UNIVERSITY OF EDUCATION, WINNEBA

USING COOPERATIVE INSTRUTIONAL APPROACH TO IMPROVE THE CONCEPT OF GENETICS.

JOHN QUARSHIE ATTIPOE

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A DISSERTATION IN THE FACULTY OF SCIENCE EDUCATION, DEPARTMENT OF SCIENCE EDUCATION SUBMITTED TO THE SCHOOL OF RESEARCH AND GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF EDUCATION IN SCIENCE.

DECEMBER, 2015

DECLARATION

STUDENT'S DECLARATION

I, JOHN QUARSHIE ATTIPOE, declare that this Dissertation with the exception of quotations and references contained in published works which have all been duly cited and acknowledged, is entirely my own original work, and it has been submitted, either in part or whole, for another dissertation in the University or elsewhere.

Candidate"s signature : …..…………………………

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SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this dissertation was supervised in accordance with the guidelines on supervision of thesis laid down by the University of Education, Winneba.

Supervisor"s signature: …………………………....

Date : ……………………………

PROF. YAW AMEYAW

(SUPERVISOR)

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To my siblings we will forever grow in unity and love.

To my darling and sweetest wife Cynthia Delali Hupenu, a virtuous woman you will forever be.

DEDICATION

I dedicate this project work to my parents, Mr. E. K. Attipoe and Madam Felicia Akligo, and my lovely wife, Cynthia Delali Hupenu for standing with me throughout my entire education.

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ABSTRACT

The study sought to improve Senior High School students‟ performance in genetics using cooperative instructional approach in the Keta Senior High Technical School in the Volta Region of Ghana. Sixty final year students of were purposively sampled for the study. The major objectives of the study were: to find out specific genetics concepts students don‟t understand; to identify the causes of students‟ inability to understand genetic concepts; use Mathematical expressions to aid students in learning genetics; how to use genetic symbols; and to identify and correct some of the misconceptions that students have in genetics. The instruments used for the study were standardized tests and questionnaire for students. Data collected were analyzed by using frequency counts and percentages. The results gathered from the study showed that 81.7% could not applied the genetic concept well and had a score of below 25. Out of a total score of 50 marks, only 18.4% scored between 21 to 30 marks. After the intervention, the students were able to answer certain questions they were not previously able to answer. After the introduction of the intervention, almost all the students scored above 25% of the total mark. The findings revealed that students exposed to cooperative instructional method of teaching performed better than those exposed to traditional method of teaching only. The study recommends that biology teachers adopt cooperative instructional approach in teaching and learning of biology concepts. This will help them gain better understanding of the concept and improve their academic performance.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter touches on the background to the study, the statement of the problem, and purpose of the study, and aims/objectives. Furthermore, it includes the research questions and significance of the study. The delimitations and limitations that were identified during the study as well as abbreviations used are also presented. Finally it presents the organization of the study.

1.1 Background to the study

Most people would agree that one of the best formats for teaching is one-on-one interaction between an instructor and a student. In this setting, continuous feedback is possible, enabling the student to work at his/her own pace and level and for the instructor to tailor the lesson to each student's individual needs. Close interaction with the instructor also helps to engage students and encourages them to become an active partner in the learning process (Armstrong, Chang & Brickman, 2007).

Unfortunately, large class sizes and the many demands placed on instructors make it difficult to devote even small amounts of time to single students. The reality is that many college-level science classes are taught almost exclusively using a lecture format even though lectures by themselves are relatively ineffective at engaging students and promoting learning (Armstrong, Chang & Brickman, 2007). Therefore, a significant challenge facing many instructors today is how to help students learn in situations where it is not possible to interact with them on an individual level. One partial solution to this dilemma that has grown in prominence over the past few decades is the use of cooperative learning strategies.

One strategy that can have an impact on student understanding of a specific discipline is to encourage deep, critical thinking about that discipline. In an age where at least superficial information is at our fingertips on a limitless number of topics including genetics, we must find methods of ensuring an enduring understanding of this information. Because students often learn only passively through lectures, reading assignments, or cursory searching of the Internet, developing critical thinking skills is necessary to ensure a level of literacy and the eventual ability to apply the knowledge (Shaw, Van-Horne, Zhang & Boughman, 2008). Providing students with an opportunity to explore challenging areas in genetics through writing is one manner of achieving this goal.

Research on student learning suggests that student misconceptions serve as barriers to student achievement. These misconceptions are often based on personal experiences and are difficult to bypass en route to meaningful understanding in any content area (Shaw *et al,* 2008). Even after instruction designed to address scientific content in an area where misconceptions are held, many students do not reconstruct their thinking. Only those students able to deconstruct their knowledge and reconstruct it using critical thinking and logical reasoning appear to have fewer misconceptions even after high-quality instruction (Ross, Lakin & McKechnie, 2010). Similarly, conceptual change generally occurs only if a learning experience can demonstrate both that a student's explanation is insufficient and that an alternative explanation is more applicable (Shaw *et al,* 2008).

There is clear evidence that students develop frameworks of belief about natural phenomena that conflict with our accepted scientific understanding. Just as scientists‟ own understandings have undergone revolutions over historical time, so children‟s ideas also do change, over a much shorter time-span. It is difficult to teach children new ideas until we know the existing ideas they hold - these often appear to conflict with accepted scientific ideas and are described as „misconceptions‟ or „alternative frameworks of belief (Ross, Lakin & McKechnie, 2010). There may be many grains of truth in these „alternative ideas‟ and we need to pay careful attention to what children say about their ideas in science.

Methods of teaching science which are based on the idea that pupils build up, or construct, ideas about their world are often called constructivist approaches. If we want pupils to understand and use scientific ideas their existing beliefs need to be challenged or extended. We cannot always replace their naive ideas, but we can encourage pupils to use the scientific ones when appropriate, and to show them the inconsistencies in many of their existing ideas.

Through frequent assessment and feedback, effective teachers regularly assess what they do in the classroom and find out whether their students are really learning. They try to anticipate the topics and concepts that will be difficult for their students and to develop teaching strategies that present these topics in ways their students will best understand. These teachers make a special point of becoming familiar with their students' preparation, knowledge, and abilities, and adjust their teaching to maximize the class's learning. Yet, teachers, especially new teachers, may sometimes be too overwhelmed by all that is involved with teaching to assess student knowledge and learning. Creating syllabus, preparing assignments, developing lectures, designing laboratories, structuring discussions, and writing test questions all take time, thought, and planning. The following sections describe various assessment schemes for both teachers and their students.

Learning science is a cumulative process; each new piece of information is added to what students already know (or believe) about the topic at hand. If students have a solid foundation, the new pieces fit together more easily. However, if the students' preparation is spotty or incomplete, they may find it harder to grasp the new material. If the new material conflicts with earlier misconceptions or firmly held assumptions, the students unfortunately may ignore or distort the new information so that it fits into their old framework of understanding. This suggests the following: At the beginning of every course, teachers should try to gauge the students' prior knowledge of the subject. What are the prerequisites for your course, and have all students taken the prerequisites? There are several ways to identify what students already know, one of the simplest is introduce a topic and then ask a question which brings out their knowledge. If student answers are recorded, the same questions can be posed again at the end of the topic or term to evaluate students' progress.

A more comprehensive way to learn about students' prior knowledge is to give a brief diagnostic pretest-ungraded and anonymous. The diagnostic pretest might include a list of key concepts, facts and figures, or major ideas. Ask students to indicate their familiarity with each topic. During the term, frequent diagnostic mini-quizzes can help identify which students are keeping up and which need help. These quizzes also help students to identify the areas on which they need to work. Reading quizzes give the instructor a good indication of where to start the next class.

1.2 Statement of the Problem

The performance of Ghanaian students in the West African Senior Secondary Certificate Examination (WASSCE) in biology has been a worry for many stakeholders in the educational enterprise for some years now. In 2006 for instance, according to Chief Examiner‟s report, out of the 15,704 candidates who sat for the WASSCE May/June biology examination in Ghana, 10,043 (63.95%) either had weak passes or failed, in other words, had grades C5-F9. In the November/December examination of the same year, out of the 9,188 candidates who sat for the Senior Secondary School Certificate Examination (SSSCE) biology paper in Ghana, 7,462 (81.21%) also either had weak passes or failed, that is, had grade E or F (equivalent to grades C6 – F9). This abysmal situation has created the perception among most SHS students that "biology and science in general is difficult" and view the study of science as the exclusive preserve of their more gifted or academically well-endowed counterparts. This seems to explain why many students shy away from studying science at the SHS level in Ghana. Students have problems learning some biology concepts meaningfully and therefore, resort to memorizing these concepts.

Questions relating to genetics appear quite frequently in the SSSCE/WASSCE Elective Biology examinations. For instance, in the Paper 1 (Essay) question 2 in May/June, 2008; question 2 in May/June, 2011; question 4 in May/June, 2012; question 4(a) and (b) November, 2007 and question 1(b) in November, 2010 were all questions relating to genetics. According to the Chief Examiner‟s reports on the performance of candidates in these questions, most SHS students however, appear to have a difficulty in answering such questions. For instance, in 2008, the Chief Examiner‟s report has noted that „many candidates attempted part (a) of question 2 in the May/June WASSCE examination but very few scored high marks. The difficulty of students in answering questions relating to genetics may be a contributory factor to the poor performance of SHS students in biology.

As a Senior High School teacher for many years, the researcher found that the majority of the students were learning passively and the atmosphere of the class was not supportive for interactions. Similarly, laboratory work seemed to stimulate student thinking rarely. Science education researchers have presented the argument in which the students have difficulty in learning some science concepts. In this perspective, identifying students" difficulties in science learning has received a big attention in science education research for that matter Biology.

The researcher explored that one of the most difficult content areas in science was genetics (Topçu & Şahin-Pekmez, 2009). Topçu and Şahin-Pekmez (2009), asked the question that why learning genetics phenomena so difficult for the learners? Two answers were developed for this question in the literature. The first one is that students have difficulties in the invisibility and inaccessibility of genetics concepts. The second one is that genetics included complicated structures. Genetics involved multiple biological organization levels-genes, proteins, cells, tissues, organs, etc. Previous studies supported this claim that the main genetics concepts which were hard to learn by students were gene, gamete, allele, mitosis and meiosis, monohybrid and dihybrid crosses and linkage. Especially similar genetics topics were confused by the students. For example, students had confusion between mitosis and meiosis topics.

In addition to difficulty in learning of these genetics concepts, the researcher found out that many students at the Keta Senior High School did not construct necessary relationships among these genetics concepts, and had the problems about the process and the mechanism of inheritance.

Another problem mostly determined by the researcher was mathematical expressions in learning genetics because these expressions caused problems and the genetics symbols (e.g. XX, XY) were not used consistently by both teachers and the students. Many of the instructional approaches that came out from the efforts of researchers could not have any considerable impact on conceptual changes on learners. Instead, rote learning and memorization have become paramount and this has brought about misconceptions in some topics within biology such as genetics, which alters teacher‟s achievement in biology teaching and students understanding resulting to low performance of students in Ghana.

1.3 The Purpose of the Study

The main purpose of the study was to investigate the use of co-operative instructional approach to improve the cognitive achievement of students on genetics at Keta Senior High Technical School and also to ensure adequate in-depth knowledge of the genetics concept.

1.4 Aims/Objectives of the study

The objectives of the study were to:

1. Find out the specific genetic concepts students do not understand.
2. Identify the causes of the students inability to understand the genetic concepts

3. Use mathematical expressions to aid students in learning genetics and how to use genetics symbols.
4. Identify and correct some of the misconceptions that students have in genetics
5. Distinguish between meiosis and mitosis and outline the processes involved.

1.5 Research Questions

The following research questions directed the investigations:

1. To what extent will the use of cooperative instructional approaches by the researcher, with the help of concrete materials, at Keta Senior High Technical School, enable students to understand the genetics concept well?
2. To what extent will the use of explanations, demonstrations and group work help students to differentiate, use mathematical expressions and explain selected topics in genetics and use the knowledge gained to solve problems related to genetics in their lives correctly?

1.6 Significance of the Study

Biology is the science of life or the study of living systems. Genetics is one of the most important branches of biology that deals with heredity and variations in living beings and forms one of the important aspects of the SHS Biology syllabus. Understanding of genetics helps the understanding about basic life processes, genetic composition of living organisms, inheritance and blood groups. However, misconceptions about genetics are obstacles to the learning of new concepts. Therefore, it is very important to identify students‟ misconceptions about genetics for an instructor to help his/her students understand the scientific conceptions properly. Again, the students who have difficulties in understanding the concept under study will be able to overcome their difficulties.

1.7 Delimitation of the study

The study aims at investigating the use of co-operative instructional approach to improve the teaching and learning of the concept genetics. The study was delimited to only the third year elective science (Biology) students and some selected concepts in genetics (example meiosis, mitosis, allele, gene chromosomal variation, etc.) in the Keta Senior High Technical School and Zion College, Anloga in the Volta Region as a result of time constraint, their proximity to the researcher and also because of cost.

1.8 Limitations of the Study

The study was limited to the SHS 3 Science students of Keta Senior High Technical School since they have had an adequate exposure to the genetics concept and will therefore be in the position to answer most questions on the genetics concept. Again, limiting the study to one SHS in the Keta Municipality of the Volta Region may not reveal the picture of the influence of co-operative learning on SHS students in genetics concept. So generalization of the findings from this study to entire population of SHS students in other SHS may have its own difficulties.

1.9 Definition of Terms

WASSCE - West African Senior High Secondary School Examination

SHS - Senior High School

GES - Ghana Education Service

KSHTS - Keta Senior High Technical School

1.10 Organization of the Study

This study is organized into five chapters. The first chapter describes the background to the study, the statement of the problem, purpose of the study, limitation and delimitation of the study as well as definitions and abbreviations of the terms used.

The second chapter provides the review of literature related to the study such as cooperative learning, essentials of cooperative learning, motivational effect of cooperative learning, cognitive development effect of cooperative learning, cooperative learning in multicultural educational program, top-down processing, alternative traditional method, behaviourism, constructivists views of learning, pedagogies related to the teaching and learning of biology, the concept of genetics and the importance of teacher‟s role in a classroom.

The third chapter presents information about the methodology employed in the study which includes research design, population and sampling, instrumentation, scoring of instruments, reliability and validity of the instrument, data collection procedure and data analysis procedure.

Chapter four focuses on research results, analysis and discussion on data. The final chapter, chapter five gives a summary of the research findings, conclusion, recommendations and suggestions for further studies.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter is devoted to the review of the literature related to the study. The review is organized under the following sub-headings. The conceptual framework, cooperative learning, essentials of cooperative learning, effects of cooperative learning, cooperative learning in multicultural education program, top-down processing, alternative traditional method, behaviourism, constructivist views of learning, pedagogies related to the teaching and learning of biology, group work approaches, the art of teaching biology and the importance of teacher‟s role in a classroom.

2.1 Conceptual Framework of the Study

Constructivism is a view of learning in which learners use their own experiences to construct understandings that make sense to them, rather than having understanding delivered to them in already organized form. Learning activities based on constructivism put learners in the context of what they already know, and apply their understanding to authentic situations (Madhavan, Arns & Bertoline, 2005). Based on the above-mentioned definitions, the researcher perceives constructivism as a process of active learning.

The idea of learner autonomy is essential, because constructivist learning relies on the learner doing the work of learning, while constructivist teaching empowers the learner to construct and interpret his/her understanding of knowledge and reality. Macchione

(2010) describe the constructivist paradigm as an act of enquiry beginning with issues and concerns of participants and unfolding through a dialectic of iteration, analysis, critique, reiteration, reanalysis, and so on that ultimately leads to constructing a model or concept.

The foundational premise of constructivism is that learners actively construct their own knowledge by anchoring new information to pre-existing knowledge, and interact with knowledge, the learning environment and with other learners (Sesemane, 2007). Mankato (2008) put it differently and say that within the environment of constructivism knowledge is viewed "as something created, discovered, and experienced". Furthermore, learners have the opportunity to take personal responsibility, exercise initiative and be in control in the instructional setting through a variety of learning experiences. Jonassen (1996) defines constructivism from the educational perspective as learners producing and constructing their own personal knowledge. He distinguishes between constructivism and instructivism, where the learner is the passive receiver of knowledge, as in the traditional educational model. The learning environment changes completely in the new paradigm to one that is more learner-centred. The teacher becomes a facilitator, coach and motivator, not the transmitter of knowledge.

2.2 What is Cooperative Learning?

Cooperative learning may be broadly defined as any classroom learning situation in which students of all levels of performance work together in structured groups toward a shared or common goal (Gholami, 2011). According to Johnson, Johnson and Holubec (1994), "cooperative learning is the instructional use of small groups through which students work together to maximize their own and each other"s learning." Cuseo (1992) defined cooperative learning as a learner-centered instructional process in which small, intentionally selected groups of three to five students work interdependently on their own a well-defined learning task. Individual students are held accountable for their own performance and the instructor serves as a facilitator/consultant in the group-learning process.

In classrooms where collaboration is practiced, students pursue learning in groups of varying size: negotiating, initiating, planning and evaluating together. Rather than working as individuals in competition with every other individual in the classroom, students are given the responsibility of creating a learning community where all students participate in significant and meaningful ways.

Cooperative learning requires that students work together to achieve goals which they could not achieve individually. To provide enhanced opportunity for interactive learning, students are generally encouraged to work in groups both in and out of class. Value is placed on cooperation and collaboration among students rather than on competitiveness and an individual"s learning success or failure is linked with the learning success or failure of other group members. To be cooperative, a group must have clear positive interdependence; members must promote each other"s learning and success face-to-face, hold each other personally and individually accountable to do his or her share of the work, appropriately use the interpersonal and small group skills needed for cooperative efforts to be successful.

Students want to be more active in their learning instead of passively listening to lectures. They also expect to meet with discussion groups and project teams and prefer to do much of their assigned work during class time instead of meeting separately.

Retention rates increase, recruitment efforts improve and early evidence suggests that the use of this approach can improve grades.

Literature in the educational realms indicates that instructional methods requiring active student engagement in the classroom promote deeper processing of content material. Examples of „„active""instructional methods include: student identification of examples or illustrations of concepts being discussed, inclusion of case studies or problem-based learning strategies (Sand-Jecklin, 2007), faculty and student development of concept maps to represent relationships between concepts and experiential strategies. Use of cooperative and active learning methodologies are also reported to be rated highly by students (Sand-Jecklin, 2007).

Cooperative learning is becoming a favoured strategy by educational experts and can also serve as a means to incorporate other active learning methodologies into larger class environments. In cooperative learning, students are assigned in small groups to complete a task, solve a problem, analyze a case scenario, complete an in-depth project, or take a test. Each member of the group is responsible for a part of the work and students must work together to complete the assignment (Sand-Jecklin, 2007).

Research indicates that student engagement and learning are facilitated and that this method of instruction is viewed positively by students (Sand-Jecklin, 2007). Although many faculties acknowledge the importance of instruction methodologies being student centered, they may not be using these methodologies in the classroom, particularly in large group settings. Current recommendations for reforming learning in Genetics matter include the use of cooperative learning activities as a form of active learning to supplement or replace traditional lectures.

Many studies have been conducted in different settings of education, using different kinds of cooperative learning techniques. Such techniques are Learning Together (LT), Jigsaw Grouping, Teams-Games-Tournaments (TGT), Group Investigation (GI), Student Teams Achievement Division (STAD), and Team Accelerated Instruction (TAI). In comparison with cooperative learning techniques, lecture-based teaching has been reported to be less effective to the demands of high rates of cognitive and affective outcomes (Slavin, 2011). In order to improve students‟ cognitive outcomes, an alternative to lecture-based teaching could be cooperative learning (Tran, 2014). This approach has been reported to improve students‟ achievement, and their knowledge retention (Johnson & Johnson, 2009).

Cooperative learning consists of five basic elements: positive interdependence, promotive interaction, individual accountability, teaching of interpersonal and social skills, and quality of group processing. Learning situations are not cooperative if students are arranged into groups without positive interdependence (Johnson & Johnson, 2009). Positive interdependence means that in cooperative learning situations, students are required to work together as a cohesive group to achieve shared learning objectives (Tran, 2014). In the process, students must be responsible for their own learning and for the success of other group members‟ learning (Slavin, 2011). In other words, students must ensure that other members in their group complete the tasks and achieve the academic outcomes. The lesson will not be cooperative if students do not *"swim together"* in the group learning activities (Johnson & Johnson, 2008). Hence, positive interdependence needs to be constructed in cooperative learning groups to help students work and learn together.

Positive interdependence results in reciprocal interaction among individuals, which promotes each group member‟s productivity and achievement. Promotive interaction occurs as individuals encourage and facilitate each other‟s efforts to accomplish the group‟s goals. In cooperative learning groups, students are required to interact verbally with one another on learning tasks (Johnson & Johnson, 2008). As part of the cooperative learning condition, students are required to interact verbally with one another on learning tasks (Johnson & Johnson, 2009), exchange opinions, explain things, teach others and present their understanding (Johnson, 2009).

Individual responsibility means that students ask for assistance, do their best work, present their ideas, learn as much as possible, take their tasks seriously, help the group operate well, and take care of one another (Johnson, 2009). Positive interdependence is recognized to create *"responsibility forces"* that increase the individual accountability of group members for accomplishing shared work and facilitating other group members‟ work (Johnson & Johnson, 2005). If there is no individual accountability, one or two group members may do all the work while others do nothing. If the achievement of the group depends on the individual learning of each group member, then group members are motivated to ensure that all group members master the material being studied (Slavin, 1996).

When group accountability and individual accountability exist in the group, the responsibility forces increase (Johnson & Johnson, 2009). In reality, students cannot work effectively if socially unskilled students are arranged into one group (Johnson & Johnson, 1998). If basic learning skills on cooperative interaction are not taught, group members cannot work together effectively to finish their tasks. Cooperative learning, compared with individualistic or competitive learning, is more complex because it requires students to engage in learning tasks and work together (Johnson & Johnson, 2005). Therefore, social and interpersonal skills, such as listening attentively, questioning cooperatively and negotiating respectfully need be taught, to help students cooperate effectively in the group. In addition, each group member should know how to manage the group, how to make decisions and how to solve conflicts that arise among group members. If these skills are not taught, cooperative learning activities are rarely successful (Slavin, 1996). To coordinate efforts to achieve mutual goals, participants must: (a) get to know and trust each other; (b) communicate accurately and unambiguously; (c) accept and support each other; and (d) resolve conflicts constructively (Johnson & Johnson, 2009).

Group processing is defined as reflecting on a group session to help students: (1) describe what member actions were helpful and unhelpful; and (2) make decisions about what actions to continue or change (Johnson & Johnson, 1999). Group processing helps improve the effectiveness of the members in contributing to the shared efforts to achieve the group‟s goals via reflection on the learning process (Yamarik, 2007). In other words, the purpose of group processing is to clarify and improve the effectiveness of the members in contributing to the joint efforts to achieve the group‟s goals. In summary, if these basic elements of cooperative learning are included in cooperative learning groups, students achieve better, demonstrate superior learning skills (Johnson & Johnson, 2008), and experience more positive relationships among group members, and between students and the teacher, and more positive self-esteem and attitudes toward the subject area (Slavin, 2011).

In all levels of education students in cooperative situations achieved greater academic, social and psychological benefits (Johnson & Johnson, 2005). Specifically, cooperative learning has been reported to improve students‟ academic achievement (Tran, 2014). In promoting greater achievement, some additional studies reported that cooperative learning also fosters greater retention of learning, as indicated by students‟ results on delayed achievement tests. For example, Tran (2014) reports that the average percentage of learning material retention after 24 hours when students were taught by different teaching methods. He indicates that there is retention of 50% of material learned in the discussion group, 75% as a result of requests for students to study through practice, and 90% when students teach others. Again studies show that a blend of *„tdling"* and *„showing"* techniques results in greater retention (65%) after three days. It is therefore argued that the best way to learn something effectively is to prepare to teach it.

In other words, whoever explains learns. Teaching others and elaborating ideas are the main features of cooperative learning. The nature of cooperative learning is learning by doing and elaborating. In cooperative learning situations, the concepts being taught are often elaborated. The consistent elaboration of learning concepts provides students who either receive the explanation or those who give the explanation with a deep understanding and a more complete retention of the concepts being learnt for a longer period of time. Consequently, as has been shown in the above review, in cooperative situations, students retain more knowledge when they offer more explanation and elaboration to others (Tran, 2014).

2.3 Essentials of Cooperative Learning

There are five basic principles fundamental to cooperative learning (Khalim, 2010):

1. Face-to-Face Promotive Interaction

By using face-to-face promotive interaction, learning becomes active rather than passive. Teams encourage discussion of ideas and oral summarization. Peer assistance clarifies concepts for both helper and the student being helped. Cooperative teams‟ help students learn to value individual differences and promote more elaborate thinking.

2. Positive Interdependence

Students must feel that they need each other in order to complete the group's task, that is, they "sink or swim together." Positive interdependence can be built into the task by jig-sawing information, by limiting materials, by having a single team product, through team roles (recorder, reporter), or by randomly selecting one student to answer for the team. It can be built into a reward structure by assigning team points based on team averages, on members reaching a predetermined criterion, or on team improvement rather than outright grades.

3. Individual Accountability/ Personal Responsibility

Students must feel that they are each accountable for helping to complete a task and for mastering material. They must know that a "chauffeur/hitchhiker" situation will not be productive. Ways to build in individual accountability include: students take individual quizzes; each student is responsible for a specific portion of a task; each must be able to summarize another's ideas; any student may be called on at random to answer for the team.

4. Interpersonal and Collaborative Skills

These include skills for working together effectively (staying on task, summarizing, recording ideas) as well as group maintenance skills (encouraging each other). Ways to foster skill development include teacher modeling, brainstorming characteristics of "good" skills, direct practice, process observing, and reflection. Skill practice can be "tacked on" to academic lessons through games (e.g., Talking Chips) or by making social skills a separate objective to be practiced and observed.

5. Reflection/Group Processing of Interaction

According to Khalim (2010), processing means giving students the time and procedures to analyze how well their groups are functioning and how well they are using the necessary collaborative skills. Processing can be individual, team-wide, or at the whole collaborative class level. Examples include:

How well did I listen?

Did we take turns and include everyone?

How could we have coached each other better?

How can the class function more smoothly?

2.4 Does Cooperative Learning Really Work?

The short answer to this question is yes. In the vast majority of studies, forms of cooperative learning have been shown to be more effective than non-cooperative reward structures in raising the levels of variables that contribute to motivation, in raising achievement, and in producing positive social outcomes.

2.5 Why Does Cooperative Learning Work?

When researchers attempt to explain the widespread positive effects that are typically found among studies of cooperative learning, they usually cite one or more of the following explanations (Slavin, 1995).

2.6 Motivational Effect of cooperative learning

The various features of cooperative learning, particularly positive interdependence, are highly motivating because they encourage such achievement-oriented behaviors as trying hard, attending class regularly, praising the efforts of others, and receiving help from one's group mates. Learning is seen as an obligation and a valued activity because the group's success is based on it and one's group mates will reward it (Johnson & Johnson, 1989; Slavin, 1995).

2.7 Cognitive Development Effect of cooperative learning

Vygotsky (1978), collaboration promotes cognitive growth because students‟ model for each other more advanced ways of thinking than any would demonstrate individually. Ghosh (2009), collaboration among peers hastens the decline of egocentrism and allows the development of more advanced ways of understanding and dealing with the world.

2.8 Cooperative Learning in Multicultural Education Programs

The general idea behind cooperative learning is that by working in small heterogeneous groups (of four or five students total) and by helping one another master the various aspects of a particular task, students will be more motivated to learn, will learn more than if they had to work independently, and will forge stronger interpersonal relationships than they would by working alone. There are several forms of cooperative learning, one of which is Student Team Learning.

Student Team Learning techniques are built on the concepts of team reward, individual accountability, and equal opportunities for success. Team reward means that teams are not in competition with one another for limited rewards. All of the teams, some of them, or none of them may earn whatever rewards are made available depending on how well the team's performance matches a predetermined standard. Individual accountability means that each member of the team must perform at a certain level (on a quiz, for example) for the team's effort to be judged successful. It is not permissible for one team member's above-average performance to compensate for another team member's below-average performance. Finally, equal opportunities for success allow students of all ability levels to contribute to their team's success by improving on their own past performances (Slavin, 1995).

Slavin (1995), a leading advocate of cooperative learning, reports that cooperative learning produced significantly higher levels of achievement than did non-cooperative arrangements in sixty-three of ninety-nine studies (64 percent). The results for the Student Team Learning programs have been the most consistently positive. Of particular relevance to this chapter are the findings that students who cooperate in learning are more apt to list as friends‟ peers from different ethnic groups and are better able to take the perspective of a classmate than are students who do not work in cooperative groups. Although cooperative learning is a generally effective instructional tactic, it is likely to be particularly useful with Hispanic-American and Native American students. Children from both cultures often come from extended families that emphasize cooperation and sharing. Thus, these students may be more prepared than other individuals to work productively as part of a group by carrying out their own responsibilities as well as helping others do the same.

2.9 Top-Down Processing (An Adaptation)-Bloom's Taxonomy

Constructivitist approaches to teaching emphasize top-down rather than bottom-up instruction. "Top-down" means that students begin with complex problems to solve and then work out to discover (with the teacher‟s guidance) the basic skill required. This top-down processing approach is contrasted with the traditional bottom-up strategy in which basic skills are gradually, built into more complex skills (Slavin, 1994). In this research, the researcher adapted the top-down approach and reserves it, adding essential ingredients such as detailed explanations of my reasons for taking certain action and the likely consequences of those decisions with the students.

2.10 Alternative Traditional Method

In comparison with cooperative learning techniques, lecture-based teaching has been reported to be less effective to the demands of high rates of cognitive and affective outcomes (Slavin, 2011). Traditional teaching approach (lecture method) is very common in education especially at university level. Traditional method ignores the students consequently the mental level of interest of the students. It involves coverage of the context and rote memorization on the part of the students. It did not involve students in creative thinking and participation in the creative part of activities. Most of the time, during teaching learning process, instruction remain unilateral which is and consider to be orthodox activity. The up-and-coming trends changed the present scenario and adopted the constructivist approach which is moral and more focus on innovative activities and knowledge acquisition. It seems more feasible to follow constructivist approach for the teaching of Science at SHS level and constructivist is more feasible in engaging the students in innovative and creative activities. A module has been developed to confirm this effect.

The traditional classroom often looks like a one-person show with a largely uninvolved learner. Traditional classes are usually dominated by direct and unilateral instruction. Traditional approach followers assume that there is a fixed body of knowledge that the student must come to know. Students are expected to blindly accept the information they are given without questioning the instructor (Lord, Travis, Magill & King, 2002). The teacher seeks to transfer thoughts and meanings to the passive student leaving little room for student-initiated questions, independent thought or interaction between students. Even in the activities based subjects, although activities are done in a group but do not encourage discussion or exploration of the concepts involved. This tends to overlook the critical thinking and unifying concepts essential to true science literacy and appreciation (Khalid & Azeem, 2012). This teacher-centered method of teaching also assumes that all students have the same level of background knowledge in the subject matter and are able to absorb the material at the same pace (Cuevas, Lee, Hart & Deaktor, 2005).

2.11 Behaviourism

Behaviourist views of learning are based on objectivist epistemological views of knowledge that assume that there exists a knowable reality outside of human subjectivity; so that even though there may be no humans to perceive it; it is still there (Lu, 2006). From this point of view, knowledge involves a universal logical structure of inference, allows that absolute truth to be tested and ascertained (Lu, 2006). Science therefore has discovered items, such as bacteria, and is doing all that is possible to accurately describe reality.

Objectivists endeavour to detach human subjectivity from the facts of reality and to remove values and historical, cultural and social considerations. Consequently, it is believed that knowledge can be transmitted from experts (teachers) to novices (students) because expert‟s knowledge is much closer to reality than novice‟s knowledge. The teacher‟s role becomes one of simply presenting the factual content of scientific knowledge; the student role is to passively receive this knowledge. It is assumed that students come into classrooms in a *tabula rasa* state, so student pre-instructional knowledge is of no interest. The assumption is that conceptual changes can happen without difficulty. Student creativity and imagination in learning are not acknowledged or appreciated. To sum up, behaviourist views of learning emphasizes the role of the teacher and the transmission of knowledge from the teacher to the student.

2.12 Constructivist views of learning

In contrast with the behaviourist view of learning as absorbing knowledge, the constructivist perspective is based on the premise that learners construct meaning actively (Lu, 2006), and then integrate the meaning into their conceptual framework. Seen this way, student existing ideas are important and need to be considered.

Constructivism has been increasingly accepted by science educators and this has had profound impact on their thinking. Indeed, it is a primary principle of contemporary science education that in the learning of scientific concepts students should develop the ability to construct their own meaning to make sense of experience (Lu, 2006). Learning is considered to involve both a personal construction of meaning and a social negotiation of meaning. These two main strands of constructivism are illustrated as follows:

Personal constructivism stresses individual internal knowledge construction processes.

Learner construction of meaning from learning material is considered to be affected by personal/individual conceptions, purposes and motivations.

Personal constructivism has its origins in Piaget‟s theory. In his stage theory, Piaget proposed that children begin by developing concrete operations to act on their world, and then, in the subsequent stage of formal operation, gain capabilities to do with abstract logical mathematical reasoning. Piaget emphasized the process of knowledge growth as being related to biological factors and preferred to use logical-mathematical reasoning to describe the structure of cognition, which attracted the attention of many mathematics and science educators. When new information comes to a learner and creates cognitive dissonance or conflict, the learner makes an intellectual adaptation through the interplay of assimilation and accommodation, in which the conflict is reduced and equilibrium is established to accelerate cognitive growth. However, Piaget‟s description of intellectual advancement was based on „increasing decentralization from subjectivity and toward objectivity‟ and the assumption that logical thinking operations were independent from context.

In short, the common assumption of personal constructivism is that learners personally construct knowledge of the realities of the external world based on their existing experience and this construction of knowledge about reality is tentative. During the learning process, the learner takes the major responsibility for his/her learning. Hence, personal constructivism portrays science learning as primarily based on changes in the mental structure of individuals.

Personal constructivism has been challenged as emphasizing the isolated universals of cognitive development to the neglect of social and cultural aspects in knowledge-construction process. Social constructivism, originating from Vygotskian psychology, is concerned with the contributions of social interaction to the construction of knowledge and self.

Over the years, research and curriculum development have shown that effective instruction is much more than the presentation of a concept, process, or skills (Ajaja, 2013). The major concern of science education researchers is the identification of the best instructional methods/strategies which will enable all learners to learn effectively. Effective science classroom appears to be one in which students are active, kept aware of instructional objectives and receive feedback on their progress towards the stated objectives. In classroom where elements of constructivism are incorporated in teaching and learning, students gets opportunities to physically interact with instructional materials and engage in varied kinds of activities. This position therefore, suggests that for effective learning to take place students must be actively involved in the learning process.

2.13 Pedagogies related to the teaching and learning of biology

In the senior high school biology classroom, the traditional teaching approach of transmission has been found to give rise to the impression that science is static and pre-determined (Lu, 2006). It seems that an absence of dialogue promotes the use of memorization and rote learning as productive learning approaches for student in biology. Moreover, content is often taught isolated from contexts which imbue it with relevance and meaning so that students are often not able to make connections between theory and real life situations. In contrast to such teacher-centred approach, student-centred and student active teaching approaches are advocated as a way of helping students learn in a meaningful way. In these approaches, students are helped to understand how biology relates to them and to integrate what they learn into their daily life. Alongside this, inquiry activities that allow students to construct new framework of the world based on their own observations and reflection are recommended.

Any discussion of student learning also needs to take into account how this learning is assessed. Senior biology assessment often stresses skills such as factual recall. It tends to include questions restricted to contexts designed to ensure marker reliability. Student familiarity with applications of biological knowledge is rarely rewarded. When student biology learning is evaluated based on rote memorization and reiteration it is hard to expect students to achieve genuine understanding (Lu, 2006). This situation has led to a recognition that assessment needs to be extended to reflect a broad range of learning and cognitive outcomes.

In biology classes, laboratory activities have tended to play a central role in teaching. However, there is some evidence that biology laboratory classes are not often used with senior biology class. There are many possible reasons for this, for example, the difficulty of obtaining living organisms and time constraints caused by an overcrowded curriculum. In addition, biology laboratories are perceived by some teachers as ineffective, mainly because they are confirmatory rather than investigative. Students in these confirmatory laboratories are passive (Lunetta, Hofstein & Clough, 2007) and thus have limited opportunities to engage in the learning process and develop skills in thinking, discussion, debate or research. It appears that when students have the opportunity to engage in open-ended investigations that allow them more autonomy in defining problems and methods, and arriving at solutions, these can contribute substantially to their understanding of the nature of science (Land, 2000).

Research indicates that inquiry-based instruction can enhance student learning significantly, such as in increasing student interest levels, ability to solve problems science skills and achievement, and student attitudes toward science (Lu, 2006)

2.14 Group Work Approaches

Group work has long been regarded as an effective strategy to meet the current challenges of science education including fostering conceptual learning and promoting creative problem-solving. Normally, groups are heterogeneous (very often in academic ability) and students play different procedural roles, such as chief investigator, recorder-reporter, material manager and harmonizer.

These roles are usually rotated among group members from activity to activity so that students participate equally. This reduces, but does not eliminate, the probability that one person will do a great deal or all of the work. Group work can provide more opportunities for students with a wide range of abilities to make important contributions to the group. Despite this, research has found that student status can influence their access to discourse during group work and thus their learning of science. Students with high status talk more, have greater access to materials, and consequently, learn more. In contrast, students with low status may participate and learn less than their high-status counterparts. In this study, group work was adopted to encourage students to have more interactions with each other and to participate in knowledge construction equally.

2.15 The Art of Teaching Biology

The art of teaching includes teaching as well as music, dancing, drama and painting. Actually, the art of teaching is a harmonious unity between the reproduction of science and artistic manifestation, a comprehensive artistic creative activity in which both teachers and students are to be developed (Yang, 1997). Biology, which is a branch of natural science, involves the studying of classification, structure, function, behaviour and evolution of different levels in creatures. In such a study, it seems it is very important to employ a variety of teaching techniques to put across different life phenomena and basic laws in the teaching delivery.

2.16 The Concept of Genetics

Science education researchers have presented the argument in which the students have difficulty in learning some science concepts. In this perspective, identifying students" difficulties in science learning has received a big attention in science education research (Beeth, 1998). The researchers explored that one of the most difficult content areas in science was genetics. (Beeth, 1998), asked the question that why learning genetics phenomena so difficult for the learners? Two answers were developed for this question in the literature. The first one is that students have difficulties in the invisibility and inaccessibility of genetics concepts.

The second one is that genetics include complicated structure. Genetics involved multiple biological organization levels-genes, proteins, cells, tissues, organs, etc. Previous studies supported this claim that the main genetics concepts which were hard to learn by students were gene, gamete, allele, mitosis and meiosis, monohybrid and dihybrid crosses and linkage. Especially similar genetics topics were confused by the students. For example, students had confusion between mitosis and meiosis topics. In addition to difficulty in learning of these genetics concepts, (Beeth, 1998), stated that many students did not construct necessary relationships among these genetics concepts, and had the problems about the process and the mechanism of inheritance.

Another problem mostly determined in the literature was mathematical expressions in learning genetics because these expressions caused problems and the genetics symbols (e.g., XX, XY) were not used consistently by teachers and textbook writers.

2.17 The Importance of Teacher's Role in a Classroom

In many teaching studies teachers were centrally involved in developing and implementing the teaching approach. It is therefore possible that improvements in student learning arise as much from changes in the way teachers conceptualize teaching and learning and deal with classroom interactions, as the sequence of activities in the teaching.

In constructivists" view teachers in science classrooms as authority figures play two essential roles. One is to introduce new ideas or cultural tools where necessary and to provide the support and guidance for students to make sense of these for themselves. The other is to listen and diagnose the ways in which the instructional activities are being interpreted to inform further action (Murphy, 1997). One hand, in the paper 'Constructing Scientific Knowledge in the Classroom', it is emphasized that the role of the science teacher is to mediate scientific knowledge for students, to help them to make personal sense of the ways in which knowledge claims are generated and validated rather than to organize individual sense-making about the natural world. Teachers are knowledgeable experts in their disciplines who introduce the scientific community"s culture to students. Teachers provide appropriate experimental evidence and make the cultural tools and conventions of the science community available to students. Teachers use specialized terms and concepts; they show specialized procedure and skills. Teachers are making and providing students with learning environments in which students construct their knowledge by using formal scientific discourses.

On the other hand, there is a hypothetical space between assisted and unassisted performance that Vygotsky (1978) identified as the zone of proximal development

(ZPD). By identifying a learner‟s ZPD, a teacher can locate the psychological space in which assistance can help to propel the learner to higher levels of understanding. Due to the fact that learners construct their understanding, the assistance provided in the ZPD has become known as scaffolding. The teacher is like a coach in a sense that teacher helps learners to figure out their weaknesses, and work on them, and gives appropriate feedback to help them perform better. To help students adopt scientific ways of thinking and knowing, science teachers should provide various experiences and encourage deep reflection. Student‟s meanings are listened to and respectfully questioned. Furthermore, teachers should offer helpful interventions to promote thought and reflection on the part of the learner with requests for argument and evidence in support of assertions.

Furthermore, teacher can provoke and initiate quality comments in the difficult discussion. The essential role of the teacher is controlling the 'flow of discourse' in the classroom. The ability to guide the classroom discourse as ideas are explored and explanations are introduced, is central to the science teacher's skill and is critical in influencing students' learning. Teachers guide classroom discourses with different kinds of pedagogical intervention. At different times the teacher might play diverse roles to:

- develop key ideas relating to the new concepts being introduced;
- introduce points relating to epistemological features of the new way of knowing;
- promote shared meaning amongst all of the students in the class, making key ideas available to all;
- check student understanding of newly introduced concepts.

Taken together these different kinds of teacher intervention and the ongoing interactions between teacher and students constitute a teaching and learning 'performance' on the social plane of the classroom (Sormunen & Saari, 2006). The challenge for teachers is one of how to achieve such a process of enculturation successfully in the round of normal classroom life. What's more, there are special challenges when the science view that the teacher is presenting is in conflict with learners" prior knowledge schemes (Driver, Asoko, Scott & Mortimer, 1994).

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter provides description of the methodology employed in the study which includes the research design, population, sample and sampling procedures, instrumentation, pre-intervention activities, intervention design and post-intervention activities, data collection procedure and methods of analysis.

3.1 Research Design

This is an action research in which the researcher explores a single entity or phenomenon bound by time and collects detailed information by using a variety of data collection procedures during a sustained period of time (Creswell, 1994). Mills (2003) defined action research as any systematic inquiry conducted by teachers, administrators, counsellors, or others with a vested interest in the teaching and learning process for the purpose of gathering data about how a particular school operates or teaching is done and how students learn.

Cohen and Manion (1994) described action research as essentially an on-the-spot procedure designed to deal with a concrete problem located in an immediate situation. This means that ideally, the step-by-step process is constantly monitored over varying periods of time and by a variety of mechanisms (questionnaires, diaries, interviews and case studies, for example) so that the ensuing feedback may be translated into modifications, adjustment, directional changes, redefinitions, as necessary, so as to bring about lasting benefit to the ongoing process itself rather than to some future occasion. Almost any phenomenon can be examined by means of the case study method.

The research was based on a case study of form three biology students of Keta Senior High Technical School, Keta. The research was therefore to improve the understanding of form three biology students on genetics concept. The study was carried out in three phases. The first phase was the pre-intervention activities, the second phase was the implementation of the intervention and the third phase consisted of the post-intervention activities.

3.2 Research Population

The target population was form three biology students of the Keta Senior High Technical School in the Volta Region of Ghana. The school is a mixed school with student population of about two thousand five hundred (2,500) with an average class of sixty students. The school was chosen because of its proximity to the researcher. The sample population consisted of form three biology students because the researcher realized that the students although did some aspects of genetics but do not have in-depth understanding as this reflected in their way of answering the end of third term examination especially in genetics.

3.3 Sampling and Sampling Techniques

Sample is the group of elements or single element from which data are obtained (McMillan, 1996). A sample is some part of a larger body especially selected to represent a whole. Sampling is a process by which a sample is chosen. Since a population can be quite large, only a sample of the population was questioned by the researcher. This is because for a quantitative survey technique, a minimum sample size of hundred (100) was good in order for the findings of the survey to be generalizable to the target population (Fraenkel & Wallen, 2003).

The science three class has a population of one hundred and eighty students which is further divided into three sub-divisions (A, B, and C) with an average of sixty students each comprising of forty five (45) males and fifteen (15) females of an average age of fifteen years. In this study sixty third year elective biology students were used as an intact group based on purposive sampling. This is because the technique starts with a purpose in mind and thus, the sample is selected to include people of interest and exclude those who do not suite that purpose (Fraenkel & Wallen, 2003). For the purpose of this study, the "lottery method" was applied by the researcher whereby out of the one hundred and eighty (180) students in the class was marked sixty (60) pieces of papers. A simple random technique was used to select the sample students.

3.4 Research Instrumentation

The data collecting instruments used were questionnaire and two test instruments of comparable standard, which were to collect data from participants. The test instruments were Pre-test questions (Appendix A1) and Post-test questions (Appendix B 1), which were both developed by the researcher. The pre-test questions were used to assess the participants" knowledge and difficulty with the concept genetics in other to have a base line about all participants before the implementation of the interventions. The post-test questions were designed to measure participants" achievement after implementation of the interventions. The pre-test questions were paper and pencil tests, which comprised four sections- A, B, C and D. and the post-test questions were paper and pencil tests, which was also made up of three sections.

Preceding section A of each test instruments was a portion that briefly stated the purpose of the test and also asked participants to provide personal data, such as name, gender and class of participants. This portion also contained general instructions to answering items in all the sections of the instruments.

3.5 Pre-Test

A pre-test on genetics concept was given to the participants to find out their strength and weaknesses. Section B of the pre-test was made up of fifteen (15) multiple choice items (Appendix A1), numbered as items 1 to 15. Each of the multiple choice items in the pre-test had a stem about an aspect of the concept genetics followed by four (4) options of alternatives. The options comprised of one correct and three plausible distracters. Each correct answer ticked, circled or chosen was awarded one mark or half mark depending on the question, resulting in a total score of 50 marks for section B. Section C and D was made up of short-answer practical items numbered 1 to 4 on the pre-test.

3.6 Administering the Pre-Test

The pre-test questions were given to students during a normal class teaching periods and were asked to solve the questions individually. Each student was given a printed question paper and answer sheets. The duration of the pre-test was forty five (45) minutes. Answers provided by the students was marked using a marking scheme (Appendix A2).

3.7 Post-Test

After the intervention, a post-test was conducted to find out how the intervention activities helped the students to improve their performance in the concept genetics. The post-test was not exactly the same as the pre-test, with the reason that if the intervention has been effective then the students would be able to answer simple questions on genetics .The post-test consisted of four (4) items and the duration was forty five minutes (Appendix B1). Answers provided by the students in answering the post-test questions were marked using a marking scheme (Appendix B2)

3.8 Validity Research Instruments.

Quinn and Carlson (1974) states that the tasks of scientific method are related directly or indirectly to the study of similarities of various kinds of objects or events. One of the tasks of scientific method is that of classifying objects or events into categories and of describing the similar characteristics of members of each type. A second task is that of comparing variations in two or more characteristics of the members of a category.

Validity is defined as the extent to which the instrument measures what it purports to measure (Remmers, 1934). To be able to draw meaningful and good conclusion based on the participants score from the pre-test and post-test (Creswell, 2008), both test instruments were presented to one senior biology lecturer in the Faculty of Science of the University of Education, Winneba and two other biology teachers with different teaching experiences in the Keta Senior High Technical School for their comments and suggestions in order to correct the errors that were associated with items on the pre-test and post-test questions.

3.9 Reliability of Research Instruments

Reliability is the consistency of your measurement, or the degree to which an instrument measures the same way each time it is used under the same condition with the same subjects (Remmers, 1934). The pre-test and post-test scores of the genetics concept test were analyzed for reliability. Major portion of the Genetics Achievement Assessment Test was extracted and modified from the West African Examinations Council past questions (from 1993 to 2014). This is to ensure that their appropriateness measures to the West African academic content standards in biology. The test items were carefully analyzed to ensure their reliability.

In order to ensure that the research instruments produced scores that are stable and consistent and their test items are devoid of any ambiguities (Creswell, 2008) as much as possible, the pre-test and post-test were pilot-tested using 30 Senior High School biology students in Zion College, Anloga, in the Anlo Municipality in the Volta Region of Ghana.

Data from the pilot test were statistically analysed to determine the reliability of the test instruments using the Spearman-Brown prophecy formula since all items on both pre-test and post-test were dichotomously scored. The analysis yielded reliability coefficients of .59 and .62 for the pre-test and post-test respectively.

According to Ary, Lucy and Asghar (2002), if the measurement results are to be used for making a decision about a group or for research purposes, or if an erroneous initial decision can be easily corrected, then scores with modest reliability coefficients in the range of .50 to .60 may be acceptable.

3.9 Pre-Intervention Stage

This stage of the study lasted for one week in the selected school. The researcher undertook a familiarization visit for formal introduction to the head of the selected school for the pilot-testing. This was done to ensure effective data collection.

3.10 Intervention Implementation

Intervention is solving an educational practice or problem located in an immediate situation using a set of planned strategies and implementing it. It involves a step-by-step procedure which is constantly monitored over a varying period of time and by using different mechanisms.

Cooperative learning may be broadly defined as any classroom learning situation in which students of all levels of performance work together in structured groups toward a share or common goal. Cooperative learning is a successful teaching strategy in which small teams, each with students of different level of ability, use of variety of learning activities to improve their understanding of a subject.

To ensure that each member of a team is responsible not only for learning what is taught but also for helping teammates to learn, thus creating an atmosphere of achievement, students were made to work in groups of six, each comprising ten (10) participants. Students worked through the assignment until all group members successfully understood and completed it. Weekly lesson plans and assignments were developed with respect to the Senior High Schools Biology Syllabus for the term. Students are supposed to learn genetics in the first term of the third year based on the biology Syllabus for Senior High Schools. Therefore teaching and learning activities about this topic was developed systematically specifying the instructional objectives to be achieved after each week ending. Students were taken thoroughly through a lot of various activities with a prepared lesson note and much attention was given to the meaning of terms and expressions identified in the question for them to grasp it well.

3.11 Peer Tutoring Techniques

Peer tutoring is an organized learning experience in which one student serves as the teacher or tutor, and one is the learner or tutee. It gives students an opportunity to use their knowledge in a meaningful, social experience (Anil & Karki, 2014). Tutors reinforce their own learning by reviewing and reformulating their knowledge. Tutees gain one-on-one attention. Both tutors and tutees gain self-confidence, the tutor by seeing self-competence in his or her ability to help someone and the tutee by receiving positive reinforcement from peers. A distributed rendering environment for teaching animation and scientific visualization. During a peer tutoring assignment, it is common for the students to work together to prompt, monitor and evaluate each other while working together toward group goals. The students alternate between the roles of tutor and tutee in groups of two.

3.12 Administering the Post-Test

The post-test was administered immediately after the intervention activities as outlined above. The post-test questions were given to students during a normal teaching class period and students were asked to do independent work.

3.13 Data Collection Procedure

Data collection can be defined as the process through which data of a study is gathered. Data for this study was collected in three stages. The first stage (Pre-intervention stage) involved the pilot testing and the administering of the pre-test questions. The second stage (Intervention stage) involved the administering of the interventional activities. The third stage (Post-interventional stage) involved administration of the post-test questions as indicated in Table 1.

Table 1: The Process of Data Collection

PRE INTERVENTION STAGE	INTERVENTION STAGE	POST INTERVENTION STAGE
✓ Pilot-Testing ✓ Familiarisation visits ✓ Administration of Pre-test Questions	✓ Administration of interventional activities	✓ Administration of Post-test Questions

3.14 Data Analysis

In this part, the data gathered from the participants on the Pre-test Questions and the Post-test Questions were analysed to reflect the research question.

The Researcher employed qualitative data analysis method using descriptive statistics (simple percentages). Data from the students‟ lessons such as responses, written answers, reasoning abilities, terminologies, explanation of phenomena were analyzed qualitatively. The researcher read through the information and made comments on the questionnaires answered by the respondents. Data on the pre-test and post-test were analyzed on computer using Statistical Package for Social Sciences (SPSS) version 16 for windows and excel programmes. The responses from the students‟ questionnaire were also presented using pie charts.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter covers results gathered from the study. Sixty (60) students were used for the study.

4.1 Analysis of Findings Related To Research Questions

Analysis of Pre-Test and Post-Test Items

The pre-test aimed at finding the performance of the students on the concept genetics. Information gathered from the pre-test served as guides in developing suitable activities to help reduce the students‟ difficulties in understanding the genetics concept. The post-test, on the other hand was conducted to see how the intervention activities helped to improve the students‟ performance on the concept genetics by using constructivist approach of teaching. The students‟ response to the pre-test and the post-test items addressing each research question was analyzed and studied. The students‟ competency, based on the first research question was the ability to understand the genetics concept and do away with some of the misconceptions. The second research question was the use of explanations, demonstrations and group work to help students to differentiate, use mathematical expressions and explain selected topics in genetics and use the knowledge gained to solve problems related to genetics in their lives correctly? The statistics shown in Tables 2 and 3 respectively represent the marks obtained by the students on the pre-test and post-test in the area of finding the performance of students in the concept genetics respectively. Tables 4 and 5 represent marks obtained by the students on pre-test and post-test in explaining, demonstrating using group works to differentiate and use mathematical expressions to explain selected genetic topics.

Table 2: Pre-Test Results on Students' Performance on Genetics.

	Female		Male		Total	
Scores	No.	%	No.	%	No.	%
46-50	0	0	0	0	0	0
41-45	0	0	0	0	0	0
36-40	0	0	0	0	0	0
31-35	0	0	0	0	0	0
26-30	0	0	1	1.7	1	1.7
21-25	2	3.3	8	13.3	10	16.7
16-20	4	6.7	11	18.3	15	25
11-15.	5	8.3	20	33.3	25	41.7
06-10.	4	6.7	5	8.3	9	15
0-5	0	0	0	0	0	0
No. Response	0	0	0	0	0	0
Total	**15**	**25**	**45**	**74.9**	**60**	**100**

In understanding the concept of genetics, items on the pre-test were examined to assess students" ability to address some of the misconceptions derived from genetics concept and how best they can answer the questions relating to the genetics concept.

Analysis with Respect to Research Question One

Research question 1: To what extent will the use of cooperative instructional approaches help students to understand the concept of genetics well?

This question was posed to determine whether there will be any difference between students taught through cooperative instructional approach and individualised learning. In order to find out the performance of students in genetics before the intervention, a pre-test was conducted for students. The total score was 50 marks.

Table 2 shows the results of the students‟ responses on performance in genetics concepts. From the table, it could be seen that nine (9) students representing 15% scored between six (6) to ten (10) marks. Twenty five (25) students representing 41.7 % scored between eleven (11) to fifteen (15). Again, Fifteen (15) students representing 25% scored between sixteen (16) to twenty (20) marks. Ten (10) students representing 16.7% scored between twenty one (21) to twenty five (25) and one (1) student representing 1.7% scored between twenty six (26) to thirty (30).

Table 3 shows the post-test results on students‟ performance on Genetics concept.

Table 3: Post-Test Results on students' Performance on Genetics Concept.

	Female		Male		Total	
Scores	No.	%	No.	%	No.	%
46-50	2	3.3	6	10	8	13.3
41-45	5	8.3	9	15	14	23.3
36-40	4	6.7	11	18.3	15	25
31-35	3	5	8	13.3	11	18.3
26-30	1	1.7	11	18.3	12	20
21-25	0	0	0	0	0	0
16-20	0	0	0	0	0	0
11-15.	0	0	0	0	0	0
6-10.	0	0	0	0	0	0
0-5	0	0	0	0	0	0
No. Responses	0	0	0	0	0	0
Total	**15**	**25**	**45**	**74.9**	**60**	**100**

The post-test results of the students" ability to explain genetic concept has been presented in Table 3. Results shown in the table indicated that, out of a total score of 50 marks, eight students scored between forty six (46) and fifty (50) representing 13.3%. Fourteen (14) students scored between forty one (41) and forty five (45) representing 23.3%. Fifteen (15) students scored between thirty six (36) and forty (40) representing 25%. Eleven (11) students scored between thirty one (31) and thirty five (35) representing 18.3% and twelve (12) students scored between twenty six (26) and thirty

(30) representing 18.3%. Table 4 shows the pre-test results on the use of mathematical expressions and explanation of selected Genetics concepts.

Table 4: Pre-Test Results on use of mathematical expressions and explanation of selected Genetics concept.

	Female		Male		Total	
Scores	No	%	No	%	No	%
46-50	0	0.0	0	0.0	0	0.0
41-45	0	0.0	0	0.0	0	0.0
36-40	0	0.0	6	10.0	6	10.0
31-35	3	5.0	7	11.7	10	16.7
26-30	3	5.0	7	11.7	10	16.7
21-25	2	3.3	4	6.7	6	10.0
16-20	4	6.7	7	11.7	11	18.3
11-15.	2	3.3	9	15.0	11	18.3
06-10.	1	1.7	5	8.3	6	10.0
0-05	0	0.0	0	0.0	0	0.0
No.Responses	0	0	0	0	0	0
Total	**15**	**25**	**45**	**75**	**60**	**100**

In Table 4, the pre-test results of the students‟ ability to differentiate, use mathematical expressions and explanation of selected Genetics concept is represented. Results shown in the table indicated that, out of a total score of 50 marks, six students scored between thirty six (36) and forty (40) representing 10.0%. Ten (10) students scored between thirty one (31) and thirty five (35) representing 16.7%. Ten (10) students again scored between twenty six (26) and thirty (30) representing 16.7%. Six (6) students scored between twenty one and twenty five representing 10.0%. Eleven (11) students each representing 18.3% each scored between eleven (11) and Fifteen (15) and Sixteen (16) and twenty (20). Six (6) students scored between six (6) and ten (10) representing 10 %. Table 5 shows the post-test results on the use of mathematical expressions and explanation of selected Genetics concept.

Table 5: Post- Test Results on the use of mathematical expressions and explanation of selected Genetics concept

	Female		Male		Total	
Scores	No	%	No	%	No	%
46-50	5	8.3	20	33.3	25	41.7
41-45	8	13.3	15	25.0	23	38.3
36-40	1	1.7	5	8.3	6	10.0
31-35	1	1.7	5	8.3	6	10.0
26-30	0	0.0	0	0.0	0	0.0
21-25	0	0.0	0	0.0	0	0.0
16-20	0	0.0	0	0.0	0	0.0
11-15.	0	0.0	0	0.0	0	0.0
06-10.	0	0.0	0	0.0	0	0.0
0-05	0	0.0	0	0.0	0	0.0
No.Responses	0	0.0	0	0.0	0	0.0
Total	15	25.0	45	75.0	60	100

In Table 5, the post-test results of the students" ability to use mathematical expressions and explanation of selected Genetics concept. Results shown in the table indicated that, out of a total score of 50 marks, twenty five students scored between forty six (46) and fifty (50) representing 41.7%. Twenty three (23) students scored between forty one (41) and forty five (45) representing 38.3%. Ten (10) students each scored between thirty six (36) and forty (40) and thirty one (31) and thirty five (35) representing ten 10 % each.

4.2 Discussion of the Result

The discussion of the result gathered is based on the research questions:

4.2.1 Research Question One

To what extent will the use of cooperative instructional approaches by the teacher, with the help of concrete materials, enable students to understand the genetics concept well? This question was posed to determine whether there will be any difference between students taught through cooperative instructional approach and individualised learning. In order to find out the performance of students in genetics before the intervention, a pre-test was conducted for students. The total score was 50 marks.

From this research question, findings from the study showed that the students can now easily analyze genetics concept problems and interpret them and this is supported by the findings of Balckon, (1992) which have documented that the proper use of cooperative learning improved academic achievement, increased self-confidence, motivation and increased liking of school and classmate.

The relative success of the students on the post-test items reflected much of what is suggested by the literature. As mentioned earlier, the researcher used different kinds of scientific approaches and also encouraged cooperative learning among the students during the intervention activities. The results from the post-test also supported the research findings by Kieran and Chalouh (1993) that allowed the students to express themselves scientifically, and these helped them to develop conceptual understanding of the concept genetics before representing them on paper.

Results from the scores in Tables 2 and 3 showed the performance of the students in the concept of genetics which was very poor. This is supported by Osborene and Collins (2000) that, the learning cycle in children consists of exploration which is manipulation of materials, investigation otherwise testing of hypothesis, and reflection that is more important on the activity.

In the pre-test, about 48 of the students scored below the pass mark which was 50%. This supported the fact that, the students performed poorly in the pre-test. The poor performance of the students in the pre-test could be as a result of the teaching method used to teach the students on genetics concept. That is the lecture method. As a result of this, the students find it difficult understanding genetics concept. Again the results also showed that the students lacked cooperative learning hence, the average students could not help their classmates. The students could not analyze simple scientific concepts and facts.

Furthermore, from the scores in the Table 2, it could be inferred that the students" performance before the intervention fell far below their performance in the post-test. In the post-test all the 60 students scored above the pass mark of at least 25 marks based on the concept genetics. This means that the students performed much better in the post-test than in the pre-test. This suggested that, the students have improved upon their level of understanding of genetics concept. The improvement of performance by the students was not due to chance, but rather, it was because of the well-planned intervention strategy the researcher adopted in the lessons supported by Young (1990). According to Young (1990), one can teach science, for example, biology well, by having a well-organized classroom with the right kinds of specimen. This is in line with the constructivist‟s approach of teaching that enables students to participate actively in the lessons, and also promoted cooperative learning among the students. Each student of a group was responsible not only for learning what was taught but also helped group mates learn, and that created the atmosphere of achievement.

According to the students, that they were inspired and motivated by the way they were taught, which in turn helped improved their level of understanding of genetics concept. The illustration indicates the fact that the constructivist approach of teaching (Yelon, 1996) has a positive effect on the students‟ performance in learning the genetics concept.

4.2.2 Research Question Two

To what extent will the use of explanations, demonstrations and group work help students to differentiate, use mathematical expressions and explain selected topics in genetics and use the knowledge gained to solve problems related to genetics in their lives correctly?

Again, from the second research questions, to what extent will the use of explanations, demonstrations and group work help students to differentiate, use mathematical expressions and explain selected topics in genetics and use the knowledge gained to solve problems related to genetics in their lives correctly? The researcher have observed from the findings (Table 5) that 100% of the students scored 31 or more marks in the post-test exercise based on the genetic concept in the use of explanations, demonstrations and group work to differentiate, use mathematical expressions and explain selected topics in genetics.

This means that the students performed much better in the post-test than in the pre-test. It is also evidenced (Table 5) that the constructivist approach of teaching the researcher employed also discouraged the students from employing the guess and check method to solve problem in genetic concept, this is supported by Dewey (1966) which says that education depends on action. Knowledge and ideas emerged only from a situation in which learners had to draw on experiences that had meaning and importance to them. The intervention process has helped the students to now understand the concepts genetics and will not rely on memorized procedures to solve questions when asked.

Some of the related studies which confirm the results of this undertaken study are discussed. Genetics has been considered by many students as the most difficult concept to be learnt. Many researchers discussed the causes behind these difficulties. Johnstone and Mahmoud (1980), reported that genetics was among the difficult biology topics to be learnt by secondary school and university students. Two years later, Finley, Stewart and Yarroch, (1982) showed that Mendelian genetics, mitosis and meiosis, were difficult and important topics for students to learn. Bahar, Johnstone and Hansell (1999), found that monohybrid and dihybrid crosses and linkages, genetic engineering, meiosis, gametes, alleles and genes were perceived by students as the topics of highest difficulty. Tolman (1982), for instance, suggested that the difficulty in relating the concepts of meiosis and genetics came from the sequence in which these topics were presented in biology textbooks.

Stewart (1983), and Cho, Kahle and Nordland (1985) stressed the importance of relationships among the concept of meiosis and genetics and the ambiguous and incorrect use of genetics concepts in textbooks.

There seems to be a problem with the biology curriculum in high schools in terms of quantity of subject matter to be covered. As a result, enough time is not given to each topic to study deeply. At the same time, students are continuously being introduced new terminology and concepts. Therefore, they tend to memorize concepts rather than learn them meaningfully and fail to realize biology as a science which involves formulating hypotheses, making observations, conducting experiments, drawing conclusions, and evaluating results.

4.3 Analysis of response from student's questionnaire.

Question: Do you attend biology class regularly?

Upon the failure of candidates to answer genetic questions very well in final examination, this question was posed to find out the interest students had in studying genetics. The response is presented in Fig 1. Result in figure 1 shows students regularity in class

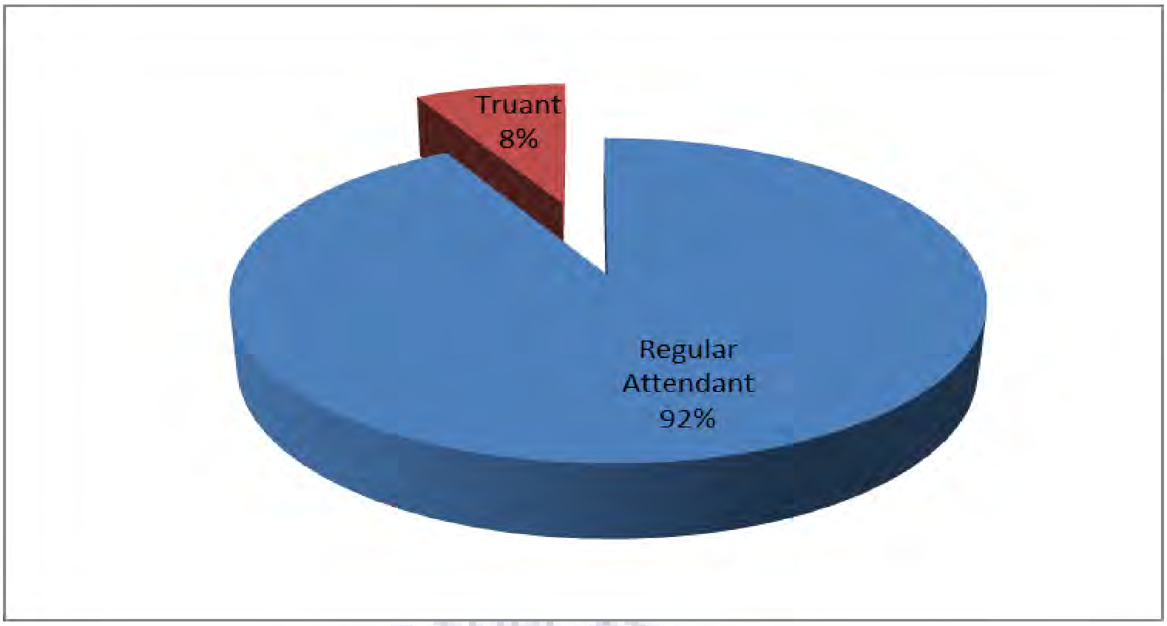

Figure 1: Students regularity in class.

Question: Do you have time practical lesson in biology?

This question sought to find out from the respondents whether practical lessons in biology have been organized for them. Result in Figure 2 shows whether students have time practical lessons in biology.

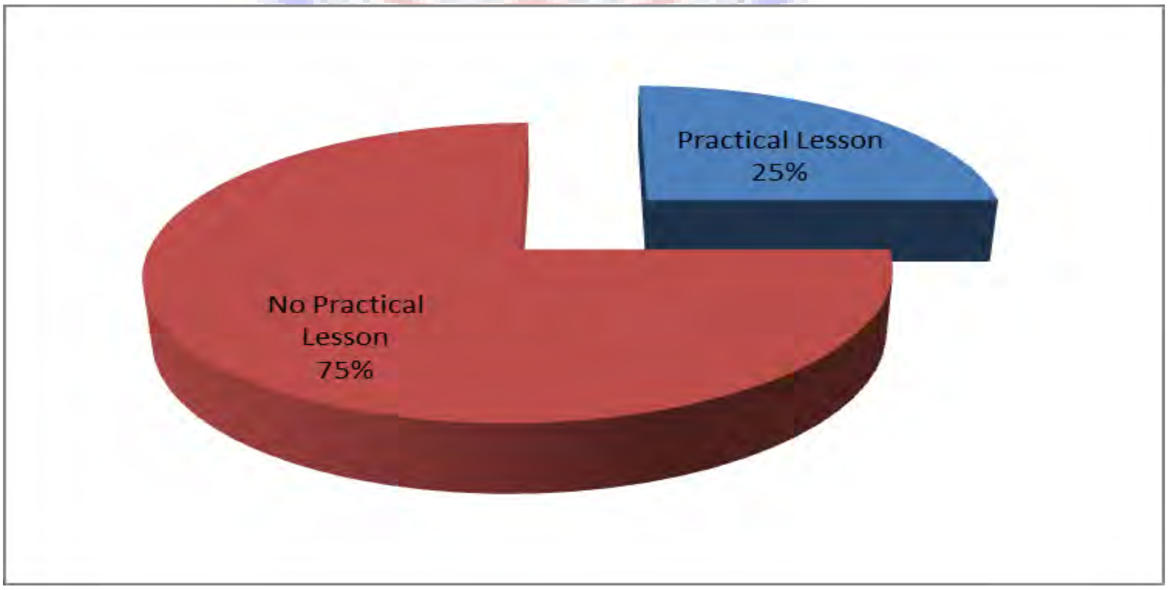

Figure 2: The percentage of practical lessons organized for students in biology.

In Fig. 2, 45 students representing 75% indicated that they had practical lessons during teaching and learning process of the biology whiles 15 students, representing 25% indicated that they never had practical lesson.

Question: What teaching method would you prefer your biology teacher to use in teaching biology?

Result in Figure 3 shows the preferred teaching method that students" would want their biology to use in teaching. This question was posed to find out students opinions about which teaching method they would prefer their teachers to use in teaching biology.

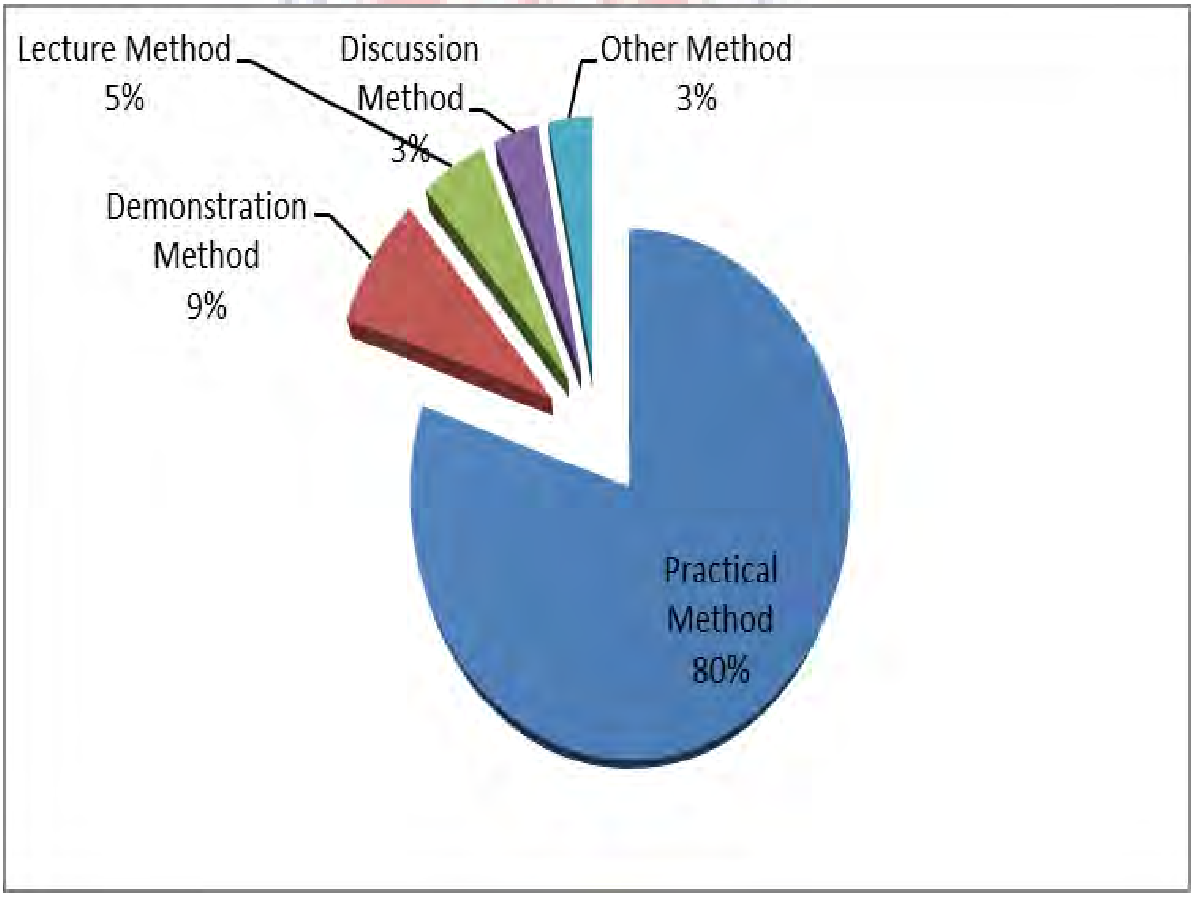

Figure 3: Students preferred teaching methods

According to Fig. 3, eighty percent (80%) of the students wished to be taught by their teachers using practical method. Nine percent (9%) prefer demonstration method whiles five percent (5%) prefer lecture method. Three percent (3%) each prefer discussion method and other methods respectively.

Reasons which appeared common in most of their explanation were the fact that, one can answer a question correctly when they are involved in discussions.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER STUDIES.

5.0 Overview

This chapter includes the summary of the findings and conclusions of the study. Also the chapter looks at recommendations for stakeholders, suggestions for further research and contributions of the study to biology educators.

5.1 Summary of the findings

The purpose of this study was to determine the influence of cooperative learning on academic performance. Cooperative learning is an important component for academic success. Based on the findings in this study, it is apparent that cooperative learning is a much needed teaching strategy for student"s achievement. Students are learning through active participation in the classroom. Posttest scores showed significantly higher performance than pretest scores. Student learning increased when cooperative learning was used. In summary using cooperative learning in social biology course will increase learning. Hence cooperative learning is as effective as traditional instruction in educational system. Considering all of the information gathered in this study, a diverse educational program that incorporates cooperative learning would be recommended.

5.2 Conclusions

According to Odubunmi and Balogun (1991), low achieving students using cooperative approach performed better than their counterparts who received the lecture method.

The findings of the study seemed to suggest that students of both Keta Senior High Technical School and Anlo Zion College in Ghana, when exposed to cooperative method of teaching and learning would retain significantly more knowledge about biology than those taught with other methods of teaching science. This is because those students who went through practical activities were able to answer questions correctly hence, their good performance.

The findings of the study give credence to the research work of Lagowski (1990), who conducted study to find out how much students retain after learning and concluded that students usually retain 10% of what they read; 26% of what they hear; 30% of what they see; 50% of what they see and hear; 70% of what they say; 90% of something they say while they are doing a task.

Generally, it can be concluded that cooperative based method of teaching and learning engaged students actively in the learning process, promoted open mindedness, helped students" acquire skills, aids better interaction among students and promote positive attitude towards biology and science in general. According to the findings of the study, it is very regrettable to describe that students are taught the theoretical lessons of genetics without practical demonstrations in the classroom or laboratory.

5.3 Recommendations

Based on the findings and the conclusions drawn from the study, the following recommendations have been made:

1. Since the findings of the study showed that students exposed to cooperative learning settings performed better than their counterparts in the individualized learning settings, students should be encourage to develop social interaction

among each other to enhance learning. This implies that biology teachers should model their instructions to enforce student – student interaction.

2. Innovative and more effective learner-centered instructional strategies, such as the cooperative instructional approach, should be used by biology teachers to promote meaningful learning of difficult biology concepts like genetics.
3. Workshops, seminars and conferences on the importance of cooperative instructional approaches should be organized for biology teachers to enable them prepare and develop themselves towards improving the achievements of their students.

5.4 Suggestions for Further Studies

By the findings of the study, the following suggestions are made for further research with respect to the use of cooperative instructional approach of teaching biology at the SHS level:

1. The study should be conducted in all parts of the country using the cooperative instructional approach to teach other difficult biology concepts such as hormonal control of human reproduction, water transport in plants, photosynthesis to see how the approach affects students" performance etc. This will help generalize the conclusions drawn from the study about the use of cooperative instructional approach to improve the concept of genetics.
2. A study should be carried out using the cooperative instructional approach on students" performance in other science subjects at different levels of science education to provide the basis for teaching and learning.

3. A study should be conducted to determine the differences between performances of students" in less endowed schools and those from highly endowed schools in biology concepts using the cooperative instructional approach.
4. Finally, the time allocated in the syllabus for the teaching and learning of science should be reviewed with enough time provided if cooperative instructional approach is to be used in teaching and learning of science subjects.

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APPENDIX A 1

KETA SENIOR HIGH TECHNICAL SCHOOL

PRE-TEST QUESTIONS

SECTION A

Background Information

1. Name…………………………………………………………………………….

2. Class…………………………………………………………………………….

Please tick [ ] in the appropriate space provided below and supply the answers where applicable

3. Gender [ ] Female [ ] Male

4. Age [ ] Years

5. Do you attend biology class regularly? [ ] Yes [ ] No

6. Do you have time practical lesson in biology? [ ] Yes [ ] No

7. What teaching method would you prefer your biology teacher to use in teaching biology?

A. Practical and discussion method

B. Demonstration method

C. Lecture method

D. Discussion method

E. Other method

SECTION B

Instruction: Please answer these questions to the best of your knowledge. Your responses will strictly be kept confidential for the purpose of this work. Answer all questions from 1-15 by circling the correct answer and answer questions C and D on a separate answer sheet to be provided.

50 Marks Time: 45 Mins.

1. The five stages of mitosis in order are:

A. anaphase, telophase, metaphase, prometaphase, prophase

B. prophase, prometaphase, metaphase, anaphase, telophase

C. prometaphase, telophase, anaphase, metaphase, prophase

D. prometaphase, metaphase, anaphase, telophase, prophase

2. Which of the following statements correctly describes meiosis?

A. Cells divide only once during meiosis

B. Meiosis does not occur in reproductive cells

C. The cells produced at the end of meiosis are genetically identical to the parent cell

D. The cells produced at the end of meiosis contain half the number of chromosomes as the parent cell

3. Which of the following statements is true about Mendel?

A. His discoveries concerning genetic inheritance were generally accepted by the scientific community when he published them during the mid-19 th century.

B. He believed that genetic traits of parents will usually blend in their children

C. His ideas about genetics apply equally to plants and animals.

D. He proposed the idea that acquired characteristics could be inherited

4. Two alternative forms of the same gene are known as

A. alleles B. genotype C. heterozygous D. phenotype.

5. Variants of genes are called………… and these arise by a process called…………

A. alleles; mutation C. recessives; differentiation

B. cells; mutation D. chromosomes; mitosis

6. If a man of blood group AB is married to a woman of blood group O then

A. all their children would belong to blood group O

B. half of their children would be blood group AB and the other half blood group O.

C. all their children would belong to blood group A,B.

D. none of their children would belong to blood group O.

7. A cross between a pure-breeding tail pea and a pure-breeding dwarf pea plant takes place, where tallness is dominant over dwarfness, and F_1 generation is selfed. The phenotypic ratio of F_2 generation will be……….

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

8. Chromosomal aberration known as deletion is said to have occurred when part of a chromosome

A. becomes detached and joined

B. breaks away and is lost

C. breaks away and attaches itself to another chromosome

D. breaks away and attaches itself to a non-homologous chromosome.

9. Which of the following features is typical of mitotic metaphase?

A. Homologous chromosome pair up

B. Nuclear membrane is visible

C. Chromatids arrange themselves on the equator

D. Crossing over occurs.

10. In the formation of mRNA molecule, thymine is replaced by

A. adenine C. guanine

B. cytosine D. uracil

11. Meiosis is important because it

A. maintains the number of chromosomes in successive generations

B. is the means of asexual reproduction in flowering plants

C. ensures that two daughter cells are genetically identical

D. brings about growth in multicellular organisms

12. Meiosis occurs in

A. somatic cells C. sperm cells only

B. all types of cells D. germ cells.

13. Separation of sister chromatids during meiosis occurs in

A. metaphase II C. prophase II

B. anaphase II D. telophase II

14. DNA replication occurs in a cell during

A. interphase of mitosis C. anaphase of mitosis

B. metaphase of meiosis D. prophase of mitosis

15. Meiosis plays a more significant role in evolution because

A. bivalents are produced

B. crossing over occurs

C. homologous chromosomes pair up

D. the division occurs twice

SECTION C

Instruction: Answer all questions in this section.

1. a) Define the following terms:

i.Test cross ii. Alleles iii. Albinism iv. Sex linkage

b) A man with a normal vision married a woman who was a carrier for colour blindness. Show clearly the vision of the offspring from these parents and explain your results

2. a) i.What do you understand by a sex-linked character?

ii. Explain why sex-linked characters are exhibited less frequent in females

b) In an experiment involving the study of two contrasting characters in pea plants, round seed plants were crossed with wrinkled seed plants. All the seeds obtained in the first filial generation were wound. When plants of the first filial generation were selfed, 5,474 round seeds and 1,850 wrinkled were obtained.

i) What conclusion can you draw from the results obtained for the first and second filial generations?

ii) Using diagrams only show the genotypes of the pea plants for the second filial generations.

SECTION D

Answer at least two (2) questions from this section.

1. (a) What is variation?

(b) Write short notes on the following:

i.Continous variation; ii. Discontinuous variation iii. Universal donor

(c) State two applications of variation.

2. a) Explain the following terms:

i. Diploid ii. Polygenic inheritance

b) i. Explain the differences between sex linkage and autosomal linkage

ii. Give two examples of a sex-linked character

c) Mr. Robert who does not have the sickle-cell anaemia traits I married to Mary who is a sickler, yet he claims the sickler child born to them is not his child. Determine by aid of a genetic whether his claim is true.

3. a) i. Differentiate between dominant and recessive gene.

ii. Differentiate between F_1 and F_2 generations.

b) Explain the following:

i. Chromosome ii. Mutation

c) State the three types of mutation.

APPENDIX A2

KETA SENIOR HIGH TECHNICAL SCHOOL

PRE-TEST MARKING SCHEME

SECTION B

1. B

2. D

3. C

4. A

5. A

6. C

7. C

8. B

9. C

10. D

11. A

12. D

13. B

14. A

15. C

(Scoring: 1 mark each) **Sub-total = 15**

SECTION C

1. a (i) **Test Cross:** A cross between an individual showing a dominant phenotype with a homozygous recessive individual, to determine the genotype of the individual.

OR

It is the mating of an F_2 individual, which has the phenotype of the dominant parent, with its double recessive (back cross) **(1 mark)**

(ii) **Alleles:** Alleles are different forms of genes that occupy the same locus or relative position on homologous chromosomes, and produce contrasting characteristics. **(1 mark)**

(iii) **Albinism:** Is a condition where there is a failure to produce skin pigment. This is caused by a recessive gene on the autosome.

Albinos lack pigmentation in the skin, eye and brain. **(1 mark)**

b.

Let „A" represent normal sight and „a" colour blindness

Parental Phenotype: Normal male Carrier female

Parental Genotype: X^AY X^AX^a

Gametes: (X^A) (Y) (X^A) (X^a)

Random fertilization

F_1 Genotype: X^AX^A X^AX^a X^AY X^aY

F_1 Phenotype: Normal female Carrier female Normal male Colour blindness male

The gene for colour blind is recessive and is carried on the X-chromosomes. The Y-chromosome carries no corresponding genes or is empty. Half of their daughters will be normal, while the other half will be carriers, half of the genes will have normal visions, while the other half will be colour-blind.

Correct drawing of diagram with correct labelling. **(4 marks) or Zero.**

Conclusion **(2 mark)**

2. a. (i) Sex-linked character: Is a character which is controlled by a gene located on the X-sex chromosome, hence the character is inherited together with that sex. **(1 mark)**

(ii) Why sex-linked characters are exhibited less in females

Females have two X-chromosomes.

Sex linked characters are controlled by recessive genes.

A female must have two recessive genes to exhibit a sex-linked character, this is a very rare occurrence because a dominant gene normally occurs in one of the chromosomes. **(2 marks)**

b. (i) Gene for roundiness is dominant **($^1/_2$ mark)**

Gene for wrinkled is recessive **(½ mark)**

(ii) Genotype for the second filial generations:

F_1 Phenotype:	Round	X		Round
F_1 Genotype	Rr			Rr
Gametes	(R) (r)			(R) (r)
Random Fertilization				
F_2 Genotype	RR	Rr	Rr	rr

Correct drawing of diagram with correct labelling. **(5 marks) or Zero.**

Conclusion **(2 mark)**

SECTION D

1. (a) <u>**Variation:**</u> It is the occurrence of difference in characters among individuals of the same species or descent as a result inherited genes from parents and or the effect of different environmental factors on the same species. **($1^1/_2$ marks)**

b. (i) <u>**Continuous variation:**</u> When variation within species is gradual or when there are intermediate forms between the two extremes. Example height, weight, skin colour, intelligence.

($1^1/_2$ marks)

(ii) **Discontinuous variation:** When variation exists in distinct groups within a species when there is no clear-cut difference between the characters with no intermediate forms. Example Rhesus factor, blood groups, sex, tongue rolling, sickle cell.

($1^1/_2$ marks)

(iii) **Universal donor:** Is a person with blood group O; who can donate blood to a recipient of any blood group, **but cannot** receive blood except from his own group as a result of the antibodies present in his blood.

($1^1/_2$ marks)

(c) Two applications of variation:

- ✓ Crime detection using thumbprints, skin colour, eye colour, height
- ✓ Blood group determination/ blood transfusion
- ✓ Determination of paternity of a child
- ✓ Classification of human race
- ✓ Evolution studies
- ✓ Admission or selection of students or pupils into an institution based on age and intelligence. **(Any 2 for 2 marks)**

2. a. (i) Diploid: Refers to a nucleus or cell of an organism with two sets of chromosomes present. **(1 mark)**

One set derived from the female parent and one set derived from the male parent.

(ii) Polygenic inheritance: Is the determination of a character or trait controlled by

many genes, each having an effect on the phenotype. **(1 mark)**

b. Difference between sex linkage and autosomal linkage

(i) In Sex linkage the gene responsible for a trait is carried on the sex or X-chromosome; while in autosomal linkage the genes occur on the autosomal chromosome or autosomes. **(2 marks)**

(ii) Examples of sex linked characters

Haemophilia, Colour blindness, Baldness etc. (**$^1/_2$ mark each, any 2 for 1 mark)**

c. Genetic diagram

	Robert (No trait)			Mary (Sickle)	
Genotype	A A		X	S S	
Gametes	(A) (A)			(S) (S)	
F_1	AS	AS		AS	AS
Phenotypic:	Carrier	Carrier		Carrier	Carrier

Correct drawing of diagram with correct labelling. **(2 marks) or Zero**.

Interpretation: All the children are carriers, therefore their claim is true.

Conclusion **(2 mark)**

3. a. (i) Dominant allele is the member of a pair of alleles that shows its characteristics in the phenotype, whatever other allele is present while recessive allele is the member of a pair of alleles that does not show its characteristics in the phenotype in the presence of any other allele. **(2 marks)**

(ii) F_1 (first filial generation) is the offspring produced by crossing the parental generation while F_2 (second filial generation) is the offspring produced by crossing the F_1 generation. **(2 marks)**

b. (i) **Chromosome:** Are threadlike structures present in the nucleus of a cell which bear genes or carry coded genetic or hereditary information or DNA; that determines the chemical and physical processes for every individual. **(1 mark)**

(ii) **Mutation:** Is a spontaneous or sadden change in the genetic make-up of an organism; resulting in a new stable characteristic or genetic information giving rise to distinct trait or character in the organism.**(1 mark)**

c. Types of mutation:

(i) Chromosomal mutation or aberration or translocation

(ii) Change in genes or point mutation or change in DNA

(iii) Change in chromosome number or deletion or duplication

($^1/_2$ mark each, total = $1^1/_2$ marks)

APPENDIX B1

KETA SENIOR HIGH TECHNICAL SCHOOL

POST-TEST QUESTIONS

SECTION A

Background Information

1. Name…………………………………………………………………………

2. Class…………………………………………………………………………

Please tick [ ] in the appropriate space provided below and supply the answers where applicable

3. Gender [ ] Female [ ] Male

4. Age [ ] Years

Instruction: Please answer these questions to the best of your knowledge. Your responses will strictly be kept confidential for the purpose of this work. Answer all questions in this section.

Time: 45 minutes 50 Marks

SECTION B

1. Identical twins have the same sex because

   A. genetical material from both parents is the same

   B. genetical material from both parent is dominant

   C. they develop from a single fertilized ovum

   D. they develop two eggs fertilized at the same time

2. The theory of evolution as proposed by Lamarck is

   A. inheritance of acquired characteristics

B. natural selection

C. origin of species through mutation

D. survival of the fittest

3. A drastic change in the genetic composition of an organism is termed

A. epistasis C. syndrome

B. mutation D. variation

4. The result of a cross between two heterozygous characters is

A. 50% recessive and 50% dominant

B. 100% recessive

C. 100% dominant

D. 25% recessive and 75% dominant

5. A female horse which mates with a male donkey produces a mule which was stronger than either parent. This is an example of

A. a dominant trait C. hybrid vigour

B. an acquired character D. incomplete dominance

6. A plant which is homozygous for the gene for red flowers is cross with a plant which is homozygous for the gene for white flowers. The F1 offspring of the two plants are selfed. How many genotypes and phenotypes would be represented in the F2 generation if red colour is dominant over white colour?

A. Three genotypes and three phenotypes

B. Three genotypes and two phenotypes

C. Two genotypes and three phenotypes

D. Two genotypes and two phenotypes

7. Which of the following statements about sex-linked characters is true?

A. Are less frequent in males

B. The characters are less frequent in males

C. Genes for such characters are dominant

D. Genes for such characters do not assort independently

8. What is the probability of a woman of blood group AB married to a man of blood group O producing child of blood group O.?

A. 75% B. 50% C. 25% D. 0%

9. How would an individual who is a carrier of haemophilia be represented?

A. $X^H X^H$ B. $X^H Y$ C. $X^h Y$ D. $X^H X^h$

10. What is the function of chromosomes in the body?

A. Getting rid of metabolic waste

B. Releasing energy in the cell

C. Breaking down a cell after death

D. Determining the characteristics of the organism.

11. A man who has normal blood clotting marries a woman who is a carrier for the recessive gene for haemophilia. What proportion of their offspring could have the disease haemophilia?

A. 1 in 8 C. 1 in 4

B. 1 in 6 D. 1 in 3

12. A man with normal blood cells (HH), had two successive wives who were both carriers of the gene for sickle-cell anaemia (HS). Altogether he fathered nine children. Which one of the shows the likely number of children who developed sickle-cell anaemia (sicklers)?

A. 9 C. 3

B. 6 D. 0

13. Two tall plants, each being hybrids and carrying a recessive factor for dwarfness, were crossed. Which one of the following shows the correct proportion of offspring that are dwarfed?

A. 1 in 2 C. 1 in 4

B. 1 in 3 D. 1 in 5

14. Which of the following is an example of continuous variation?

A. tongue rolling C. Rh factor

B. blood group D. height

SECTION C

Instruction: Answer all questions in this section.

1(a) State the first and second law of Mendel

(b) i. Determine using the appropriate genetic symbols, the possible blood groups of the offspring of parents with blood groups A (Father, heterozygous A) and B (Mother, heterozygous B)

ii. State four applications of variations.

2. (a) i. What is monohybrid cross?

ii. If the recessive gene responsible skin colour in albinism is represented by a, what are the possible genotypes and phenotypes of offspring produced by a homozygous normal man and a heterozygous albino woman.

(b) Explain the importance of DNA replication

SECTION D

Instruction: Answer any two questions from this section.

1. (a) i.Explain how the sex of a human body is determined

ii. Name two sex-linked characters.

b) A couple had four children, two boys and two girls. On investigation it was discovered that all the children had different blood groups. With the aid of a genetic diagram determine the blood groups of the parents.

2. a) Differentiate between homozygote cell and heterozygote cell

b) Explain the following:

i. Chromosome ii. Mutation

c) State the three types of mutation.

3. a) Define the following terms:

i.Test cross ii. Alleles iii. Albinism iv. Sex linkage

b) A man with a normal vision married a woman who was a carrier for colour blindness. Show clearly the vision of the offspring from these parents and explain your results

APPENDIX B2

KETA SENIOR HIGH TECHNICAL SCHOOL

POST-TEST MARKING SCHEME

SECTION A

1. C	**8. D**
2. A	**9. D**
3. B	**10. D**
4. D	**11. C**
5. C	**12. D**
6. B	**13. D**
7. D	**14. C**
(Scoring: 1 mark each)	**Sub-total = 14**

SECTION C

1. **(a) First and Second laws of Mendel**

   First Law: The first of Law of Mendel is the Law of Segregation which states that characters of an organism characters of an organism are controlled by genes occurring in pairs which are independently transmitted in gametes from one generation to another. **(2 marks)**

   Second law: The second Law of Mendel is the Law of Independent Assortment which states that each character behaves as a separate unit and is inherited independently of another character. **(2 marks)**

b. (i) **using the appropriate genetic symbols**

Parents:	Male		Female
Phenotype:	Group A	x	Group B
Genotype:	A O	x	B O
Gametes:	(A) (O)	x	(B) (O)

F_1 Genotype: AB AO BO OO

Correct drawing of diagram with correct labelling. **(2 marks) or Zero.**

Therefore the blood groups are AB, A, B, and O. **(2 marks)**

(ii) **Applications of variation**

- ✓ Crime detection using thumbprints, skin colour, eye colour, height.
- ✓ Blood group determination / blood transfusion
- ✓ Determination of paternity of a child
- ✓ Classification of a human race
- ✓ Evolution studies
- ✓ Admission / selection of students / pupils into an institution based on age and intelligence. **($^1/_2$ mark each, any 4 for 2 marks)**

2. a. (i) Monohybrid cross: Is a cross between two individuals of parents who differ in only one genetic character or which involves alleles of one specific character. **(1 mark)**

(ii). A cross between homozygous normal man and heterozygous female albino

Phenotype: Homozygous normal male Heterozygous Female albino

Genotype: A A x A a

Gametes: (A) (A) x (A) (a)

Genotype: AA Aa AA Aa

Correct drawing of diagram with correct labelling. **(4 marks) or Zero.**

Phenotype: 2 normal skin colour skin and 2 carriers. **(2 marks)**

b. **Importance of DNA replication**

- ✓ DNA keeps the number of chromosomes in an organism constant from generation to generation
- ✓ It transmits the characteristics of parents to offspring
- ✓ Used for cloning of organisms e.g. cow
- ✓ Used for protein or enzyme synthesis
- ✓ Used in the production of crops or seedless fruits or fast-maturity, yielding crops. **(1 mark for each, any 3 = 3 marks)**

SECTION D

1. a. (i) How the sex of a Human baby is determined

   - ✓ In humans the sex chromosome or 23^{rd} pair of chromosome determines the sex of an individual. **($^1/_2$ mark)**

- ✓ The female sex chromosomes re homozygous or the same or homogametic, designated as X-chromosomes. The woman therefore produces only X gametes (**$^1/_2$ mark)**
- ✓ The male sex chromosomes are heterozygous or different or heterogametic, designated as X and Y. (**$^1/_2$ mark)**
- ✓ During fertilization, if the Y gamete from the male fuses with the female X gamete, the zygote formed is XY and the baby is a male. **($^1/_2$ mark)**
- ✓ If the X gamete of the male fuses with the female X gamete, the zygote formed is XX; hence the baby will be female.**(1 mark)**

(ii) **Sex-linked characters**

Red-green colour blindness, Haemophilia, Diabetes insipidus, Retinitis, Pigmentosa, Hair on the ear, Baldness. (**$^1/_2$ mark each, any 2 = 1 mark)**

b. **Blood group of parents**

There are only 4 possible blood groups in humans- AB, O, A and B and their genotypes are AB, OO, AO and BO.

For the offspring to four (4) blood groups, the gametes I^A, I^B, and I^o must be involved

For a child to have blood group AB, one parent must have produced gamete A and another B.

For a child to have blood group OO both parents must have produced O gametes each. Thus each parent must have/ possess an O gamete.

Heterozygous A and B

Genotype: $I^A I^O$ x $I^B I^O$

Gametes: (I^A) (I^O) x (I^B) (I^O)

F_1 I^AI^B I^AI^O I^BI^O I^OI^O

Blood groups AB OA OB OO.

Correct drawing of diagram with correct labelling. **(3 marks) or Zero.**

Phenotypic expression of blood groups of parents are A and B. **(1 mark)**

2. a. Heterozygote cell is a cell or organism that contains two different alleles for any one gene while homozygote cell is a cell or organism that contains two identical alleles for any one gene.**(2 marks)**

b. (i) **<u>Chromosome:</u>** Are threadlike structures present in the nucleus of a cell which bear genes or carry coded genetic or hereditary information or DNA; that determines the chemical and physical processes for every individual. **($1^1/_2$ marks)**

(ii) **<u>Mutation:</u>** Is a spontaneous or sadden change in the genetic make-up of an organism; resulting in a new stable characteristic or genetic information giving rise to distinct trait or character in the organism. **($1^1/_2$ marks)**

c. **Types of mutation:**

(i) Chromosomal mutation or aberration or translocation

(ii) Change in genes or point mutation or change in DNA

(iii) Change in chromosome number or deletion or duplication

(Each point for 1 mark, total = 3 marks).

3. a. (i) **Test Cross:** A cross between an individual showing a dominant phenotype with a homozygous recessive individual, to determine the genotype of the individual. OR

It is the mating of an F2 individual, which has the phenotype of the dominant parent, with its double recessive (back cross). **(1 mark)**

(ii) **Alleles:** Alleles are different forms of genes that occupy the same locus or relative position on homologous chromosomes, and produce contrasting characteristics**. (1 mark)**

(iii) **Albinism:** Is a condition where there is a failure to produce skin pigment. This is caused by a recessive gene on the autosome.

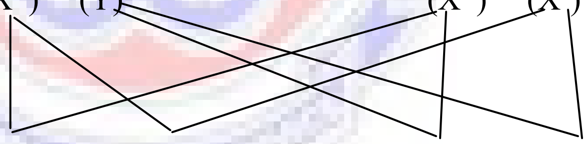
Albinos lack pigmentation in the skin, eye and brain. **(1 mark)**

b. Let „A‟ represent normal sight and „a‟ colour blindness

Parental Phenotype: Normal male Carrier female

Parental Genotype: X^AY X^AX^a

Gametes: (X^A) (Y) (X^A) (X^a)



Random fertilization

F_1 Genotype:	X^AX^A	X^AX^a	X^AY	X^aY
F_1 Phenotype:	Normal female	Carrier female	Normal male	Colour blindness male

Correct drawing of diagram with correct labelling. **(3 marks) or Zero.**

The gene for colour blind is recessive and is carried on the X-chromosomes. The Y-chromosome carries no corresponding genes or is empty. Half of their daughters will be normal, while the other half will be carriers, half of the genes will have normal visions, while the other half will be colour-blind. **(2 marks).**

APPENDIX C

LETTER OF INTRODUCTION

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF SCIENCE EDUCATION
P. O. BOX 25, WINNEBA - TEL. NO. 0202041079

[illegible]

Dear Sir,

TO WHOM IT MAY CONCERN
INTRODUCTORY LETTER

The bearer of this letter, Ebo Quarshie Atupoe with Index Number 7130130016 is a student offering Master of Education in Science Education in the Department of Science Education of the above University.

He is conducting a research on "*[illegible] Cooperative Instructional Approach [illegible] Concept of Genetics in [illegible] SHS*"

Please Mr Ebo Quarshie Atupoe started his research work in August 2014.

Your school has been selected as part of his sampling area.

I hope you would assist him to do a good thesis write-up.

Thank you

VICTOR ANTWI, PHD.
Head of Department