on conceptual change and performance in Genetics among secondary school biology students in Potiskum, Yobe State, Nigeria.

1.1.1 TheoreticalFramework

This study adopts Posner, Strike, Hewson, and Gertzog (1982) conceptual change theory as its theoretical framework.

The conceptual change theory proposed by Posner *et al* (1982), sees conceptual change as more than just a socio-cultural interaction or a teaching strategy but as a process of identifying prior misconceptions which the learner carries into the environment in order to help the learner exchange the misconceptions or add new conceptions that are more useful, plausible and intelligible. The assumption that knowledge is gradually crafted (constructed) from a base of prior knowledge by constructivist is what is at variance with modern conceptual change theories and have attracted the following questions. How can a misconceived knowledge base which interfere with learning be replaced and not resists instruction but support students' knowledge construction? (Ozdemir & Clark 2007).

The above observation points out that for constructivism to be taken seriously, the mistaken character of misconceptions in the prior knowledge base of the learner has to be reconsidered. In other words, other ways of dealing with the problem of misconceptions is to enable the learner construct his/her own knowledge without obstructions. From the above, conceptual change refers to what happens in the learner who has come to the learning environment with prior knowledge that might be a misconception that need to be changed or erased in order to accept a better conception.

Hence, the theory of conceptual change proposed by Posner et al (1982) describes learning as an interaction between new and existing conceptions. The “Conceptual Change Model” developed by Posner et al which has two components: The first is the four conditions necessary for conceptual change. These are: (i) dissatisfaction; (ii) intelligibility; (iii) plausibility; (iv) fruitfulness. Posner et al (1982) considered the phase of conflict, generated by dissatisfaction with the existing concepts, as a first step to achieve conceptual change. In this phase of dissatisfaction students should realize they need to “reorganize”, “restructure” or change to some extent their existing ideas or concepts (Limon, 2001). A kind of “metacognition awareness” seems to be necessary, but not sufficient, condition to achieve conceptual change in both weak or a radical sense (Carey,1985; Vosniadou & Brewer, 1987; Vosniadou, 1994). It seems that to change something, an individual needs to realize that he/she has to change something and to be willing to do it. Posner *et al* also added that for the new conception to be assimilated or accommodated, it must be intelligible (clear enough), plausible (reasonably true) and fruitful (potentially productive). He and his associates further added that these cognitive conditions must be met during the learning process as the teacher lead the learners towards creating cognitive conflicts to make the learner dissatisfied with his/her existing conception. This is necessary because a misconception that disorganizes and constraints learning is highly resistant to change due to the web-like links it has formed with the artefacts within the learner's conceptual ecology(Agiande, Williams, Dunnamah & Tumba, 2015).Therefore, the process of changing one concept requires a corresponding change in the other related concepts in ways that resemble a kind of paradigm shift (Hewson, 1992).

The second component of conceptual change is a person’s conceptual ecology. Conceptual ecology may be seen as the learner’s previous knowledge, or the alternative cognition of the learner. Conceptual ecology provides the context in which the conceptual change occurs. It influences the change and gives it meaning. Conceptual ecology consist of many different forms of knowledge, the most important of which may be epistemological commitments (for example, to consistency or generalizability), metaphysical beliefs about the world (for example, nature of time), and analogies and metaphors that may serve to structure new information (Hewson, 1992).

Therefore, Posner et al. (1982) stated that if the existing conception was found unsuccessful, it would more likely to be rejected. If the new concept has a potential to solve the problem, it will be more likely to be accepted. According to authors, for the conceptual change, a student must have a conceptual ecology related to his / her existing concept and there must be anomalies that make him / her feel dissatisfied. Also, new concept must be comprehensible, plausible, and fruitful. The term comprehensible indicates the new concept’s potential to solve problem and plausible means student’s being in accordance with knowledge that he / she has constructed up to now. Fruitfulness indicates the feature of new concept that implies applicability, transferability.

It means the new concept's potential to encourage students to conduct new researches(Hewson & Hewson, 1983; Hewson & Thorley, 1989).

The conceptual change theory is based on Piaget (1970) in the point of explaining learning. Students' tendency of using preconceptions when they encounter the new phenomena to explain the new concepts is defined as "*assimilation*". However, in some cases, preconceptions do not allow students to explain new phenomena successfully. They realize that their preconceptions are incapable of solving the problems and this condition makes them feel dissatisfied. Students feel the need for changing or reorganizing their existing conceptions. This stage is called "*accommodation*" in Conceptual Change Theory.

Therefore, Piaget (1975) considered cognitive conflict as a step in the process of equilibration. He distinguished between adapted and unadapted responses to contradictory information. Adapted responses are classified into three types: *alpha,beta and gamma.* Alpha answers involve individuals who ignore or do not take into account the conflicting data. Beta answers are characterized by producing partial modifications in the learner's theory, through generalization and differentiation (generating an "ad hoc" explanation). Finally, gamma answers involve the modification of the central core of the theory.

Many studies on conceptual change have focused on specifically designed strategies employing a cognitive conflict approach on the basis of the model. A cognitive conflict strategy emphasizes on destabilizing students' confidence in their existing conceptions through contradictory experiences such as discrepant events and then enabling students to replace their inaccurate preconceptions with scientifically accepted conceptions (Chan, Burtis, & Breiter, 1997; Limon, 2001; Pintrich, 1999).

However, this study is hinged on Conceptual Change Theory of Piaget (1970) and the "Conceptual Change Model" developed by Posner and colleagues (1982). Posner and colleagues noted that learning proceeds smoothly when the learner meets the conditions for conceptual change. For example, when a learner encounters a new concept that conflicts with his or her conceptual beliefs, the learner may first feel dissatisfied, but then on checking the intelligibility of that concept, its plausibility and fruitfulness, the learner accepts it by replacing the old wrong concept. Without this, the learner rejects the new concept.

Therefore this study sought to investigate the impact of cognitive conflict instructional model on conceptual change and performance in genetics among secondary school biology students in Potiskum, Yobe State, Nigeria.

1.2 Statement of the Problem

Poor performance in Biology has become a trend in the West African Examination Council (WAEC) results of Nigerian secondary schools. For instance, from the year 2009 to the year 2017 the total number of students that failed Biology over these years is on the increase. The summary of WAEC for 2009 to 2017 is presented in Table 1.1.

Table 1.1:Students' SSCE Results in Biology (2006 - 2017) in Nigeria.

Year	Number of Candidates in Attendance	Number of Candidates that passed	Number of Candidates that Failed	%Passed (A1-C6)	%Failed (D7-F9)
2006	1,137,221	559,854	577,367	49.23	50.77
2007	1,238,300	413,221	825,079	33.37	66.63
2008	1,260,000	427,644	832,356	33.94	66.06
2009	1,340,489	383,112	957,377	28.58	71.42
2010	1,300,630	645,633	654,997	49.64	50.36
2011	1,505,409	579,432	925,977	38.49	61.51

2012	1,646,225	587,044	1,059,181	35.66	64.34
2013	1,698,187	564,138	1,134,049	33.22	66.78
2014	1,692,535	529,425	1,163,110	31.28	68.72
2015	1,701,048	508,613	1,192,435	29.90	70.10
2016	1,804,048	604,000	1,200,048	29.98	70.12
2017	1,903,552	687,573	1,215,979	31.79	68.21

Source: WAEC office, Lagos (2017).

Table 1.1 showed that students' performance in Biology was quite unsatisfactory. Despite the increasing number of candidates over the year under review, the percentage of candidates with credit pass and above is usually below 45% for every year. It is stipulated in the 2013/2014 curriculum that at the secondary school level students must offer one of the basic science subjects, and therefore most secondary school students offered Biology at this level. Consistent poor performance of students in Biology at SSCE level leaves one in doubt about the effectiveness of the teaching method used by Biology teachers in teaching biological concept. Students do find some biological concepts difficult, complicated and abstract such as concept of genetics. This difficulty, complication and abstract of some concepts may lead to misconception. Misconceptions may be another reason for low achievement of students.

Misconceptions may arise through interaction with environment and cultural beliefs including the cultural use of imprecise language. Hence, when using child's complexion to judge the complexion of his parents, one become accustomed to physical character that usually appears dark or fair complexion and combine such experiences into a generalization that provides some explanation for that experience. Interaction with environment and cultural beliefs leads to misconception. Common statements such as "skin colour of a child" lead to beliefs that may be in conflict with scientific views. Society's use of physical characters for genetic purposes, beliefs that marrying light-skinned lady to producelight-skin children and failure in practice. Observation of light-skinned parents that give birth to dark-skinned child among others, leads to confusion about physical and genetic make ups. Naïve beliefs can also be developed through classroom instruction and reading textbooks or other educational material. Bauman in Yeo and Zadnik (2001) apportions the blame between poorly understood or inconsistent use of terminology in textbooks, teachers' inadequate knowledge, and the inherent conceptual difficulty of the topic.

However, to understand the conceptual change components requires an instructional model that can stimulate and enhance students' conceptual change. This is because some instructional models have been found to be defective in changing students' concept in science. Example of such models is traditional teaching methods (for example, the lecture method).

Students' misconception cannot be eliminated easily by traditional method. Ways of eliminating have been identified and seems to be methods that provide cognitive conflict and resolution of such conflict. Intentional activity to show conflict and help in resolution could be effective and cognitive conflict has this property. Madu and Orji (2015) investigated the efficacy of cognitive-conflict-based physics instruction over the traditionally designed physics instruction on students' conceptual change in heat and temperature. The result of the research indicated that the level of understanding of heat and temperature was significantly dependent on the treatment. Based on this, the researcher intends to investigate the impact of cognitive conflict instructional model on conceptual change and performance in genetics among secondary school biology students in Potiskum, Yobe State, Nigeria.

One alternative way is to change the instruction from teacher-centered to student-centered using a constructivist approach. Conceptual change is mainly linked to students' alternative conceptions and their own experience. In constructivists' perspective, students' alternative conceptions are interpreted. Students enter the classroom with their own ideas and experiences and they shape their formal knowledge based on their existing ideas and experience at school. Their preconception can be valid, invalid, or incomplete. When the new information or experiences are presented to students in the classroom, they will either reject or reformulate their existing cognitive structures whether their knowledge and experience are connected to their background information. In essence, students' own perceptions and new idea may be integrated as a useful part of their memory. Hence, this study is therefore aim to determine the impact of cognitive conflict instructional model on conceptual change and performance among secondary school Biology students in Genetics in Potiskum, Yobe State, Nigeria.

1.3 Objectives of the Study

The study was guided by the following objectives to;

1. determine the impact of cognitive conflict instructional model on conceptual changeamong secondary school Biology students in genetics concept.
2. determine the impact of cognitive conflict instructional model on academic performance among secondary school Biology students in genetics concept
3. determine the impact of cognitive conflict instructional model on conceptual change of males and females secondary school biology students in genetics concept
4. determine the impact of cognitive conflict instructional model on academic performance of males and females secondary school biology students in genetics concept

1.4 Research Questions

The following research questions were formulated to guide the study:

1. What is the difference in the mean conceptual change score of secondary school students taught genetics concept using cognitive conflict instructional modeland those taught using lecture method?
2. What is the difference between the mean academic performance scores of secondary school biology students taught genetics concept using cognitive conflict instructional model and those taught using lecture method?
3. What is the difference between the mean conceptual change score of males and females secondary school students taught genetics concept using cognitive conflict instructional model?
4. What is the difference between the mean academic performance scores of males and females secondary school biology students taught genetics concept using cognitive conflictinstructional model?

1.5 Null Hypotheses

The following null hypotheses were formulated to be tested at $P \leq 0.05$ level of significance:

HO_1: There is no significant difference in the mean conceptual changescores among secondary school biology students in genetics taught using cognitive conflict instructional model and those taught using lecture method.

HO_2: There is no significant difference between the mean academic performance scores among secondary school biology students in genetics taught using cognitive conflict instructional model and those taught using lecture method.

$H0_3$: There is no significant difference between the mean conceptual change scores of males and females secondary school biology students in genetics taught using cognitive conflict instructional model.

HO_4: There is no significant difference between the mean academic performance scores of males and females secondary school biology students in genetics taught using cognitive conflict instructional model.

1.6 Significance of the Study

The findings of this study would be hopefully significant to the following:

Science Teachers: it would provide some information about cognitive conflict strategy; how it can be conducted on genetics topics, how it affects students' achievement and understanding levels of genetics.

Biology Students: Students misconceptions in science can be minimized, their ability to reason scientifically enhanced and improvement in their performance in science through conceptual change approach.

Textbooks Publishers: The study would be useful to design activities that involve the use of cognitive conflict strategy on conceptual change and performance among secondary school students.

Curriculum Planners: the result of the study would guide the future update in secondary school curriculum design and implementation about use of cognitive conflict as a strategy of teaching science

Professional Bodies: such as STAN, MAN, can benefit from it by training the prospective members with cognitive conflict strategy researches.

This study would give information to science teachers, particularly biology teachers about how students understand genetic concepts. It is the hope that the result of the study will guide the future studies about the implementation of the cognitive conflict strategy in the other science areas.

Researchers: hopefully the outcome of the study may be use by fellow researchers to replicate it in other study areas, improve on it or adapt it for similar studies and also add more information to the existing literature.

1.7 Scope of the Study

The population of the study comprised secondary school III Biology students in public secondary schools in Potiskum zonal education of Yobe State, Nigeria. The schools are single-sexed in the zone. The samples used for this study are four public senior secondary schools randomly selected from the sixteen (16) public senior secondary schools in the zone. In addition, genetics was chosen for this study because the concepts therein have been perceived to be abstract, difficult and complicated for students to understand. The topics chosen under genetics are as follows:

1. Transmission and expression of characters in organism;
2. Chromosomes, the basis of hereditary;
3. Probability in genetics;
4. Application of the principles of heredity;
5. Explain the terms: - Cross fertilization; -Self fertilization; - out and in-breeding using mendelian crosses.

These topics are selected based on the weaknesses observed by the WAEC chief examiners' report (May/June, 2015).

1.8 Basic Assumptions

The study has the following basic assumptions: That;

1. the students already have a good knowledge in genetics concept.

2. the selected concepts in genetics are appropriate to the level of subjects used for the study.
3. the Biology teachers in the various schools under this study are not familiar with cognitive conflict instructional model.
4. the instruments used for the study are appropriate.

CHAPTER TWO

REVIEW OF THE RELATED LITERATURE

2.1 Introduction

This study set to examine the impact of cognitive conflict instructional model on conceptual change and performance among secondary school Biology students in genetics in Potiskum, Yobe state, Nigeria. This chapter reviewed some literatures related to this study under the following headings:

2.2 Science Teaching Methods

2.2.1 Teaching of Biology as Science Subject at Secondary School Level

2.2.2 Genetics Concept in Biology

2.3 Misconceptions in Concept of Genetics

2.3.1 Identification and Correction of Misconceptions

2.4 Conceptual Change Approach

2.4.1 Instructional Models for Conceptual Change

2.5 Cognitive Conflict Instructional Model

2.5.1 Cognitive Conflict Instructional Model and Academic Performance

2.6 Gender and Academic Performance in Biology

2.7 Overview of Similar Studies

2. 8 Implication of the Literature Reviewed on the Present Study

2.2 Science Teaching Methods

There are several methods that have been used for effective teaching and learning scientific facts, information, principles, and skills at secondary school level. Some of these methods include; Demonstration, Inquiry, Discovery approach, Discussion, Project, Laboratory, Individualized, Fieldtrip, Excursion, Lecture, Linear Programmed Instruction, Direct expository methods, Problem solving, conceptual change approach, to mention just a few. For this study, the researcher used Cognitive conflict instructional model to teach the experimental group and lecture method for the control group.

Lecture method is viewed by James (2000) as one of the most popular method of instruction commonly used for science teaching. He described lecture method as that traditional approach which is referred to as didactic approach, and thus can be defined as a teaching technique in which one person usually the teacher presents a spoken discourse on a particular subject. Lecture method emphasizes “Talk and Chalk” in the teaching of science subjects. More than 80% of scientific information and principles are delivered as lectures (Bichi, 2002). Teachers embrace this method for easy coverage of the school syllabus. It is characterized by one-way flow of information from the teacher who is always active, while the students are always passive. The method saves time and energy. It allows easy handling of large classes without much stress and is not expensive as only the chalkboard is required. In its true nature the lecture approach is not effective in science teaching. Usman (200), James (2000) and Bichi (2002) all argued against it because it does not promote meaningful learning in science. The differences in students’ ability are not considered because it cannot satisfy the difference in individuals such as slow learners and fast learners. The students easily become restless and disruptive since their attention span is very limited.

Field trip teaching strategy is discovery-oriented, project-oriented, students oriented and encourage humanistic and students gain complete picture of the concept better than any other methods of teaching science (Dike,1997). However, field trip is expensive, time consuming and difficult to plan. Even with careful and adequate preparation, there is danger of accident in fieldtrip.

Demonstration is another method in science teaching; which Anaso (2008) simply described as a 'to display something'. This approach involves showing a particular procedure or skills to the students who after careful teaching and learning and interaction repeat and practice the same process shown to them. Demonstration approach can be used when the available resources, equipment cannot go around for all the students in the class. The teacher or some groups of students usually carry it out. The method is less costly in term of materials and it can be used to teach certain techniques or skills, theory and practice. However, demonstration does not allow students to develop their skills or manipulation and therefore do not satisfy the psychomotor domain. Students always have problem in seeing the details of the objects or activities being carried out during demonstration (Obeka 2010).

Therefore the present study investigated the impact of cognitive conflict instructional model as a conceptual approach on conceptual change and academic performance in genetics among senior secondary school biology students. This is also to determine and correct misconceptions in genetics.

2.2.1 Teaching of Biology as Science Subject at Secondary School Level

Biology as a separate science was developed in the nineteenth century as scientists discovered that organisms shared fundamental characteristics. Biology is now a standard subject of instruction at a schools and universities around the world and over a million papers are published annually in wide array of biology and medicine journals, (Crystal, 2011). According to Ambuno, Egunyomi & Osakwe (2008), biology forms the basis of disciplines like human medicine, veterinary medicine, Nursing, Agriculture, Forestry, Fishery, pharmacy, laboratory science and human nutrition to mention just a few.

Most biological sciences are specialized disciplines. Traditionally, they are grouped by the type of organism being studied: botany (the study of plants); zoology (the study of animals); and microbiology (the study of microorganisms). The fields within biology are further divided based on the scale at which organisms are studied and the methods used to study them (Adeniyi, 2004).

I. Biochemistry examines the fundamental chemistry of life;
II. Molecular biology studies the complex interactions of systems of biological molecules;
III. Cellular biology examines the basic building block of all life, the cell;
IV. Physiology examine the physical and chemical functions of the tissues and organ system of an organism; and
V. Genetics study of heredity and inheritance.

Biology is a very important part of everyday life, whether we realize it or not. Any advancements in medicine, dealing with environmental issues, or biotechnology depend on an understanding of living organisms, great, medium, and small (Bichi, 2003; Kalu & Ndokwo, 2006). Even if our main goal is simply ensuring the survival of the human race, we still must be able to understand and sustain the biosphere. We poison our land, air and water. The greenhouse effect and global warming are both threats that concern our biosphere (Christryl, 2011). According to Okeke (2007), it would be utterly hopeless to try to sustain the diversity of life on earth in the future without a decent knowledge of biology. In order to maintain the delicate balance of life on earth, we first must understand that we are not alone on this planet. We need to learn about the ffect we have on our environment and other living things.

The value of many species cannot be predicted. Many plants may contain chemicals that could prove useful in treating illnesses, among other things. Also, the extinction of any specie can disturb the equilibrium of an ecosystem. Therefore, there is need to understand that all of our actions have effects on other organisms and the environment (Christyl, 2011).

Biological concepts (Physiology, Genetics, molecular biology, biochemistry, evolution etc.) require more than one method or strategy to teach for effectiveness. For example, lecture method can be used alongside indoor laboratory teaching strategy in teaching and learning of physiology which examines the physical and chemical functions of the tissues and organ systems of organism. This concept ecology deals with the science of the interrelationship between organism and their environment. The teaching and learning of ecology requires strategy that involved direct observation of organisms in their natural surroundings, this strategy is known as fieldtrip. Genetics and evolution which contain abstracts require a strategy that involved conceptual change approach. Therefore, the present study investigated the effect of cognitive conflict instructional model on conceptual change and academic performance in genetics among secondary school biology students.

2.2.2 Genetics Concept inBiology

Biology as a branch of science has many branches which are: Zoology, study of animals; Botany, study of plants; microbiology and virology, the study of bacteria and viruses; anatomy and morphology, the study of structure and general form of plants and animals; physiology, the study of how living organisms function; cytology study of cells; Ecology, study of behavior of organisms in relation to their environment; biochemistry, the study of the structure and properties of molecules found in the cells; and Genetics, which is the study of how characteristics are transmitted from an organism to its off springs.

Genetics concept of Biology is the study of genes, heredity and variation in living organisms. Ahmad (2010) described genetics as the study of heritable characteristics, attributes and traits of organism. The father of Genetics is Gregor Mendel (1822-1884), an Australian Monk-Scientist. Mendel studied 'trait inheritance' patterns in the way trait was handed down from parent to their offspring. The knowledge of Genetics according to Ambuno et al (2008) improved varieties of species of plants and animals through selective breeding, inbreeding, out breeding, counseling parents on the risks of diseases on themselves and their offspring, if there is a record of genetic diseases in the family. The knowledge has also helped in determination of both sex and determination of paternity of the child in case of any dispute. Recent advances in genetics affect many aspects of life. For instance, Human Genome Project, animal and plant cloning, DNA fingerprinting, stem cells and genetically modified organisms are become reality of our daily life. It is possible to claim that in order to understand the basic life science concept such as in vitro fertilization (IVF), cloning, DNA finger printing and others basic genetic knowledge is necessary.

Research finding has shown that a number of topics in Biology among which are Genetics, contain some concepts or terminologies which are difficult to learn by students (Umeh, 2006

&Lawal 2010). It is also observed by Okafor & Okeke (2006) that when concepts in genetics are not understood by students, they tend to avoid attempting such questions in Senior Secondary School Certificate Examination (SSCE). Those who attempt them have performed badly and this accounts for poor performance in Genetics and similar difficult concepts in Biology.

A study conducted by Lakpini (2006) showed that when students were taught genetic concepts using constructivist teaching strategies, they achieved better than those taught with lecture method. Also a study conducted by Lawal (2005) on genetic concepts showed that students taught using concept mapping strategy performed better than those taught with lecture method. It is the aim of this study to determine the impact of cognitive conflict instructional model on conceptual change and performance of secondary school biology students in genetics.

It is important to know students' misconceptions, presuppositions, and prior knowledge in Genetics. Teachers have a difficult time changing and teaching ideas, while students have a hard time understanding and connecting these ideas because Genetics is taught at the macro, micro, and symbolic level (Mbajiorgu et al, 2006). Teachers must be aware of this because it allows insight into the observations that students have already made. This can be used as a starting point in trying to re-conceptualize their ideas.

2.3 Misconceptions in Concept of Genetics

Genes, DNA, chromosomes, and related terms and concepts, have become familiar due to their occurrence in popular media. One of the misconceptions pertaining to genes is that they control every aspect of an organism's biology, including inheritance and behavioral patterns (Oztas &Oztas, 2016). However, those with an in-depth understanding of the subject of genetics would know about the different factors which play an important role in inheritance.

According to Oztas et al (2016) the living cell is one of the learning topics which appear in the junior-high science and technology syllabus, as part of the subject "organisms: phenomena, structures and processes". From the scientific point of view, understanding the main principle thata living cell is the structural and functional unit in all living organisms, is essential for understanding all the biological processes that take place in our world. Students mostly come to school with ideas about and explanation of the natural World and these ideas are as diverse as the students' backgrounds and they are often different from those of scientists.

These differing frameworks have been described as misconception that the characteristics of misconceptions are summarized by Adeniyi (1985). They tend to be stable, well embedded in individual, often resistant to traditional teaching methods. Misconceptions may originate from certain experiences that some of them rooted in everyday experiences. However, from the pedagogical point of view reports on research which was conducted students pointed to difficulties in the comprehension of the living cell concept and its involvement in the processes of heredity. Genetics is considered to be one of the most difficult concepts in Biology (Oztas et al. 2003). The mechanisms are hard to understand because it is difficult to make the ideas betangible without the help of special instruments (Mbajiorgu et al, 2006). The understanding comes from their formal education, the interpretation of the media, and from their own social experiences and observations (Venville et al, 2004). Students come to the classroom with their own conceptions of genetics from their own experience and observations.

The uses of the words, cell, chromosomes, DNA, genes, are interchanged in trying to explain how traits are passed from one generation to the next (Lewis & Kattmann, 2004). Students may have an understanding on how genes play a role in transmitting traits, but this understanding may not aligned with the biological theory. The idea of heredity and DNA is drawn from what researchers call, “low culture sources” (Venville et al, 2004). These sources were movies, comic books, television dramas, sitcoms, and science fiction. Media does not distinguish between genes and DNA. The words are interchangeable in situations and its mechanisms are not even considered during explanations.

The preconceptions also come from "everyday conceptual framework" (Lewis & Kattman, 2004). Children create this framework from what they observe in their own families. Children's conception of genetics is based on the kinship of their families and relationships (Mbajiorgu et al, 2006). On the other hand, some other cultures do not use genetics at all to explain biological diseases, but they would rather make the connection with a belief system or an outside force.

The difficult thing about this misconception, and any other misconception, is reconciling it with a newer and correct conception of the topic (Lewis & Kattmann, 2004). The everyday struggle with misconceptions does not lie only with the students, but also with the teachers. Even if children use the science jargon, they are not using the words properly. Students get lost in the science jargon and do not make any connections in between.

It is often said, out of ignorance, that genes provide a blueprint of the functioning of the body. Analogy between genes and architectural blueprints is drawn, taking into account the properties shared by them on a superficial level. However, in reality, the one-dimensional model of genes (organized into a string of nucleotides) doesn't hold true. The flow of information originating from genes is not always a one-way flow. The chain of causality doesn't operate in isolation. In a biochemical system, different elements are entangled with each other. Therefore, it is difficult to single out a certain gene for a particular functionality. Finally, one should understand that there are many elements which act together in the smooth functioning of biochemical systems.

Generally, the literature has shown that traditional instruction, which does not take into account the existing beliefs of students, is largely ineffective in changing students' naive scientific ideas (Baser,2006; Eryilmaz, 2002; Yeo & Zadnik, 2001). However, conceptual change research has led to the development of a variety of teaching methods and strategies which encourage students to actively reflect on, and evaluate, their existing knowledge (Yeo & Zadnik, 2001). Among others, one such strategy is a cognitive conflict instructional strategy.

2.3.1 Identification and Correction of Misconception

Students learn from their environment and at school. They have several alternative conceptions about everyday contexts, scientific knowledge, and facts. Students' alternative conceptions can be referred to as alternative ideas, alternative frameworks, children's science, or misconceptions. The main characteristic of students' alternative ideas is that are resistant to change with scientific ideas. Students may reject new ideas even after the teaching process (Gülcan, 2003).

The difficult thing about misconception, is reconciling it with a newer and correct conception of the topic (Lewis & Kattmann, 2004). The everyday struggle with misconceptions does not lie only with the students, but also with the teachers. Even if children use the science jargon, they are not using the words properly. Students get lost in the science jargon and do not make any connections in between. Students' misconceptions seemed to reflect an inadequacy of the curriculum or instruction, or both (Gülcan, 2003). Misconceptions may originate from several reasons such as previous learning, teacher expectations, everyday life experiences, and school activities. Çapa (2000) found that social practices and school experiences caused ninth graders' misconceptions about photosynthesis and respiration in plants. Misconceptions may also occur because of teachers' misconceptions in science topics and misconceptions in the textbooks (Storey, 1989; Duit, 1991; Storey, 1992; Gauld, 1997 & Galley, 2001).

For instance students do not fully grasp the mechanisms of inheritance in genetics. Genes are seen as small molecules that bear traits and are simply passed on from parent to child. Unfortunately it is not this simple. Students cannot connect how genes and DNA are related. It is not a tangible idea because it is something that they can easily observe with their own eyes. Students rely on being taught the mechanisms, but they get so lost in their own confusion.

Teachers have a difficult time changing and teaching ideas, while students have a hard time understanding and connecting these ideas. Teachers must be aware of this because it allows insight into the observations that students have already made. This can be used as a starting off point in trying to re-conceptualize their ideas. The conceptions mentioned before prove that students do not holistically understand Genetics. If teachers are not aware of these misconceptions, it creates barriers that lead to confusion and incoherence (Lewis & Kattmann, 2004).

According to Gülcan (2003) science teachers and curriculum designers need to know which alternative framework is specifically found in science, so thatif students' misconceptions or misunderstandings in certain science concepts were known beforehand, it would be helpful for teachers. Thus, a teacher can prepare a teaching scheme to remove those kinds of misconceptions and improve students' understanding of those science concepts (Griffiths & Grant, 1985; BouJaoude, 1992). Thusly, the present study is to examine the impact of cognitive conflict instructional model on conceptual change and performance among secondary school biology students in Potiskum, Yobe State, Nigeria.

2.4 Conceptual Change Approach

Over the immediate past decades, conceptual change has become one of the most crucial domains of research in science education (Hunsik, Lawrence, Sukjin & Taeche, 2010). Conceptual change can be seen as the process of using strategies to bring children's thinking in line with that of scientists (Westbrook & Rogers 1992, in Agiande, James, Albert & Danbiyu 2015). From this definition, conceptual change is seen as a set of teaching strategies employed where the students' views are seen as wrong and that of the teacher or scientist is right and as such, it is expected that the student must change their view points to conform to the teacher's views for learning to have taken place.

According to Ozdemir and Clark (2007), the conceptual change theory proposed by Posner *et al* (1982), sees conceptual change as more than just a socio-cultural interaction or a teaching strategy but as a process of identifying prior misconceptions which the learners carry into the environment in order to help the learner exchange the misconceptions or add new conceptions that are more useful, plausible and intelligible. The assumption that knowledge is gradually crafted (constructed) from a base of prior knowledge by constructivist is what is at variance with modern conceptual change theories and have attracted the following questions. How can a misconceived knowledge base which interfere with learning be replaced and not resists instruction but support students' knowledge construction? (Ozdemir & Clark,2007).

The above observation points out that for constructivism to be taken seriously, the mistaken character of misconceptions in the prior knowledge base of the learner has to be reconsidered. In other words, other ways of dealing with the problem of misconceptions is to enable the learner construct his/her own knowledge without obstructions. From the above, conceptual change refers to what happens in the learner who has come to the learning environment with prior knowledge that might be a misconception that need to be changed or erased in order to accept a better conception.

The concept of change itself can be misleading if it is not properly defined. According to Hewson (1992), change can be seen to have three different contextual meanings as the case may be - change can be understood to mean extinction. Change can be understood as an extension or addition. Change can be seen as an exchange. The new conceptual change theory of learning sees the acquisition of knowledge as a process of extension of knowledge and as a process of exchange of misconceptions with meaningful knowledge, to this end, the teacher is expected to ensure that the student's prior knowledge is identified and worked upon as a basis for helping the student to construct meaningful learning in their schemata (Agiande et al, 2015).

Student’s preconceptions is often different from conceptions which scientists have been constructed so far and resists to change that put the hard barrier in front of science teaching (Tytler, 2002). It is a common view in the literature that preconceptions persist after the uses of traditional methods in instruction (Gilbert, Osborne &Fensham, 1982; Tytler, 2002). How student’s preconception change towards to scientificconceptions and which strategies enable this change have been one of the most strikingpoint of all time in the literature.

Use of a conceptual change learning model is one way of closing the gap between children's science and scientists’ science (for example, Hewson, 1981, Posner et al., 1982). Most of the earlier methods developed to deal with student misconceptions depend on Piagets' ideas and notions of constructivism (Hewson & Hewson, 1983; Stofflett, 1994;). These methods suggested creating dissatisfaction in the student with his alternative conception, followed by strengthening the status of the preferred scientific conception. Posner at al. (1982) suggested four conditions: (1) students must become dissatisfied with their existing conceptions (dissatisfaction); (2) the new concept must be clear and understandable for students (intelligibility) (3) the current problem should be solved by using the new concept (plausibility); (4) similar future problems can be solved by using the new concept (fruitfulness). In this study, these are referred to as “conceptual change conditions.” Teachers should develop strategies in accord with conceptual change conditions in order to create cognitive conflict in students, organize instruction to diagnose errors in students’ thinking, and help students translate from one mode of representation to another.

Table 2: Conceptual change approaches in post conceptual change theory

Theorists	Conceptual change approach	Most striking features of approach
Posner et al.	Rational Learning Approach	Conceptual ecology Cognitive conflict Dissatisfaction, comprehensible, plausible, fruitful.
Hewson & Thorley	Rational Learning Approach	Conceptual change is about raising or lowering the status of the conception
Hewson & Hewson	Status Change instead of Conceptual Change	Conceptual Change is change of status of concept
Strike & Posner	Rational Learning Approach	In order to explain conceptual ecology motivation, goals and social context should be regarded.
Carey	Rational Learning Approach	Weak/ Strong re-structuring, Change from novice to expert
Thagard	Rational Learning Approach	Conceptual revolution Problem-based concept learning, tree swapping, tree switching.
Chi et al.	Ontological perspective of conceptual change	Conceptual change is a change of ontological category of concepts
Vosniadou	Restructuring	Enrichment of concepts, Revision, Conceptual change is a gradual process.

Source: Kural and Kocakülah (2016).

Conceptual change in this study is taken to be a student's change in reasoning patterns on moving from one level of understanding to another. That is, tracing the movement of a student from one level of understanding to another. That is, tracing the number of students who move from transitional conception (TC) to scientificconception (SC) or from an alternative conception (AC) to a transitional conception (TC) or scientific conception (SC). Hence, conceptual change is viewed from the social context. For instance, Tobin (1992 in Madu and Orji, 2015) states that conceptual change is a social process by which students make sense of their experience in terms of extant knowledge. As all learning occurs in a social milieu, all learning is inherently social. By extension, conceptual change is primarily brought about by way of thinking about learning, that is, it is something that a learner does as an intentional act, rather than something done by a teacher (Hewson, 1992 in Madu & Orji, 2015). So, in summary, conceptual change is a change or modification or rejection of one's conceptual beliefs when presented with an anomalous situation. Thus, this study investigated the impact of cognitive conflict instructional model on conceptual change and academic performance in genetics among secondary school biology students in Potiskum, Yobe State, Nigeria.

2.4.1 Instructional Models for Conceptual Change

Despite a significant decrease in interest in conceptual learning among science education researchers in recent years (25% of publications [1998–2002] vs. 15% [2008–2012]) (Lin, Lin, & Tsai, 2014), it is still a very important and challenging topic and a major concern for science teachers. Indeed, conceptual change research could help educators understand the best ways toensure students give scientifically inspired answers rather than intuitive or non-scientific ones. The field has focused much of its efforts on identifying and finding the roots of the most common non-scientific ideas (oftentimes called "misconceptions") in various scientific disciplines (for example, Arslan, Cigdemoglu, & Modeley, 2012; Tasdere & Ercan, 2011), describing conceptual change (Vosniadou, 1994), and understanding which teaching operations can favor it (Duit&Treagust, 2003).

Some theoretical models were developed to explain conceptual change (i.e. Posner, Strike, Hewson, & Gertzog, 1982; Strike & Posner, 1985; Carey, 1985; diSessa 1988, 1993; Vosniadou & Brewer, 1987; Vosniadou, 1994; Chi, 1992; Chi & Slotta, 1993; Chi, Slotta, & de Leeuw, 1994; Thagard, 1992; Tyson, Venville, Harrison, & Treagust, 1997). Although not all of them were developed to be applied to the context of school learning, many empirical studies were conducted in an attempt to apply these models to the classroom. According to Limon (2001) three kinds of instructional strategies can summarize many of the instructional efforts made to promote conceptual change: (a) the induction of cognitive conflict through anomalous data; (b) the use of analogies to guide students' change; and (c) cooperative and shared learning to promote collective discussion of ideas. This research will focus on cognitive conflict instructional model for conceptual change.

The earliest models of conceptual change sometimes labeled as classical models (Nussbaum&Novick, 1982; Posner, Strike, Hewson, & Gertzog, 1982) of conceptual change were mostly derived from the Piagetian concept of accommodation (Piaget, 1974) or the Kuhnian notion of scientific revolution (Kuhn, in Potvin & Guillaume, 2017). According to Potvin, Erik and Martin (2015) the conceptual change paradigm suggests that learning scientific concepts is not always the result of accumulating information or knowledge. Indeed, if prior knowledge can serve as a basis for new understanding, it can also interfere with learning because it occasionally contradicts scientific knowledge and, in many of such cases, can also be "surprisingly resistant to change in response to traditional instruction" (Hewson &Hewson, in Potvin et al, 2015).

Thus, to address this issue, educational researchers in the 1980s proposed that the Piagetian idea of *accommodation* (1963), the Kuhnian concept of *scientificrevolution* (1962), and/or (though not as often) Festinger's idea of "reduction of dissonance" (1957) might positively inspire the development of "conceptual change" models. Although their origins differ considerably, all of these ideas suggest that the appropriation of unfamiliar or counter-intuitive knowledge is a difficult operation that (i) requires a transformation of knowledge and (ii) must be triggered by the initial perception of a discrepancy. For Festinger, becoming aware of discrepancies produces *cognitivedissonance*, an *uncomfortable* state that has to be *reduced*. For Kuhn, only when recorded *anomalies* “accumulate” (Ohlsson, 2009) within a scientific *paradigm* can a *scientific revolution* occur (Kuhn, 1962). Finally, for Piaget, learning by *accommodation* can only be the result of the existence of a preliminary *disequilibrium*. Indeed, “Piaget viewed equilibration as a process fueled by cognitive conflict” (Lee & Yi, 2013).

We believe that it is not unreasonable to think of all these sources of inspiration as contributing to the “founding myth” of the conceptual change movement. In this perspective, cognitive conflict is the “spark plug” of conceptual change, and therefore must be triggered at the beginning of teaching sequences that address scientific “misconceptions.” Furthermore, it presumes that these misconceptions cannot be left intact. According to Potvin (2013) misconceptions have to be, according to the concept of change, either completely abandoned (Villani, 1992), modified (Limon, 2001), replaced (Posner, Strike, Hewson, & Gertzog, 1982, p. 212), reorganized (Jensen& Finley, 1995), eliminated (Nersessian, 1998), rejected (Hewson, 1981), transformed or restructure[d] (Limon, 2001). Even in some of the most recent and productive research efforts, conceptions are presumed to be “evolving”.

Conceptual change learning involves a gradually evolutionary process rather than a broad theory replacement process (Dega, Kriekk & Mogese, 2013). And indeed, since the 1990s, cognitive conflict-based instruction has been extensively used in science education. Baser (2006) posits that several studies concluded that cognitive conflict has an important/positive effect on conceptual change” (Baser, 2006). The model of cognitive conflict is considered to be a psychological state generated when a learner is confronted with an anomalous situation. In this state, the learner (i) recognizes an anomalous situation, (ii) expresses interest and/or anxiety in resolving the cognitive conflict, and (iii) engages in a cognitive reappraisal of the situation to resolve this conflict (Lee & Byun, 2012).

Therefore this study investigated the impact of cognitive conflict instructional model on conceptual change and academic performance in genetics among secondary school biology students in Potiskum,Yobe State, Nigeria.

2.5 Cognitive Conflict Instructional Model

Lee (2013) describes cognitive conflict as a perceptual state in which one notices the discrepancy between one's cognitive structure and environment (external information) or between the components of one's cognitive structure (that is, one's conceptions, beliefs, substructures, among others, which are part of the cognitive structure) (Lee & Yi, 2013). In their 2012 article, Lee and Byun proposed an interesting and quite complete review of the available definitions. Most of them encompass the ideas of awareness, disequilibrium, not-confirmed expectations or predictions, logical conflicts between conceptions, among others (Lee& Byun, 2012). There are different types of conflicts. Some occur between conceptions that exist within the same person, other conflicts occur between different people (socio-cognitive conflicts), but, most often, the models aim to trigger conflict by introducing new, contradictory information (Limon, 2001). In this case, a contradiction occurs, for example, between a student's conception or expectations and the crucial information that a knowledgeable teacher brings to the student's attention and which the student perceives to be discrepant. Thus, such a "discrepant event" can be defined as "the physical experience that provides students with novel evidence to contradict their existing conceptions" (Kang, Scharmann, & Noh, 2004). Moreover, Baddock and Bucat (2008) also suggest that conflict is a puzzling situation which is counter-intuitive. The discrepancy between expectation and observation is often brought into sharp focus by asking students to predict what will happen before the demonstration is conducted. Many different means of triggering conflict have been proposed. Among others, "baffling demonstrations or paradoxes to arouse motivation" (Lee et al., 2003) are recommended to teachers who should probably not be afraid to overemphasize their examples or illustrations and involve cases of striking differences (Potvin, Masson, Lafortune&Cyr, 2015). To summarize, cognitive conflicts are used by teachers to destabilize learners, force awareness, among others so as to ultimately produce positive outcome on learning. However, the nature of the effects they produce is subject to many hypotheses.

Indeed, researchers have suggested many possible immediate effects of cognitive conflicts on students. For example, they have suggested that it could make them discover that their preconceptions are inadequate to explain the new experience (Kang et al., 2004) or realize that they must replace or reorganize their central concepts because they are inadequate to allow [them] to grasp some new phenomenon successfully (Dreyfus, Jungwirth, & Eliovitch, 1990). It has also been suggested that conflicts could arouse attention(Lee et al., 2003), or make students show more curiosity and interest when the given phenomenon or information is not consistent with their expectations (Kang et al., 2004). However, these positive conjectures contrast with the uncomfortable or aversive state (Lee & Byun, 2012) described by Festinger, or the possible anxietythat Gyoungho Lee recorded with his team (2003), and which has been judged by the authors to be an important and somewhat positive component of cognitive conflict (Lee&Byun, 2012).

But regardless of what conflict actually does to students, analyses of the literature on cognitive conflict-based teaching initiatives have generally recorded positive results (Baser, 2006; DiSessa, 2006; Duit & Treagust, 2003; Guzetti, 1993; Kang et al., 2004; Vosniadou, 2007), thus providing rather convincing evidence that cognitive conflict should not be disqualified as a promising tool to address teaching difficulties caused by misconceptions. Fears that it could be a waste of time, even counter-productive, to consider ‘incorrect’ ideas (Hewson & Hewson, 1984) have been expressed, but usually these risks are not considered important, nor are the risks of unproductively marstudents with the wrong ideas. Indeed, in a study described by Margarita

Limon, she states that, although students were taught explicitly the Lamarckian view[before being taught Darwinian concepts], they did not learn the 'wrong' idea (Limon, 2001). In another experiment, conducted on students learning simple electricity notions, it appeared that, fear of an eventual 'contamination effect' of students by a teaching operation that consists of making students' initial conceptions explicit and heard by their classmates is not justified (Potvin, Mercier, Charland & Riopel, 2012).

The usual cognitive conflict paradigm involves: (a) identifying students' current state of knowledge, (b) confronting students with contradictory information which is usually presented through texts (Guzzetti & Glass, 1993) and interviewers, who make explicit the contradiction or only guide the debate with the student or among peers (small groups or the whole classroom) (Dreyfus, Jungwirth, & Eliovitch, 1990; Tillema & Knol, 1997; Weaver, 1998), or by the teacher and new technologies, and (c) evaluating the degree of change between students' prior ideas or beliefs and a post test measure after the instructional intervention. Often, conflict isinduced by presenting information that clearly for the experimenter or for the teacher contradicts children's or students' ideas, beliefs or theories.

Lee and Kwon (2001) developed a three-stage cognitive conflict process model, which includes preliminary, conflict, and resolution. The preliminary stage represents a process in which a student who has belief in preexisting conception accepts an anomalous situation (for example, experimental results obtained by a teacher) as genuine. If the students do not have a strong confidence in a well formulated conception or if they consider the anomalous situation as deceptive, they do not experience cognitive conflict. Thus, the preliminary stage is the stage before cognitive conflict (Lee et al., 2003). In this model, the cognitive conflict process occurs when a learner (a) recognizes an anomalous situation, (b) expresses interest or anxiety about resolving the cognitive conflict, and (c) engages in cognitive reappraisal of the situation. For instance, when learners recognize that a situation is incongruous with their conceptions, they become interested in or anxious about this situation (Lee et al., 2003). Relating this to genetics, where student, who originally connects biological diseases with belief system or any other outside force, now observes through anomalous situation that belief system does not reliably have connection with some biological diseases, the student becomes interested or anxious about the situation and how cognitively reappraises his or her previously held misconceptions and accepts the scientific conception of the use of knowledge of genetics to connect some biological diseases. The resolution stage is external response behavior (Lee et al., 2003). Response behaviors include ignoring, rejection, uncertainty, exclusion, abeyance, reinterpretation, peripheral and theory change.

The purpose of this study was to investigate the impact of cognitive conflict instructional model on conceptual change and academic performance in genetics among secondary school biology students in Potiskum, Yobe State, Nigeria.

2.5.1 Cognitive Conflict Instructional Model and Academic Performance in Science

Studies show that cognitive conflict is an instructional strategy for changing students' alternative conceptions to scientific conception and enhancing academic performance. Academic performance according to Lawal (2009) is the overall measure of academic achievement of students in a given test after a period of instruction and teaching usually weighted by score. Also, Obeka, Bichi and Yusuf (2012) have further defined academic performance as the display ofknowledge attained or skills developed in school subjects designed by test and examinations score or marks assigned by subject teachers.

Erdal Taşlıdere (2013) investigates the effect of conceptual change oriented instruction on Students' conceptual understanding and decreasing their misconceptions in direct current electric circuits. Participants were 139 pre-service science teachers from four intact classes. A quasi-experimental design was used in the study. The experimental group studied the concept with the application of concept cartoon worksheet and simulation, and the control group studied it with traditional instruction. Students' conceptual understanding and misconceptions were measured by a tree-tired misconception test. It was administered as pretest and posttest. There was no significant difference between the means of pretest scores of experimental and control groups. The main effect of treatment on posttest scores was examined via ANCOVA with pretest scores used as covariate. The frequency of each misconception was calculated for both groups, from pre to post-tests regarding all tiers of items. The analysis yielded a significant treatment effect on students' posttest performances. The findings indicated that the conceptual change oriented instruction accompanied by concept cartoon worksheet and simulation is likely to be effective for conceptual understanding and decreasing most of students' misconceptions in direct current electric circuits.

Also a study conducted by Madu and Orji (2015) investigates the efficacy of Cognitive Conflict based physics instruction over the traditionally designed physics instruction on students' conceptual change in heat and temperature. The subjects were 249 senior secondary II students from 2 schools purposively sampled from 12 secondary schools. The 2 schools sampled had well-equipped laboratory, experienced physics teachers, and two intact classes. One of the intact classes in each school was assigned to control group. In one school, there were 70 subjects for experimental group and 60 for control group, while in the other school, there were 60 for experimental group and 59 for control group. Both groups were taught by the same teacher, and this lasted for 6 weeks of intensive treatment. The experimental group received cognitiveconflict based instruction, while the control group received traditionally designed physics instruction. The instrument for obtaining the data was thermal concept evaluation (TCE). Students in both groups were pretested using TCE to establish their level of initial understanding of heat and temperature. At the end of the treatment, the same test was administered as posttest. The data generated from the TCE were analyzed using frequency and chi-square statistics, indicating that the level of understanding of heat and temperature was significantly dependent on the treatment. Furthermore Lakpini (2006) has also conducted a study on the effect of conceptual change instructional strategy on the academic performance, retention and attitudes of secondary Biology students with varied abilities in Sabon Gari Zaria, the study showed that students exposed to conceptual change instructional strategy performed better in all the ability levels than their counterparts exposed to traditional instruction only.

Moreover in study carried by Bello (2012) on effects of learning cycle teaching strategy on students acquisition of formal reasoning ability and academic performance in Genetics in Senior Secondary School II Biology students, it was found that students taught using learning cycle teaching strategy performed better than those taught with lecture method and their reasoning ability improved. Jibrin and Zayum (2012) carried out studies on the effect of peer-tutoring instructional method on the academic performance in Biology among secondary school students in Zaria metropolis and found that students taught Biology using peer instructional method performed better than those taught using expository method.

Several studies (such as Lakpini, 2006; Usman, 2007; Adeyemi, 2008; Akinbobola & Folashade, 2009; Lawal, Obeka & Mohammed, 2011; & Ibrahim, 2013) had been carried out all over the world on changes in conception and academic performance and all were carried out in different science disciplines, using different teaching methods. None of these studies examine the impact of cognitive conflict instructional model on academic performance of secondary school biology students in genetics.

2.6 Gender and Academic Performance in Biology

Gender issues in science, and in particular, Biology has been the concern of many educators and series of researches have been going on in this area. Bello (2014) described Gender as a social construct used to differentiate sex roles between males and females. Also, Okeke (2008) has described gender as the socially and culturally constructed characteristic and roles which are ascribed to male and female in any society. This biological difference (gender) has attracted wide attention and interest in academic environment and within international agencies like; UNICEF, UNESCO etc. Some of the studies conducted have shown that significant differences exist between male and female students while others reported no gender influence in relation to students' performance (Yusuf, 2004).

Some researchers such as Aigbomian (2002), Njoku (2004) reported that boys performed better than girls in science, technical and mathematical subjects. Other researchers like Dahiru (2013) showed that sex plays no significant role in performance in science and technology. He still raised the concern and worries that female performance and achievement in science, technology and mathematics is not fully encouraging. Nwaiwu and Audu (2005) in the same vein agreed that the number of women enrolment for tertiary education has increased at a slower rate than male enrolment. Nwaiwu et al, (2005) viewed it that gender gap in education is at the highest with male enrolment, at least, three times higher than that of female. More so, girls and women tend to enroll in humanities and are found to be under-represented in science subjects and mathematics where male or men dominate. This development perhaps has evolved from the fact that girls still have difficulty in understanding physical sciences, notably, physics, as observed by Aigbomian (2002). Nwagbo (2002) reported that female science student appreciation of the role of science is as much as their male counterparts but lagging behind in knowledge application and communication in science. Okeke (2001) agreed that gender stereotyping which assigns science as male domain has also contributed to the poor enrolment and achievement of girls in science and technology in tertiary institutions.

Ogunboyede (2003) in a study of sex difference and students' achievement at the primary school level indicated that boys are not better than girls in terms of educational achievements. Anagbogu and Ezeliora (2007) investigated gender differences of boys and girls in scientific performance. The study revealed that girls performed better than boys.

All the researches on gender issues are being carried out in order to improve the teaching and learning of science. In a study, Philip et al (2000) revealed that girls show greater participation in science than boys. Bichi (2004) findings show no significant difference between the posttest mean scores of male and that of the female. It is also observed by Oluwatoyin (2007) that when women are exposed to science, they better their scores. Lawal (2009) found no significant difference in gender when taught using conceptual change instructional strategy, but she found significant gender difference when exposed to traditional instructional strategy. On the issue of gender and retention ability, Lawal (2009) found that gender has no significant effect on retention ability of students when they were taught selected genetic concepts using conceptual change instructional strategy.

Lakpini (2006) in her study of gender and different ability levels found out that no gender difference existed when students were exposed to conceptual change instructional strategy in Zaria-Giwa Educational Zone. Bunkure (2012) also found same result when he carried out similar study in Kano state. Concerning gender and achievement in science, Osborne (2003) opined that the early established difference in the interest and activities of boys and girls results in parallel difference in their science achievement.

2.7 Overview of Similar Studies

This study investigated the impact of cognitive conflict instructional model on conceptual change and academic performance in genetics among secondary school biology students in Potiskum, Yobe state, Nigeria. Conceptual change research has led to the development of a variety of teaching methods and strategies that encourage students to actively reflect on and evaluate their existing knowledge (Yeo & Zadnik, 2001). A number of studies that are relevant to this study have been overviewed by the researcher in this section.

Madu and Orji (2015) investigated the Effects of Cognitive Conflict Instructional Strategy on Students' Conceptual Change in Temperature and Heat. The subjects were 249 senior secondary II students from two (2) schools purposively sampled from 12 secondary schools in Nsukka Education Zone. The two (2) schools sampled had well equipped laboratory, experienced physics teachers, and two intact classes. One of the intact classes in each school was assigned to control group. In one school, there were 70 subjects for experimental group and 60 for control group, while in the other school; there were 60 for experimental group and 59 for control group. Both groups were taught by the same teacher, and this lasted for 6 weeks of intensive treatment. The experimental group received cognitive-conflict-based instruction, while the control group received traditionally designed physics instruction. The instrument for obtaining the data was thermal concept evaluation (TCE). Students in both groups were pretested using TCE to establish their level of initial understanding of heat and temperature. At the end of the treatment, the same test was administered as posttest. The data generated from the TCE were analyzed using frequency and chi-square statistics, indicating that the level of understanding of heat and temperature was significantly dependent on the treatment. Therefore, the study reviewed is similar to the present one because it used the cognitive conflict instructional strategy on conceptual change and lecture method on one hand, and it is dissimilar, on the other hand where the present study will investigate the effect of cognitive conflict instructional strategy on conceptual change and academic performance in genetics. Also, the study reviewed was on physics but the present study is on biology and it is limited to Potiskum educational zone, Yobe state, Nigeria.

Kang, Scharmann, Kang and Noh (2010) investigated Cognitive conflict and situational interest as factors influencing conceptual change. The investigation was based on the relationships among cognitive conflict and situational interest induced by a discrepant event, attention and effort allocated to learning, and conceptual change in learning the concept of density. The subjects in the study were 183 seventh graders from six middle schools in Seoul, Korea. A preconception test, a test of responses to a discrepant event, and a questionnaire of situational interest were administered as pretests. Computer assisted instruction was then provided to the students as a conceptual change intervention. Questionnaires regarding attention and effort, and a conception test were administered as posttests. The conception test was administered once more as a retention test four weeks later. The results of path analysis indicated that both cognitive conflict and situational interest induced by a discrepant event respectively had an indirect effect on students' conceptual understanding, which were mediated by attention and effort allocated to concept learning. Situational interest, however, was found to exert a stronger influence on conceptual change than cognitive conflict. It was also found that attention, either directly or indirectly through effort, influenced students' conceptual understanding. However this study combined the effect of cognitive conflict and situational interest as factors influencing conceptual change in learning the concept of density in Physics in Seoul, Korea. The present study will investigate the effect of cognitive conflict instructional model on conceptual change and academic performance in genetics concept of Biology in Potiskum, Yobe State, Nigeria.

Also, Toka and Askar (2002) investigated the effect of cognitive conflict instruction (CCI) and conceptual change text instruction (CCTI) over traditionally designed mathematics instruction (TDI) on achievement of 7th grade students related to first degree equations with one unknown. The subjects of the study consisted of 79 7th grade students from three different classes of mathematics lessons instructed by the same teacher from a school in Ankara. Mathematics potential test (MPT) was utilized at the beginning of the study to determine students' potential in mathematics. After the treatments, achievement test results were taken. ANOVA was used for testing the hypothesis of the study. The results showed that the students at CCI got significantly higher scores on achievement comparing to CCT. Thus this study investigated the effect of cognitive conflict instruction and conceptual change text instruction over traditionally designed mathematics instruction on achievement of 7^{th} grade student, and the present study investigated the impact of cognitive conflict instructional model on conceptual change and academic performance in genetics among secondary school biology students in Potiskum, Yobe State, Nigeria.

Also, Sukariasih (2016) investigated The Use of Cognitive Conflict Strategy to Reduce Student Misconceptions on The Subject Matter of Rectilinear Motion. This study aimed to describe the student's misconceptions beforeexposed to cognitive conflict strategy and to determine the changes of conceptstudent’s understanding at class X SMAN 1 Watopute on the subject matter ofrectilinear motion after learning by cognitive conflict strategy. The method usedwas a case study. The populations in this study were all students of class X SMAN 1Watopute who was registered in the odd semester 2015/2016 academic year. Thesample in this research is student at class X3 of SMAN 1 Watopute as many as 23students were taken by using purposive sampling method. Data obtained from thedocumentation and diagnostic tests understanding of the concept in the form of amultiple choice test with open grounds. In this study, the results are as follows:1)the percentage of the number of students toward understanding of the concept ofrectilinear motion before learning that is: the category to understand the concept of4.6%, amounting to 38.8% misconceptions category and the category did notunderstand the concept of 56.5%; 2) the percentage of students' understanding ofthe concept of rectilinear motion after learning is: the category to understand theconcept of 48.9%, 19.7% misconceptions category and the category did notunderstand the concept of 31.4%. It can be concluded that there is a decreasemisconceptions after learning with cognitive conflict strategy on the subject matter of rectilinear motion.Therefore, the present study investigated the effect of cognitive conflict instructional model on conceptual change and performance in genetics among secondary school Biology students in Potiskum, Yobe state.

Moreover, a study conducted by Çetin (2003) investigated the effects of conceptual change text oriented instruction accompanied by demonstrations in small groups (CCTI) on ninth grade students' achievement and understanding levels of ecology, attitudes towards biology, and attitudes towards environment. The instruments used in this study were the Test of Ecological Concepts (TEC), the Attitude Scale towards Biology (ASB), the Attitude Scale towards Environment (ASE), and the Test of Logical Thinking (TOLT). All data were collected from the public high school in Bal_kesir in the Spring Semester of 2001- 2002. 88 students from four classes and two teachers were included in this study. Two of the classes were called control group and two of them were called experimental group. While the TEC, ASE and ASB were administered to all of the students as pre- and post-tests, the TOLT were conducted as pre-test. Data related to the TEC, ASB, and ASE was analyzed by multivariate analysis of covariance (MANCOVA). The results of the MANCOVA showed that there was significant effect of the treatment which was the conceptual change texts oriented instruction accompanied by demonstrations in small groups on the TEC, while there were no significant effect of the treatment on the attitudes towards biology and attitudes towards environment. Accordingly this study investigated the effects of conceptual change text oriented instruction accompanied by demonstrations in small groups (CCTI) on ninth grade students' achievement and understanding levels of ecology, attitudes towards biology, and attitudes towards environment, whilethe present study will determine the impact of cognitive conflict instructional model on conceptual change and academic performance in genetics among secondary school biology students.

Furthermore, Taşlıdere (2013) examined the effect of conceptual change oriented instruction on Students' conceptual understanding and decreasing their misconceptions in direct current electric circuits. The participants of the study were 139 pre-service science teachers from four intact classes. A quasi experimental design was used in the study. The experimental group studied the concept with the application of concept cartoon worksheet and simulation, and the control group studied it with traditional instruction. Students' conceptual understanding and misconceptions were measured by a tree tired misconception test. It was administered as pre and posttest. There was no significant difference between the means of pre-test scores of experimental and control groups. The main effect of treatment on posttest scores was examined via ANCOVA with pretest scores used as covariate. The frequency of each misconception was calculated for both groups, from pre to post-tests regarding all tiers of items. The analysis yielded a significant treatment effect on students' post-test performances. The findings indicated that the conceptual change oriented instruction accompanied by concept cartoon worksheet and simulation is likely to be effective for conceptual understanding and decreasing most of students' misconceptions in direct current electric circuits. Hence the study reviewed was on conceptual change of pre-service science teachers in physics but the present study is on conceptual change of secondary school biology students and it is limited to Potiskum educational zone, Yobe state, Nigeria.

In addition, Murad and Ahmad (2014) investigated the effect of using Stepans' model of conceptual change on students' modification of alternative mathematical concepts and on their ability of solving mathematical problems. The investigation was conducted by using ninth graders in two different sections in a secondary school in Amman, Jordan. The study dealt with intact groups, but the treatments were randomly assigned to the classes so that the Conceptual Change Group (CCG) contains one section and the Non Conceptual Change Group (NCCG) contains the other section.Two instruments were used, the first is a mathematical concept test and the second instrument is a problem solving test. The first instrument is a test of twenty five multiple choices items and the second instrument is a test of eight essay non-routine problems. These two instruments were administered before starting the treatment and used as covariate variables for research questions1 and 2 respectively. Then, they were administered at the end of the treatment and used as dependent variables to measure students' modification of alternative mathematical concepts and students' problem solving abilities respectively. An analysis of covariance (ANCOVA) showed that the CCG outperformed the NCCG in terms of students' modification of alternative mathematical concepts and their ability of solving mathematical problems. The study reviewed employed Stephans' model of conceptual change on students' modification of alternative mathematical concepts and on their ability of solving mathematical problems, and the present study set to employ cognitive conflict instructional model on conceptual change and academic performance of secondary school biology students in genetics.

Additionally, Mustafa (2006) conducted a study onEffect of Conceptual Change Oriented Instruction on Students' Understanding of Heat and TemperatureConcepts. The instrument used for the study was Heat and Temperature Concepts Test. The subjects of the study consisted of 74 seventh grade students (39 boys and 35 girls) from two classes of a science course taught by the same teacher in an urban high school in Turkey. Prior to instruction, students in both groups were pre-tested in order to determine their understanding of heat and temperature at the beginning of instruction.The effects of the two modes of instructions on students' understanding of heat and temperature concepts were determined by means of analysis of covariance (ANCOVA) by controlling the effect of students' logical thinking ability as a covariate. Students taught by means of conceptual change oriented instruction outperformed students who received traditionally designed instruction. Results indicated that students' logical thinking ability accounted for a significant variation in heat and temperature concepts achievement. However, the present study is to investigate the impact of cognitive conflict instructional model on conceptual change and academic performance among secondary school biology students in genetics.

Patrice, Erik and Martin (2015) investigated the effects on 558 grades five and six students of three different teaching conditions: the classical model of conceptual change, the prevalence model of conceptual change, and repetition of traditional teaching. Participants were 565 voluntary students (262 boys and 303 girls) in grades five and six from 35 classes in seven elementary schools in the greater Montreal area, in Canada. These conditions were reduced to sequencing considerations, as classical model participants were first subjected to a possible cognitive conflict induced by a video, followed by another video about the targeted conceptions; prevalence model participants were subjected to the same videos but in the opposite chronological order; and repetition condition participants watched the "traditional teaching" video twice. Differences in accuracy and response times between our computerized and validated "sink/float" pretest and retest were analyzed using T-test and Analysis of Variance (ANOVA). Results and interpretations confirm that cognitive conflicts are useful in teaching sequences that aim at producing conceptual changes. However, the major findings of this research suggest that such conflicts should not necessarily be triggered at the very beginning of teaching sequences, and therefore that the prevalence model might possibly be the preferable one to promote conceptual changes in real-life school science teaching settings. Therefore the present study investigated the impact of cognitive conflict instructional model on conceptual change and academic performance in genetics among secondary school biology students in Potiskum, Yobe State, Nigeria.

Further, Gülcan (2004) conducted a study on Developing and Implementing an Instructional Technology Aided Conceptual Change Approach in Teaching Ecology Concepts at Ninth Grade. The purpose of the study was to investigate the effectiveness of using conceptual change texts accompanied with small group work on ninth grade students' learning of ecology in a high school in a center of a province of West of Turkey. The experimental group took instructional technology aided conceptual change approach, whilethe control group was taught with traditional method over a four weeks period. An Ecology Concepts Test was constructed to identify students' misconceptions and to indicate how successful the course had been in improving students' learning about ecology. All students were administered Ecology Concepts Test as pre-test and post-test. The experimental and the control groups were observed using nonparticipant approach as much as possible. The Ecology Concepts Test was also conducted to all subjects of the study as pre- and post-test. Independent samples t-test was used to test the hypothesis at a significance level of 0.05. The results of post-test indicated that experimental groups caused a significantly better acquisition of scientific conceptions related to ecology concepts than the traditional instruction. As such, the present study will investigate the impact of cognitive conflict instructional model on conceptual change and performance in genetics among secondary school biology students.

Jibrin and Zayum (2012) investigated the Effect of Concept Map Teaching Strategy on the Academic Achievement of Senior Secondary School Students in Genetics. The subjects were 80 senior secondary II students from two (2) schools randomly selected using balloting method from 20 secondary schools in Dengi metropolis. The two schools sampled had well equipped laboratory, experienced Biology teachers. The two schools were divided into experimental and control groups using 'odd and even' number method where the odd number school becomes the control group while the even number the experimental school.In each school selected intact class of Senior Secondary II Students was used. In one school, there were 50 subjects for experimental group and 30 for the control group. Both groups were taught by the same teacher, and this lasted for 6 weeks. The experimental group received concept mapped teaching strategy, while the control group received using lecture method. The instrument for the studyGenetics Achievement Test (GAT) was prepared by the researchers and validated by two senior lecturers from education department, ABU, Zaria Nigeria and a reliability coefficient r=0.70 was arrived at after pilot testing. Genetics Achievement Test (GAT) was administered to the students by the researchers. Data collected was analysed using z- test statistics. The results indicated that students taught Genetics using concept mapped instructional strategy achieved higher than those taught using expository method. Hence, the study reviewed is similar to the present study because it investigated the academic achievement of students in genetics using concept mapped teaching strategy and lecture method on one hand, and it is dissimilar on the other hand where the present study investigated the academic achievement of students in genetics using cognitive conflict instructional model and lecture method.

Odagboyi (2015) examined the effect of gender on the achievement of students in biology using the jigsaw method. The sample was made up 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. These questions are standardized test and so were not subjected to further reliability test. 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 showedthat there was a significant difference between the mean scores in favour of the males. This showed that themales gained more from the jigsaw method compared with the females. Therefore, the study reviewed is similar to the present study because it examined the effect of gender on the achievement of students in biology using the jigsaw method on one hand, and it is dissimilar, on the other hand where the present study investigated the on the achievement of students in genetics using cognitive conflict instructional model. Also, the present study investigated the impact of cognitive conflict instructional model on conceptual change and academic performance in genetics among secondary school students in Potiskum, Yobe State, Nigeria.

Peter and David (2014) investigated the effects 5Es constructivist instructional strategy would improve students' interest in senior secondary school genetics in Gwer Local Government Area of Benue State, Nigeria. The design of the study was Quasiexperimental, specifically, the pretest post-test non-equivalent control group design. A sample of 147 students from four schools, out of a population of 2,183 SSII Biology students. A validated 30 item Genetics Interest Inventory (GII) was the instrument for data collection. A reliability co-efficient of 0.85 was established for the GII using Cronbach Alpha method. Out of the four schools, two schools were assigned to the experimental group while the other two to the control group. The experimental group were taught genetics using the 5Es (engagement, exploration explanation elaboration and evaluation) constructivist instructional strategy while the control group were taught using the conventional (lecture) method. Mean and standard deviation were used to answer the two research questions and Analysis of Covariance (ANCOVA) was used to test the two hypotheses at $P<0.05$ level of significance. The result revealed that the 5Es constructivist instructional strategy was more effective in facilitating students' interest in genetics in both urban and rural schools. In essence, the study reviewed is similar to the present study because it examined the effect of 5Es constructivist instructional strategy on students' interest in genetics on one hand, and it is dissimilar, on the other hand where the present study investigated the impact of cognitive conflict instructional model on conceptual change and academic performance in genetics among secondary school students in Potiskum, Yobe State, Nigeria.

In conclusion, most studies reviewed on conceptual change were carried in different subjects at different levels of education. Even those conducted in Biology did not consider the impact of cognitive conflict instructional model on conceptual change and performance of students in Genetics concepts. Thus, the present study sought to usecognitive conflict instructional modelin changing biology students' misconceptionsto scientific conceptionsin genetics concept at secondary school level. Therefore, this work will fill the gap of using cognitive conflict instructional model on conceptual change and academic performance in genetics among secondary school biology students in Potiskum, Yobe State, Nigeria which is new.

2.8 Implications of the Literature Reviewed on the Present Study

The related literature reviewed so far has given some insight into the effects of conceptual change instructional approach on conceptual change and academic performance in different science subjects. It also gave an insight to the impact of instructional method (cognitive conflict) and the role of presenting conflicting data and anomalous data on conceptual change and performance in different places, home and abroad, at different levels of education and different science subjects. This has some implication on the present study.

Studies by Madu and Orji (2015), Kang, Scharmann, Kang, Noh (2010), Toka and Askar (2002) showed that subjects exposed to cognitive conflict approach had significantly experienced conceptual change when compared with those exposed to traditional method of teaching. The related literatures reviewed for the purpose of this study showed that the use of Cognitive Conflict Instructional strategy in science instruction enhanced students' conceptual change. However, the use of the lecture method of teaching has been shown to be of little help for learners' conceptual change. Most of the studies reviewed were carried out in abroad and to determine students' conceptual change and not considering students' academic performance and gender relation. Based on this, the present study considered it necessary to determine the effect of cognitive conflict instructional on conceptual change and academic performance of males and females in Genetics.

According to Potvin and Guillaume (2017), some recent research findings support the hypothesis that acquired scientific knowledge does not necessarily erase or alter initial non-scientific knowledge but rather coexists with it. In keeping with this coexistence claim, the present studyaims at determining students' misconceptions in genetics as well as tracingthe students' conceptual change and academic performance.

Furthermore, the reviewed literature showed that cognitive conflict instructional strategy improved performance of students (Toka & Askar, 2002). From the knowledge of the researcher, no work was done on cognitive conflict instructional model on conceptual change and performance in genetics in Potiskum, Yobe State, Nigeria. Specifically, the study will investigate the impact of cognitive conflict instructional model on conceptual change and performance in genetics among secondary school students in Potiskum, Yobe state, Nigeria.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This study investigated the impact of cognitive conflict instructional model on conceptual change and performance in genetics among secondary school Biology students in Potiskum educational zone, Yobe State, Nigeria. This chapter presented the methodology used for the study under the following sub headings:

3.2 Research Design

3.3 Population of the Study

3.4 Sample and Sampling Technique

3.5 Selection of Concept to be Taught

3.6 Instrumentation

3.6.1 Description of the Instruments

3.6.2 Validity of the Instrument

3.7 Pilot Testing

3.7.1 Reliability of the Instruments

3.7.2 Item Analysis

3.8Administration of the Treatment

3.9 Procedure for Data Collection

3.10 Procedure for Data Analysis

3.2 Research Design

The research design for this study is quasi-experimental and control group design employing Pretest and Posttest as proposed by Kerlinger (1973).

Pretest was administered on the subjects, before they are exposed to the treatment Cognitive conflict instructional model to ascertain their academic equivalent and to determine conception. The Experimental Group were taught using the Cognitive Conflict Instructional Model for six (6) weeks according to the scheme of work and Biology Concepts chosen for the study, while the Control Group were taught same Biology Concepts by the use of lecture method for the same period. After the treatment, the posttest was administered to the groups to evaluate the effectiveness of the treatment on Conceptual change and Academic Performance of the students before and after exposure to the cognitive conflict instructional model. The posttest was given to determine the effects of exposure to cognitive conflict instructional model which was for experimental and control groups.

An illustration of the research design is shown in figure 3.1

EG → O1 → X1O2 →

CGO1X0O2 → → →

Figure 3.1 Research Design

Where: -

EG = Experimental group
CG = Control group
X_1 = Treatment
O_1 = Pre-Test
X_0 = No Treatment
O_2 = Posttest

A quasi- experimental and control group design employing pretest and posttest was suitable for this study because of the summed up advantages listed by (Lakpini, 2006) which is as follows;

a) The superiority of one instructional strategy over the other can easily be tested
b) It gives indications of concept attainment ability of understanding gained by students after they have been exposed to a particular teaching treatment.
c) The pretest scores giving indication as to whether the groups are equal in the concepts they hold before interaction was given.

3.3 Population of the Study

The target population for this study is all Senior Secondary School Biology Students in Potiskum Educational zone and the parent population comprise of all SS III Biology Students in the sixteen (16) public Senior Secondary Schools in Potiskum Educational zone, Yobe State, Nigeria. All of the sixteen schools are single sex (that is, either male or female). Public Schools were used because their teaching and learning condition are relatively the same, such as; Uniform condition of staff, Class Size, Academic calendar, Environment, and Laboratory Facilities etc. According to Potiskum Zonal Educational Board (2018), there are a total of 1021 students offering Biology in the zone. The details of the schools in the targeted population are presented in Table 3.1

Table 3.1: Population of the Study

S/N	Name of School	Location	School type	BOYS	GIRLS	Total
1	GGSS NGELZARMA	FUNE LGA	Girls	-	47	47
2	GSS JAJERE	‘’	Boys	75	-	75
3	GSTC DAMAGUN	‘’	Boys	69	-	69
4	GSS DAURA DAMAGUN	‘’	Boys	49	-	49
5	GSS MAMUDO	POTISKUM LGA	Boys	45	-	45
6	GDSS POTISKUM	‘’	Boys	98	-	98
7	GSTC POTISKUM	‘’	Boys	53	-	53
8	GGSTC POTISKUM	‘’	Girls	-	50	50
9	FIKA GSS	‘’	Boys	83	-	83
10	GSS NANGERE	NANGERE LGA	Boys	62	-	62
11	GSS KUKURI	‘’	Girls	-	47	47
12	GSS DEGUBI	‘’	Boys	54	-	54
13	GSS KUKAR GADU	FIKA	Boys	68	-	68
14	GGSS GADAKA	‘’	Girls	-	77	77
15	GSS FIKA TOWN	‘’	Boys	79	-	79
16	GSS ZADAWA	‘’	Boys	65	-	65
	TOTAL			800	221	1021

Source: Potiskum Educational zone, Yobe State (2018).

3.4 Sample and Sampling Procedure

To select the sample, initially eight schools (four single-sex male and four single-sex female schools) were selected from the population of the study listed in Table 3.1, through Simple Random Sampling using draw-from the hat method. The eight schools were: Government Secondary School Jajere, Government Science and technical Potiskum, Fika Government Secondary School, Government Secondary School Daura Damagun, Government Girls’ Science and Technical Potiskum, Government Girls Secondary School Ngelzarma, Government Girls’ Secondary School Gadaka andGovernment Secondary School Kukuri ; all schools were located within Potiskum Educational zone of Yobe State. A pretest was administered to the subjects of the eight schools chosen for the purpose of comparability of academic equivalence. Two schools from each boys and girls schools with close academic performance equivalence were selected as the sample of this study. The result obtained from the pretest was subjected to Analysis of Variance (ANOVA), the eight schools showed no significant difference. To ascertain the schools with significant difference, the result was subjected to Scheffe test. Three schools from boys showed significant differences, out of which two schools were randomly picked. Simple Random Sampling technique by balloting was used to select the Experimental and Control Group. The first school picked was labeled Experimental and the second picked was labeled Control group. From the boys, the first picked which was Government Science and Technical School, was assigned the Experimental group while the second picked which was Government Secondary School Daura Damagun, was assigned the Control group, while from the girls, the first picked was Government Girls Secondary School Ngelzarma, was assigned the Experimental group while the second picked was Government Girls' Science and Technical Potiskum, was assigned control group, both schools were single-sex schools.

From each of the schools, the two intact classes of SS III offering Biology were used so as to reduce the work load of the schools' Biology teachers so that he/she doesn't have to go through the concept to be taught over again. The Experimental group consist of One hundred students (fifty three males and fourty seven females) while the Control group consist of Ninety nine students (49 males and fifty females). A class of minimum of thirty students is considered a viable representation for experiment research in line with Central Limit theorem recommendation, Tuckman (1975) and Frankel & Wallen (2000). The sum total of the sample size of the two groups is One hundred and ninety nine (199) students. The sample for the Study is presented in Table 3.2.

Table 3.2 Number of Sampled Students in Experimental and Control Groups.

School	Group	Male	Female	Total
GSTC Potiskum	Experimental	53	-	50
GSS Daura Dam	Control	49	-	49
GSS Ngelzarma	Experimental	-	47	47
GGSTC Potiskum	Control	-	50	53
TOTAL		**102**	**97**	**199**

3.5 Selection of Concept to be Taught

The following concepts were selected from the Senior Secondary Education Curriculum developed by the Nigerian Educational Research and Development Council (2006),

1. Transmission and expression of characters in organisms
2. Chromosomes the basis of hereditary
3. Probability in genetics
4. Application of the principles of heredity
5. Genetic disorder
6. Variation

The choice of these concepts was informed by a number of reasons; Studies show that students have difficulties in understanding some concepts in Biology, Ecology, Evolution, Genetics (Umeh, 2006 and WAEC Chief Examiners Report, 2016).

The concepts are taught at the senior secondary schools, as well as at the university level, as such, the understanding of the concepts is very important for the learner. In addition, Umeh (2006) stated that students find these concepts difficult earlier because they were not taught in most cases or the teaching method used by the teacher was not appropriate.

3.6 Instrumentation

Two instruments were used in this study. These are;

1. Genetic Performance Test (GPT);
2. Genetics Concept Evaluation (GCE);

3.6.1 Description of the Instruments

The instruments for the purpose of this study are described as follows:

The Genetic Academic Performance Test

The Genetic Academic Performance Test (GPT) contained name of school, sex, students' number and thirty(30) multiple choice genetic test items designed by the researcher from past WAEC question papers to find out the extent to which the students understand the selected genetic concepts. The performance test was based on the objectives of the topics selected as stated in secondary school syllabus. The items constructed were checked for appropriateness and cognitive level by a panel of Science Educators and seasoned Biology Lecturers with minimum of Ph.D qualification and rank of Senior Lecturer. To ascertain the internal consistency of the GPT item, a pilot version of the test containing 30 items was administered on SS3 students in one secondary school other than the one used in the study. The reason for using multiple choice formats is that it allows for wider range and coverage of the content that was taught. It is normally bias free in marking. Each of the thirty (30) multiple choice items consisted of four response options (A,B,C and D), one of which was the correct answer and the remaining three were distracters as presented in Appendix 1. The students were asked to select the correct option by ticking the letter bearing it. The test items reflected the six (6) cognitive levels based on Bloom (1975) taxonomy for the cognitive domain as well the psychomotor domain.

The multiple choice items referred to as Genetic Performance Test (GPT) was used on two different occasions: first, as Pre-test to determine the strength of the sample at the start of the study, secondly, as a Post-test in order to determine the effectiveness of the treatment or otherwise. The detail of item specification for GPT based on topics selected is presented in Table 3.4.

Table3.4 Item Specification for GPT based on Bloom Taxonomy of Cognitive Domain

S/N	TOPIC	KN	COMP	APP	ANA	SYN	EVA	TOTAL
1	Heredity and Variation	2,7,9, 4,12, 21			1,15	22		**9**
2	Mendelian Law	28	23	3				**3**
3	Monohybrid cross		8	14				**2**
4	Dihybrid cross			5,6, 30				**3**
5	Application of the Principles of Genetics			10, 11			18, 25, 29	**5**
6	Genetic Disorder		20					**1**
7	Variation	16, 19	13,26, 27	17		24		**7**
	TOTAL	**9**	**6**	**8**	**2**	**2**	**3**	**30**

Source: Researcher(2018)

The Genetics Concept Evaluation (GCE)

The genetics concept evaluation (GCE) instrument adapted by the researcher was used for both the pretest and posttest to measure students' conceptual change in their understanding of genetics. The instrument was originally developed by Yeo and Zadnik (2001) with reliability of 0.81and has been proven valid in real life application by researchers (Baser, 2006). The Thermal Concept Evaluation (TCE) was then adapted by Madu and Orji (2015) with a reliability of 0.79. TCE originally had 26 items with four choices and space for students to give reason for their answer. This is aimed at finding out the students' reason for the option preference and to enable the researchers to determine qualitatively the nature of the learners' conceptual change. For this study, each response in GCE was scored at four levels (3-0), where 3 was assigned to Scientific conception (that is, SC), 2 was assigned to Transitional conception (that is, TC), 1 was assigned to Alternative conception(that is, AC) and 0 to No conception (that is, NC), respectively. The scientific conception represented the most preferred and acceptable response. Transitional (partial) conception showed a learner's abandonment of his or her naive conception, while an alternative or no conception represented a naive conception.

The researcher modified the instrument by changing the items in the instrument from thermal concept to genetics concepts and named it as GCE with 24 numbers of items. This is because the present study is on Genetics in Biology while the previous study was on Thermal concept in physics. In determining the specific level of changes in the students' knowledge, the following criteria were adapted to classify responses:

- Scientific Conception (SC): Such responses indicate that students seem to have acquired an integrated scientific perspective. They are able to restructure their ideas and give a coherent explanation of the phenomenon.

- Partial/Transitional Conception (TC): Such responses indicate that students seem to have merely a partial knowledge of the phenomena/concept. Although ideas will not verbalize in an integrated way, some understanding can be evident.
- Alternative conception: students just gave one simplistic, incorrect viewpoint. Generally, students gave a linear explanation rather than seeing a number of factors as being responsible for the phenomenon. These responses indicated a lack of understanding about the phenomenon or concept.
- No Conception (NC): Students fail to formulate answer. They sometime admitted that they had some exposure to the information but could not access it, that is, the students' reasoning was contrary or irrelevant response, or no response.

3.6.2 Validation of the Instruments

The content validity of the Genetic Academic Performance Test (GPT) and Genetics Concept Evaluation (GCE) were carried out by a panel of experts comprising the following:

a) Two Science Educators from Science Education Section, Ahmadu Bello University Zaria with at least Ph.D qualification and a rank of Senior Lecturer.

b) Three Biology Teachers in secondary schools with at least Bachelor degree. These experts among other things critically assessed GPT, and GCE with respect to:

i) The appropriateness of the items;

ii) Whether or not the statements in the tests were clear, readable, difficult or too simple for SS III Biology students

iii) Whether or not the test items are related to the objectives of the study;

iv) Give suggestions and criticisms that were helpful in improving the quality of the test items.

Their suggestions were taken into consideration in the final formulation of the test instruments before the administration. The letter written to validators is presented in Appendix G.

3.7 Pilot Testing

The pilot Study was carried out using the instrument, Genetics Performance Test (GPT) onthirty (30) SS III Biology students of Fika Government Secondary School, Potiskum, Yobe State. The trial school is not part of the sample school of the study to prevent the students from having an idea of the instrument. The purpose of the pilot test as stated by Bichi\

(2002) is to:

- determine the reliability of the instrument before administration,
- assess the feasibility of the study before trial,
- identify possible problems or difficulties that respondents may encounter with a view of eliminating them,
- determine the approximate time duration required for the students to answer the test questions correctly.

3.7.1 Reliability of the instruments

Reliability is the consistency with which an instrument measures what it claims to measure at any given time. An index of reliability measure is the reliability coefficient (Usman, 2000). The data obtainedfrom the pilot study was analyzed to establish the reliability of the instruments.

The test-retest method was used in this study to test the reliability of the instrument (GPT) within the interval of two weeks in line with Tuckman, (1975) and Sambo (2008). Pearson Product Moment Correlation (PPMC) was used to determine the reliability of the instrument with the aid of SPSS statistical package. The reliability coefficient of the instrument was found to be $r = 0.78$, which indicate high correlation between the test. The instrument was said to be consistent and reliable for the study this is supported by Mohammad, (2007) who states that a test is said to be reliable if repeated measurements using the test gives more or less the same result.

The reliability of the GCE was determined using Cronbach's alpha because this instrument has polytomously scored items (i.e. each item had no preferred right or wrong answer). Using this formula, the internal consistency index of the instrument was calculated to be 0.79.

3.7.2 Item Analysis

The result from the data collected from the pilot study was used to determine the facility index (F.I.) and discrimination index (D.I.) of the Genetic Performance Test (GPT). The analysis was based on item difficulty, and discrimination indices.

The facility index gives the difficulty level or ease of answering an item. It indicates the percentage of candidates that got an item right (Tuckman, 1975). The facility indices for each GPT item was calculated using the formula given by Furst (1958) who stated that if facility index of a test is between 0.30- 0.70, the items are then recommended for use. Using the Furst (1958) formula for the calculation of facility index (F.I.) is as follows:

$F.I. = RU + RL/N \times 100;$

Where;

F.I. = Facility Index

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

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

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

Facility index of 75% or higher is regarded as easy in terms of facility level, whereas an index of 25% or less is regarded as hard in terms of facility level. For this study, Genetic Performance Test with facility index which ranges from 0.30 to 0.70 is used in line with Usman (2008),and James (2000).

From the calculation, the test item with the facility indices between 0.01-0.29 was difficult and it was rejected. Test item with facility indices between 0.30-0.70 was moderate and accepted for use but the test item with facility indices of 0.71 and above is simple and it was also discarded. From appendix f, the test item 4,6,17,20,21,23,26,35,38 and 40 were discarded while all the other ones were retained. Test items with facility indices in the range of 0.30 to 0.70 were used. Based on this analysis, thirty items were used for the study. A detail of the facility index of GPT is presented in Appendix f.

DiscriminationIndex (D.I.)

Discrimination index of a test is the capacity of such a test to distinguish between high and low achievers, between good and not so good achievers. It enables students to be ranked in a given test. It was calculated by using the following formula by Furst (1958) and Atadoga (2001).

The calculation was done using scores of the top twenty seven percent (27%) and bottom twenty seven percent (27%) of the total respondents. This was calculated using the formula given by (Furst, in Olorukooba, 2001).

D.I = RL-RU ⁄ 1 ⁄2N

Where D.I. = Discrimination Index

Ru= the number among the upper 27 percent of the respondents who scored item correctly.

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

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

Discrimination indices ranging from 0.30 to 0.49 were described as moderately positive, those above 0.59-0.70 were high positive values while those of 0.30 to 0.48 or below were described as low positive values. Discrimination Indices (D.I.) selected was 0.30-0.70 as used by Atadoga (2001). The discrimination indices of all the test items were calculated as presented in (Appendix f). Items that were marked RR in the table were reframed and accepted while those marked* were discarded. Items discarded or rejected include 4, 6,11, 17, 20, 21, 23, 26, 35,Items selected with Modification are 32, 34, 36, 37, 39, 4. Items selected without modification are 1, 2, 3, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 19, 22, 24, 27, 28, 29, 30, 31 .

Thirty items were used for the study (Appendix A).

3.8 Administration of the Treatment

Strategy involving cognitive conflict instructional model was used to teachthe experimental groups. The control groups were exposed to lecture method. The treatment that was administered to the subjects involved teaching the concept of genetics by the researcher using:

Treatment for the Experimental Group

The Experimental groupswere exposed to Conceptual change instruction based on the Cognitive Conflict Instructional Model, for 1hour 30mins period (45mins per period/ twice a week) for six weeks contact session. One Biology class containing 53male students was used. The group was taught by the researcher for the period stated. The experimental group students were exposed to cognitive conflict instructional model; this is attempted to trigger *dissatisfaction*, by providing discrepant events. It provides the opportunity to confront misconceptions by showing multiple cases. Short group discussions providedthe students with the opportunity to make undisclosedpredictions, some which were contradicted. It sometimes overemphasized examples in order to increase a likelihood of cognitive conflicts. The instructor adhered to follow the following steps stepwise during the teaching, these are;

STEP I: Introduction: The teacher starts the lesson by grouping the students into 5 groups, each group with at least one biology textbook and activity sheet.

STEP II: Students' Activity (Using Cognitive Conflict Instructional Model)

Stage i: The teacher asks the students the following questions that will trigger students' conception and set them into cognitive conflict, such as:

a. What is morphological variation?
b. What is your blood group?

Stage ii: Creation of cognitive conflict with the anomalous situation as follows;

Do you all have the same blood group? Why do you have the same blood group with your friend but different blood group with your brother?

Stage iii: Students interaction: the students interact with each other in their group by sharing ideas using their textbook and report their findings or answers in the activity sheet. For example;

a. We have different blood groups, even though some of us have the same blood groups with our friends
b. Variation causes our blood groups to be different from our brothers.

STEPIII: Discussion/summary: the teacherwill use their report and guidea discussion between the groups. As, what is variation?

Group (a): Variation is the difference which exists in individual of the same species.

Variation is due to combination of genes resulting into a new product. Variation sometimes makes the new offspring more suited to adapt to its new environment, giving it better chance to survive and reproduce through the transfer genes from generation to generation.

The teacher asked the student how many types of variation do we have?

Student (a): there are two types of variation in organisms. These are;

i. Morphological variation
ii. Physiological variation

Group(b): What is morphological variation?

Group (c)**:morphological variation**is the variation that results in physical difference in appearance of an organism. For instance, height, skin color, hair, eyes, lips etc.

The teacher encourages the students to give more examples.

Group (a): Shape of the head, nose, mouth, face, ears etc.

Group (b): Finger prints

Group (c): Do plants have variation like humans?

Group (b): Yes, for instance, plants height, color of flower leaves and seed crops etc.

Group (a): size of leaves, fruits, lemon, tubers of yam and cassava etc.

The teacher asked, since we know what morphological variation is, then what about physiological variation?

Group (b): **Physiological variation** is referred to as discontinues variation which is a type of variation that is internal and only visible with the use of powerful microscope. This type of variation has no intermediate character. For instance, gender i.e. male or female, the differences in blood groups, such as blood group A, B, AB and O.

Theteacher asked for more examples from the student

Group (c): Movement of the ear with turning of the head, ability to roll tongue etc.

Group (a): differences in sex i.e. male and female or boy and girl, bravery and timidity etc.

Theteacher guides the students to know how to apply the knowledge of variation in our life.

Group (d):Crime detection: finger prints are used in crime detection in advanced countries, because every man has a unique finger print. Some types of finger prints are; whorl, whoop, arch and double whorl.

DNA finger print are used in developed countries to detects crimes like arm robbery, murder case, rape etc. the body cells left at the scene of the crime are compared with that of suspect and used in identifying the person who commits the crime.

Group(e):Blood transfusion: Blood transfusion is the donation of blood to people suffering from certain illness or victims of accidents.

People with blood group A have an antigen A and α and antibody B and β; those with blood group B have antigen B and β and antibody A and α; those with blood group AB have antigen A,B or α,β and antibodies A,B and α,β.

In blood transfusion, the blood group of donor and recipient must match otherwise it can lead to glotulation.

Can we apply variation in identifying humans?

Group(a): Yes we can. **HumanRace** which is variation in skin color and other physical (morphological) characters that are been used to classify people into four major groups:

a) Caucasoid
b) Mongoloids
c) Negroid
d) Australoid

Theteachersummarized the discussion by explaining **causes of variation**. There are many factors responsible for variations in man and plants. Some of the causes are;

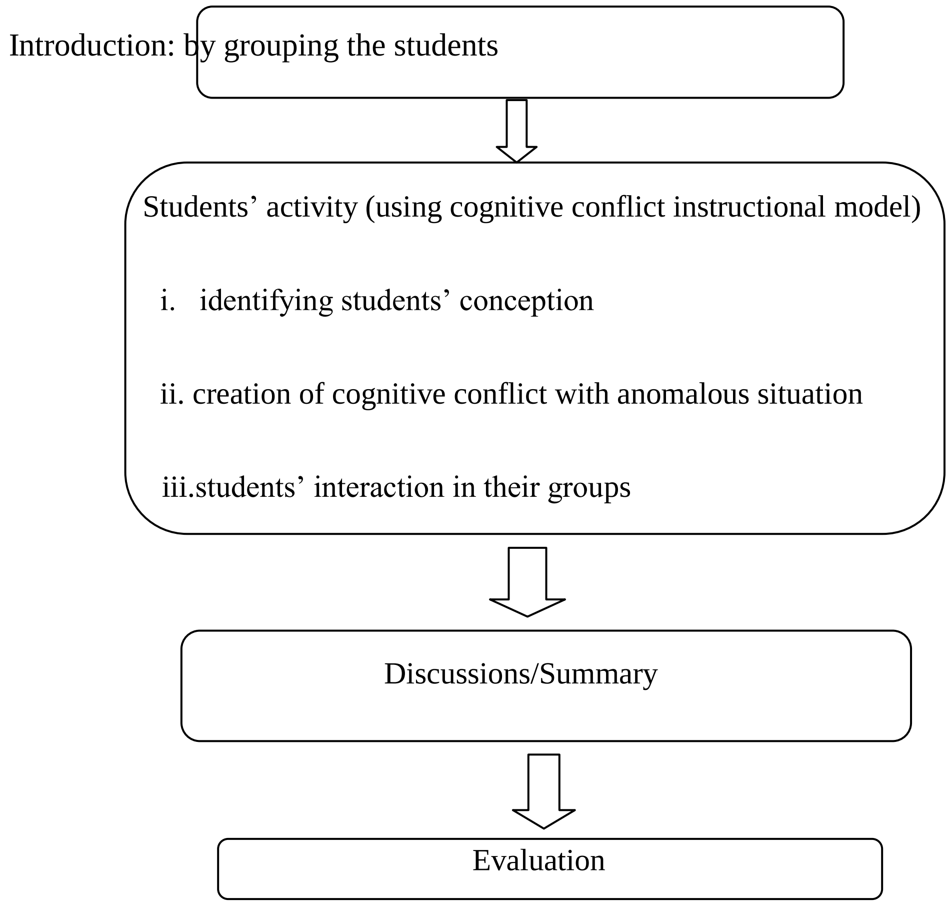
i. When genes are reshuffled (mutation) during meiosis due to Mendel's laws of segregation and independent assortment.
ii. Crossing-over of chromosomes (chromatids) during mitosis i.e. division of somatic cells leading to exchange of genetic materials
iii. Fertilization (of two haploid) sex cells from different gametes.

STEPIV: Evaluation: the teacher evaluates the students based on the activities carried out by the students.

The detail of administration of treatment Flow chart is presented in the figure 3.2 and the lesson plans for experimental group are presented in appendix d

The lesson flow chart for Cognitive conflict instructional model is presented in Fig. 3.2

Fig 3.2: Flow chart illustration cognitive conflict instructional model



Source: Adapted from, Modu and Orji, 2015**.**

Teaching the Control Group

The Control Group was taught same topic in Biology for the same period as the experimental group by the Researcher, using lecture method for effective result, using the second intact class containing 49 students. This involves verbal presentation of the concept to be taught. The students are expected to listen to the teacher and take down note presented on the chalk board. Students' conceptions will be determined after pretest and posttest. Students were allowed to ask questions at intervals and the teacher respond to the students' questions.

The lesson plan for both Experimental and Control Groups are presented in Appendix D and E.

3.9 Procedure for Data Collection

The group pretest and post test scores were used as data for the study. The pretest was administered on the two groups (Experimental and Control groups). There-after, the two groups were taught the same Genetics concept by the researcher. The control group was taught using lecture method while the experimental group was exposed to the Cognitive Conflict instructional model employing appropriate questions covering the six hierarchy of Bloom's taxonomy of cognitive domain. After a period of six weeks treatment, the post test was administered to the groups by the researcher. The researcher marked the scripts based on the marking scheme.

Data obtained from administering the GCE as a preconception test to the students to both groups was used to determine the students' naïve or preconception related to genetics. Conceptual trace analysis was used in measuring specific type of change or conceptual shift of the students in genetics, that is, tracing the movement of students from one level of understanding to another conception (understanding).

The scores from the scripts were collated and were subjected to data analysis using SPSS statistical package.

3.10Procedure for Data Analysis

The data collected for this study were used for two folds; answering research questions and testing of hypotheses.

3.10.1Answering Research Questions

The research questions were answered using descriptive statistics in form of mean scores and standard deviations.

3.10.2 Null Hypotheses Testing

The hypotheses stated were analyzed to test the significant difference between the variables of the study using t-test and chi-square at probability level of $p \leq 0.05$ for retaining or rejecting the stated hypotheses.

HO1: There is no significant difference between the conceptual change of secondary school biology students taught genetics using cognitive conflict instructional model and those taught using lecture method.

The chi-square test was used to trace changes that had occurred from the pretest to the posttest, this being nonparametric statistic able to handle items at a nominal level (i.e. frequency and percentage).

HO2: There is no significant difference between the mean academic performance scores among secondary school biology students in genetics taught using cognitive conflict instructional model and taught using lecture method.

The t-test statistical tool was used to test for any significant difference in the post test mean academic performance scores among those taught using cognitive conflict instructional model and those taught using lecture method.

HO3: There is no significant difference between the mean conceptual change scores of males and females secondary school biology students in genetics taught using cognitive conflict instructional model and those taught using lecture method.

The chi-square test was used to trace changes that had occurred from the pretest to the posttest, this being nonparametric statistic able to handle items at a nominal level (i.e. frequency and percentage).

HO4: There is no significant difference between the mean academic performance scores of male and female secondary school biology students in genetics taught using cognitive conflict instructional model and those taught using lecture method.

The t-test statistical tool was used employ to test for any significant difference in the mean academic performance scores of those exposed to cognitive conflict instructional model and those exposed to lecture method.

CHAPTER FOUR

DATA PRESENTATION, RESULTS AND DISCUSSION

4.1 Introduction

This study was carried out to determine the impact of cognitive conflict instructional model on conceptual change and performance in genetics among secondary school biology students in Potiskum, Yobe State, Nigeria.

In this chapter, the result obtained from the analysis of the data collected and the discussions of the results are presented. The Statistical Package of Social Science (SPSS) IBM 20th Edition was used for the analysis.

The work is presented in the following subheadings;

- Data Analysis and Result presentation
- Summary of Findings
- Discussions of the Findings

4.2 Data Analysis and Result Presentation

One hundred and ninety-nine (199) students, split into experimental group (100) and control group (99). Pre-test and post-test were given to the students and were subjected to statistical analyses using descriptive and inferential statistics. The results presented in the tables below:

Table 4.1: Distribution of Participants in Groups

Groups	Frequency	Percentage
Experimental	100	50.25
Control	99	49.75
Total	**199**	**100**

Table 4.1revealed 100(50.25%) were experimental group and 99(49.75%) of the respondents were in the control group. This indicated that the distribution for experimental and control groups were fairly presented in the study.

4.3 Response to Research Questions

The results of the analysis presented in this section shows the students' results from both pre-test and post-test which were analyzed using frequency count, and descriptive statistics of mean and standard deviation.

Question One: What is the difference in the mean conceptual change score of secondary school students taught genetics concept using cognitive conflict instructional model and those taught using lecture method?

Table 4.2 presents a summary of the analysis carried out in respect to the conceptual change score of secondary school students taught genetics concept using cognitive conflict instructional model and those taught using lecture method.

Table 4.2: Summary of the conceptual changes and analysis of students by level of understanding on pre-test – post-test scores

Treatment	SC	PC	AC	NC	Total
CCI Pre-Test	5(2.5)	20(10.0)	28(14.0)	47(23.5)	100
Post-Test	52(26.0)	28(14.0)	14(7.0)	6(3.0)	100
TTM Pre-Test	6(6.2)	22(21.6)	27(27.8)	44(44.3)	99
Post-Test	17(17.5)	37(38.1)	30(30.9)	15(13.4)	99

CCI= Cognitive Conflict Instruction, TTM= Traditional Teaching Method, SC= Sound Conception, PC= Partial Conception, AC= Alternative Conception, NC= No Conception

Table 4.2 shows the pre-test and post-test for mean conceptual change of CCI and TTM groups. The study subjects at the pretest exercise indicate almost the same level of conception. In the CCI group 47 subjects with mean score of (23.5) had NC, 28 subjects with mean score of (14.0) had AC, 20 subjects with mean score of (10.0) had PC, and 5 subjects with mean score of (2.5) had SC respectively. It indicated that the level of students' conception under SC had a mean score of (2.5) at the preconception. The post-conception exercise indicated that the level of students' conception significantly changes; the NC that recorded more subjects with the highest mean score of (23.5) during preconception had widely reduced to fewer students with (3.0) mean score. Also,more students with NC/AC/PC had shifted to sound conception (SC) at the end of the exercises with 52 subjects and mean score of (26.0) compared to their preconception which recorded fewer students with the least mean score of 2.5 of all their level of conception. While for the control group 44 subjects with mean score of (44.3) had NC, 27 subjects with mean score of (27.8) had AC, 22 subjects with mean score of (21.6) had PC, and 6 subjects with mean score of (6.2) had SC. At the post-conception the level of students' conception indicated that; 15 subjects with mean score of (13.4) remained with NC, 30 subjects with mean score of (30.9) had AC, 37 subjects with mean score of (38.1) had PC, and 17 subjects with mean score (17.5) had shifted to SC.

However, at the end of the exercise CCI group had the highest students of 52 with sound conception with the highest mean score of 26.0 which indicated students' response to CCI treatment.

Question Two: What is the difference between the mean academic performance scores of secondary school biology students taught genetics concept using cognitive conflict instructional model and those taught using lecture method?

Table 4.3 presents a summary of the analysis carried out in respect to the students taught genetics concept using cognitive conflict instructional model and those taught using lecture method.

Table 4.3: Summary of themean score of students' taught genetics concept using cognitive conflict instructional model and those taught using lecture method

Variables	N	Post-test	
Experimental	100	**Mean**	**SD**
		21.33	4.20
Control	99	11.09	2.87

Source: Field Study, 2019

Table 4.3 shows the post-test mean scores of experimental and control groups for students taught genetics concept using cognitive conflict instructional model and those taught using lecture method. For experimental group the mean score is 21.33 with standard deviation 4.20, while control group revealed the mean score of 11.09 with standard deviation of 2.87. Therefore, the mean score of the experimental group is higher than that of the control group with the mean difference of 10.24, this indicate that students taught genetics concept using cognitive conflict instructional model significantly performed better than those taught using lecture method.

Question Three: What is the difference between the mean conceptual change score of males and females secondary school students taught genetics concept using cognitive conflict instructional model?

Table 4.2 presents a summary of the analysis carried out in respect to the conceptual change score of males and females secondary school students taught genetics concept using cognitive conflict instructional model.

Table 4.4: Summary of the conceptual changes and analysis of male and female students by level of understanding on post-test scores

Treatment	SC	PC	AC	NC	Total
Male-Pre-Test	3(3.1)	12(12.4)	13(13.4)	25(25.8)	53
Post-Test	27(27.8)	15(15.5)	7(7.2)	4(4.1)	
Female Pre-Test	2(2.1)	8(8.2)	15(15.5)	22(22.7)	47
Post-Test	25(25.8)	13(13.4)	7(7.2)	2(2.1)	

Source: Field Study, 2019

The table 4.4 shows the post-test for mean conceptual change of males and females in the experimental group. In the CCI, Male and female students at their preconception exercise indicated nearly the same level of conception. The male students group had 25 subjects with the mean score of (3.1) had NC, 13 subjects with the mean score of (13.4) had AC, 12 subjects with the mean score of (12.4) had PC, and 3 subjects with the mean score of (3.1) had SC respectively compared to their female counterpart that recorded 22, 15, 8 and 2 with the mean score of (22.7), (15.5), (8.2) and (2.1) under NC/AC/PC and SC, respectively during their preconception. During the post-test exercise, male students recorded 27 subjects with highest mean score of (27.8) for SC compared to their preconception exercise of3 subjects with mean score of (3.1). Also, female recorded25 subjects with high mean score of (25.8) for SC compared to their preconception exercise of 2 subjects with mean score of (2.1). The mean score difference recorded (2.0) for SC which indicated that male shifted significantly to SC. For PC, male and female shifted significantly with 15 and 13 subjects with mean score of (13.4)and (15.5), for AC, male and female recorded 7 and 7 subjects with the mean scores of (7.2) and (7.2), and for NC, male and female 4 and 2 with mean scores of (4.1) and (2.1) respectively during the treatment.

However, the results from the table 4.4 indicated that there is no significant difference in the shift between male and female during the treatment.

Question Four: What is the difference between the mean academic performance scores of males and females secondary school biology students taught genetics concept using cognitive conflict instructional model?

Table 4.5 presents a summary of the analysis carried out in respect to the male and female biology students taught genetics concept using cognitive conflict instructional model.

Table 4.5: Summary of the Mean performance of male and female biology students taught genetics concept using cognitive conflict instructional model.

Variable	N	Mean	SD
Male	53	21.58	4.97
Female	47	21.04	4.34

Source: Field Study, 2019

The table 4.5 the results indicate that male and female biology students taught genetics concept using cognitive conflict instructional model recorded that; male students taught genetic concept using cognitive conflict instructional model have the mean score of 21.58 and standard deviation 4.97, while the female studentsrecorded the mean score of 21.04 and standard deviation of 4.34. The mean difference is 0.54. This implies that the treatment (Cognitive conflict instructional model) according to the mean difference of male and female students is gender friendly as it favor both male and female students and enhances their performance.

4.4 Hypotheses Testing

HypothesisOne ($H0_1$): There is no significant difference in the mean conceptual change scores among secondary school biology students in genetics taught using cognitive conflict instructional model and those taught using lecture method

Table 4.6: Summary of theChi-Square Analysis of students' response by level of conception on post-test scores

Treatment	SC	PC	AC	NC	Total	df	X^2	P
CCI	52(26.0)	28(14.0)	14(7.0)	6(3.0)	100	3	76.471	.000
TTM	17(17.2)	37(37.4)	30(30.3)	15(15.2)	99			

CCI: Cognitive Conflict Instruction, TTM: Traditional Teaching Method

Table 4.6, shows that, the result of chi-square test for the secondary school biology students conceptual change scores in experimental group showed there is significant difference. The P-value of 0.00 at Df 3, X^2= 76.471 is less than theα-value $\leq$ 0.05 alpa value. This revealed that the level of conceptionin genetics was significantly depended on the treatment.

This implies that the treatment with Cognitive Conflict Instructional Model significantly enhanced the level of the students' conception in the experimental group compared to their counterpart in the control group. Therefore, the null hypothesis which says that there is no significant difference between the mean conceptual change scores in genetics among secondary school biology students is hereby rejected.

Hypothesis Two ($H0_2$): There is no significance difference between the mean academic performance scores among secondary school biology students taught genetics using cognitive conflict instructional model and those taught using lecture method.

Table 4.7: Summary of the Paired sample t-test results of mean academic performance scores of Experimental and Control groups

Variable	N	Mean	SD	Df	α	t-cal	t-crit	sig	Decision
Experimental	100	21.33	4.20						
				197	0.05	20.101	1.65	.000	Rejected
Control	99	11.09	2.87						

Source: Field Study, 2019

Table 4.7, shows a P-value of 0.000 is less than α-value ≤ 0.05 alpha value. This revealed that the study subjects who were exposed to Cognitive Conflict Instructional Model in the experimental group performed significantly better in academic performance than those in the control group taught with lecture method.

This implies that the treatment with Cognitive Conflict Instructional Model significantly enhanced the academic performance of the students in the experimental group compared to their counterpart in the control group. Therefore, the null hypothesis which says that there is no significant difference between the mean scores of secondary school biology students' Academic Performance is hereby rejected.

Hypothesis Three ($H0_3$): There is no significant difference between the mean conceptual change scores of male and female secondary school biology students in genetics taught using cognitive conflict instructional model

Table 4.8: Summary of the Chi-squire Analysis of male and female biology students' response by level of conception on post-test scores

CCI	SC	PC	AC	NC	Total	df	X^2	P
Male	27(50.0)	15(28.3)	7(13.2)	4(7.5)	53			
						3	.528	.913
Female	25(47.2)	13(24.5)	7(13.2)	2(3.8)	47			

Table 4.8, shows that, the result of chi-square test of male and female mean conceptual change scores of students in experimental group showed there is no significant difference. The P- value of 0.913 at Df 3, $X^2 = 0.528$, and P-value of 0.913 is greater thanα-value ≤ 0.05. This revealed that the treatment has significantly enhanced the scientific conception of both male and female Biology students.

This implies that the treatment with Cognitive Conflict Instructional Model is gender friendly significantly. Therefore the treatment is gender friendly. Hence the hypothesis which state that, no significant difference is hereby retained.

Hypothesis Four ($H0_4$): There is no significant difference between the mean academic performance scores of males and females secondary school biology students in genetics taught using cognitive conflict instructional model

Table 4.9: comparison of mean score of male and female biology students taught cognitive conflict instructional model using T-test

Variable	N	Mean	SD	Df	α	t-cal	t-crit	sig	Decision
Male	53	3.13	0.962						
				99.98	0.05	0.169	1.65	.100	retained
Female	47	3.16	0.898						

Table 4.9 shows that the P-value of 0.100 is higher than the α-value ≤0.05. This revealed that the treatment (Cognitive Conflict Instructional Model) is gender friendly. Hence the hypothesis which state that, no significant difference is hereby retained.

This implies that the treatment with Cognitive Conflict Instructional Model significantly enhanced the academic performance of both the male and female students.

4.5 Summary of Findings

The following findings were revealed from the research:

1. Biology students in their post-test treatment had significant shift to sound conception using Cognitive Conflict Instruction (CCI), compared to their counterpart in the Traditional Teaching Method (TTM). The CCI group had more subjects that shifted significantly from NC/AC/PC to SC, while TTM group had fewer that shiftedfrom NC/AC to PC.

2. Biology students taught genetics using cognitive conflict instructional model performed significantly better than those taught using lecture method with the p-value of 000< 0.05.

3. Male and female biology students had significant shift to sound conception using cognitive conflict instruction. Both had significantly shifted from NC/AC/PC to SC.

4. The study shows that Cognitive Conflict Instruction is equally effective for both Male and female biology students in genetics taught using cognitive conflict instructional model.

4.6 DiscussionsoftheResults

The findings of the results are been discussed as follows;

From the table 4.4, a significant change occurred in the number of students whoshifted from one level of conception to another as a resultof the treatment. The trace analysis indicated a large gain in responses moving into SC, as well as PC, from AC/NC. However, itwas observed that students in the two groups differed in theirshift from AC/NC to scientific conception. This is not surprising, given that PC is a typical outcome of many differenttypes of science instruction

(Madu & Orji, 2015). Although both types of instruction provided gains in achievement related to genetics, the gain in the experimentalgroup was statistically higher than that in the control group.The difference was taken to indicate that CCI provides anopportunity for students to take an active role in buildingtheir own knowledge by modifying their existing conceptionsthrough the process of conceptual change. Empirical findings by others are in consonancewith the findings of this study. For instance, Madu (2004)found that students' level of understanding is significantlydependent on instructional treatment in 80% of questions.Madu's finding has been validated by Agumuoh (2010) whofound that students' levels of understanding depended oninstructional treatment. A study by Gulcan (2004) indicated that experimental groups caused a significantly better acquisition of scientific conceptions related to ecology concepts than the traditional instruction.

Also, this study supports the observation by Madu and Orji (2015), that the level of understanding of concept was significantly depended on the treatment. Other studies by Mustafa (2006), Chi (2008), Agumouh (2010), Lee and Byun (2011) and Erdal Taslidere (2013) indicated that conceptual change oriented instruction is more effective for conceptual understanding and decreasing most of students' misconceptions.

In this study, therewas an overall increase in the students' ability to answer questions about genetics afterthe intervention. This implied that the students in the experimental group (CCI) had significant gains in theircontent understanding compared with those in control group.

It could be claimed that this difference could be attributed tothe following properties: activation of students' ACs, presentationof a situation that could not be explained with existingconcepts, creation of cognitive conflict to deal with thisanomalous situation, active construction of students' non-knowledge,students' interaction with each other to sharetheir ideas about the anomalous situation and its possiblesolution, and the new conception seen as helpful to solvesimilar problems that could be encountered in the future.These were in agreement with the themes of both constructivismand conceptual change theory posed by Posner andcolleagues (1982).

Also, trace analysis in this study revealed, based on students' levels of conception, that students' misconceptions/AC/NC are resistant and persistent to change. Thisfinding is in line with Chi (2008) and Lee and Byun (2011)who showed similar findings and called resistant misconceptions"robust misconceptions."

The result in Table 4.7, the experimental group performed significantly better than the control group. This shows that Cognitive Conflict Instructional Model is effective in enhancing the acquisition of scientific conception on the subjects under study, stimulating them to interact, to share and to get experience of their own. This is supported by the study conducted by Murad and Ahmad (2014) revealed that Conceptual Change Group outperformed the Non Conceptual Change Group in terms of students' modification of alternative mathematical concepts and on their ability of solving mathematical problems. This study also supports the observation by Martins and Oyebanji (2000), that teaching methods affects the response of students and determine their interest level, motivation and involvement in the lesson. Other studies by Mukherjee (2007) have also shown that learners' cognitive process and academic performance can be enhanced through effective method of instructions.

The relatively poor performance of the subjects in the control group is an indication that the lecture method adopted in teaching science by science teachers is not effective in promoting cognitive processes in secondary school students as observed by Lawson (2002), Aikenhead (2005) and Mukherjee (2007) that subjects do not acquire cognitive skills unless concerted effects are made to identify and use instructional strategy that promotes its development and lecture method does not as it is teacher centered.

Table 4.8 indicated that there is no significant difference in the mean conceptual change scores in relation to gender, as the male and female students have almost the same level of conception which . This is because the level of students' conception shifted from one level to another through the treatment result. After the treatment it was observed that male students' conceptual changes in CCI group have shifted from NC/AC/PC to SC. The female counterparts in same CCI group have shifted their understanding from NC/AC/PC to SC. A study by Potvin, Sauriol and Riopel (2015) indicated that cognitive conflicts are useful in teaching sequences that aim at producing conceptual changes. This indicates that using CCI provide students with the opportunity to take an active role in diversifying their knowledge of understanding in the process of conceptual change. Empirical findings that supports this study are that of Madu and Orji (2015), Sukariasih (2016), Akmam, Anshari, Amir, Jalinus and Amran (2018), Labobar, Setyosari Nyoman, Degeng and Dasna (2015) and Amponsah and Ochonogor (2016) indicated that there was no significant interaction effect between gender and treatment, that is equally effective for both male and female students. Hence, the result of this study indicated that using CCI there is significant gain in students' responses which have both shifted from NC/AC/PC to SC.

The result in Table 4.9 shows that at significant confidence of $P < 0.05$, there is no significant difference in the mean academic performance scores in relation to gender, as the treatment with Cognitive Conflict Instructional Model was noticed to be gender friendly. This finding is in agreement with the report of Usman (2002), Bichi (2002), Ogunboyede (2003), Gandu (2006) who independently reported that male and female students perform the same in academic achievement when exposed to activity based teaching method.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The aim of this study was to investigate the impact of Cognitive Conflict Instructional Model on Conceptual Change and Performance in Genetics among Secondary School Biology Students in Potiskum, Yobe state, Nigeria. In this chapter, the summary of the procedure for data collection and the findings from the study are presented. The conclusions and recommendations arising from the findings are presented as follows.

5.2 Summary

This study investigated the impact of cognitive conflict instructional model on conceptual change and performance in genetics among secondary school Biology students in Senior Secondary School (SSS).

The design of the study was quasi-experimental and control group design employing Pretest and Posttest (Kerlinger, 2000).A total of 199 subjects (100in the experimental group and 99 in the control group) were used for the study. The experimental group was exposed to cognitive conflict instructional model for (6) six weeks. The four sample schools were selected by stratified random sampling technique. The four sample schools were;

- Government Science and Technical Potiskum
- Government Secondary School Daura Damagun
- Government Secondary School Ngelzarma
- Government Girls Science and Technical College Potiskum

A simple random sampling technique was used to select the experimental and control group respectively. Two instruments, Genetics Performance Test (GPT) and Genetics Concept Evaluation (GCE) were used for data collection. The tests were used to collate data as pretest and posttest which was also used in answering the research questions and to test the stated null hypothesis. The GPT consists of 30 items multiple choices question on genetics with a reliability coefficient of 0.78. While the GCE was used to trace changes on the students' conception before and after being taught using cognitive conflict instructional model with the reliability coefficient of 0.79. The GCE had 24 items with four choices and space for given reason for the answer that exposed learners' conception.

The treatment lasted for six weeks consisting of six periods of 80 minutes each. The subjects were taught the concept of genetics comprising of Heredity and variation, Mendelian laws of heredity, Monohybdrid crossing, Dihybrid crossing (multiple factor inheritance), application of the principle of heredity, genetic disorder and variation using Cognitive Conflict Instructional Model adapted from Madu & Orji(2015).The control groups were taught same concepts using lecture method. At the end of the treatment, study subjects were post-tested. The data collected through the use of GPT and GCE was subjected to T-test and Chi- square tests statistics to determine the significant difference in the academic performance and conceptual change of the experimental group. The results indicated that the academic performance and conception of Biology students taught genetic concept using cognitive conflict instructional model were significantly better. Student's gender had no significant effect in their performance and conception in genetics when cognitive conflict instructional model is used. From the results, hypotheses one and two of the study were rejected, while hypothesis three and four were retained.

5.3 Summary of Major Findings

The following findings were obtained.

1. The analysis of the posttest scores indicates that there is a significant difference between students exposed to cognitive conflict instructional model compared to those taught with lecture method in favor of the experimental group. That is to say, the experimental group had better scientific conception than the control group in their conception after undergoing the experimental treatment of cognitive conflict instructional model. The Cognitive conflict instructional model was found to be more effective in changing the conception of Biology students at the Senior Secondary School level.
2. There is a significant difference between students exposed to Cognitive Conflict Instructional Model compared to those taught with lecture method in favor of the experimental group. That is to say, the experimental group performed better than the control group in their academic achievement after undergoing the experimental treatment of Cognitive Conflict Instructional Model.
3. There is a no significant differencein conception of male and female students exposed to the treatment with Cognitive Conflict Instructional Model. This indicates that Cognitive Conflict Instructional Model is gender friendly as it is suitable for both male and female subjects.
4. There is no significant difference between male and female students' academic performance that were exposed to the treatment with Cognitive Conflict Instructional Model. This indicates that Cognitive Conflict Instructional Model is gender friendly as it is suitable to improve the academic performance for both male and female subjects.

5.4 Conclusion

Based on the findings of this study, the following conclusions were made:

- Cognitive conflict instructional model is effective in enhancing students' conception in Biology. The paradigm shift from the alternative or no conception to partial or sound conception for the concept took place in the students' conception when exposed to cognitive conflict instructional model.
- The performance of students in Biology increased after exposure to Cognitive conflict instructional model.
- Exposure of male and female students to the treatment shows that the two groups gained tremendously from the treatment. This implies that the treatment is suitable for male and female students meaning it is gender insensitive and not bias
- The male and female students that were exposed to the treatment show that the two groups gained tremendously from the treatment. This implies that the treatment is suitable for male and female students meaning it is gender insensitive and not bias. Therefore, Cognitive Conflict Instructional Model has potentiality for enhancing student academic performance and it is gender friendly.

5.5 Contributions to Knowledge

This research work was initiated to determine the most effective ways to correct students' misconceptions and improve their performance through the use of Cognitive Conflict Instructional Model. It was observed that;

1. The Cognitive Conflict Instructional Model as a conceptual change approach was effective in correcting students' misconception in genetics. Thus the method enhances

meaningful learning of genetics concept by both males and females students in secondary school.

2. The use of Cognitive Conflict Instructional Model encourages students to construct their own knowledge from pre-existing knowledge. This implies that, the treatment improves the students' performance in class.

3. The use of Genetic Concept Evaluations (GCE) as a tracing tool to conceptual change approach traces individual progressive conceptions level in real-life situation, as the instrument has the potential to identify students' misconceptions. The use of this approach develops teachers with the spirit of tracing conceptual change in terms of correcting misconceptions, while constructing assessment tool to this effect.

4. Also the findings of this study have added new information to the frontier of knowledge in the existing literature.

5. This study has successfully developed lesson plan that can be used to spur conceptual change in learners. This has proved beyond just use of effective strategies can enhance conceptual change.

6. The study has established that misconception can be change by using appropriate instructional strategy.

5.6 Recommendations

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

1. There is need for the promotion of scientific conceptions of Biologyin the learning and teaching conditions and practices existing in Nigerian secondary school through the use of different effective teaching and learning methods, and models such as Cognitive Conflict Instructional Model which is a conceptual change approach to teaching and learning instead of the conventional lecture method.
2. Conceptual change instructions like cognitive conflict instruction should be adopted by science teachers, educators, and authors and publishers of science books.
3. Since the level of students' preconception affects the learning of science concepts, there is therefore the need for science teacher to systematically and periodically identify thepreconception of their students. One way of doing this is by the use of questions that triggers students' conception and set them into cognitive conflict. This is with a view to adapting circular contents, achievement goals, instructional method and educational strategies to improve their conception.
4. Science teachers should be trained on how and when to use conceptual change instructions like cognitive conflict to foster conceptual change.
5. It is recommended that the text book publishers should develop suitable training manuals and work books that will promote effective delivery of scientific conceptions for scientific knowledge through the use of conceptual change approach.
6. Nigerian universities and colleges of education as well as secondary school educational planner should be encouraged to design educational programs that will equip teachers in

training with skills for the use of students' preconceptions for effective teaching and learning of Biology.

5.7 Limitations of the Study

The following limitations were noted in the course of this study;

1. The study was restricted to only fourgovernment schools and to biology students. A widen scope of the study might influence the study. The geographical coverage in Potiskum educational zone of Yobe state only thus limiting generalization made from the study.

2. The late resumption of students in Yobe State during the courses of the study effect commencement of the study due to the 2019 Nigeriangeneral elections.

3. Incomplete randomization might have affected the observations.

5.8 Suggestions for Further Studies

Considering the available literatures, it is obvious that not much work have been done in the area of Conceptual Change Approach using Cognitive Conflict Instructional Model on conceptual change and performance in genetics. Thus, in concluding this study the following were suggested for further studies on Conceptual Change Approach in Biology:

1. A similar study should be carried out focusing on other concepts in biology for conceptual change other than genetics as well as other subject areas in science.
2. Similar studies should be carried out at tertiary institutions such as colleges of education, Polytechnics, Mono-technics and Universities.

3. It is needful to extend the study over a period of two or three years to ascertain the substances or other wise of the effects of cognitive conflict instructional model in promoting scientific conception gains in students. This will also help to establish if a long period of exposure to cognitive conflict model will help to remedy misconceptions as well as poor academic achievement in science and biology in particular.
4. The use of other teaching method such as Demonstration Method, Science Process Teaching Approach, Discovery Methods, Problem Solving Methods and Practical Methods should be employed to determine it effect on of science students' conceptual change.
5. This study can be replicated in rural schools to determine if there are difference in the conceptual change between students in the rural schools and those in urban areas.

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APPENDICES

APPENDIX A

GENETICS PERFORMANCE TEST (GPT)

School Name: ____

Student's Number: ____

Sex: Male ☐ **Female** ☐

Time Allowed: 30 Minutes

Instruction: Attempt all questions by circling the correct option

1) Which of the statements below is true about heredity?
A. Transmission of characters from grandparents to offspring.
B. Characters transmitted cannot be controlled by genes.
C. Environmental factors cannot change genotype
D. Brings about only differences between parents and offspring.

2) An organism with two sets of chromosomes is said to be ………………………………..
A. polyploid
B. diploid
C. haploid
D. hybrid

3) The genotype ratio of 1:2:1 in the offspring of a hybrid cross illustrate the law of ……………………
A. use and disuse.
B. dominance
C. segregation.
D. linkage.

4) The haploid number of chromosomes in man is ………………
A. 48 B. 46 C. 24 D. 23

5) If a cross is made between a pure breeding red flower plant and a pure breeding white flower plant where 'R' is dominant for red flower and 'r' is recessive for white, the most likely F1 generation will be ……………………..
A. 75% red flowers and 25% white flowers.
B. 100% all red flowers.
C. 50% red flowers and 50% white flowers.
D. 75% white flowers and 25% red flowers

6) Which of the following represents the phenotypic ratio when a plant Rr is crossed with another plant Rr, assuming that the gene 'R' for round seed is dominant and wrinkled 'r' is recessive?

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

7) All hereditary characters in a cell are passed on from parent-cell to daughter-cell through the process of ……………..
A. mitosis
B. meiosis
C. fertilization
D. gestation

8) When gametes from pure breeding parents with contrasting features such as tallness and shortness are involved in monohybrid cross, the offspring in the first filial generation are usually ……………………
A. pure bred
B. heterozygous
C. homozygous
D. co-dominance

9) The genetic make-up of an organism is known as the …………………………
A. phenotype
B. genotype
C. character
D. gene

10) Which of these is not hereditary?
A. Poliomylietis
B. Blood group
C. Sickle cell anaemia
D. Shape of face and nose

11) An individual with blood group AB can receive blood from those in blood group(s) …………….
A. AB only
B. A and B only
C. AB and O only
D. A, B, AB and O

12) Which of the following is the unit of transmission of hereditary traits in living organisms?
A. Nucleus
B. Nucleolus
C. Gene
D. Chromosome

13) Blood group and tongue rolling are examples of …………………..

A. Continuous variation

B. Discontinuous variation

C. Variation due to environment

D. Adaptive variation

14) If a black guinea pig of genotype 'BB' is crossed with a white guinea pig of genotype 'bb'; what will be the phenotype of the F1 generation?

A. Half of the offspring would be black while the other half would be white

B. All the offspring would be black

C. All the offspring will be grey

D. One-third of the offspring would be black while two-third would be white

15) The process that results in gamete formation is …………………………….

A. Mitosis

B. Fertilization

C. Pregnancy

D. Meiosis

16) Which of the following is NOT an example of continuous variation?

A. Height of plant

B. Ability to roll tongue

C. Skin colour

D. Length of fingers

17) Morphological variation deals with ………………………..

A. organism's genotype

B. organism's phenotype

C. organism's Chromosome numbers

D. organism's skin colour

18) The paternity of a child, which is in dispute, can be ascertained by comparing the child's ……………

A. phenotype with that of the father and mother

B. genotype with that of the father alone

C. genotype with that of the mother and father

D. genotype with that of his grand parents

19) Variation is the study of ……………………………..

A. differences in height and weight of organisms
B. differences in the number of males and females
C. the observable differences between parents and offspring
D. the observable differences in the rich and the poor

20) Which of the following diseases or disorders can be prevented by application of the knowledge of heredity through marriage counseling?

A. sickle cell anemia
B. haemophilia
C. diabetis mellitus
D. colour blindness

21) How many chromosomes are found in the human ovum?
A. 46
B. 23
C. 33
D. 13

22) The branch of science which deals with resemblance, origin and expression of biological variations is called …………………………………...

A. Embryology
B. Ecology
C. Entomology
D. Genetics

23) The offspring produced when pure strains interbreed is described as ………character.

A. dominance
B. phenotype
C. genotype
D. hybrid

24) A sudden loss of black pigments from the skin of an African can be attributed to …………

A. blending of black and white genes
B. recombination of genes
C. loss of the epidemis
D. mutation in the skin gene cells

25) Which of the following statements is not correct about sex determination?
A. females contribute half of the sex chromosomes
B. males contribute an X or Y chromosomes
C. males contributes half of the sex chromosomes
D. the sex of an individual is determined by the contribution of the male and female

Use the following human characteristics to answer question 39 and 40

I Complexion
II Height
III Blood Rhesus factor
IV Colour blindness

26) Which of the above human characteristics are discontinuous variations?
A. I and III only
B. II and III only
C. II and IV only
D. III and IV only

27) which of the characteristics can be expressed phenotypically?
A. I and II only
B. I, II and IV only
C. I, III, and IV only
D. I, II, III and IV

28) Which of the following determines a normal male offspring?
A.M X
B. YX
C. XX
D. XY

29) Variation is important in human life and can be used for the following activities except …………………..

A. crime detection
B. population distribution
C. blood transfusion
D. determination of sickle cell anemia

30) Which of the following is the correct allelic pair of a homozygous pure-stock of garden pea plants that is round and yellow?

A. RyRy
B. Ryry
C. ryry
D. RYRY

APPENDIX B

GENETICS CONCEPT EVALUATION

(For Pretest and Posttest)

SchoolName: ____

Student Number: _______________________

Sex: Male ☐ Female ☐

Instruction: - Circle the Correct Answer and give reason for your answer.

Time allowed: 1 hour

1) Which of the statements below is true about heredity?
A. Transmission of characters from grandparents to offspring.
B. Characters transmitted cannot be controlled by genes.
C. Environmental factors cannot change genotype
D. Brings about only differences between parents and offspring.

Give reason for your answer:
…………………………………………………………………………………………
…………………………………………………………………………………………………

2) An organism with two sets of chromosomes is said to be ……………….
A. polyploid
B. diploid
C. haploid
D. hybrid

Give reason for your answer:
…………………………………………………………………………………………….
…………………………………………………………………………………………………

3) The genotype ratio of 1:2:1 in the offspring of a hybrid cross illustrate the law of..……………….
A. use and disuse.
B. dominance
C. segregation.
D. linkage.

Give reason for your answer:
…………………………………………………………………………………………….
…………………………………………………………………………………………………

4) 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

Give reason for your answer:
………………………………………………………………………………………………
………

5) The haploid number of chromosomes in man is …………………
A. 48 B. 46 C. 24 D. 23

Give reason for your answer:
……………………………………………………………………………………………….
………

6) If a cross is made between a pure breeding red flower plant and a pure breeding white flower plant where 'R' is dominant for red flower and 'r' is recessive for white, the most likely F1 generation will be
A. 75% red flowers and 25% white flowers.
B. 100% all red flowers.
C. 50% red flowers and 50% white flowers.
D. 75% white flowers and 25% red flowers

Give reason for your answer:
……………………………………………………………………………………………….
………

7) Which of the following represents the phenotypic ratio when a plant Rr is crossed with another plant Rr, assuming that the gene 'R' for round seed is dominant and wrinkled 'r' is recessive?
A. 1:2:1
B. 2:2:1
C. 2:2
D. 3:1

Give reason for your answer:
……………………………………………………………………………………………….
………

8) All hereditary characters in a cell are passed on from parent-cell to daughter-cell through the process of ………………..

A. mitosis
B. meiosis
C. fertilization
D. gestation

Give reason for your answer:
……………………………………………………………………………………………….
……

9) When gametes from pure breeding parents with contrasting features such as tallness and shortness are involved in monohybrid cross, the offspring in the first filial generation are usually………………………

A. pure bred
B. heterozygous
C. homozygous
D. co-dominance

Give reason for your answer:
……………………………………………………………………………………………….
……

10) The genetic make-up of an organism is known as the …………………………………….

A. phenotype
B. genotype
C. character
D. gene

Give reason for your answer:
……………………………………………………………………………………………….
……

11) Which of these is not hereditary?

A. Poliomyelitis
B. Blood group
C. Sickle cell anemia
D. Shape of face and nose

Give reason for your answer:
……………………………………………………………………………………………….
…………………………………………………………………………………………………

12) An individual with blood group AB can receive blood from those in blood group(s)
A. AB only
B. A and B only
C. AB and O only
D. A, B, AB and O

Give reason for your answer:
…………………………………………………………………………………………….
………………………………………………………………………………………………………

13) Blood group and tongue rolling are examples of …………………….
A. Continuous variation
B. Discontinuous variation
C. Variation due to environment
D. Adaptive variation
Give reason for your answer:
…………………………………………………………………………………………….
……….

14) Which of the following is NOT an example of continuous variation?
A. Height of plant
B. Ability to roll tongue
C. Skin colour
D. Length of fingers

Give reason for your answer:
…………………………………………………………………………………………….
………………………………………………………………………………………………………

15) Morphological variation deals with ……………………………………
A. organism‗s genotype
B. organism‗s phenotype
C. organism‗s Chromosome numbers
D. organism‗s skin colour

Give reason for your answer:
…………………………………………………………………………………………….
……………………………………………………………………………………………………

16) The paternity of a child, which is in dispute, can be ascertained by comparing the child's ……………

A. phenotype with that of the father and mother

B. genotype with that of the father alone

C. genotype with that of the mother and father

D. genotype with that of his grand parents

Give reason for your answer:

…………………………………………………………………………………………….

……………………………………………………………………………………………………

17) Which of the following diseases or disorders can be prevented by application of the knowledge of heredity through marriage counseling?

A. sickle cell anemia

B. haemophilia

C. diabetis mellitus

D. colour blindness

Give reason for your answer:

………………………………………………………………………………………

……………………………………………………………………………………………………

18) The offspring produced when pure strains interbreed is described as

A. dominance

B. phenotype

C. genotype

D. hybrid

Give reason for your answer:

………………………………………………………………………………………

……………………………………………………………………………………………………

19) A sudden loss of black pigments from the skin 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

Give reason for your answer:

………………………………………………………………………………………

……………………………………………………………………………………………………

20) Which of the following statements is not correct about sex determination?
A. females contribute half of the sex chromosomes
B. males contribute an X or Y chromosomes
C. males contributes half of the sex chromosomes
D. the sex of an individual is determined by the contribution of the male and female

Give reason for your answer:
………………………………………………………………………………………
……

Use the following human characteristics to answer question 39 and 40

I Complexion
II Height
III Blood Rhesus factor
IV Colour blindness

21) Which of the above human characteristics are discontinuous variations?
A. I and III only
B. II and III only
C. II and IV only
D. III and IV only

Give reason for your answer:
………………………………………………………………………………………
……

22) Which of the characteristics can be expressed phenotypically?
A. I and II only
B. I, II and IV only
C. I, III, and IV only
D. I, II, III and IV

Give reason for your answer:
………………………………………………………………………………………
……

23) Variation is important in human life and can be used for the following activities except
A. crime detection
B. population distribution
C. blood transfusion
D. determination of sickle cell anemia

Give reason for your answer:
………………………………………………………………………………………
………………………………………………………………………………………………………

24) Which of the following is the correct allelic pair of a homozygous pure-stock of garden pea plants that is round and yellow?

A. RyRy
B. Ryry
C. ryry
D. RYRY

Give reason for your answer:
………………………………………………………………………………………
………………………………………………………………………………………………………

APPENDIX C

MARKING SCHEME

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

APPENDIX D

LESSON PLAN FOR THE EXPERIMENTAL GROUP EXPOSED TO COGNITIVE CONFLICT INSTRUCTIONAL MODEL

Lesson 1 **-** WEEK 1

Group – Experimental

Class Level **-** SS3

Subject **-** Biology

TOPIC: **-** Transmission and Expression of characters in organism

Duration **-** 90 minutes

Instructional Materials **-** Biology textbook, activity sheet, cardboard paper, pencils & eraser.

SPECIFIC OBJECTTIVES: At the end of the lesson students should be able to:

1. Define genetics;

2. Differentiate heredity and variation;

3. Draw a crossing in genetics

STEP I: Introduction: The teacher will start the lesson by grouping the students into 5 groups, each group with at least one Biology text book and activity sheet.

STEP II:Students' activity (Using cognitive conflict instructional model)

Stage i: The teacher asks the students the following questions that trigger students' conception and set them into cognitive conflict, such as:

a) Why do we look like our parents?

b) What is responsible for our resemblance?

Stage ii: creation of cognitive conflict with anomalous situation as follows;

c) Black man and white man look alike because they are of the same species, does it mean that donkey and zebra look alike because they are of the same species? What is responsible for their differences?

Stage iii: Students' interaction: the students interact with each other by sharing ideas and using Biology textbook in their group and report their findings or answers in the activity sheet. For example;

a. We look like our parents because we inherit some genes from our parents.
b. Genes are responsible for our resemblance.
c. Zebra and donkey are not the same species, because they cannot mate. Organisms of the same species mate and during mating there is transfer of genes from parents to daughter cells which causes inheritance and variation.

STEP III. Discussion/summary: the teacher uses the reports and guides the discussion as; what is the difference between genetics and heredity?

Group (a): Genetics is the study of heredity and variation.

Heredity is the study of transfer of traits or characters from the parents to its offspring from one generation to another.

Variationis the difference which exists in individuals or organisms of the same specie at corresponding stages of their life cycle. For instance, the difference between a child and his or her grandfather or grandmother.

Teacher: what is gene?

Group (b):Geneis the basic unit of inheritance.

Group (c): Gene is the physical unit of inheritance transmitted from one generation to another and it is responsible for developing and controlling character or traits in the new organism.

Group (d): **Gene** is a segment of deoxyribonucleic acid (DNA) molecule that usually codes for the synthesis of polypeptides chains (protein) that eventually determines the nature of an organism.

Group (e): what is genotype?

Group(a): genotype is the sum of total genes present in the cells of an organism. The genotype character is not externally visible but responsible for controlling physiological activities or characteristics.

Group(c): what is phenotype?

Group(b**):Phenotype**is the physical observable (visible) expression of the gene present in an organism. The phenotypic character is as a result of the interaction of genetic materials and the surrounding of the environmental condition.

Group(d): what is chromosome?

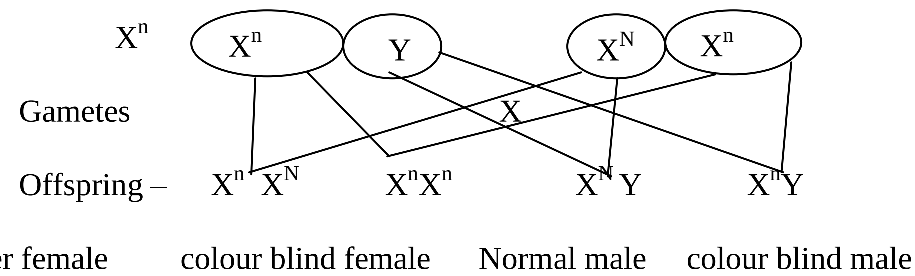
Group(e):Chromosomesare strands of genetic materials which becomes obvious or visible during cell division (meiosis). Chromosomes are usually found in the nucleus of a cell and always carry a gene. They consist of deoxyribonucleic acid (DNA) and protein. Each specie or organism has a peculiar characteristic number of chromosomes. For example, the human being has 23 pairs of chromosomes.

Teacher: the teacher guides the students on determining where students will link gene factors using diagram.

Sex-linked character: these are characters determined by a gene located on either X or Y chromosome. For instance, haemophilia and colour blindness are recessive characters located on

‘X^n’ chromosome. That is the reason why only male human organism suffers from the disease while the female is a carrier.

Group (a): **Male** (colour blind) X**Female**(carrier)



Group(b): what is mutation?

Group (c): Mutation is a permanent change in DNA structure that alters or destroys a given character resulting into a new character. For instance, when pure-line stocks of red and white pea plants are crossed and the result of F1 self pollinated to produce a phenotypic pink pea plant at F2 generation. The pink plant is as a result of mutation. Sickle-cell anaemia, haemophilia, colour blindness and blood groups etc are example of mutation. What are alleles?

Group (d): Allelesare two or more alternative forms of gene. For instance, the gene for tallness is represented as ‘TT’ or dwarfness as ‘tt’ is referred to as ‘allele’. If they are in pair is referred to as ‘alleles’.

Group (e): what is locus?

Group (**b):Locus** is the location of a gene on a chromosome. In other words, it is a position on the chromosome where the gene is located or placed.

Group (c): what is pure-line?

Group(a): **Pure-line** is a homologous pair of allelic gene of a character. For instance, tall plants ‘TT’ and short plant (dwarf) ‘tt’.

Teacher: what is the different between homozygous and heterozygous?

Group (b): Homozygous are two dissimilar alleles for a particular character in an organism. For instance, ‘Tt’ for heterozygous tall plant. This means that, the tall plant has a recessive gene for shortness i.e small‘t’.

Summary: Theteacher summarizes the discussion by explain the meaning of **Gamete** as a haploid sperm cell or ova which fuses together to produce a zygote. It is usually the half number of chromosomes i.e 23 that each parent contributes during meiosis to gamete formation.

Zygote is the cells formed as a result of the fusion of haploids cells of a male and female. The zygote can be described as diploid cell having 46 numbers of chromosomes.

STEPIV: Evaluation: Based on the activities carried out by the students, the teacher evaluates the students as follows:

1) What is genetics?
2) Differentiate between genetics and variation
3) Using genetic crossing draw a crossing between a dominant character DD and recessive character dd.

Lesson 2 - WEEK 2

Group - Experimental

Class Level –SS3

Subject - Biology

Topic: - Mendelian laws of heredity

Duration - 90 minutes

Instructional Materials - chalkboard, photographs, activity sheet and textbook

Behavioral Objective: At the end of the lesson students should be able to:

I. State Mendel's first law of segregation of genes
II. State Mendel's second law of independent assortment of genes
III. Differentiate between transmissible and non-transmissible characters
IV. Identify non-transmissible character

STEP I: Introduction: The teacher starts the lesson by grouping the students into 5 groups, each group with at least one biology textbook and activity sheet.

STEPII:Students'activity (using cognitive conflict instructional model)

Stage i: The teacher asks the students the following questions that will trigger students' conception and set them into cognitive conflict, such as:

a) Are all characters from parents transmissible to their offspring?
b) What forms the genetic constitution of a gamete?
c) Is segregation of a gene pair depends on other gene pair?

Stage ii: **creation of cognitive conflict with anomalous situation as follows;**

A newly married couple took their ill twin daughters to hospital. One of the twin daughters was diagnosed with pneumonia and the other twin sister is sickle cell patient.

The couples are physically healthy although the mother has a history of pneumonia disease; but now none of the parent neither sickle cell nor pneumonia patient. Now, how did the twin daughters got such diseases?

Stage iii: Students interaction: the students interact with each other by sharing ideas in their group and report their findings or answers in the activity sheet. For example;

a. Pneumonia is non-transmissible disease, it is an infection. So, the twin daughter was infected with pneumonia not inherited from her mother.
b. Sickle cell is a hereditary disease, even though the parents are not sickle cell patients they are carriers. The twin daughter inherited the sickle cell disease from her parent.

STEP III: Discussion/summary: theteacher guides the discussion by naming and showing photographs of Gregor Mendel (1822-1884) an Austrian Monk who in 1856 conducted a precise experiment on heredity using garden pea plants (*Pisiumsativum)* which he used in formulating the basic laws of genetics.

Mendel worked with the following contrasting character;

a) Height of the stem (tallness and shortness)
b) Flower colours (red and white)
c) Pods colours (green and yellow)
d) Surface of pods (smooth and constricted)
e) Surface of testa (round and wrinkled)
f) Colour of seeds (yellow and green)

What is the other name of mendel's first law of heredity?

Group (a): Mendel's first law of heredity is also known as law of segregation.

Group (b): what is Mendel's first law of segregation?

Group(c): Mendel's first law of segregation states that, during gamete formation each allelic pair separates from the other member to form the genetic constitution of the gamete.

Group(d): Illustration of **Mendel's First Law of segregation**

Pure Line stock DD (Tall Pea Plant) X dd (Short Pea Plant)

D d

F1 generation genotype Dd

Teacher: the teacher guides the students to illustrate self fertilization of F1 generation genotype using crossing as done by group (e)

Group (e): Self fertilization of F1: D d (genotype) X D d (genotype)

DD Dd Dd dd

Genotype ratio of F2 1DD: 2Dd: 1dd (3D:1dd)

Phenotype ratio of F2 3 tall: 1 short

Teacher: the teacher guide the students to explains **Principles of Segregation of Genes** as done by group (a)

Group (a): principles of segregation of Genes

- **i.** The heredity character of an organism are determined by genes
- **ii.** Genes for a character have alternative forms (alleles)
- **iii.** In a diploid organism, each character is controlled by a pair of identical alleles (homozygous) or different alleles (heterozygous)
- **iv.** In a diploid organism, or heterozygous character, the two alternative alleles segregate during meiosis, each going randomly to a different gamete.

  What is the Mendel's second law of independent assortment of gene?

Group (b): Mendel's Second Law of Independent Assortment of Genes states that, the segregation of a gene pair occurs independently of any other gene pair.

This law can be stated as 'for two characteristics, the genes are inherited independently'.

This law however applies to allelic gene pairs on different homologous chromosomes.

The teacher guides the group to show the Illustration of the Mendel's second law on the board, as follows;

Round and Yellow seed color (RRYY) X Wrinkled and green seed color (rryy)

(homozygous) RRYY X rryy (homozygous)

R Y r y

RY ry

RYry

Group (c): explain the **Transmissible Characters as** characters carried in the genes of the parent. The dominant genotype genes manifest outwardly over recessive genes. Examples of transmissible characters are; skin color, ability to roll tongue, dimple cheek etc. transmissible diseases are sickle-cell anemia, hemophilia, color blindness etc.

What are non transmissible characters?

Group (d): Non-transmissible characters are those characters that cannot be transmitted through genetic materials from parents to their offspring. For instance, lose of eye by accident, development of muscles by weight lifting etc.

STEPIV: Evaluation: The teacher evaluates the students based on the activities carried out by the students as follows;

I. State Mendel's first law of segregation of genes

II. What is the Mendel's second law?

III. Differentiate between transmissible and non-transmissible characters

IV. Mention ten (10) non-transmissible characters.

Lesson- Week 3

Group **-** Experimental

Class Level – SS3

Subject **-** Biology

Topic: **-** Monohybrid cross (Single Factor Inheritance)

Duration **-** 90 minutes

Instructional Materials **-** chalkboard, cardboard paper, activity sheet and textbook

Behavioral Objective: At the end of the lesson students should be able to:

I. Explain monohybrid crossing

II. Incomplete dominance

III. Co-dominance

STEP I: Introduction: The teacher starts the lesson by grouping the students into 5 groups, each group with at least one Biology textbook and activity sheet.

STEP II: Students' activity (using cognitive conflict instructional model)

Stage i: the teacher asks the students the following questions that trigger students' conception and set them into cognitive conflict, such as:

1. What is the character of a dominant gene?
2. What is co-dominance?

Stage ii: **Creationofcognitiveconflictwiththeanomaloussituation as follows;**

Two white broilers and brown layers chickens were crossed independently. The first crossing produced an offspring with a blue character while the second crossing produced an offspring with brown character.

How comes the first crossing produced a blue offspring which has character that is neither white nor brown, while the second produced offspring that has same character with one of the parent?

Stage iii: Students interaction: the students interact with each other by sharing ideas in their group and report their findings or answers in the activity sheet. For example,

a. Genes segregate independently according to Mendel's first law of inheritance. The hybrid that shows different character from the parents, none of the parents' character dominate the other.

b. A character can dominate other character. So, the one that shows a character from one of the parent, it is simply the character of one of the parents dominated the other character.

STEP III: Discussion/summary: theteacher guide the discussion by asking group (a) to explain **Monohybridcross**(**singlefactorinheritance**)

Group(a): Monohybrid cross (single factor inheritance) is the crossing of a pure-line stock having one character. This involves the crossing of plants with single character. For instance, Mendel crossing of a red flowered pea plant (RR) with another white flowered pea plant (rr). This type of cross is said to be single factor, because only red and white characters are contained in the genotype of the pea plant.

Group (b): how can monohybrid cross be illustrated using diagram?

Group(c**):Parents:**Red Pea Plant X White Pea Plant

RR X rr

Meosis

R r

F1 generation Rr (All red flowered plants)

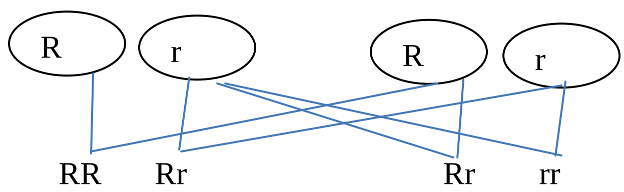
Group (d): explain the diagram as; the gene for red is dominant over the gene for white. These red-flowered offspring are referred to as the first filial generation (F1). From the product of F1 generation, we have two types of red flowered pea plants.

Group(e): explain further that; we have RR for homozygous red i.e. the alleles for the red color are identical and Rr for heterozygous red i.e. the alleles for red color are different. The heterozygous red pea plant is said to be a **hybrid**.

Teacher: when the products of F1 generation are allowed to self pollinate, the genotypic and phenotypic characters of the monohybrid cross is fully expressed in F2 generation.

The teacher guide group (a) to illustrate and explain the crossing on the board

Group (a):Parents'gamete: Rr X Rr



Analysis of F2 generation; **phenotype**: 3 red and 1 white pea plant

Genotype: 1 homozygous red (RR), red (Rr) and 1 homozygous white (rr)

Group (b): If neither of the contrasting character is dominant, what will be the situation?

Group(c): The situation will be incomplete. Where this happens, it is said to be incomplete or partial dominance. It results in a mixture or a blend of the two contrasting characters.

Theteacher guides the group to illustrate a crossing of a white feather chicken (WW) and red feather cock

Parents: WW (White)   X   RR (Red)

W   X   R

F1   WR (Brown)

The brown chicken is as result of blending of the two colors (i.e. white and red).

RW (brown chicken)   X   RW (Brown chicken)

R   W   R   W

RR   RW   RW   WW

Red   Brown   Brown   White

F2 generation: 1 black: 2 brown: 1 white

Group (d): From the illustrated diagram on the board, the cross of F1 has resulted in the white and black feather and again the blue color in a ratio of 1:2:1.

Then, what is co-dominance?

Group (e): Co-dominance refers to the situation whereby both alleles in a heterozygous individual are fully expressed. The presence of an allele does not modify the presence of another allele. This will result in the production of three distinct phenotypes.

Group (a): can we find an example of co-dominance in human?

Group (b): Yes, a good example of co-dominance in humans is inheritance of blood groups ABO i.e. A, B, AB and O according to the antigens contained in the red blood cells and antibodies found in plasma.

Teacher: summarizes the discussion by explaining and showing a cardboard containing two tables as follows;

Table1. Antigens and antibodies in red blood cells and plasma

Blood group	Antigen on red blood cell	Antibody in plasma
A	A	Anti-b
B	B	Anti-a
AB	A,B	Neither
O	Neither	Anti-a,anti-b

Table2. Identifying blood groups

Blood groups	Anti-A serum	Anti-B serum
A	Clumping	No clumping
B	No clumping	Clumping
AB	Clumping	Clumping
O	No clumping	No clumping

Clumping is the grouping together of blood to form an undifferentiated mass.

Therefore, when we go to hospital for blood groups identification, medical technologist take blood sample and add drops of anti-a. if the blood clumps, the blood group d is either A or AB and not B or O. When anti-b is added, blood groups B and AB will clump while A and O will not clump.

STEP IV: Evaluation: the teacher evaluates the students based the activities carried out by the students as follows;

I. Explain monohybrid crossing

II. Incomplete dominance

III. Differentiate between Co-dominance and incomplete dominance?

Lesson: -Week4

Group - Experimental

Class Level – SS3

Subject - Biology

Topic: - Dihybrid cross (Multiple Factor Inheritance)

Duration - 90 minutes

Instructional Materials - chalkboard, cardboard paper, activity sheet and textbook

Behavioral Objective: At the end of the lesson students should be able to:

I. Differentiate between monohybrid cross and dihybrid cross

II. Carryout a dihybrid cross with two pairs of contrasting characters

STEP I: Introduction: The teacher starts the lesson by grouping the students into 5 groups, each group with at least one Biology textbook and activity sheet.

STEP II: **Students' activity (using cognitive conflict instructional model)**

Stagei: The teacher asks the students the following questions that trigger students' conception and set them into cognitive conflict, such as:

1. The crossing of plants with two pair of characters can be referred as
   a. Monohybrid
   b. Hybrid cross
   c. Paired crossing
   d. Dihybrid crossing
2. What is meiosis?

Stage ii: **creation of cognitive conflict withanomaloussituationas follows**;

A dwarf and dark man want to have beautiful daughters; he marries fair and tall lady. Their first daughter is dark and dwarf. She got married to dark and dwarf husband fortunately she gave birth to tall and fair daughter.

What happens to the genetic make-up of the grandchild from dark and dwarf parents?

Stage iii: Students interaction: the students interact with each other by sharing ideas in their group and report their findings or answers in the activity sheet. For example,

a. The first daughter inherited genes from her parents, although some of the inherited characters are recessive.
b. The grandchild inherited her characters from her parents' characters where the recessive characters of the parents are now dominant in their daughter. This is because characters are transfer from generation to generation according to the Mendels' second law of inheritance.

STEP III: Discussion/summary: theteacherguides the discussion by asking group (a) to state Mendel's second law of inheritance.

Group(a): **Mendel's second law of inheritance** states that the segregation of a gene pair occurs independently of any other gene pair.

Group(b): What is dihybrid crossing?

Group (c):Dihybridcrossing is the crossing of two plants with more than one pair of allelic character.

The teacher guide the students to see that Mendel carried out an experiment crossing garden pea plants with two contrasting characters of seed color and seed shape and observed how they are transmitted from one generation to another.

A typical example is the crossing of a pure-stock garden pea plants having round and green seeds with another pure stock of wrinkled and green seeds. The F1 generation offsprings produced were all round and yellow.

The teacher guide group (c) with the illustration and explanation of the crossing as follows

Group(c):

Parentsgamete: Round and yellow X Wrinkled and green

RYRY X ryry

R Y r y

F1 RYry (round and yellow)

When the F1 RYry undergoes **meiosis**to produce four (RY,Ry,Ry&ry) gametes, if these four were crossed, how many phenotypes will they produce?

Group(b): There will be 16 phenotypes to be produce. How will these phenotypes be presented?

Teacher guide group (a) to explain and show the illustration of the combination on the board as follows;

	RY	Ry	rY	Ry
RY	RYRY 1	RYRy 2	RYrY 3	RYry 4
Ry	RyRY 5	RyRy 6	RyrY 7	RYry 8
Ry	rYRY 9	rYRy 10	rYrY 11	rYry 12
Ry	ryRY 13	ryRy 14	ryrY 15	ryry 16

Group (a):

Phenotypicanalysis:1. Round and yellow seeds: 1,2,3,4,5,7,8,9,10& 13 = 9

2 . Round and green seeds: 6, 8 & 14 =3

3 . Wrinkled and yellow seeds: 11, 12 & 15 = 3

4 . Wrinkled and green seeds: 16 only = 1

Genotypic analysis;1. Homozygous round and yellow seeds: 1 = 1

2. Homozygous round and green seeds: 6 = 1

3. Homozygous wrinkled and yellow seeds: 11=1

4. Homozygous wrinkled and green seeds: 16 = 1

5. Homozygous round, heterozygous yellow seeds: 2 & 5 = 2

6. Heterozygous round, homozygous green seeds: 8 & 14 = 2

7. Heterozygous round, homozygous yellow seeds: 3 & 9 = 2

8. Homozygous wrinkled, heterozygous yellow seeds: 12 & 15 = 2

9. Heterozygous round and yellow seeds: 4, 7, 19 & 13 = 4

Theteacher summarizes the discussion as **Dihybrid** crossing obeys Mendel's principle or Mendel second law of independent assortment of genes. This is because, each of the characters e.g. Round, Wrinkled, yellow and green assort independently during (meiosis) gamete formation. i.e. the assortment of the alleles controlling round character does not affect the assortment of the other characters like wrinkle shape of seeds nor seeds colors (yellow and green) during meiosis.

STEP IV: Evaluation: the teacher evaluates the students based on the activities carried out by the students as follows;

A. The crossing of plants with two pair of characters can be referred to as …………
B. Differentiate between monohybrid cross and dihybrid cross.
C. Draw a crossing between a homozygous (DWDW) and a wringle and dark (dwdw).

LESSON **-** WEEK**5**

Group **-** Experimental

Class Level **-**SS3

Subject **-** Biology

Topic: **-** Application of the principles of heredity

Duration **-** 90 Minutes

Instructional Materials **-** chalkboard, cardboard paper, activity sheet and textbook

Behavioral Objective: At the end of the lesson students should be able to:

i. Discuss areas of knowledge where the science of genetics can be applied and can be useful to man, such as agriculture.

ii. Use genetics knowledge in counseling

STEP I: Introduction: The teacher starts the lesson by grouping the students into 5 groups, each group with at least one Biology textbook and activity sheet.

STEP II: Students' activity (using Cognitive Conflict Instructional Model)

Stagei: the teacher asks the students the following questions that trigger students' previous knowledge and set them to cognitive conflict, such as;

1. How did a man get crops varieties and birds (poultry) that grow and mature in a small period or number of days?
2. How did we get animals such as dairy cattle that can produce a10-20 liters of fresh milk daily?
3. Who among the father and mother determines the sex of a baby?

Stage ii: **Creationofcognitiveconflictwiththeanomaloussituation as follows;**

Your friends from village come to you seeking for advice; one invested in farming but always running at loss due to crop diseases and stunt growth of rearing animals; the other informs you his marriage is coming up with a one beautiful lady.

Stage iii: Students interaction: the students interact with each other in their group by sharing ideas and report their findings or answers in the activity sheet. For example,

a. The farmer should look for genetically modified crops that are disease resistance with high yield. Or he should have a history of a crop before planting in a particular farm. In case of the animals, cross breeding can be done to produce a hybrid that is genetically improved
b. The one that is getting married it is advisable for him to know his own genotype and ask his fiancé also for her genotype, so as to have a healthy family without genetic disorder like sickle cell.

STEP III: Discussion/summary: theteacher starts the discussion by asking group (e) to explain how genetics is used in **PlantBreeding**

Group (e): Genetics principles is applied in the field of agriculture by plant breeders in developing new (hybrid) crops varieties through the processes like; asexual reproduction (self fertilization) and cross fertilization.

The hybrid produced will be better than its parents in so many ways, such as

a. The quantity of crops produced i.e. improve crop yield
b. To produce crops that meet modern needs or crops that can adapt to new environments or mechanization i.e. the use of modern implements that ensures high yield
c. To improve crop quality such as color, size height, shape etc
d. To produce crops that is resistant to pest and diseases.

Group (d): Explain the**Animalimprovement** as the upgrading of local breeds by crossing them with improved foreign (exotic) breeds. For instance, cross breeding of a local breed (N'dama) and exotic breed such as the new jersey of Friesian though the process of artificial insemination. The offspring that is produced will combine the attributes of both parents and will be better and more desirable.

Animal improvement can help in;

a. Producing dairy cattle that have the potential of producing large quantity of milk
b. Producing pest and diseases resistant breed of cattle
c. Producing high quality beef cattle i.e. cattle that can produce large quantity of meat for human consumption

Group (c): Explain that **Geneticsinmedicine** as the principles and knowledge of heredity is useful in the field of medicine to influence sex determination and prevention of heredity diseases transfer from parent to offspring's.

Every human being has 22 pairs of chromosomes (autosomes) and one pair of sex chromosomes in all. In a woman, the sex chromosomes is a pair of X homologous chromosomes while the man contributes X and Y chromosomes.

The teacher guide group (c) to illustrate their explanation as follows;

Female Male

XX X XY

XX XY

MALE FEMALE

The teacher summarizes the discussion by explaining **Geneticcounseling**

Genetics counseling refers to the assistance given by professionals or experts known as genetic counselors to the public in case of inheritance. They tend to advise intending marriage couples about the risk of giving birth to children with genetic disorders. Some examples of genetic disorders are;

1. Brachydactylic (short toes)
2. Albinism (mutation of melanin in the skin)
3. Polydactyl (having more than five fingers)
4. Sickle-cell anemia (Rhesus factor of incompatible blood group).

STEPIV: Evaluation: the teacher evaluates the students based on the activities carried out by the students as follows;

1) Discuss areas of knowledge where the science of genetics can be applied and can be useful to man, such as agriculture.
2) How will you use genetics in marriage counseling?

LESSON - Week6

Group - Experimental

Class Level – SS3

Subject - Biology

Topic: - Genetic Disorder

Duration - 90 minutes

Instructional Materials - Chalkboard, cardboard paper and textbook

Behavioral Objective: At the end of the lesson students should be able to:

I. Mention some disease that are related to genetics

II. Explain genetic disorders like;

a. Sickle-cell anemia

b. Haemophilia

c. Color-blindness

STEP I: Introduction: The teacher starts the lesson by grouping the students into 5 groups, each group with at least one Biology textbook and activity sheet.

STEP II:Students' activity (Using cognitive conflict instructional model)

Stagei: The teacher asks the students the following questions that trigger students' conception and set them into cognitive conflict, such as:

a. What happens when a man with genotype 'AS' marries a woman with the same genotype i.e. AS?

b. Have you seen a man who died as a result of excessive loss of blood from a small cut?

c. Have you experienced difficulty in differentiating color types?

Stage ii: **Creationofcognitiveconflictwiththeanomaloussituation as follows;**

An accident involving two victims, both are bleeding. The one with big cut from his thigh stops bleeding after a while he died, while the one with small cut from his head is still bleeding. He died as a result of incessant bleeding from the small cut.

How can a person with small cut bleeds more than the one with the big cut?

Stage iii: Students interaction: the students interact with each other in their group by sharing of ideas and report their findings or answers in the activity sheet. For example,

The one with small cut can be suffering from hemophilia disease, which is a genetic disease that causes blood not to clot, as a result a patient losses a lot of blood. While the one with big cut his blood is easily to control by clotting.

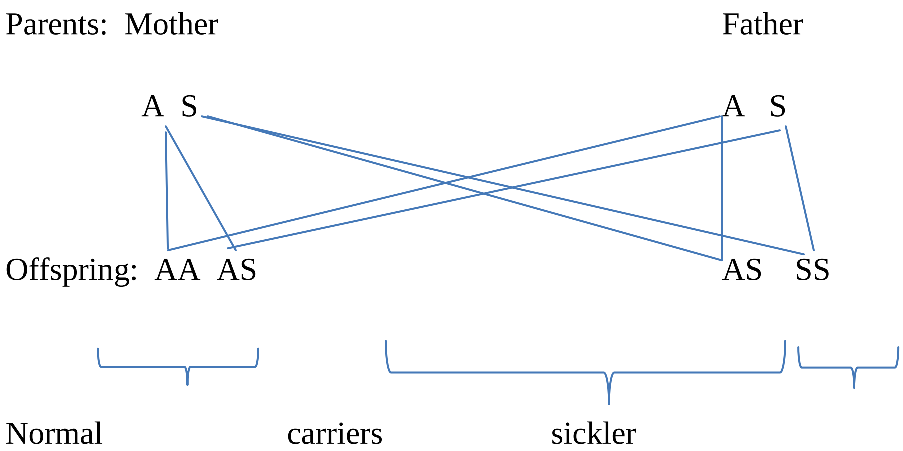
STEP III: Discussion/summary: theteacher guides the discussion by asking group (b) to explain what is causing genetic disorders.

Group(b): Several genetic disorders are cause through inheritance of incompatible defective genes.

Some of the common genetic disorders in humans that can be prevented through genetic counselors are: Sickle-cell anemia, haemophilia, color blindness etc.

Group(a): Explain that **Sickle-cellanemia** is a hereditary haemolytic anemia peculiar to Africans. It is caused as a result of abnormality in haemoglobin (red blood cells) inherited from genes of both parents.

Theteacher guide group (a) to illustrate the crossing as follows; parents with ‘AS’ as their genotype i.e. carriers.



The probability of having a sickle-celled offspring from parents whose genotype are ‘AS’ can be seen from the cross above, which is one out of four children.

Group (c): Explains **Haemophilia** as a disease condition which arises as a result of lacking the protein (fibrinogen) for blood clothing in an individual or patient. This will cause a patient who has a small cut to loss imaginable blood quantity.

Haemophilia is an example of sex-linked character disorder that is commonly affecting male sex only. Females can be carriers of the recessive trait, which is passed to males that show the defect or disorder.

Group (d): Explain **ColorBlindness**as a sex-linked genetic disorder that is also common with male sex. It is the inability of an infected person to distinguish colors, especially between green and red colors.

The disease is transmitted by the recessive X^n chromosome of a carrier mother and infected male, resulting in color blindness. Only females that have homozygous recessive allelic gene pairs X^nX^n that will suffer color blindness.

STEPIV: Evaluation: the teacher evaluates the students based on the activities carried out by the students as follows;

III. Mention some disease that are related to genetics
IV. Explain the following genetic disorders like;
   d. Haemophilia
   e. Color-blindness

LESSON **-** Week **6**

Group **-** Experimental

Class Level – SS3

Subject **-** Biology

Topic: **-** Variation

Duration **-** 90 minutes

Instructional Materials **-** chalkboard, cardboard paper and textbook

Behavioral Objective: At the end of the lesson students should be able to;

I. Define variation

II. Mention types of variation

III. State causes of variation

STEP I: Introduction: The teacher will start the lesson by grouping the students into 5 groups, each group with at least one biology textbook and activity sheet.

STEPII: Students' Activity (Using Cognitive Conflict Instructional Model)

Stagei: the teacher asks the students the following questions that trigger students' conception and set them into cognitive conflict, such as:

c. What is morphological variation?

d. What difference is between continues and discontinues variation?

Stage ii: **Creationofcognitiveconflictwiththeanomaloussituation as follows;**

Do you all have the same blood group? Why do you have the same blood group with your friend but different blood group with your brother?

Stage iii: Students interaction: the students interact with each other in their group by sharing ideas using their textbook and report their findings or answers in the activity sheet. For example;

c. We have different blood groups, even though some of us have the same blood groups with our friends
d. Variation causes our blood groups to be different from our brothers

STEP III: Discussion/summary: the teacher guides the discussion by asking group (a) to explain the concept of variation.

Group (a): Variation is the difference which exists in individual of the same species.

Variation is due to combination of genes resulting into a new product. Variation sometimes makes the new offspring more suited to adapt to its new environment, giving it better chance to survive and reproduce through the transfer genes from generation to generation.

The teacher asked the student how many types of variation do we have?

Student (a): there are two types of variation in organisms. These are;

iii. Morphological variation
iv. Physiological variation

Group(b): What is morphological variation?

Group (c**):morphological variation**is the variation that results in physical difference in appearance of an organism. For instance, height, skin color, hair, eyes, lips etc.

The teacher encourages the students to give more examples.

Group (a): Shape of the head, nose, mouth, face, ears etc.

Group (b): Finger prints

Group (c): Do plants have variation like humans?

Group (b): Yes, for instance, plants height, color of flower leaves and seed crops etc.

Group (a): size of leaves, fruits, lemon, tubers of yam and cassava etc.

The teacher asked, since we know what morphological variation is, then what about physiological variation?

Group (b): **Physiological variation** is referred to as discontinues variation which is a type of variation that is internal and only visible with the use of powerful microscope. This type of variation has no intermediate character. For instance, gender i.e. male or female, the differences in blood groups, such as blood group A, B, AB and O.

Theteacher asked for more examples from the student

Group (c): Movement of the ear with turning of the head, ability to roll tongue etc.

Group (a): differences in sex i.e. male and female or boy and girl, bravery and timidity etc.

Theteacher guides the students to know how to apply the knowledge of variation in our life.

Group (d):Crime detection: finger prints are used in crime detection in advanced countries, because every man has a unique finger print. Some types of finger prints are; whorl, whoop, arch and double whorl.

DNA finger print are used in developed countries to detects crimes like arm robbery, murder case, rape etc. the body cells left at the scene of the crime are compared with that of suspect and used in identifying the person who commits the crime.

Group(e):Blood transfusion: Blood transfusion is the donation of blood to people suffering from certain illness or victims of accidents.

People with blood group A have an antigen A and α and antibody B and β; those with blood group B have antigen B and β and antibody A and α; those with blood group AB have antigen A,B or α,β and antibodies A,B and α,β.

In blood transfusion, the blood group of donor and recipient must match otherwise it can lead to glotulation.

Can we apply variation in identifying humans?

Group(a): Yes we can. **HumanRace** which is variation in skin color and other physical (morphological) characters that are been used to classify people into four major groups:

e) Caucasoid
f) Mongoloids
g) Negroid
h) Australoid

Theteachersummaries the discussion by explaining **causes of variation**. There are many factors responsible for variations in man and plants. Some of the causes are;

iv. When genes are reshuffled (mutation) during meiosis due to Mendel's laws of segregation and independent assortment.
v. Crossing-over of chromosomes (chromatids) during mitosis i.e. division of somatic cells leading to exchange of genetic materials
vi. Fertilization (of two haploid) sex cells from different gametes.

STEPIV: Evaluation: the teacher evaluates the students based on the activities carried out by the students as follows;

1) Variation is described as ……………………….
    a) Traits acquired from parents
    b) Traits and characters acquired from environment
    c) The differences which exist in individuals of the same species*
    d) Traits and characters acquired as a result of use of cosmetics and surgery
2) One of the following is not a morphological variation
    a) Height
    b) Blood group*
    c) Skin color
    d) Hairiness

3) The inability of an organism to roll tongue is an example of ……..

   a) Morphological variation
   b) Morphological adaptation
   c) Physiological variation*
   d) Physiological adaptation

4) Variation can be used to detect the following criminals EXCEPT ……

   a) Arm robbers
   b) Kidnappers
   c) Rapists
   d) Drug dealers *

5) Which of the following is not a hereditary variation?

   a) Blood group
   b) Infant paralysis*
   c) Shape of face and lips
   d) Sickle-cell anemia

APPENDIX E

LESSON PLAN FOR THE CONTROL GROUP EXPOSED TO LECTURE METHOD

Lesson 1 - Week 1

Group – Control

Class Level - SS3

Subject - Biology

TOPIC: - Transmission and Expression of Characters in Organism

Duration - 90 minutes

Instructional Materials - chalkboard, charts and textbook

SPECIFIC OBJECTTIVES: At the end of the lesson students should be able to:

1. Define genetics;

2. Explain heredity

3. Explain the following terms associated with genetics

a) Genes

b) Chromosomes

c) Locus

d) Alleles

e) Genotype

f) Phenotype

g) Sex-linked character

h) Pure-line

INTRODUCTION: The teacher introduces the lesson by asking students the following questions that will identify students' previous knowledge, such as:

d) Why do we look like our parents?

e) What is responsible for our resemblance?

f) How is sex determined during reproduction?

PRESENTATION: The teacher presents the lesson using the following steps:

STEP I: The teacher defines the concept of genetics, heredity and variation as;

Genetics is the study of heredity and variation.

Heredity is the study of transfer of traits or characters from the parents to its offspring from one generation to another.

Variationis the difference which exists in individuals or organisms of the same specie at corresponding stages of their life cycle. For instance, the difference between a child and his or her grandfather or grandmother.

STEP II: Explanation of the terms associated with genetics.

A. **Gene**is the basic unit of inheritance. It is the physical unit of inheritance transmitted from one generation to another and it is responsible for developing and controlling character or traits in the new organism.

   The Gene is a segment of deoxyribonucleic acid (DNA) molecule that usually codes for the synthesis of polypeptides chains (protein) that eventually determines the nature of an organism.

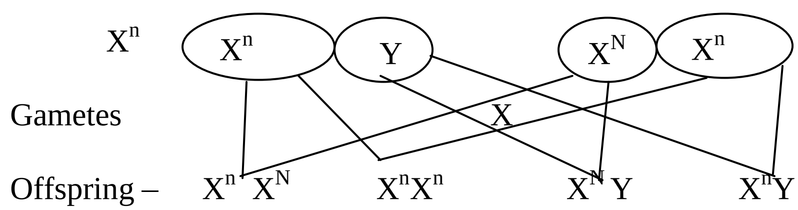
B. **Genotype** is the sum of total genes present in the cells of an organism. The genotype character is not externally visible but responsible for controlling physiological activities or characteristics

C. **Phenotype** is the physical observable (visible) expression of the gene present in an organism. The phenotypic character is as a result of the interaction of genetic materials and the surrounding of the environmental condition.

D. **Chromosomes** are strands of genetic materials which becomes obvious or visible during cell division (meiosis). Chromosomes are usually found in the nucleus of a cell and always carry a gene. They consist of deoxyribonucleic acid (DNA) and protein. Each specie or organism has a peculiar characteristic number of chromosomes. For example, the human being has 23 pairs of chromosomes.

E. **Sex-linked character:** these are characters determined by a gene located on either X or Y chromosome. For instance, haemophilia and colour blindness are recessive characters located on 'X^n' chromosome. That is the reason why only male human organism suffers from the disease while the female is a carrier.

Male (colour blind) X**Female**(carrier)



Carrier female colour blind female Normal male colour blind male

F. **Mutation** is a permanent change in DNA structure that alters or destroys a given character resulting into a new character. For instance, when pure-line stocks of red and white pea plants are crossed and the result of F1 self pollinated to produce a phenotypic pink pea plant at F2 generation. The pink plant is as a result of mutation. Sickle-cell anaemia, haemophilia, colour blindness and blood groups etc are example of mutation.

G. **Alleles** are two or more alternative forms of gene. For instance, the gene for tallness is represented as 'TT' or dwarfness as 'tt' is referred to as 'allele'. If they are in pair is referred to as 'alleles'.

H. **Locus** is the location of a gene on a chromosome. In other words, it is a position on the chromosome where the gene is located or placed.

I. **Pure-line** is a homologous pair of allelic gene of a character. For instance, tall plants 'TT' and short plant (dwarf) 'tt'.

J. **Homozygous** are two dissimilar alleles for a particular character in an organism. For instance, 'Tt' for heterozygous tall plant. This means that, the tall plant has a recessive gene for shortness i.e small't'.

K. **Gamete** as a haploid sperm cell or ova which fuses together to produce a zygote. It is usually the half number of chromosomes i.e 23 that each parent contributes during meiosis to gamete formation.

L. **Zygote** is the cells formed as a result of the fusion of haploids cells of a male and female. The zygote can be described as diploid cell having 46 numbers of chromosomes.

EVALUATION: The teacher evaluates the students as follows;

4) Which of the following best describes the homologous chromosomes?
   a) They are a product of the division of a chromosome
   b) Two identical chromosome *
   c) Chromosomes arranged on spindle fibres
   d) Chromatids formed during meiotic division
5) The physical unit of inheritance responsible for controlling character is
   a) Alleles
   b) Gene *
   c) Chromosomes
   d) Genetics

6) Which of the following is the precise location of gene?

a) Chromosomes

b) Centriole

c) Loci*

d) Centroseme

7) The branch of science which deals with resemblance, origin and expression of biological variation is called…………..

a) Ecology

b) Entomology

c) Genetics*

d) Taxonomy

8) The pair of gene expressed in heterozygous individual is described as ……..

a) Chromatids

b) Gene

c) Allele*

d) Haploid cells

9) Heredity is …………………………………….

a) Resemblance of closely related organisms

b) Absence of variation in organisms

c) A branch of science that deals with resemblance

d) A transfer of characteristics from parents to offspring

Lesson 2 - Week 2

Group - Control

Class Level –SS3

Subject - Biology

Topic: - Mendelian laws of heredity

Duration - 90 minutes

Instructional Materials - chalkboard, photographs and textbook

Behavioral Objective: At the end of the lesson students should be able to:

V. State Mendel's first law of segregation of genes

VI. State Mendel's second law of independent assortment of genes

VII. Identify characters that are transmissible and

VIII. Identify non-transmissible character

INTRODUCTION: The teacher introduces the lesson by naming and showing photographs of Gregor Mendel (1822-1884) an Austrian Monk who in 1856 conducted a precise experiment on heredity using garden pea plants (*Pisiumsativum)* which he used in formulating the basic laws of genetics.

Mendel worked with the following contrasting character;

g) Height of the stem (tallness and shortness)

h) Flower colours (red and white)

i) Pods colours (green and yellow)

j) Surface of pods (smooth and constricted)

k) Surface of testa (round and wrinkled)

l) Colour of seeds (yellow and green)

PRESENTATION: the teacher presents the lesson under the following steps

STEP I: Mendel's first law of segregation.

Mendel's first law of segregation states that, during gamete formation each allelic pair separates from the other member to form the genetic constitution of the gamete.

Illustration of Mendel's First Law of segregation

Pure Line stock DD (Tall Pea Plant) X dd (Short Pea Plant)

D d

F1 generation genotype Dd

Self fertilization of F1: D d (genotype) X D d (genotype)

DD Dd Dd dd

Genotype ratio of F2 1DD: 2Dd: 1dd (3D:1dd)

Phenotype ratio of F2 3 tall: 1 short

Principles of Segregation of Genes

- **v.** The heredity character of an organism are determined by genes
- **vi.** Genes for a character have alternative forms (alleles)
- **vii.** In a diploid organism, each character is controlled by a pair of identical alleles (homozygous) or different alleles (heterozygous)
- **viii.** In a diploid organism, or heterozygous character, the two alternative alleles segregate during meiosis, each going randomly to a different gamete.

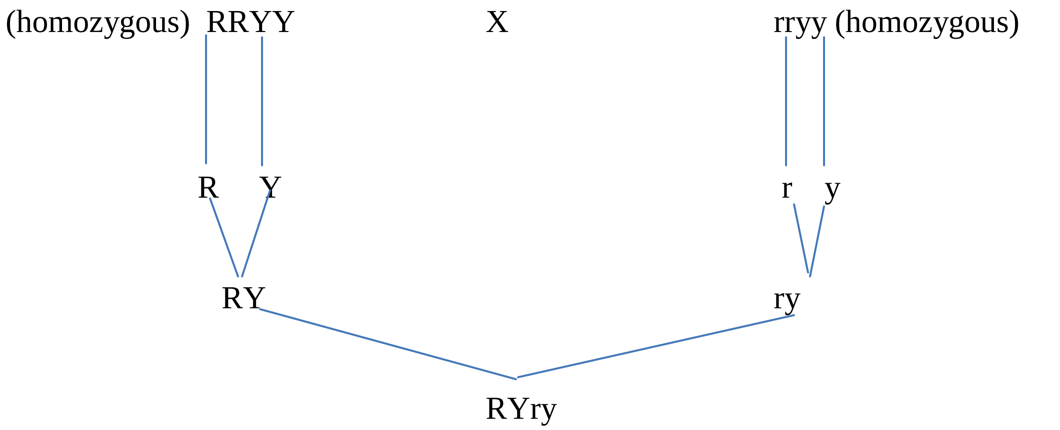
What is the Mendel's second law of independent assortment of gene?

STEPII: **Mendel's Second Law of Independent Assortment of Genes**

The law states that, the segregation of a gene pair occurs independently of any other gene pair. This law can be stated as 'for two characteristics, the genes are inherited independently'.

This law however applies to allelic gene pairs on different homologous chromosomes. For example:

Round and Yellow seed color (RRYY) X Wrinkled and green seed color (rryy)



STEP III:Transmissible Characters

These are characters that are carried in the genes of the parent. The dominant genotype genes manifest outwardly over recessive genes. Examples of transmissible characters are; skin color, ability to roll tongue, dimple cheek etc. transmissible diseases are sickle-cell anemia, hemophilia, color blindness etc.

STEP IV:Non-transmissible characters

These are characters that cannot be transmitted through genetic materials from parents to their offspring. For instance, lose of eye by accident, development of muscles by weight lifting etc.

EVALUATION: The teacher evaluates the students with the following questions;

1) Mendels's first law of inheritance is referred to as ……..
   a) Law of independent assortment of gene
   b) Law of segregation assortment
   c) Law of characteristics inheritance
   d) Law of segregation of genes *
2) How many laws Mendel was able to develop after garden pea plants experimentation?
   a) 4
   b) 3
   c) 2*

d) 1

3) Single factor inheritance best describes Mendel's

a) First law of inheritance*

b) Second law of inheritance

c) Third law of inheritance

d) First and second law of inheritance

4) In what year did Gregor Mendel conducted precise experiment on heredity using garden pea plants (*Pisium sativum*)

a) 1856*

b) 1857

c) 1858

d) 1884

5) The F1 generation produced after crossing homozygous red 'RR' and white 'rr' flowered pea plants is…………

a) Dominant white flowers

b) Recessive red flowers

c) Dominant red flowers*

d) Recessive white flowers

LESSON -Week3

Group - Control

Class Level – SS3

Subject - Biology

Topic: - Monohybrid cross (Single Factor Inheritance)

Duration - 90 minutes

Instructional Materials - chalkboard, cardboard paper and textbook

Behavioral Objective: At the end of the lesson students should be able to:

IV. Explain monohybrid crossing

V. Incomplete dominance

VI. Co-dominance

INTRODUCTION: The teacher introduces the lesson by, restating Mendel's first law of inheritance i.e. during gamete formation each allelic pair separates from the other member to form the genetic constitution of the gamete.

PRESENTATION: the teacher presents the lesson under the following headings;

Step I: Monohybridcross(**singlefactorinheritance**)

Monohybrid cross (single factor inheritance) is the crossing of a pure-line stock having one character. This involves the crossing of plants with single character. For instance, Mendel crossing of a red flowered pea plant (RR) with another white flowered pea plant (rr). This type of cross is said to be single factor, because only red and white characters are contained in the genotype of the pea plant. For example,

Parents: Red Pea Plant X White Pea Plant

RR X rr

Meosis

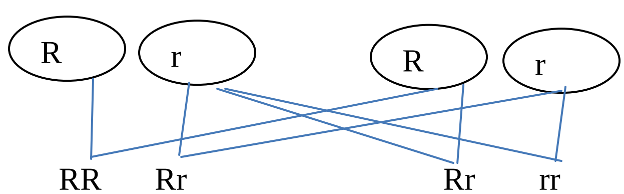
R r

F1 generation Rr (All red flowered plants)

The gene for red is dominant over the gene for white. These red-flowered offspring are referred to as the first filial generation (F1). From the product of F1 generation, we have two types of red flowered pea plants. RR for homozygous red i.e. the alleles for the red color are identical and Rr for heterozygous red i.e. the alleles for red color are different. The heterozygous red pea plant is said to be a **hybrid**.

When the products of F1 generation are allowed to self pollinate, the genotypic and phenotypic characters of the monohybrid cross is fully expressed in F2 generation.

Parents'gamete: Rr X Rr



Analysis of F2 generation; **phenotype**: 3 red and 1 white pea plant

Genotype: 1 homozygous red (RR), red (Rr) and 1 homozygous white (rr)

STEP II:Incompletedominance

This is the situation where neither of the contrasting character is dominant. It results in a mixture or a blend of the two contrasting characters. Where this happens, it is said to be incomplete or partial dominance. For example, the crossing of a white feather chicken (WW) and red feather cock (RR).

Parents: WW (White) X RR (Red)

W X R

F1 WR (Brown)

The brown chicken is as result of blending of the two colors (i.e. white and red).

RW (brown chicken) X RW (Brown chicken)

R W R W

RR RW RW WW

Red Brown Brown White

F2 generation: 1 black: 2 brown: 1 white

The cross of F1 has resulted in the white and black feather and again the blue color in a ratio of 1:2:1.

STEP III:Co-dominance

Co-dominance refers to the situation whereby both alleles in a heterozygous individual are fully expressed. The presence of an allele does not modify the presence of another allele. This will result in the production of three distinct phenotypes.

Agood example of co-dominance in humans is inheritance of blood groups ABO i.e. A, B, AB and O according to the antigens contained in the red blood cells and antibodies found in plasma.

Table1. Antigens and antibodies in red blood cells and plasma

Blood group	Antigen on red blood cell	Antibody in plasma
A	A	Anti-b
B	B	Anti-a
AB	A,B	Neither
O	Neither	Anti-a,anti-b

Table2. Identifying blood groups

Blood groups	Anti-A serum	Anti-B serum
A	Clumping	No clumping
B	No clumping	Clumping
AB	Clumping	Clumping
O	No clumping	No clumping

Clumping is the grouping together of blood to form an undifferentiated mass.

Therefore, when we go to hospital for blood groups identification, medical technologist take blood sample and add drops of anti-a. if the blood clumps, the blood group d is either A or AB and not B or O. When anti-b is added, blood groups B and AB will clump while A and O will not clump.

EVALUATION: Theteacherevaluates the students'comprehension using the following question;

1) An experiment undertaken with a plants having single character genotype can be said to be………………

a) Homozygous cross
b) Dihybrid cross
c) Heterozygous cross
d) Monohybrid cross*

2) The crossing of a heterozygous plant (Rr) with a pure-line character (rr) to determine the phenotype appearance of the plant in F2 generation can be referred to as …………………..
a) Incomplete dominance
b) Co-dominance
c) Monohybrid cross
d) Test cross*

3) Two homozygous rabbits that are white and black were crossed. The offspring produced was a blue colour rabbit. The situation is known as ……….
a) Dominance
b) Incomplete dominance *
c) Complete dominance
d) Variation

Lesson: - Week4

Group - Control

Class Level – SS3

Subject - Biology

Topic: - Dihybrid cross (Multiple Factor Inheritance)

Duration - 2 hours

Instructional Materials - chalkboard, cardboard paper and textbook

Behavioral Objective: At the end of the lesson students should be able to:

III. Explain a dihybrid cross

IV. Carryout a dihybrid cross with two pairs of contrasting characters

INTRODUCTION: The teacher introduces the lesson by stating Mendel's second law of inheritance.

PRESENTATION: The teacher presents the lesson using the following steps:

STEP I: **Mendel's second law of inheritance** states that the segregation of a gene pair occurs independently of any other gene pair.

Dihybridcrossing: is the crossing of two plants with more than one pair of allelic character. Mendel carried out an experiment crossing garden pea plants with two contrasting characters of seed color and seed shape and observed how they are transmitted from one generation to another.

A typical example is the crossing of a pure-stock garden pea plants having round and green seeds with another pure stock of wrinkled and green seeds. The F1 generation offsprings produced were all round and yellow. For example,

Parentsgamete: Round and yellow X Wrinkled and green

RYRY X ryry

R Y r y

F1 RYry (round and yellow)

When the F1 RYry undergoes **meiosis**to produce four (RY,Ry,Ry&ry) gametes, which were crossed, to produce 16 phenotypes.

	RY	Ry	rY	Ry
RY	RYRY 1	RYRy 2	RYrY 3	RYry 4
Ry	RyRY 5	RyRy 6	RyrY 7	RYry 8
Ry	rYRY 9	rYRy 10	rYrY 11	rYry 12
Ry	ryRY 13	ryRy 14	ryrY 15	ryry 16

Phenotypicanalysis:1. Round and yellow seeds: 1,2,3,4,5,7,8,9,10& 13 = 9

2 . Round and green seeds: 6, 8 & 14 =3

3 . Wrinkled and yellow seeds: 11, 12 & 15 = 3

4 . Wrinkled and green seeds: 16 only = 1

Genotypic analysis;1. Homozygous round and yellow seeds: 1 = 1

2. Homozygous round and green seeds: 6 = 1

3. Homozygous wrinkled and yellow seeds: 11=1

4. Homozygous wrinkled and green seeds: 16 = 1

5. Homozygous round, heterozygous yellow seeds: 2 & 5 = 2

6. Heterozygous round, homozygous green seeds: 8 & 14 = 2

7. Heterozygous round, homozygous yellow seeds: 3 & 9 = 2

8. Homozygous wrinkled, heterozygous yellow seeds: 12 & 15 = 2

9. Heterozygous round and yellow seeds: 4, 7, 19 & 13 = 4

Dihybrid crossing obeys Mendel's principle or Mendel second law of independent assortment of genes. This is because, each of the characters e.g. Round, Wrinkled, yellow and green assort independently during (meiosis) gamete formation. i.e. the assortment of the alleles controlling round character does not affect the assortment of the other characters like wrinkle shape of seeds nor seeds colors (yellow and green) during meiosis.

EVALUATION: the teacher evaluates the students' level of cognition of the lesson covered as follows;

1) The crossing of plants with two pair of characters can be referred to as …………
   a) Monohybrid cross
   b) Hybrid cross
   c) Dihybrid cross*
   d) Paired crossing
2) What would be the genotype of a cross between a homozygous round and yellow (RRYY), and wrinkled and green (rryy) pea plants?
   a) RRYY
   b) Rryy
   c) Ryry*
   d) RRyy
3) The phenotypic ratio of a dihybrid cross at F2 generation is ………..
   a) 6: 3: 3: 1
   b) 9: 2: 4: 1
   c) 8: 4: 3: 1
   d) 9: 3: 3: 1
4) From the phenotypic analysis of the hybrid cross, how many seeds are round and yellow?
   a) 3
   b) 4
   c) 9*

d) 1

5) Multiples factor inheritance best describes …….

a) Mendelian first law
b) Mendelian principles of variation and genetics
c) All the two Mendelian laws of inheritance
d) Mendels second law of inheritance

LESSON - Week5

Group - Control

Class Level – SS3

Subject - Biology

Topic: - Application of the principles of heredity

Duration - 90 Minutes

Instructional Materials - chalkboard, cardboard paper and textbook

Behavioral Objective: At the end of the lesson students should be able to:

iii. Discuss areas of knowledge where the science of genetics can be applied and can be useful to man, such as agriculture.

iv. Explain how genetics is used in the field of medicine

v. Use genetics knowledge in counseling

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

4. How did a man get crops varieties and birds (poultry) that grow and mature in a small period or number of days?
5. How did we get animals such as dairy cattle that can produce a 10-20 liters of fresh milk daily?
6. Who among the father and mother determines the sex of a baby?

PRESENTATION: Theteacherpresents the lesson under the following steps;

STEPI:PlantBreeding: Genetics principles is applied in the field of agriculture by plant breeders in developing new (hybrid) crops varieties through the processes like; asexual reproduction (self fertilization) and cross fertilization.

The hybrid produced will be better than its parents in so many ways, such as

e. The quantity of crops produced i.e. improve crop yield

f. To produce crops that meet modern needs or crops that can adapt to new environments or mechanization i.e. the use of modern implements that ensures high yield
g. To improve crop quality such as color, size height, shape etc
h. To produce crops that is resistant to pest and diseases.

STEP II: Animalimprovement: Thisissimply the upgrading of local breeds by crossing them with improved foreign (exotic) breeds. For instance, cross breeding of a local breed (N'dama) and exotic breed such as the new jersey of Friesian though the process of artificial insemination. The offspring that is produced will combine the attributes of both parents and will be better and more desirable.

Animal improvement can help in;

d. Producing dairy cattle that have the potential of producing large quantity of milk
e. Producing pest and diseases resistant breed of cattle
f. Producing high quality beef cattle i.e. cattle that can produce large quantity of meat for human consumption

STEP III: Geneticsinmedicine: The principles and knowledge of heredity is useful in the field of medicine to influence sex determination and prevention of heredity diseases transfer from parent to offspring's.

Every human being has 22 pairs of chromosomes (autosomes) and one pair of sex chromosomes in all. In a woman, the sex chromosomes is a pair of X homologous chromosomes while the man contributes X and Y chromosomes. For example,

Female Male

XX X XY

XX XY

MALE FEMALE

STEP III: Geneticcounseling

Genetics counseling refers to the assistance given by professionals or experts known as genetic counselors to the public in case of inheritance. They tend to advise intending marriage couples about the risk of giving birth to children with genetic disorders. Some examples of genetic disorders are;

5. Brachydactylic (short toes)
6. Albinism (mutation of melanin in the skin)
7. Polydactyl (having more than five fingers)
8. Sickle-cell anemia (Rhesus factor of incompatible blood group).

EVALUATION: the teacher evaluates the students with the following questions;

3) Genetics principles can be applied in the following field EXCEPT ……..
   a) Plant breeding
   b) Animal improvement
   c) Bio engineering
   d) Robotic science
4) Probability is ………………………….
   a) Greater than zero and less or equal to one*
   b) Greater than one and less or equal to one
   c) Less than zero and greater than one
   d) Always equal to one
5) A hybrid is more likely to have the following advantages over it parents EXCEPT that it ……………
   a) Increase crop yield
   b) Causes the loss of traits or characters through gene mutation*
   c) Can adapt to environmental condition
   d) Is resistant to pest and disease
6) One of the following genetic disorders can be avoided through marriage counseling
   a) Brachydactyl (short toes)
   b) Sickle cell anemia*

c) Polydactyl (having more than five fingers)

d) Skin color

7) ………… is a knowledge that is applied to influence sex determination of a child.

a) Cloning

b) Breeding technology

c) Artificial insemination

d) Genetic medicine*

Lesson - Week6

Group - Control

Class Level – SS3

Subject - Biology

Topic: - Genetic Disorder

Duration - 90 minutes

Instructional Materials - Chalkboard, cardboard paper and textbook

Behavioral Objective: At the end of the lesson students should be able to:

V. Mention some disease that are related to genetics

VI. Explain genetic disorders like;

f. Sickle-cell anemia

g. Haemophilia

h. Color-blindness

INTRODUCTION: The teacher introduces the lesson with the following questions;

d. What happens when a man with genotype ‘AS’ marries a woman with the same genotype i.e. AS?

e. Have you seen a man who died as a result of excessive loss of blood from a small cut?

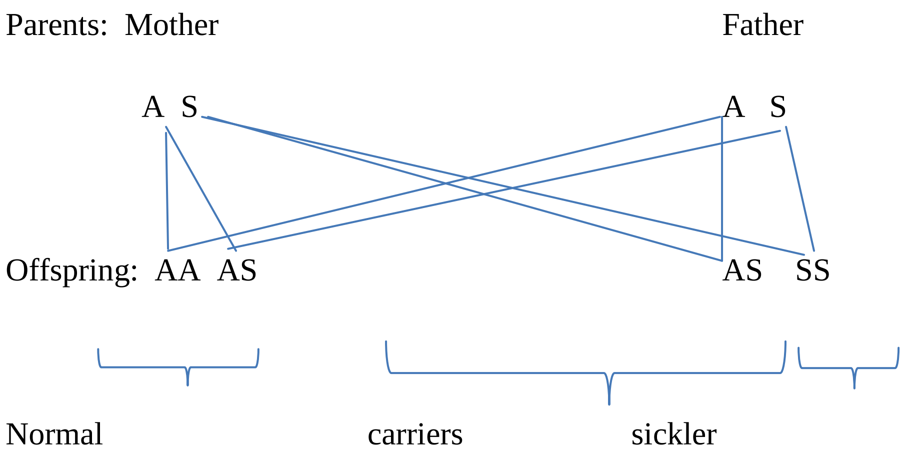
f. Have you experienced difficulty in differentiating color types?

PRESENTATION: Theteacher presents the lesson using the following steps;

STEP I: Several genetic disorders are cause through inheritance of incompatible defective genes.

Some of the common genetic disorders in humans that can be prevented through genetic counselors are: Sickle-cell anemia, haemophilia, color blindness etc.

1. **Sickle-cell anemia** is a hereditary haemolytic anemia peculiar to Africans. It is caused as a result of abnormality in haemoglobin (red blood cells) inherited from genes of both parents. For example,



The probability of having a sickle-celled offspring from parents whose genotype are ‘AS’ can be seen from the cross above, which is one out of four children (1/4).

2. **Haemophilia:** Thisis a disease condition which arises as a result of lacking the protein (fibrinogen) for blood clothing in an individual or patient. This will cause a patient who has a small cut to loss imaginable blood quantity.Haemophilia is an example of sex-linked character disorder that is commonly affecting male sex only. Females can be carriers of the recessive trait, which is passed to males that show the defect or disorder.
3. **Color Blindness** as a sex-linked genetic disorder that is also common with male sex. It is the inability of an infected person to distinguish colors, especially between green and red colors.

The disease is transmitted by the recessive X^n chromosome of a carrier mother and infected male, resulting in color blindness. Only females that have homozygous recessive allelic gene pairs X^nX^n that will suffer color blindness.

EVALUATION: Theteacherevaluates the students with the following questions;

1) Which of the following disease is not as a result of genetic disorder?
   a) Beriberi
   b) Haemophilia

c) Sickle-cell anemia

d) Color blindness

2) The knowledge of genetics can be use to prevent the following disease Except ……

a) Down's syndrome

b) Blood pressure

c) Diabetics mellitus

d) Sickle-cell anemia

3) If a mother's genotype is 'AS', she can be described as ………..

a) Sickle-cell anemia patient

b) Having blood group A

c) Carrier of sickle-cell anemia

d) Normal

4) Haemophilia is a genetic disorder caused by absence of blood protein called ……………

a) Polypeptide chain

b) Thymine

c) Fibrinogen

d) DNA and RNA molecules

5) A patient who losses plenty of blood as a result of a small cut is said to be suffering from………..

a) Anemia

b) Lack of protein in the blood

c) Haemophilia*

d) Blood clotting disorder

6) Inability of person to differentiate between green and red colors is known as …………

a) Green blindness

b) Black and white sightedness

c) Red blindness

d) Color blindness

Lesson - Week **6**

Group - Control

Class Level – SS3

Subject - Biology

Topic: - Variation

Duration - 90 minutes

Instructional Materials - chalkboard, cardboard paper and textbook

Behavioral Objective: At the end of the lesson students should be able to;

IV. Define variation

V. Mention types of variation

VI. State causes of variation

INTRODUCTION: The teacher introduces the lesson by explaining the meaning of variation as,

Variation is the difference which exists in individual of the same species. Variation is due to combination of genes resulting into a new product. Variation sometimes makes the new offspring more suited to adapt to its new environment, giving it better chance to survive and reproduce through the transfer genes from generation to generation.

PRESENTATION: the teacher presents the lesson using the following steps;

STEPI: There are two types of variation in organisms. These are;

v. Morphological variation
vi. Physiological variation

Morphological variation is the variation that results in physical difference in appearance of an organism. For instance, height, skin color, hair, eyes, lips, shape of the head, nose, mouth, face, ears, finger prints, plants height, color of flower leaves and seed crops, size of leaves, fruits, lemon, tubers of yam and cassava etc.

Physiological variation is referred to as discontinues variation which is a type of variation that is internal and only visible with the use of powerful microscope. This type of variation has no intermediate character.

Physiological variation gives rise to differences in humans like;

i. Gender i.e. male or female, the differences in blood groups, such as blood group A, B, AB nd O
ii. Movement of the ear with turning of the head, ability to roll tongue etc.
iii. Differences in sex i.e. male and female or boy and girl, bravery and timidity etc.

STEP II:Applicationsofvariation

A. **Crime Detection:** finger prints are used in crime detection in advanced countries, because every man has a unique finger print. Some types of finger prints are; whorl, whoop, arch and double whorl.
   DNA finger print are used in developed countries to detects crimes like arm robbery, murder case, rape etc. the body cells left at the scene of the crime are compared with that of suspect and used in identifying the person who commits the crime.
B. **Blood Transfusion**: Blood transfusion is the donation of blood to people suffering from certain illness or victims of accidents.
   People with blood group A have an antigen A and α and antibody B and β; those with blood group B have antigen B and β and antibody A and α; those with blood group AB have antigen A,B or α,β and antibodies A,B and α,β.
   In blood transfusion, the blood group of donor and recipient must match otherwise it can lead to glotulation.

STEP III:HumanRace which is a variation in skin color and other physical (morphological) characters that are been used to classify people into four major groups:

i) Caucasoid : these are light skinned (white) people with narrow or pointed nose and wavy hairs. Example, the Europeans.

j) Mongoloids: these are yellow-brown skinned people with straight hair and moderately broad nose. Example are the Chinese and Japanese i.e. Asians.

k) Negroid: these are dark-skinned people with wooly hair and broad nose. Example are Africans

l) Australoid: these are brown skinned people with curly hair and moderately broad nose. Example are the Australians.

STEPIV:Causes of Variation

There are many factors responsible for variations in man and plants. Some of the causes are;

vii. When genes are reshuffled (mutation) during meiosis due to Mendel's laws of segregation and independent assortment.

viii. Crossing-over of chromosomes (chromatids) during mitosis i.e. division of somatic cells leading to exchange of genetic materials

ix. Fertilization (of two haploid) sex cells from different gametes.

EVALUATION: the teacher evaluates the students using the following questions;

6) Variation is described as ……………………….
   - e) Traits acquired from parents
   - f) Traits and characters acquired from environment
   - g) The differences which exist in individuals of the same species*
   - h) Traits and characters acquired as a result of use of cosmetics and surgery

7) One of the following is not a morphological variation
   - e) Height
   - f) Blood group*
   - g) Skin color
   - h) Hairiness

8) The inability of an organism to roll tongue is an example of ……..
   - e) Morphological variation
   - f) Morphological adaptation
   - g) Physiological variation*
   - **h)** Physiological adaptation

APPENDIXF

Facility Index and Discriminating Index for Genetics Performance Test (GPT)

S/N	F=$\frac{RU+RL}{N+100}$	D=$RU - \frac{RL}{1/2N}$
1	0.30	0.65
2	0.40	0.70
3	0.50	0.62
4	-0.11*	0.95 *
5	0.50	0.62
6	-0.12 *	0.20 *
7	0.60	0.70
8	0.50	0.62
9	0.70	0.70
10	0.40	0.60
11	0.35	0.86 *
12	0.35	0.55
13	0.50	0.70
14	0.55	0.65
15	0.62	0.67
16	0.51	0.45
17	-0.90 *	0.94 *
18	0.62	0.70
19	0.70	0.70
20	0.85 *	0.68
21	-0.80 *	0.94 *
22	0.33	0.47
23	-0.90 *	0.96 *
24	0.35	0.68
25	0.40	0.60
26	0.90 *	0.92 *
27	0.70	0.72
28	0.75	0.60
29	0.32	0.70

30	0.70	0.60
31	0.60	0.69
32	0.50	0.72 RR
33	0.40	0.90 *
34	0.30	0.50 RR
35	-0.11*	0.90*
36	0.50	0.70 RR
37	0.60	0.62 RR
38	-0.12*	0.91*
39	0.70	0.60
40	0.75*	0.65 RR