UNIVERSITY OF EDUCATION, WINNEBA

TEACHING METHODS AND STUDENTS' ACADEMIC PERFORMANCE IN GENETICS.

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DECEMBER, 2016

DECLARATION

STUDENT'S DECLARATION

I, Benjamin Dadzie, declare that this Dissertation, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE:……

DATE:……

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this Dissertation was supervised in accordance with the guidelines for supervision of Dissertations as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: PROFESSOR K. D. TAALE

SIGNATURE:……

DATE:……

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DEDICATION

This work is dedicated to my dear mother, Ms. Comfort Gyan.

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ABSTRACT

The purpose of this study was to determine the effects of Concept Mapping Teaching Approach on students' achievement in Genetics. The research design for this investigation was an experimental study design that employed pre-test and post-test control group design. The population for the study was all the 1,500 students of Hwidiem Senior High School located in Ahafo in the Asutifi North District of Ghana. Purposive

sampling technique was used to select three classes that formed the sample. Together, 108 students including 22 boys and 86 girls were selected. Group A, the control group, was made up of 20 boys and 13 girls offering general science as their major course. The experimental groups (B and C) were made up of 30 girls and a boy and 34 girls and a boy respectively; all of which offered home economics as their major course. The data for this study was collected using the instrument Genetics Achievement Test (GAT). Descriptive statistics was used to analyze the estimated marginal means, standard deviation and standard error estimates while student t-test statistics was used to test the hypothesis at 0.05 level of significance. Analysis of variance (ANOVA) was used to analyze the differences in post-test mean scores of the groups. The results of this study show that Concept Mapping Approach of Teaching resulted in significantly higher students' achievement in Biology. The results of this study may be beneficial to Biology teachers, teacher trainers and curriculum developers in improving teaching-learning process and achievement in Biology.

CHAPTER ONE

INTRODUCTION

The primary purpose of teaching at any level of education is to bring a fundamental change in the learner (Tebabal & Kahssay, 2011). To facilitate the process of knowledge transmission, teachers should apply appropriate teaching methods that best suit specific

objectives and level exit outcomes. In the traditional epoch, many teaching practitioners widely apply teacher-centred methods to impart knowledge to learners comparative to student-centred methods. Until today, questions about the effectiveness of teaching methods on student learning have consistently raised considerable interest in the thematic field of educational research (Adunola, 2011). Moreover, research on teaching and learning constantly endeavour to examine the extent to which different teaching methods enhance growth in student learning. Quite remarkably, regular poor academic performance by the majority of students is fundamentally linked to application of ineffective teaching methods by teachers to impact knowledge to learners (Adunola, 2011). Substantial research on the effectiveness of teaching methods indicates that the quality of teaching is often reflected by the achievements of learners. According to Ayeni (2011), teaching is a process that involves bringing about desirable changes in learners so as to achieve specific outcomes. In order for the method used for teaching to be effective, Adunola (2011) maintains that teachers need to be conversant with numerous teaching strategies that take recognition of the magnitude of complexity of the concepts to be covered.

Traditional instructional practices that center on teacher dominated pedagogy predominate in most schools. Learning activities in most secondary school classrooms focus on textbooks and past examination papers. These two serve as major determinants of what is taught in schools.

Biology is one of the fundamental science subjects. Research has shown that students have consistently performed poorly in Biology Examinations conducted by external bodies such as West African Examinations Council (WAEC) (Osokoya, 2003; Ibraheem,

2004). Prominent among the contributing factors to students' persistent poor performance or under achievement in Biology include ineffective teaching methods or approaches used by science teachers (Njoku, 2004).

An analysis of the chief examiner's report of WAEC, NOV/DEC and MAY/JUNE (2009-2013) of West African Senior Secondary School Certificate Examination (WASSCE) revealed that most of the senior high school candidates are not familiar with genetic questions. In most of the cases, many candidates avoid it and those who attempt it do not do very well manifesting candidates aversion for genetics. According to the report, many candidates are not familiar with the genetic terms making their understanding of them very difficult. Candidates who attempt questions with genetic diagrams perform woefully and cannot give any logical explanation as to how some genetic traits are inherited. Many candidates can also not explain the application of genetics in marriage counselling per the report. The report further suggested that adequate coverage of the syllabus coupled with effective teaching strategies can help remedy the situation.

One of the teaching strategies found to be effective in helping students to learn is the use of concept maps. Concept maps were developed in 1972 in the course of Novak's research program at Cornell University where he sought to follow and understand changes in children's knowledge of science (Novak & Musonda, 1991). The fundamental idea in Ausubel's cognitive psychology is that learning takes place by the assimilation of new concepts and propositions into existing concept and propositional frameworks held by the learner (Novak & Cañas, 2008). This knowledge structure as held by a learner is also referred to as the individual's cognitive structure. Out of the necessity to find a better

way to represent children's conceptual understanding emerged the idea of representing children's knowledge in the form of a concept map.

Concept maps are graphical tools for organizing and representing knowledge (Novak & Cañas, 2008). They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts. Words on the line referred to as linking words or linking phrases, specify the relationship between the two concepts.

Concept is a perceived regularity in events or objects, or records of events or objects, designated by a label (Novak & Cañas, 2008). The label for most concepts is a word, although sometimes symbols such as + or %, and sometimes more than one word is used. Propositions are statements about some object or event in the universe, either naturally occurring or constructed. Propositions contain two or more concepts connected using linking words or phrases to form a meaningful statement (Novak & Cañas, 2008).

One characteristic of concept maps is that they are represented in a hierarchical fashion with the most inclusive, most general concepts at the top of the map and the more specific, less general concepts arranged hierarchically below. The hierarchical structure for a particular domain of knowledge also depends on the context in which that knowledge is being applied or considered. Therefore, it is best to construct concept maps with reference to some particular question we seek to answer, called a focus question. The concept map may pertain to some situation or event that we are trying to understand through the organization of knowledge in the form of a concept map, thus providing the context for the concept map (Novak & Cañas, 2008).

Another feature that may be added to concept maps is specific examples of events or objects that help to clarify the meaning of a given concept. Normally these are not included in ovals or boxes, since they are specific events or objects and do not represent concepts (Novak & Cañas, 2008).

The question sometimes arises as to the origin of our first concepts. These are acquired by children during the ages of birth to three years, when they recognize regularities in the world around them and begin to identify language labels or symbols for these regularities (Novak & Cañas, 2008). This early learning of concepts is primarily a discovery learning process, where the individual discerns patterns or regularities in events or objects and recognizes these as the same regularities labeled by older persons with words or symbols. This is a phenomenal ability that is part of the evolutionary heritage of all normal human beings. After age 3, new concept and propositional learning is mediated heavily by language, and takes place primarily by a reception learning process where new meanings are obtained by asking questions and getting clarification of relationships between old concepts and propositions and new concepts and propositions. This acquisition is mediated in a very important way when concrete experiences are available. This makes "hands-on" activity for science learning with young children very important, but this is also true with learners of any age and in any subject matter domain (Novak & Cañas, 2008).

In addition to the distinction between the discovery learning processes, where the attributes of concepts are identified autonomously by the learner, and the reception learning processes, where attributes of concepts are described using language and

transmitted to the learner, Novak and Cañas, (2008) made a very important distinction between rote learning and meaningful learning.

One of the powerful uses of concept maps is not only as a learning tool but also as an evaluation tool, thus encouraging students to use meaningful-mode learning patterns (Mintzes, Wandersee & Novak, 2000). It has been reported by Wallace and Mintzes (1990) that concept map instructional method enhanced academic achievement more than computer assisted instruction in science when taught to pre-service teachers. Also Jibrin, Abba and Zayum (2012) found significant difference in the academic achievement of secondary school students taught genetics using concept map instructional strategy.

Concept maps are also effective in identifying both valid and invalid ideas held by students. The only solution to the problem of overcoming misconceptions is to help learners learn meaningfully, and using concept maps can be very helpful (Novak, 2002).

Another reason concept mapping is so powerful for the facilitation of meaningful learning is that it serves as a kind of template or scaffold to help to organize knowledge and to structure it, even though the structure must be built up piece by piece with small units of interacting concept and propositional frameworks (Novak & Cañas, 2008).

1.1.0 PROBLEM STATEMENT

Many students avoid genetic questions in their final WASSCE examination and those who attempt such questions perform woefully and this has largely been cited to be the result of ineffective teaching methods by teachers. In most of the cases, many candidates avoid genetic questions and those who attempt it do not do very well manifesting

candidates aversion for genetics. Candidates who attempt questions with genetic diagrams perform woefully and cannot give any logical explanation as to how some genetic traits are inherited. Many candidates can also not explain the application of genetics in marriage counselling.

1.2.0 OBJECTIVES

This study was guided by the following objectives:

1. To investigate whether there are any significant differences between the effectiveness of different teaching methods on students' academic performance in genetics.
2. To determine whether the use of Concept Mapping Teaching Approach is gender friendly with students.
3. To establish whether the use of Concept Mapping Teaching Approach in genetics is achievable in terms of time allocated for in the Ghana Education Service Biology syllabus.

1.3.0 RESEARCH QUESTIONS

The following research questions guided the study:

1. To what extent does the mean of scores of students taught using Concept Mapping Approach have any significant differences than the mean scores of students taught using other expository methods?

2. To what extent does the use of Concept Mapping Approach of Teaching gender friendly with students?
3. To what extent does the use of Concept Mapping Approach of teaching genetics achievable in terms of time allocated for in the Ghana Education Service biology syllabus?

1.4.0 THE NULL HYPOTHESIS WAS FORMULATED FOR TESTING AT ≤ 0.05 SIGNIFICANT LEVELS.

Ho: There is no significant difference in the mean academic achievement of male and female senior high school students taught genetics using concept map instructional method.

1.5.0 SIGNIFICANCE OF THE STUDY

The results of this study will provide useful insights on differential effects diverse teaching methods have on students' academic performance in genetics.

1.6.0 DELIMITATIONS OF THE STUDY

Hwidiem Senior High School was selected for the experiment because the researcher teaches in the school and has direct interaction with the sample population to eliminate possible biases. Again, it is also very difficult to get access to students to conform to experimental conditions when the researcher is not a staff in the school as most of the heads of such schools may not allow access to the students. Fraenkel and Wallen (2000) recommended that at least 30 subjects per experimental group were appropriate for such studies and the experimenter could not have selected more students for the study.

1.7.0 LIMITATIONS OF THE STUDY

The study was limited in the extent of the individual student's academic ability. Individual students' academic abilities affected how much they scored when they have been subjected to the same treatment and available resources.

Ministry of Education, (2003) puts a total of six periods a week, each period consisting of forty minutes, for the teaching of biology. The syllabus proposes that the teaching of biology should be student-centered and activity oriented and it is very difficult for the researcher to manipulate the contact hours and the approach of teaching.

CHAPTER TWO

LITERATURE REVIEW

2.1.0 THEORIES OF LEARNING

2.1.1 The Behaviourist View of Learning

Behaviourists regard all behaviour as a response to a stimulus. They assume that what we do is determined by the environment we are in, which provides stimuli to which we respond, and the environments we have been in in the past, which caused us to learn to

respond to stimuli in particular ways. Behaviourists believe that it is unnecessary to speculate about internal mental processes when explaining behaviour: it is enough to know which stimuli elicit which responses. Behaviourists also believe that people are born with only a handful of innate reflexes and that all of a person's complex behaviours are the result of learning through interaction with the environment. They also assume that the processes of learning are common to all species and so humans learn in the same way as other animals. Behaviourists explain behaviour in terms of the stimuli that elicit it and the events that caused the person to learn to respond to the stimulus that way. Behaviourists use two processes to explain how people learn: classical conditioning and operant conditioning. In classical conditioning, people learn to associate two stimuli when they occur together, such that the response originally elicited by one stimulus is transferred to another. The person learns to produce an existing response to a new stimulus. In operant conditioning, people learn to perform new behaviours through the consequences of the things they do. If a behaviour they produce is followed by reinforcement then the likelihood of that behaviour being repeated increases in future. A consequence can be reinforcing in two ways: either the person gets something good (positive reinforcement) or they avoid something bad (negative reinforcement). Conversely, if behaviour is followed by a punishment then the likelihood of that behaviour being repeated in future decreases (Ferster & Skinner, 1957).

2.1.2 The Cognitivist View of Learning

Piaget believed that people's thinking changed as a way to adapt to their environment and that the highest level of thinking people could develop is abstract thought. Piaget believed that we construct knowledge. Cognitive development happens as children's

concrete hands-on experiences and knowledge of the physical world become mental actions. This happens so that children can adapt to their environment (Duffy & Jonassen, 2013). Children use schemas to make sense of the world. Schemas are actions that organize and give structure to our thoughts. They can be simple or complex. The number of schemas or actions increases as children grow older. They also become more complex. Change happens because the information that a child encounters is different from what he or she already knows. This creates disequilibrium or a sense of being out of balance for the child. Mentally, he or she needs to take an action in order to get back into balance. When a child comes across new information, this new information is automatically compared to what already exists. If the new information is like what's already there, it's added and the child ends up with more schemas; more actions he or she can use to adapt to his or her environment. This process is called assimilation. When a child comes across new information that doesn't fit with what's already there, the information is ignored or the child's brain tries to make a match for it. This process is called accommodation. The child's existing schema or actions have to change to make room for this new information.

Piaget's idea that knowledge is constructed takes place in four different periods, the sensorimotor period, the preoperational period, the concrete operational period and the formal operational period. Children move from one stage to the next as their schemas become more complex. Each stage has unique qualities that help us to have appropriate expectations about children's thinking.

At the sensorimotor period (birth to Age 2), infants and toddlers begin constructing knowledge and learning about their world by using their senses (sight, hearing, feeling, taste, and smell) and their motor abilities. It starts with each baby's automatic reflexes.

These automatic reflexes can include the rooting, sucking and startle reflexes. There are two very important characteristics of the sensorimotor period; object and person permanence and egocentric thinking. Object permanence is the idea that even if something is out of sight, it still exists. You probably know it as, out of sight, not out of mind. During egocentric thinking, the children are unable to stand in someone else's shoes and see things from a different perspective. Children in these stages of development literally believe that what they see, everyone sees, what they think, everyone thinks, and what they feel, everyone feels. They haven't developed the mental ability to understand that their behaviour can set off someone else's reactions and responses.

The Preoperational Period (Ages 2 to 7) is the stage where children acquire language. Language development plays a big role in this period. Children use their spoken language to change their physical actions and experiences into mental thoughts (Duffy & Jonassen, 2013). They are able to think about things that are out of sight or a very long way off. Until this happens, though, children in this period of cognitive development will need you to continue to provide them with lots of hands-on concrete activities. They will still need lots of opportunities to see, hear, smell, touch and talk about new objects and experiences in order to learn. Appropriate expectations about how children's mental abilities develop come from understanding perception, centration, egocentric speech and intuitive thought.

The Concrete Operations Period (Ages 7 to 11) is the next stage of development. It takes years for a child's ability to think to advance to this level. Only as a child gets closer to eleven does he or she have the ability to think concretely and to think like an adult.

Children in this period don't always have to have an actual physical experience with an object in order to know it. It's during this phase that children can perform more complex mental operations (Piaget, Inhelder & Piaget, 2013).

The Formal Operations Period (Ages 11 to 15) is the final stage of development in children. When children reach the formal operations period, they are able to think abstractly. This child no longer needs to have hands-on experience with objects or physical knowledge of objects he or she knows in order to think about them and to solve problems that will result in adaptations to their environment. Everything takes place in the mind (Duffy & Jonassen, 2013).

Vygotsky's ideas about how mental abilities develop, on the other hand, show us how important and necessary the social and cultural context are to developing each child's mental abilities. Vygotsky believed that children depend on others to develop their cognitive skills and abilities. According to Makitalo (2016), each child understanding of the world and their ability to adapt to it comes from their interactions with their parents, their siblings and others in their environment. Makitalo (2016) contends that knowledge is developed as a result of social interactions in which children, working alongside others, more knowledgeable and experience than they are work together to solve problems and build knowledge. As a result of these interactions children gradually learn to think on their own. Two essential elements of the social interactions that result in cognitive development are scaffolding and the Zone of Proximal Development (ZPD) (Gibbons, 2002). Scaffolding is a way of interacting with children that helps them to develop the ability to reason. It happens when children use adults who are more knowledgeable than them as a benchmark for their learning. Such adults also serve as lifting points in the

learning processes of the child. In Vygotsky's view of cognitive development, the adults or other partners in a child's world provide scaffolding to help children learn new information and develop more complex thinking abilities. The Zone of Proximal Development helps to decide if a task is too easy or too hard for a child and make changes so that the activity will fall within a child's ZPD. The ZPD is what a child is able to do with some help. Vygotsky's theory showed how important people are in a child's cognitive development.

2.1.3 The Constructivist View of Learning

Watts and Bentley (1991) defined constructivism as a family of theories that share the assertion that human knowledge and experience entail the active participation of the individual. The constructivist position holds that knowledge is not passively received, but is actively built up by the cognizing subject (Driver, Asoko, Leach, Scott & Mortimer, 1994). Different proponents of constructivism emphasize different aspects about construction of knowledge. Radical constructivism, on the one hand, focuses on personal construction of knowledge. This perspective posits that the learner constructs his own knowledge and the meaning constructed is peculiar to the individual learner (Duffy & Jonassen, 2013). However, Jaworski, Dyster, Moore, Nienow and Wyszynski (1997) interpreted this view to mean that learners should perceive science as what they observe. Some researchers have criticized the radical constructivist perspective, arguing that its individualistic emphasis appears to put a learner in a privately constructed experiential world of his or her own (Silberstein, Mathew, Saper & Jenkins, 2000). The personal and idiosyncratic meanings constructed by a learner seem to ignore the influence of the social environment within which a learner constructs knowledge (Silberstein, Mathew, Saper &

Jenkins, 2000). Layens and Gijbels (2008) refers to this unrealistic individual focus as romantic progressivism, and asserts that it considers anything the learner does as an expression of their individual creativity, and it naively assumes that the learner can discover much of conventional school knowledge on his own.

The social constructivist approach, on the other hand, emphasizes that knowledge is acquired through interaction with others as well as by individual processes. This perspective ties in with the present research which is grounded on the viewpoint that the socio-cultural context of a learner has a significant role to play in the learner's construction of knowledge. As Driver *et al*., (1994) has argued, there is no way in which a human being could master the world without the assistance of others. This view correlates with Jaworski's assertion that though learners construct scientific knowledge for themselves, it is unreasonable to expect that they will do it solely of their own accord (Brown & Duguid, 2001).

Driver *et al*., (1994) contend that learning science involves being initiated into the ideas and practices of the scientific community and making these ideas and practices meaningful at an individual level. This means that construction of scientific knowledge incorporates individual knowledge as well as knowledge constructed and agreed upon by the scientific community. Therefore, this knowledge is not privately held, but communal. This viewpoint shows the need for teachers' intervention in order to provide appropriate experiential evidence and to make the cultural tools and conventions of the science community available to students (Driver *et al.,* 1994). Teachers should interact with the learners to ease the understanding of socially accepted knowledge. In this way, learners' knowledge will not be singly based on individual knowledge construction. Powell and

Kalina (2009) asserts that in a social environment, learners construct ideas new to them when individual knowledge is challenged through the use of language and social interactions. The contention that learners construct their own meanings implies that different individuals may construct alternative conceptions from the same information.

The theory of constructivism is characterized by the recognition of and respect for learners' prior ideas (Martinez-Delgado, 2002). According to Martinez-Delgado (2002), learners' prior ideas have impact on the learning of new scientific concepts. In his principle of meaningful learning, he states that the most important single factor influencing learning is what the learner already knows and teachers must ascertain this and teach him accordingly. Meaningful learning is therefore seen to occur when learners interact and relate new concepts to the mental models they already possess (Gokhale, 1995). This view correlates with Piaget's belief that the new ideas learnt at school should link with the child's existing mental schema (Duffy & Jonassen, 2013). According to Hewson, Beeth and Thorley (1998), valuing learners' ideas is good pedagogic practice, as it is the basis for conceptual change. They contend that discussing the range of ideas held by students during science lessons enables students to realize the variety of ideas harboured about the topic or concept being discussed. In this way students have the opportunity of choosing between different ideas, and the status of some ideas is reduced, while the status of the idea that seems to be more intelligible, plausible, and fruitful is raised within the learner's conceptual ecology.

When teachers recognize learners' prior knowledge during instruction, this enables learners to fit together the ideas from school science knowledge with their experiences, in an attempt to make sense of the world. This helps in bridging the gap between everyday

experiences and scientific knowledge, should such a gap exist. The emphasis on the incorporation of teaching based on students' prior ideas is what distinguishes constructivism from teaching based on traditional practice, which does not value learners' prior knowledge. In traditional practice, learners were considered to have minds like blank slates with no prior ideas on the topic to be taught, and that they were ready to receive knowledge passively (Pinker, 2003). Constructivism thus provides a perspective from which to assess the students' ideas and perceptions. This perspective also helps to explain the existence of learners' misconceptions in science education, which may arise due to learners' failure to construct scientifically meaningful understandings, or their inability to link the new information with already existing schema. There is evidence that students have a tendency of maintaining their views despite classroom instruction (Aikenhead, 1996). In recent years it has become clear through research that children develop beliefs or views about the natural world prior to formal instruction about scientific concepts (Driver *et al.,* 1994), and that in science classrooms, children's views may be incompatible with the scientific worldview. In order to promote meaningful learning in science classrooms, teachers should incorporate students' everyday experiences and understandings within formal science learning. Mayoh and Knutton (1997) assert that incorporating out of school experiences in science lessons can be a powerful tool in the hands of skilled teachers. This can also make a strong contribution to successful learning, by bridging the everyday experiences with the scientific domains. Jenkins (2000) questions the purpose of eliciting students' prior ideas, and argues that the pedagogical consequences of eliciting these ideas are far from clear. He warned researchers and educators against uncritical espousal of constructivism, a model that

appears to be merely a fashionable research paradigm. Matthews (1998) opposes attempts geared towards connecting science with human and social affairs, arguing that such efforts can be damaging and anti-scientific. Matthews (1998)'s contempt for constructivism is that it is philosophically unsound, has weak empirical support, and is subversive not only to good science education but to honesty and critical thought in general. Matthews claims that regarding science as a social construction denies the fact that the scientific worldview is grounded in nature and should be given higher priority than other worldviews. This argument ends with the suggestion that constructivism must be wholly rejected, though this does not imply a rejection of the sociocultural perspective of science (Matthews 1998). Lee (1999) suggests that the role of prior knowledge is especially important for students from diverse social and cultural backgrounds because their cultural experiences and beliefs may differ from those of teachers and peers.

2.2.0 METHODS OF TEACHING

2.2.1 Teacher-Centered Approach of Teaching

Many teachers are still using the traditional teaching methods. The traditional teaching methods are one-way learning process, where teachers alone introduce subject contents. Arends (2007) suggested that these methods are teacher-centered. Under this method, students simply obtain information from the teacher without building their engagement level with the subject being taught (Boud & Feletti, 1999). The approach is least practical, more theoretical and memorizing (Teo & Wong, 2000). It does not apply

activity based learning to encourage students to learn real life problems based on applied knowledge. Since the teacher controls the transmission and sharing of knowledge, the lecturer may attempt to maximize the delivery of information while minimizing time and effort. As a result, both interest and understanding of students may get lost. The teachers expect the students to repeat what was taught in the classroom. This is based on traditional perspectives and the student is tasked to learn the subject materials through their cognitive process (Osterman & Kottkamp, 2004). Apparently traditional methods may have contributed in the students' declining academic performance, especially where students diversity are voided in their educational development. To address such shortfalls, Zakaria, Chin and Daud (2010) specified that teaching should not merely focus on dispensing rules, definitions and procedures for students to memorize, but should also actively engage students as primary participants. Various research studies have concluded that lecture is still the most widely used teaching method today (Berrett, 2012). A recent study by Momeni, Zarshenas, Oshagh, Khoda, and Maryam (2011) on college students' perceptions of the traditional lecture method suggests that lecture is of great value and receives positive responses from students. Momeni *et al* further suggests that the lecture method may carry learning characteristics such as problem solving, critical thinking, etc., usually found only in active learning. Lecture is seen as the most convenient teaching method even though it may not have the greatest impact on student learning (Jones, 2007), because it seems to be the easiest to prepare compared to other methods. Nevertheless, the impact of lecture should not be underestimated. Tormey and Henchy (2008) argue that the effect will be even greater when lecture is revised and combined

with other teaching methods or used with educational technology. This sort of enhanced lecture does contribute to student learning (Campbell & Mayer, 2009).

2.2.2 Student-Centered Approach of Teaching

Student-centered instruction (SCI) is an instructional approach in which students influence the content, activities, materials, and pace of learning. This learning model places the student in the center of the learning process. The instructor provides students with opportunities to learn independently and from one another and coaches them in the skills they need to do so effectively. The SCI approach includes such techniques as substituting active learning experiences for lectures, assigning open-ended problems and problems requiring critical or creative thinking that cannot be solved by following text examples, involving students in simulations and role plays, and using self-paced and/or cooperative (team-based) learning.

With the advent of the concept of discovery learning, many scholars today widely adopt more supple student-centered methods to enhance active learning (Burrowes, 2003). Most teachers today apply the student-centered approach to promote interest, analytical research, critical thinking and enjoyment among students (Burrowes, 2003). The teaching method is regarded more effective since it does not centralize the flow of knowledge from the lecturer to the student (Lindquist, 1995). The approach also motivates goal-oriented behaviour among students, hence the method is very effective in improving student achievement (Slavin, 1996).

Learner-centered learning environments recognize that the prior knowledge of learners powerfully influences future learning and thus attempt to build on prior knowledge. Many learner-centered learning approaches involve faculty putting students into small

groups or teams for learning activities. In light of the growing evidence on the effectiveness of student-centered learning approaches, Handelsman, Ebert-May, Beichner and Bruns (2004), in an article in Science, stated "There is mounting evidence that supplementing or replacing lectures with active learning strategies and engaging students in discovery and scientific process improves learning and knowledge retention". Although faculty members may find student-centered learning approaches to be more enjoyable and lead to improved student learning, they still have questions about the amount of content that can be covered using these approaches (Burrowes, 2003). Content coverage is still high priority for faculty members, especially for faculty members teaching prerequisite courses on which faculty members teaching downstream courses are depending for student preparation. Answers to whether faculty members can cover the same or more content with student-centered learning approaches as can be covered with traditional lecture-based approaches depend on individual teachers. Although some teachers indicate that they cover as much or most content with student-centered learning approaches, some adopters of student-centered learning approaches indicate that they now cover less content than when they exclusively lectured, but students learning are more.

First, using student-centered learning approaches to teaching never means that teachers do not lecture. Next, slow, thoughtful, reflective transitions to student-centered learning approaches are likely to lead to the most sustainable changes in teaching. Faculty members might begin with informal cooperative learning approaches. Finally it should be acknowledged that the greatest motivation for learning is learning itself. If a student can

make the transition from extrinsic rewards to intrinsic rewards, then the basis for lifelong learning will have been established (Parkinson & Totterdell, 1999).

2.2.3 Interactive Approach of Teaching

Moyles, Hargreaves, Merry, Paterson, Pell and Esart-Sarries (2003) argue that it is easier to talk about what interactive teaching is all about than to define it as a concept and that even among those charged with the responsibility of providing advice to teachers about how to operate this pedagogic strategy, there appears to be uncertainty about what exactly the term means. This argument gives a picture that interactive teaching may be easier to describe in its practical terms than defining it as a concept. In fact it is more meaningful and important to describe what happens in interactive teaching and why it has to happen in that specific way than simply defining it as a concept without emphasizing its practicalities. Interactive teaching is that type of teaching in which there is two way communication between the teacher and the pupils; pupil to pupil and the teacher continuously monitors and responds to pupil's thinking as he/she continues teaching by adjusting the flow and focus of the lesson in response to how pupils are thinking with the aim of allowing pupils to dig into deeper meanings (Moyles *et al.,* 2003). Thus it is about the notion of knowledge being constructed jointly rather than content being delivered to learners by teachers. Instead of the teacher giving procedures and full information to pupils, the teacher allows pupils to think deeply about how the given problem(s) can be solved. To allow learners think and dig deeper into meanings of scientific concepts, the teacher structures classroom communication in such a way that each learner freely communicates without hindrance from the teacher's dominance. Learners communicate with confidence and assurance from the teacher that by working together they shall

deeply learn meanings of scientific concepts. They have the understanding and that the teacher is there to support them and not to find out who is making mistakes or to spoon feed them nor is he/she there to give them procedures for finding solutions to given questions. Learners have an assurance of openness to each other and their teacher; and with some amount of control of the learning process. In this pedagogy, the teacher does not only emphasize the enhancement of learner interest in the given work or learner participation or discussions during lessons but also aims at developing pupil deep thinking and learning of meanings so that their knowledge would be extended. The teacher ensures that learners are focused more on learning meanings of the concepts than merely interacting.

Central to interactive teaching is the perspective of social constructivism propagated by Vygotsky (Palincsar, 2005). This perspective emphasize on the need for social interactions amongst students to construct knowledge. The argument is that qualitative changes in students' thinking occur as students co-participate in the learning process. When students discuss and exchange ideas, they construct knowledge about what they are discussing. Learners socially interact as they use the knowledge. They critically mix their knowledge with others and in so doing be able to construct new knowledge about what they were discussing. It should be stated that the thinking behind arguments raised in favour of interactive teaching is that there are certain ways in which learners can socially interact which would lead them to deeply understand scientific meanings.

The Piagetian perspective on the other hand contends that interactions lead to individual's cognitive development through the individual's cognitive conflicts. Piagetian thinking is that as individuals strive to resolve their mental conflicts, which in this emanates from

interactions, they recognize their mental activities and construct new knowledge. Thus though the Piagetian perspective does not necessarily emphasize on the social aspects as much as the Vygotskian perspective does, it still relates to the fact that interactions can lead to knowledge construction in individuals (Limón 2001).

Interactive mode of teaching has many roles in the teaching and learning more than the transmission mode of teaching could do. This is achieved because the quality of the teaching and learning process is the main objective for its successful implementation (Van Dijk & Jochems, 2002). This means that this mode of teaching does not only emphasize and focus on learners finding correct answers but also the nature and quality of interactions taking place as a process through which learners go in order to find meaning of concepts under study. While some researchers argues the role of interactive teaching in developing higher order thinking, Van Dijk & Jochems, (2002) argue that through interactive teaching, learners develop resilient attitude. This attitude develops in learners who have been subjected to interactive teaching because in interactive teaching, learners are prepared to keep on trying and this is for the reason that learning is taken as their own activity and not as though it were imposed on them. They also develop flexibility that helps them to tolerate the anxiety experienced when reaching out the unknown steps in their attempts to learn meanings of concepts.

2.2.3.1 Concept Map as an Interactive Approach of Teaching

One of the teaching strategies found to be effective in helping students to learn is the use of concept maps. Concept maps were developed in 1972 in the course of Novak's research program at Cornell where he sought to follow and understand changes in children's knowledge of science (Novak & Musonda, 1991). The fundamental idea in

Ausubel's cognitive psychology is that learning takes place by the assimilation of new concepts and propositions into existing concept and propositional frameworks held by the learner (Novak & Cañas, 2008). This knowledge structure as held by a learner is also referred to as the individual's cognitive structure. Out of the necessity to find a better way to represent children's conceptual understanding emerged the idea of representing children's knowledge in the form of a concept map.

Concept maps are graphical tools for organizing and representing knowledge (Novak & Cañas, 2008). They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts. Words on the line referred to as linking words or linking phrases, specify the relationship between the two concepts.

Concept is a perceived regularity in events or objects, or records of events or objects, designated by a label (Novak & Cañas, 2008). The label for most concepts is a word, although sometimes symbols such as + or %, and sometimes more than one word is used. Propositions are statements about some object or event in the universe, either naturally occurring or constructed. Propositions contain two or more concepts connected using linking words or phrases to form a meaningful statement (Novak & Cañas, 2008).

One characteristic of concept maps is that the concepts are represented in a hierarchical fashion with the most inclusive, most general concepts at the top of the map and the more specific, less general concepts arranged hierarchically below. The hierarchical structure for a particular domain of knowledge also depends on the context in which that knowledge is being applied or considered. Therefore, it is best to construct concept maps with reference to some particular question we seek to answer, called a focus question.

The concept map may pertain to some situation or event that we are trying to understand through the organization of knowledge in the form of a concept map, thus providing the context for the concept map (Novak & Cañas, 2008).

Another feature that may be added to concept maps is specific examples of events or objects that help to clarify the meaning of a given concept. Normally these are not included in ovals or boxes, since they are specific events or objects and do not represent concepts (Novak & Cañas, 2008).

The question sometimes arises as to the origin of our first concepts. These are acquired by children during the ages of birth to three years, when they recognize regularities in the world around them and begin to identify language labels or symbols for these regularities (Novak & Cañas, 2008). This early learning of concepts is primarily a discovery learning process, where the individual discerns patterns or regularities in events or objects and recognizes these as the same regularities labeled by older persons with words or symbols. This is a phenomenal ability that is part of the evolutionary heritage of all normal human beings. After age 3, new concept and propositional learning is mediated heavily by language, and takes place primarily by a reception learning process where new meanings are obtained by asking questions and getting clarification of relationships between old concepts and propositions and new concepts and propositions. This acquisition is mediated in a very important way when concrete experiences are available. This makes "hands-on" activity for science learning with young children very important, but this is also true with learners of any age and in any subject matter domain (Novak & Cañas, 2008).

In addition to the distinction between the discovery learning processes, where the attributes of concepts are identified autonomously by the learner, and the reception learning processes, where attributes of concepts are described using language and transmitted to the learner, Novak and Cañas (2008) made the very important distinction between rote learning and meaningful learning.

One of the powerful uses of concept maps is not only as a learning tool but also as an evaluation tool, thus encouraging students to use meaningful-mode learning patterns (Mintzes, Wandersee & Novak, 2000). It has been reported by Wallace and Mintzes (1990) that concept map instructional method enhanced academic achievement more than computer assisted instruction in science when taught to pre-service teachers. Also Jibrin, Abba and Zayum (2012) found significant difference in the academic achievement of undergraduate students taught genetics using concept map instructional strategy.

Concept maps are also effective in identifying both valid and invalid ideas held by students. The only solution to the problem of overcoming misconceptions is to help learners learn meaningfully, and using concept maps can be very helpful (Novak, 2002).

Another reason concept mapping is so powerful for the facilitation of meaningful learning is that it serves as a kind of template or scaffold to help to organize knowledge and to structure it, even though the structure must be built up piece by piece with small units of interacting concept and propositional frameworks (Novak & Cañas, 2008).

2.3.0 Senior High School Biology Syllabus

A total of six periods a week, each period consisting of forty minutes, is allocated to the teaching of biology. The syllabus proposes that the teaching of biology should be student-centered and activity oriented. The teacher acts as a facilitator (Ministry of Education,

2003). However, the teacher may change the teaching order of the syllabus in a particular year provided the linkage between the sections and the respective units is maintained. General objectives have been listed at the beginning of each section in the syllabus. The general objectives specify the skills and behaviours students should acquire by the end of instruction in the units of a section. The syllabus has been planned on the basis of sections and units. Each year's work is divided into sections. A section consists of a fairly homogeneous body of knowledge within the subject links in a concept map. Within each section are units. A unit consist of a more related and homogenous body of knowledge and skills. A central aspect of the syllabus is the concept of profile dimensions that should be the basis for the instruction and assessment. Learning may be divided into a number of classes. A student may acquire some knowledge through learning. The student may also learn to apply the knowledge acquired in some new context. The four learning behaviours; knowledge, understanding, application and process are referred to as dimensions of knowledge. Knowledge is a dimension; application of knowledge is also a dimension. More than one dimension forms a profile of dimensions (Ministry of Education, 2003). Each of the specific objectives in the syllabus contains an action verb that describes the behaviour the student will be able to demonstrate after the instruction. Instruction in most cases has tended to stress knowledge acquisition to the detriment of other higher-level behaviours such as application, analysis, etc. The focus of teaching and learning indicated in the syllabus is to move teaching and learning from the didactic acquisition of knowledge and rote memorization to a new position where students will be able to apply their knowledge, develop analytical thinking skills, develop plans, generate

new and creative ideas and solutions and use their knowledge in a variety of ways to solve problems (Ministry of Education, 2003).

2.3.1 Senior High School Genetics

Senior High School Genetics consist mainly of heredity. However, students need previous knowledge from topics such as nucleic acids, DNA structure and replication, Mitosis and Meiosis. The content of heredity involves the definition of some basic terms used in genetics such as gene, genotype, phenotype, dominant and recessive, allele, locus, test cross, back cross, etc. It is important that the structure of the chromosome is explained. The concept of inheritance should include hereditary units; genes, traced to Gregor Mendel's experiments. Replication of DNA which produces gametes is the vehicle of inheritance. Mendel's First and Second Laws as conclusions from his experiments on monohybrid and dihybrid inheritance should be discussed. Mendel in his experiment used genetic diagrams to explain how traits are transferred from parents to offspring and how the individual genes segregate and recombine. Again sex determination and sex linked characters such as Hemophilia, red-green colour blindness, baldness, and hairy ear lobes involving the sex chromosomes should be treated during genetic lessons. Gene interactions involving co-dominance, multiple alleles (ABO blood group system, Rhesus factor), polygenes (e.g. Skin colour in humans) should also be treated (Ministry of Education, 2003).

CHAPTER THREE

METHODOLOGY

3.1.0 Research Design

The research design for this investigation was an experimental study design that employed pre-test and post-test control group design. Pre-test was administered before the treatment. This was to determine the equivalent in the academic ability of the

students. Post-test was administered after the treatment to determine the effect of the treatment (concept map instructional method) on the students. This was done using the instrument; Genetics Achievement Test (GAT). Experimental groups received treatment which was concept map instructional method. In post-test, the instrument was reshuffled to avoid test wiseness (Jibrin, Abba & Zayum, 2012).

3.2.0 Population for the study

The population for the study was all the 1,500 students of Hwidiem Senior High School. The school is located in Ahafo in the Asutifi North District of Ghana. The school is made up of 900 boys (60%) and 600 girls (40%). The courses the school offers are Home Economics, General Arts, Visual Arts, Business, General Agriculture and General Science. Hwidiem Senior High School was selected for the experiment because the researcher teaches in the school and has direct interaction with the sample population to eliminate possible biases. Again, it is also very difficult to get assess to students to conform to experimental conditions when the researcher is not a staff in the school as most of the heads of such schools may not allow access to the students.

3.3.0 Sampling size and sampling procedure

Purposive sampling technique was used to select three classes that formed the sample of the study. This sampling method was used in order to minimize experimental contamination (Fraenkel & Wallen, 2000). Together, 108 students including 22 boys (20.4%) and 86 girls (79.6%) were selected. The unit of sampling was the entire class rather than the individual learners because classes exist as intact groups (Fraenkel &

Wallen, 2000). This therefore meant that, each class was considered as one group. Group A was made of 20 boys (90.9%) and 13 girls (15.2%) offering general science as their major course. Group B was also made of 30 girls (34.9%) and a boy (4.5%) and Group C, 34 girls (39.5%) and a boy (4.5%) all of which offered home economics as their major course. The reasons why those classes were selected were that they were the only students offering biology as elective and in their third year who are supposed to be taught genetics per the September, 2003 biology teaching syllabus of the Ghana Education Service (G.E.S). Fraenkel and Wallen (2000) also recommend that at least 30 subjects per group are appropriate for such studies. Hence this number was adequate for the study.

The experimental groups (B and C) were taught using concept map instructional approach while the control group (A) was taught using other expository methods. Group B and C were chosen as the experimental group because they had a lower mean score compared to the mean score of group A. This was to enable the experimenter to detect changes in the group's achievement after the implementation of the treatment.

3.4.0 Instrument for data collection

The instrument for data collection was Genetics Achievement Test (GAT) as was suggested by Jibrin, Abba and Zayum, (2012). A 20 item multiple choice questions were developed by the researcher based on the West African Examinations Council's Senior School Certificate Examination (WASSCE) genetic questions for the previous years.

3.5.0 The Development and use of Instructional Materials

The content of the study used in this research was based on the revised G.E.S. biology syllabus, G.E.S. biology text book for Senior High Schools and the Ghana Association of Science Teachers (GAST) biology book for Senior High Schools. A guiding manual

based on the above learning materials was constructed for the teachers involved in administering the concept map approach and was used throughout the treatment period. The teachers of the experimental groups were each trained by the researcher on how to use the manual. Each of these teachers taught using the concept map approach on a different topic other than genetics for one week to enable them to master the skills. After that period the pre-test was administered to all the groups by the researcher assisted by the biology teachers in the biology department. Treatment period took three weeks as recommended in the syllabus. At the end of the treatment period, a post-test was administered to all the groups by the researcher assisted by the same teachers.

3.6.0 Method of Data Collection

The data for this study was collected after the administration of the instrument, Genetics Achievement Test (GAT), which was done by the researcher assisted by biology teachers with a minimum qualification of first degree and a good teaching experience in the school. It contained twenty multiple choice items with a maximum score of 20 to measure students' achievement in genetics. Each item contains only one single answer and three distracters. After the pre-test to all the three groups, the experimental group, B and C were taught using the concept map approach of teaching by the researchers which lasted for three weeks. The control group A was also taught using other expository approach of teaching. The instrument was then again administered to all the three groups as post-test but was reshuffled to avoid test wiseness and generated quantitative data which were analyzed.

3.7.0 Method of Data Analysis

Descriptive statistics was used to analyze the estimated marginal means, standard deviation and standard error estimates while student t-test statistics was used to test the hypothesis at 0.05 level of significance. A t-test is used when dealing with two means because of its superior power to detect differences between two means and also to examine whether any significant differences exist between the students' performance mean scores of the teaching methods. Analysis of variance (ANOVA) was used to analyze the differences in post-test mean scores of the groups (Coolican, 1994).

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1. Results

The objective of the study was to investigate whether there are significant differences between the effectiveness of different teaching methods on students' academic performance in genetics. Pre-test and Post-test mean scores were analyzed using t-test and Anova in the tables below.

4.1.1. To what extent does the mean of scores of students taught using Concept Mapping Approach have any significant differences than the mean of scores of students taught using other expository methods?

Table 4.1.2. shows significant differences between the mean scores of the first experimental group, B taught using concept mapping approach and the control group, A taught using other expository methods.

Table 4.1.2: Pre-test Analysis by Teaching Approach

Scale	Group	N	Mean	SD	df	t- value	p- value
GAT	A	33	6.70	1.79	68	2.83	0.006*
	B	40	5.50	1.80			

*(p< 0.05, df= 68, tstat = 2.83, tcrit = 1.99), *Denotes significant at p< 0.05, otherwise, not significant.

From the pre-test analysis on GAT Table 4.1.2, the mean score of group A (6.70) was higher than that of B (5.50) out of a maximum of 20. It was found out that group B achievement level in this unit were low before the experiment. Also the results in the table revealed that groups A and B are not similar on entry level since their mean scores are significantly different at (t (68) = 2.83, P<0.05).

Table 4.1.3. shows significant differences between the mean scores of the second experimental group, C taught using concept mapping approach and the control group, A taught using other expository methods.

Table 4.1.3: Pre-test Analysis by Teaching Approach

Scale	Group	N	Mean	SD	df	t- value	p- value
GAT	A	33	6.70	1.79	66	4.63	1.79E-05*
	C	35	4.6	1.94			

*(p< 0.05, df= 66, tstat = 4.63, tcrit = 1.99), *Denotes significant at p< 0.05, otherwise, not significant.

From the pre-test analysis on GAT Table 4.1.3, the mean score of group A (6.70) was higher than that of C (4.60) out of a maximum of 20. It was found out that group C achievement level in this unit were low before the experiment. Also the results in the table revealed that groups A and C are not similar on entry level since their mean scores are significantly different at ($t(66) = 4.63$, $P<0.05$).

However, when dealing with intact classes, the ideal situation is not usually realized. These differences were taken care of using covariates during post-test analysis. The differences in GAT achievement at entry point could be due to the variations in the ability of individual students since they are all exposed to the same available teaching and learning resources.

4.1.4: Post-test Analysis for Examining the Effects of GAT on Student's Genetic Achievement

Students' achievement was determined by conducting a mean gain analysis on students' GAT post-test. The purpose of gain analysis was to check which of the groups A, B and C gained more after undergoing the course. Hypothesis H_{01} of the study sought to find out whether there was any statistically significant difference in achievement scores between students exposed to Concept map teaching Approach and those not exposed to it. The mean gain of the experimental and control groups is shown in Table 4.1.5.

Table 4.1.5: GAT Post-test Mean Gain by Teaching Approach

Scale		A	B	C
Pre-test	N	33	40	35
Mean		**6.70**	**5.50**	**4.6**
SD		1.79	1.80	1.94

Post-test	N	33	40	35
Mean		**9.33**	**12.88**	**12.86**
SD		2.48	2.63	2.49
Mean Gain		**1.3**	**5.86**	**5.38**

Post-test mean gain analysis tested the differences between the groups, thus revealing which one performed better. The gain analysis involved finding out the gain of each group by determining the differences between post-test and pre-test out of a maximum of 20. It tests the differences in gain between the three groups. Pre-test GAT score of A was found to be 6.70 while that of B was found to be 5.5 and C also to be 4.6. This showed that the mean score of group A was higher than that of B and C. On the other hand, the post-test GAT mean score of A was found to be 9.33 while that of B was 12.88 with C having a post-test mean score of 12.86. The mean gain of B and C were greater than that of A which means the experimental groups B and C improved more than the control group A. However, the results in the Table 4.1.5. do not show whether this difference in improvement is significant or not. Consequently, it was necessary to carry out t-test to check whether the difference was statistically significant at 0.05 alpha.

Table 4.1.6. shows the comparison of mean gains of the first experimental group B and the control control group, A after the treatment.

Table 4.1.6: Comparison of Mean Gain of A and B Groups on GAT

Group	N	Mean Gain	df	t- value	p- value
A	33	1.30	70	-5.90	1.17E-07*
B	40	5.86			

*(P<0.05, df= 70 tstat= -5.84, tcrit= 1.99)

From Table 4.1.6, the mean gain by using t-test is significant at 0.05 alpha level of significance (t (70) = -5.90, p< 0.05). This significance in mean gain of Experimental groups B over the control group A is attributable to the treatment. This means that, despite the fact that group B had a lower mean score on the pre-test than group A, they managed to score higher in the post- test on GAT. This implies that exposure to the treatment enhanced learning. This can be explained by the fact that the concept map teaching approach allows students to actively interact in small groups, solve problems and construct their own knowledge while the teacher acts as a facilitator.

Table 4.1.7. shows the comparison of mean gains of the first experimental group C and the control control group, A after the treatment.

Table 4.1.7: Comparison of Mean Gain of A and C Groups on GAT

Group	N	Mean Gain	df	t- value	p- value
A	33	1.30	66	-5.84	1.72E-07*
C	35	8.26			

*(P<0.05, df= 66 tstat= -5.84, tcrit= 1.99)

From Table 4.1.7., the mean gain by using t-test is significant at 0.05 alpha level of significance (t (66) = -5.84, p< 0.05). This significance in mean gain of Experimental group C over the control group A is attributable to the treatment. This means that, despite the fact that groups C had a lower mean score on the pre-test than group A, they managed to score higher in the post- test on GAT. This implies that exposure to the treatment enhanced learning. This can be explained by the fact that the concept map teaching approach allows students to actively interact in small groups, solve problems and construct their own knowledge while the teacher acts as a facilitator.

Table 4.1.8.shows that the differences between the experimental groups, B and C and the control group, A are significant using one-way ANOVA.

Table 4.1.8: One – way ANOVA of Students' post-test GAT Mean Scores

Scale	SS	df	Mean square	F- value	P- value
Between groups	286.11	2	143.05	22.15	9.4E-09
Within groups	677.99	105	6.46		
Total	964.10	107			

*(P< 0.05, df= 2, F= 22.15)

The results in Table 4.1.8 showed that the differences in achievement among the three groups were significant (F (2,105) = 22.15, P<0.05). Again, this implies that the groups were different in the post-test GAT mean score.

4.2. To what extent does the use of Concept Mapping Approach of Teaching Gender Friendly with Students?

The experimental groups B and C had a male each and the remaining being females. They were able to achieve mean scores significantly higher than their counterparts in the control group A which was made up of almost 50% males and 50% females. It can therefore, be said that the Concept Mapping Approach is gender friendly.

4.3. To what extent does the use of Concept Mapping Teaching Approach of teaching genetics Achievable in terms of time allocated for in the Ghana Education Service Biology Syllabus?

The researcher was also able to finish the topic "Genetics" in three weeks as provided for in the Ghana Education Service Biology Teaching Syllabus. This means that the Concept Mapping Approach of teaching Biology is achievable in terms time allocation.

4.4. Discussions

The findings of the study showed that there was statistically significant difference in pre-test mean scores between A, B and C groups with respect to the topic "Genetics" implying that the students were not similar with the topic before the treatment. This meant that the groups were not equal in terms of their prior knowledge. Consequently measures were put in place in the post-test so as to adjust for those differences. Similarly at the post- test level, there was statistical significant difference in the mean scores and

standard deviations between the students in the experimental groups B and C and the control group A suggesting that students in the experimental groups gained significantly higher after the treatment compared with their counterparts in the control group.

From the mean gain analysis, it was found out that the experimental groups B and C gained more than the control group A. This implies that concept mapping approach of teaching is more effective than the convectional teaching method in enhancing students' achievement in Biology. It can be said that the students learnt more meaningfully in an interactive learning environment and became more successful. These findings are in line with several earlier studies (Palincsar, 2005; Van Dijk & Jochems, 2002; Makitalo, 2016; Driver *et al*., 1994; Brown & Duguid, 2001) to the effect that the concept map teaching approach involves the learners more in the instructional process both individually and in groups. The students would remember better what they participated in doing because they involve more sense organs than just their prior knowledge in knowledge construction (Novak & Cañas, 2008).

The findings of this study are also in agreement with those of (White, 1996; Brandt & Elen, 2001; Loyens & Gijbels, 2008) which reported that concept mapping as a Constructivist Teaching Approach led to a higher student's academic achievement than the traditional lecture methods. The results indicated that students taught by the constructivist instructional approach had a significantly better acquisition of scientific conceptions related to "Genetics" and less misconceptions than the students taught by the traditionally designed Biology instruction. Novak and Cañas (2008) found that the concept map approach enabled students to perform better in Genetic Achievement Test than the traditional lecture method. This is because, the students in the constructivist

group benefited from discussion and interaction with peers. In this way, the teacher also provided a learning environment where students could use their prior knowledge and become aware of their already existing conceptions. During discussions with the peers, the students tried to make connections between their existing knowledge and the new concepts. They analyzed, interpreted and predicted information. In this way, they actively constructed knowledge instead of being passive recipients. Teaching and learning was an interactive process that engaged the learners in knowledge construction. Information does not become knowledge automatically until learners have been actively involved in its processing (Martinez-Delgado, 2002). However, in the control group, the teachers' thoughts and meanings were expected to be transferred to the passive learners. The teacher provided information without considering the students' prior knowledge. Another reason why the students' achievements were not that high in the control group was that they may have lacked the opportunity to develop their thinking, reasoning and communication skills. The students did not become confident in the understanding of Biology hence meaningful learning may have not occurred. Wallace and Mintzes (1990) reported that concept map instructional method enhanced academic achievement more than computer assisted instruction in science when taught to pre-service teachers. The researchers concluded that learning in co-operation with others is an important source of motivation, support, modeling and coaching (Brown & Duguid, 2001). In concept map Teaching Approach, the teacher initially raised questions to activate students' prior conceptions that were subsequently discussed within groups of students. Thus the teacher created a learning environment where students could use their prior knowledge and became aware of their existing conceptions. During discussion with their peers, the

students tried to make connection between their existing knowledge and the new concept. Gokhale (1995) in his study noted that students' performance was enhanced because students in the experimental group were encouraged to apply their experiences to the new situations and through group discussion and appropriate teacher guidance they tried to find relevant answers to their questions. Similarly in this study, the students engaged each other in discussion, co-operation and application of concepts learned. They also took responsibility for their own learning rather than passively accepting the teacher's explanations as it may have occurred in the control groups. In the experimental group, social interaction was also emphasized and the teachers encouraged students to work together, to explain what they were doing and reflect during the learning process, hence meaningful learning occurred (Gokhale, 1995).

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1. Summary

The results of this study show that Concept Mapping Approach of Teaching resulted in significantly higher students' achievement in Biology than students' taught using other expository methods. This implies that exposure of students to concept mapping approach

of teaching allows students to actively interact in small groups, solve problems and construct their own knowledge while the teacher acts as a facilitator.

5.2. Conclusion

The study sought to find out whether there are significant differences in the mean score of students taught Biology using Concept Mapping Approach and others taught using other Conventional Teaching Methods. Based on the findings of the study, it was found out that students taught Biology using the Concept Mapping Approach achieved a statistically significant mean score higher than their colleagues taught Biology using other Conventional Teaching Methods.

Again, the experimental groups B and C had a male each and the remaining being females. They were able to achieve mean scores significantly higher than their counterparts in the control group A which was made up of almost 50% males and 50% females. It can therefore, be said that the Concept Mapping Approach is gender friendly.

The researcher was also able to finish the topic "Genetics" in three weeks as provided for in the Ghana Education Service Biology Teaching Syllabus. This means that the Concept Mapping Approach of teaching Biology is achievable in terms of time.

5.3. Recommendations

Considering the findings of this study, the following recommendations are made:

1. With regards to academic performance, this study indicates that the concept map instructional method enhances better performance and it is therefore, recommended for use in teaching genetics.

2. Government should put in place a policy that will encourage the use of activity-based instructional method such as concept map instructional method in teaching secondary school students.

3. Teachers should take care of individual differences while teaching genetics in order to motivate the female students participate fully in the learning process.

4. Induction courses and workshops should be organized for teachers on the application of the activity-based instructional method in teaching and learning genetics.

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APPENDIX A

GENETIC ACHIEVEMENT TEST (GAT)

1. What is the probability of producing a child with blood group **O**, if a woman of blood group **A** marries a man of blood group **AB**?
   A. 0%
   B. 25%
   C. 50%
   D. 75%

2. A cross between a pure-breeding tall pea plant 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. 1:1:1

3. How would an individual who is a carrier of haemophilia be represented?
   A. X^HX^H
   B. X^HY
   C. X^hY
   D. X^HX^h

4. The F_1 generation of a cross between a red cock and a white hen were all red because the genes for the
   A. White colour did not segregate
   B. Red colour were dominant
   C. White colour were dominant
   D. Red colour were recessive

5. Which of the following conditions represents co-dominance?
   A. AB blood group
   B. Dwarfism
   C. Polyploidy
   D. Sickle cell anaemia

6. Which of the following traits is sex-linked?
   A. Albinism
   B. Colour blindness
   C. Night blindness
   D. Tongue rolling

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

A. Alleles
B. Genotype
C. Heterozygous
D. Phenotype

8. Women with ***Rh*** negative may experience still birth because
   A. They have poor circulatory system
   B. The blood of the foetus might clump
   C. The foetus is deprived of nourishment
   D. Disease inflicts the woman during pregnancy

9. An individual that has identical alleles for a trait is
   A. A carrier
   B. A hybrid
   C. Heterozygous
   D. True-bleeding

10. Which of the following about sex-linked characters is true?
    A. The characters are less frequent in females
    B. The characters are less frequent in males
    C. Genes for such characters are dominant
    D. Genes for such characters do not assort independently

11. Chromosomal aberration known as deletion is said to have occurred when part of a chromosome
    A. Becomes detached and then joined
    B. Breaks away and is lost
    C. Breaks away and attaches itself to another chromosome
    D. Breaks away and attaches itself to non-homologous chromosome

12. Which of the following notations implies that an individual is a carrier of the sickle cell trait?
    A. AB
    B. AO
    C. AS
    D. SS

13. Two tall plants were crossed and all the F1 plants were tall. Some of the F2 plants were tall and others short when the F1 plants were selfed. The possible genotype of the original parental plants were
    A. TT and TT
    B. TT and Tt
    C. Tt and tt

D. Tt and Tt

14. If an albino child is born to parents with pigmented eyes and skin, then the parental genotypes is
    A. Double recessive
    B. Heterozygous
    C. Homozygous
    D. Polyploidy

15. The most crucial factor in the determination of sex of a baby is the
    A. Types of drugs the mother takes during pregnancy
    B. Chromosomes contributed by the father
    C. Nature of nutrition the embryo receives
    D. Chromosomes contributed by the mother

16. A dominant gene refers to a gene
    A. Which is prevalent in all populations
    B. That suppresses the effect of its alternate form
    C. That is resistant to mutation
    D. Which occurs in healthy individuals

17. Outbreeding may lead to
    A. Hybrid vigour
    B. Few offspring being produced
    C. Identical individuals in populations
    D. More offspring being produced

18. One of the genetic phenomena that causes variation is
    A. Dominance
    B. Hybrid vigour
    C. Independent assortment
    D. Mitosis

19. A colour blind man marries a normal woman. The probability of them producing a colour blind child will be
    A. 0.00
    B. 0.125
    C. 0.25
    D. 0.50

20. Which of the following traits is not controlled by genes?
    A. Tongue rolling
    B. Eye colour
    C. Ability to play piano
    D. Sickle cell anaemia

APPENDIX B

MARKING SCHEME

1. A

2. C

3. D
4. B
5. A
6. B
7. A
8. B
9. D
10. A
11. C
12. B
13. B
14. B
15. B
16. B
17. A
18. C
19. A
20. C

APPENDIX C

SAMPLED MARKED SCRIPTS OF STUDENTS

Ellen Adusei 3H2

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF SCIENCE EDUCATION
GENETIC ACHIEVEMENT TEST (GAT)
FOR HWIDIEM SENIOR HIGH SCHOOL
PRE-TEST

03

1. What is the probability of producing a child with blood group **O**, if a woman of blood group **A** marries a man of blood group **AB**?
   A. 0%
   B. 25%
   C. 50%
   D. 75%

2. A cross between a pure-breeding tall pea plant 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. 1:1:1

3. How would an individual who is a carrier of haemophilia be represented?
   A. X^HX^h
   B. X^hY
   C. X^HY
   D. X^HX^H

4. The F_1 generation of a cross between a red cock and a white hen were all red because the genes for the
   A. White colour did not segregate
   B. Red colour were dominant
   C. White colour were dominant
   D. Red colour were recessive

5. Which of the following conditions represents co-dominance?
   A. AB blood group
   B. Dwarfism
   C. Polyploidy
   D. Sickle cell anaemia

6. Which of the following traits is sex-linked?
   A. Albinism
   B. Colour blindness
   C. Night blindness
   D. Tongue rolling

7. Two alternative forms of the same gene are known as
   A. Alleles
   B. Genotype
   C. Heterozygous
   D. Phenotype

8. Women with ***Rh*** negative may experience still birth because
   A. They have poor circulatory system
   B. The blood of the foetus might clump
   C. The foetus is deprived of nourishment
   D. Disease inflicts the woman during pregnancy

9. An individual that has identical alleles for a trait is
   A. A carrier
   B. A hybrid
   C. Heterozygous
   D. True-bleeding

10. Which of the following about sex-linked characters is true?
   A. The characters are less frequent in females
   B. The characters are less frequent in males
   C. Genes for such characters are dominant
   D. Genes for such characters do not assort independently

11. Chromosomal aberration known as deletion is said to have occurred when part of a chromosome
   A. Becomes detached and then joined
   B. Breaks away and is lost
   C. Breaks away and attaches itself to another chromosome
   D. Breaks away and attaches itself to non-homologous chromosome

12. Which of the following notations implies that an individual is a carrier of the sickle cell trait?
   A. AB
   B. AO
   C. AS
   D. SS

13. Two tall plants were crossed and all the F1 plants were tall. Some of the F2 plants were tall and others short when the F1 plants were selfed. The possible genotype of the original parental plants were
   A. TT and TT
   B. TT and Tt
   C. Tt and tt
   D. Tt and Tt

14. If an albino child is born to parents with pigmented eyes and skin, then the parental genotype is
   A. Double recessive
   B. Heterozygous
   C. Homozygous
   D. Polyploidy

15. The most crucial factor in the determination of sex of a baby is the
   A. Types of drugs the mother takes during pregnancy
   B. Chromosome [illegible] carried by the father
   C. Nature of nutrition the embryo receives
   D. Chromosome [illegible] carried by the mother

16. A dominant gene refers to a gene
   A. Which is prevalent in all populations
   B. That suppresses the effect of its alternate form
   C. That is resistant to mutation
   D. Which occurs in healthy individuals

17. Outbreeding may lead to
   A. Hybrid vigour
   B. Few offspring being produced
   C. Identical individuals in populations
   D. More offspring being produced

18. One of the genetic phenomena that causes variation is
   A. Dominance
   B. Hybrid vigour
   C. Independent assortment
   D. Mitosis

19. A non-albino man marries a normal woman. The probability of them producing a non-albino child will be
   A. 0.00
   B. 0.125
   C. 0.25
   D. 0.50

20. Which of the following traits is not controlled by genes?
   A. Tongue rolling
   B. Eye colour
   C. Ability to play piano
   D. Sickle cell anaemia

END OF TEST

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF SCIENCE EDUCATION
GENETIC ACHIEVEMENT TEST (GAT)
FOR HWIDIEM SENIOR HIGH SCHOOL
PRE-TEST

1. What is the probability of producing a child with blood group O, if a woman of blood group A marries a man of blood group AB?
   A. 0%
   B. 25%
   C. 50%
   D. 75%

2. A cross between a pure-breeding tall pea plant 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. 1:1:1

3. How would an individual who is a carrier of haemophilia be represented?
   A. X^HX^h
   B. X^HY
   C. X^hY
   D. X^hX^h

4. The F_1 generation of a cross between a red cock and a white hen were all red because the genes for the
   A. White colour did not segregate
   B. Red colour were dominant
   C. White colour were dominant
   D. Red colour were recessive

5. Which of the following an abnormal represents co dominance?
   A. AB blood group
   B. Dwarfism
   C. Polyploidy
   D. Sickle cell anaemia

6. Which of the following traits is sex linked?
   A. Albinism
   B. Colour blindness
   C. Night blindness
   D. Tongue rolling

7. Two alternative forms of the same gene are known as
   A. Alleles
   B. Genotype
   C. Heterozygous
   D. Phenotype

8. Women with *Rh* negative may experience still birth because
   A. They have poor circulatory system
   B. The blood of the foetus might clump
   C. The foetus is deprived of nourishment
   D. Disease inflicts the woman during pregnancy

9. An individual that has identical alleles for a trait is
   A. A carrier
   B. A hybrid
   C. Heterozygous
   D. True-breeding

10. Which of the following about sex-linked characters is true?
   A. The characters are less frequent in females
   B. The characters are less frequent in males
   C. Genes for such characters are dominant
   D. Genes for such characters do not assort independently

11. Chromosomal aberration known as deletion is said to have occurred when part of a chromosome
   A. Becomes detached and then joined
   B. Breaks away and is lost
   C. Breaks away and reattaches itself to non homologous chromosome
   D. Breaks away and attaches itself to non homologous chromosome

12. Which of the following mating implies that an individual is a carrier of the sickle cell trait?
   A. AA x AB
   B. AO
   C. AS
   D. SS

13. Two tall plants were crossed and all the F1 plants were tall. Some of the F2 plants were tall and others dwarf when the F1 plants were selfed. The possible genotype of the original parental plants were
   A. TT and TT
   B. TT and Tt
   C. Tt and tt
   D. T and TT

14. If an albino child is born to parents with pigmented eyes and skin, then the parents genotypes is
   A. Double recessive
   B. Heterozygous
   C. Homozygous
   D. Co-dominant

15. The most crucial factor in the determination of sex of a baby is the
   A. Type of diet as the mother takes during pregnancy
   B. Chromosomes contributed by the father
   C. Nature of nutrition the embryo receives
   D. Chromosomes contributed by the mother

16. A dominant gene refers to a gene
   A. Which is prevalent in all populations
   B. That suppresses the effect of its alternate form
   C. That is resistant to mutation
   D. Which occurs in heterozygous individuals

17. Outbreeding can lead to
   A. Hybrid vigour
   B. Low offspring number produced
   C. Identical individuals in populations
   D. More of a gene being produced

18. One of the genetic phenomena that causes variation is
A. Dominance
B. Hybrid vigour
C. Independent assortment
D. All of these

19. A colour blind man marries a normal woman. The probability of them producing a colour blind child will be
A. 0.00
B. 0.125
C. 0.25
D. 0.50

20. Which of the following traits is not controlled by genes?
A. Tongue rolling
B. Eye colour
C. Ability to play piano
D. None of the answers

END OF TEST

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF SCIENCE EDUCATION
GENETICS ACHIEVEMENT TEST (GAT)
FOR SWEDRU SENIOR HIGH SCHOOL
PRE-TEST

1. What is the probability of producing a child with blood group O, if a woman of blood group A marries a man of blood group AB?
A. 0%
B. 25%
C. 50%
D. 75%

2. A cross between a pure-breeding tall pea plant and a pure breeding dwarf pea plant takes place where tallness is dominant over dwarfness, and F1 generation is called. The phenotypic ratio of F2 generation will be
A. 1:3:1
B. 2:1:1
C. 3:1
D. 1:1:1

3. How would an individual who is a carrier of two recessive be represented?
A. $X^R X^R$
B. $X^r Y$
C. $X^r X^r$
D. $X^R X^r$

4. The F1 generation of a cross between a red cock and a white hen were all red because the genes for the
   A. White colour did not segregate
   B. Red colour were dominant
   C. White colour were dominant
   D. Red colour were recessive

5. Which of the following conditions represents euploidy?
   A. Rh blood group
   B. Down's
   C. Polyploidy
   D. Sickle cell anaemia

6. Which of the following traits is sex linked?
   A. Albinism
   B. Colour blindness
   C. Night blindness
   D. Tongue rolling

7. Two alternative forms of the same gene are known as
   A. Alleles
   B. Genotype
   C. Heterozygous
   D. Phenotype

8. Women with Rh negative may experience still birth because
   A. They have poor circulatory system
   B. The blood of the foetus might clump
   C. The foetus is deprived of nourishment
   D. Placenta fails to function during pregnancy

9. An individual that has identical alleles for a trait is
   A. A carrier
   B. A hybrid
   C. Heterozygous
   D. True breeding

10. Which of the following sex linked characters is true?
   A. The characters are controlled by genes
   B. The characters are transmitted by males
   C. Genes for such characters are dominant
   D. Genes for such characters are independent

11. The commonest aberration known as deletion is said to have occurred when part of a chromosome
   A. Becomes detached and lost/joined
   B. Breaks away and is lost
   C. Breaks away and attaches itself to another chromosome
   D. Breaks away and attaches itself to non-homologous chromosome

12. Which of the following genotypes implies that an individual is a carrier of the sickle cell trait?
   A. AS
   B. AO
   C. AA
   D. SS

13. Two tall plants were crossed and all the F1 plants were tall. Some of the F2 plants were tall and others short when the F1 plants were selfed. The possible genotype of the original parental plants were
   A. TT and TT
   B. TT and Tt
   C. Tt and tt
   D. Tt and Tt

If an albino child is born to parents with pigmented eyes and skin, then the parental genotypes is

A. Double recessive
B. Heterozygote
C. Homozygous
D. Polyploidy

The most crucial factor in the determination of sex of a baby is the

A. Types of drugs the mother takes during pregnancy
B. Chromosomes contributed by the father
C. Nature of nutrition the embryo receives.
D. Chromosomes contributed by the mother

A [illegible] gene refers to a gene

A. Which is prevalent in all populations
B. That suppresses the effect of its alternate form
C. That is resistant to mutation
D. Which appears in healthy individuals

Outbreeding can lead to

A. Hybrid vigour
B. Few offspring being produced
C. Identical individuals in populations
D. More offspring being produced

One of the genetic phenomena that causes variation is

A. Dominance
B. Hybrid vigour
C. Independent assortment
D. Mitosis

A colour blind man marries a normal woman. The probability of them producing a colour blind girl will be

A. 0.00
B. 0.125
C. 0.25
D. 0.50

Which of the following traits is not controlled by genes?

A. Tongue rolling
B. Eye colour
C. Ability to play piano
D. Sickle cell anaemia

END OF TEST

Boadi Abigail ~~Female~~ Female

05

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF SCIENCE EDUCATION
GENETIC ACHIEVEMENT TEST (GAT)
FOR KWADIEM SENIOR HIGH SCHOOL
PRE TEST

1. What is the probability of producing a child with blood group O, if a woman of blood group A marries a man of blood group AB?
   A. 0%
   B. 25%
   C. 50%
   ✓ D. 75%

2. A cross between a pure breeding tall pea plant and a pure breeding dwarf pea plant takes place where tallness is dominant over dwarfness, and F_2 generation is selfed. The phenotypic ratio of F_2 generation will be
   A. 1:2:1
   ✓ B. 3:1
   C. 3:3
   D. 1:1:1

3. How would an individual with a pattern of inheritance be represented?
   ✓ A. X^1X^1
   B. X^1Y
   C. XY
   D. X^1X^1

4. The F_1 generation of a cross between a red cock and a white hen were all red because the genes for red
   A. White colour did not segregate
   B. Red colour were dominant
   ✓ C. White colour were dominant
   D. Red colour were recessive

5. Which of the following conditions represents a dominant?
   A. AB blood group
   B. Dwarfism
   ✓ C. Polydactyly
   D. Sickle cell anaemia

6. Which of the following traits is sex-linked?
   A. Albinism
   ✓ B. Colour blindness
   C. Night blindness
   D. Tongue rolling

7. Two alternative forms of the same gene are known as
   ✓ A. Alleles
   B. Genotype
   C. Heterozygous
   D. Phenotype

8. Women with Rh negative may experience still birth because
   A. They have poor circulatory system
   ✓ B. The blood of the foetus might clump
   C. The foetus undergoes rapid development
   D. Disease inflicts the woman during pregnancy

9. An individual that has identical alleles for a trait is
   A. A carrier
   B. A hybrid
   C. Heterozygous
   D. True breeding

10. Which of the following about sex-linked characters is true?
    A. The characters are less frequent in females
    B. The characters are less frequent in males
    C. Genes for such characters are dominant
    D. Genes for such characters do not assort independently

11. Chromosomal aberration known as deletion is said to have occurred when part of a chromosome
    A. Becomes detached and then joined
    B. Breaks away and is lost
    C. Breaks away and attaches itself to another chromosome
    D. Breaks away and attaches itself to non-homologous chromosome

12. Which of the following genotypes implies that an individual is a carrier of the sickle cell trait?
    A. AB
    B. AO
    C. AS
    D. SS

13. Two tall plants were crossed and all the F1 plants were tall. Some of the F2 plants were tall and others short when the F1 plants were selfed. The possible genotype of the original parental plants were
    A. TT and Tt
    B. TT and Tt
    C. Tt and tt
    D. tt and Tt

14. If an albino child is born to parents with pigmented eyes and skin, then the parents genotypes are
    A. Double recessive
    B. Heterozygous
    C. Homozygous
    D. Polyploids

15. The most crucial factor in the determination of sex of a baby is the
    A. Types of drugs the mother takes during pregnancy
    B. Chromosomes contributed by the father
    C. Nature of nutrition the embryo receives
    D. Chromosomes contributed by the mother

16. A dominant gene refers to a gene
    A. which is prevalent in all populations
    B. That suppresses the effect of its alternative gene
    C. That is resistant to mutation
    D. Which occurs in healthy individuals

17. Outbreeding may lead to
    A. Hybrid vigour
    B. Few offspring being produced
    C. Identical individuals in population
    D. More offspring being produced

18. One of the genetic phenomena that causes variation is
   A. Dominance
   B. Hybrid vigour
   C. Independent assortment
   D. Mitosis

19. A colour blind man marries a normal woman. The probability of them producing a colour blind child will be
   A. 0.00
   B. 0.13
   C. 0.25
   D. 0.50

20. Which of the following traits is not controlled by genes?
   A. Tongue rolling
   B. Eye colour
   C. Ability to play piano
   D. Sickle cell anaemia

END OF TEST

Answer Key

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF SCIENCE EDUCATION
GENETIC ACHIEVEMENT TEST (GAT)
FOR HWIDIEM SENIOR HIGH SCHOOL
PRE TEST

1. What is the probability of producing a child with blood group O, if a woman of blood group A marries a man of blood group AB?
   A. 0%
   B. 25%
   C. 50%
   D. 75%

2. A cross between a pure-breeding tall pea plant 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. 1:1:1

3. How would an individual who's a carrier of haemophilia be represented?
   A. X^hX^h
   B. X^hY
   C. X^HY
   D. X^HX^H

4. The F1 generation of a cross between a red cock and a white hen were all red because the genes for the
   A. White colour is not segregate
   B. Red colour were dominant
   C. White colour were dominant
   D. Red colour were recessive

5. Which of the following conditions represents co-dominance?
   A. ABO blood group
   B. Dwarfism
   C. Polyploidy
   D. Sickle cell anaemia

6. Which of the following traits is sex-linked?
   A. Albinism
   B. Colour blindness
   C. Night blindness
   D. Tongue rolling

7. Two alternative forms of the same gene are known as
   A. Allele
   B. Genotype
   C. Heterozygous
   D. Phenotype

8. Women with *Rh* negative may experience still birth because
   A. They have poor immune system
   B. The blood of the foetus might attack
   C. The foetus is deprive of nourishment
   D. Disease influence the women during pregnancy

9. An individual that has identical alleles of the gene is
   A. A carrier
   B. A hybrid
   C. Heterozygous
   D. True breeding

10. Which of the following about sex-linked characters is true?
   A. The characters are less frequent in females
   B. The characters are less frequent in males
   C. Genes for such characters are dominant
   D. Genes for such characters do not assort independently

11. Chromosomal aberration known as deletion is said to have occurred when part of a chromosome
   A. Rearranges detached and then joins
   B. Breaks away and is lost
   C. Breaks away and attaches itself to another chromosome
   D. Breaks away and attaches itself to non-homologous chromosome

12. Which of the following genotypes is an individual that is a carrier of the sickle cell trait?
   A. AB
   B. AA
   C. As
   D. SS

13. Two tall plants were crossed and all the F1 plants were tall. Some of the F2 plants were tall and others short but the tall ones were twice. The possible genotype of the original parental plants were
   A. TT and Tt
   B. TT and Tt
   C. Tt and t
   D. Tt and Tt

15. If an albino child is born to parents with pigmented eyes and skin, then the parental genotypes is

A. Double recessive
B. Heterozygous
C. Homozygous
D. Polyphyletic

16. The most crucial factor in the determination of sex of a baby is the

A. Types of drugs the mother takes during pregnancy
B. Chromosomes contributed by the father
C. Nature of nutrition the embryo receives
D. Chromosomes contributed by the mother

17. A dominant gene refers to a gene

A. Which is prevalent in all populations
B. That suppresses the effect of its alternate form
C. That is resistant to mutation
D. Which confers a boon to individuals

18. Outbreeding may lead to

A. Hybrid vigour
B. Less offspring being produced
C. Identical individuals in populations
D. More offspring being produced

19. One of the genetic phenomena that causes variation is

A. Dominance
B. Hybrid vigour
C. Independent assortment
D. Meiosis

20. A colour blind man marries a normal woman. The probability of them producing a colour blind child will be

A. 0.00
B. 0.25
C. 0.25
D. 0.50

21. Which of the following traits is not controlled by genes?

A. Tongue rolling
B. Eye colour
C. Ability to play piano
D. Sickle cell anaemia

END OF TEST

OTOKU AFRIYIE JANET 3441

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF SCIENCE EDUCATION
GENETICS ACHIEVEMENT TEST (GAT)
FOR HWIDIEM SENIOR HIGH SCHOOL
PRE-TEST

1. What is the probability of producing a child with blood group O, if a woman of blood group A marries a man of blood group AB?
   A. 0%
   B. 25%
   C. 50%
   D. 75%

2. A cross between a pure-breeding tall pea plant 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. 3:1
   B. 1:1:1:1
   C. 3:1
   D. 1:1:1

3. How would an individual who is a carrier of haemophilia be represented?
   A. X^hX
   B. X^hY
   C. X^hY
   D. X^hX^h

4. The F_1 generation of a cross between a red rock and a white hen were all pink because the genes for the
   A. White colour did not segregate
   B. Red colour were dominant
   C. White colour were dominant
   D. Red colour were recessive

5. Which of the following conditions is/are due to dominance?
   A. ABO blood group
   B. Dwarfism
   C. Polyploidy
   D. Sickle cell anaemia

6. Which of the following traits is sex linked?
   A. Albinism
   B. Colour blindness
   C. Night blindness
   D. Tongue rolling

7. Two alternative forms of the same gene are known as
   A. Alleles
   B. Genotype
   C. Heterozygous
   D. Phenotype

8. Women with Rh negative may experience still birth because
   A. They have poor circulatory system
   B. The blood of the foetus might clump
   C. The foetus is deprived of nourishment
   D. Disease inflicts the woman during pregnancy

9. An individual that has identical alleles for a trait is
   A. A carrier
   B. A hybrid
   C. Heterozygous
   D. Free bleeding

10. Which of the following about sex-linked characters is true?
   A. The characters are less frequent in females
   B. The characters are less frequent in males
   C. Genes for such characters are dominant
   D. Genes for such characters do not assort independently

11. Chromosomal aberration known as deletion is said to have occurred when part of a chromosome
   A. Becomes detached and then joined
   B. Breaks away and is lost
   C. Breaks away and attaches itself to another chromosome
   D. Breaks away and attaches itself to non-homologous chromosome

12. Which of the following genotypes implies that an individual is a carrier of the sickle cell trait?
   A. AA
   B. AO
   C. AS
   D. SS

13. Two tall plants were crossed and all the F1 plants were tall. Some of the F2 plants were tall and others short when the F1 plants were selfed. The possible genotype of the original parental plants were
   A. TT and TT
   B. Tt and Tt
   C. Tt and tt
   D. Tt and Tt

14. If an albino child is born to parents with pigmented eyes and skin, then the parental genotypes is
   A. Double recessive
   B. Heterozygous
   C. Homozygous
   D. Polygenic

15. The main role of ... factor in the determination of sex of a baby is the
   A. Types of drugs the mother takes during pregnancy
   B. Chromosomes contributed by the father
   C. Nature of nutrition the embryo receives
   D. Chromosomes contributed by the mother

16. A dominant gene refers to a gene
   A. Which is prevalent in all populations
   B. That suppresses the effect of its alternate form
   C. That is resistant to mutation
   D. Which occurs in heterozygous individuals

17. Outbreeding may lead to
   A. Hybrid vigour
   B. Less offspring being produced
   C. Weeding of inferior traits in populations
   D. More offspring not being produced

18. One of the genetic phenomena that causes variation is
A. Dominance
B. Hybrid vigour
C. Independent assortment
D. Mitosis

19. A colour blind man marries a normal woman. The probability of them producing a colour blind child will be
A. 0.50
B. 0.25
C. 0.75
D. 0.00

20. Which of the following traits is not carried on the sex chromosome?
A. Foreign willing
B. Eye colour
C. Ability to play piano
D. Sickle cell anaemia

END OF TEST

Obeng - Fofuaa Josephine F 350

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF SCIENCE EDUCATION
GENETIC ACHIEVEMENT TEST (GAT)
FOR HWIDIEM SENIOR HIGH SCHOOL
PRE-TEST

06

1. What is the probability of producing a child with blood group O, if a woman of blood group A marries a man of blood group AB?
A. 0%
B. 25%
C. 50%
D. 75%

2. A cross between a pure breeding tall pea plant and a pure breeding dwarf pea plant is a plant 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. 1:1:1

3. How would an individual who is a carrier of haemophilia be represented?
A. X X
B. X Y
C. X^{h}Y
D. X^{h}X^h

4. The F_1 generation of a cross between a red cock and a white hen were all red because the genes for the
   A. White colour did not segregate
   B. Red colour was dominant
   C. White colour was dominant
   D. Red colour is controlled

5. Which of the following conditions represents polyploidy?
   A. AB blood group
   B. Dwarfism
   C. Polyploidy
   D. Sickle cell anaemia

6. Which of the following traits is sex-linked?
   A. Albinism
   B. Colour blindness
   C. Night blindness
   D. Tongue rolling

7. Two alternative forms of the same gene are known as
   A. Alleles
   B. Genotype
   C. Heterozygous
   D. Phenotype

8. Women with *Rh* negative may experience still birth because
   A. They have poor circulatory system
   B. The blood of the foetus might clump
   C. The foetus is deprived of nourishment
   D. Disease in which the woman during pregnancy

9. An individual that has identical alleles for a trait is
   A. A carrier
   B. A hybrid
   C. Heterozygous
   D. True-breeding

10. Which of the following statements is true?
   A. The characters are less frequent in females
   B. The characters are less frequent in males
   C. Genes for such characters are dominant
   D. Genes for such characters do not assort independently

11. Chromosomal aberration known as deletion is said to have occurred when part of a chromosome
   A. Becomes detached and then joined
   B. Breaks away and is lost
   C. Breaks away and attaches itself to new non-homologous chromosome
   D. Breaks away and attaches itself to non homologous chromosome

12. Which of the following notations implies that an individual is a carrier of the sickle cell trait?
   A. SS
   B. AA
   C. AS
   D. Ss

13. Two tall plants were crossed and all the F1 plants were tall. Some of the F2 plants were tall and others short, when the F1 plants were selfed. The most likely genotypes of the original parental plants were
   A. TT and TT
   B. TT and Tt
   C. Tt and tt
   D. Tt and Tt

15. If an albino child is born to parents with normal eyes and skin, then the parental genotypes is
   A. Double recessive
   B. Heterozygous
   C. Homozygous
   D. Polyploidy

15. The [illegible] in the determination of sex of a baby is the
   A. [illegible] the mother takes during pregnancy
   B. Chromosomes contributed by the father
   C. Nature of [illegible] the embryo receives
   D. Chromosomes contributed by the mother

16. A dominant gene refers to a gene
   A. Which is prevalent in all populations
   B. That suppresses the effect of its alternate form
   C. That is resistant to mutation
   D. Which occurs in healthy individuals

17. Outbreeding may lead to
   A. Hybrid vigour
   B. Few offspring being produced
   C. Identical individuals in population
   D. More offspring being produced

18. One of the genetic phenomena that causes variation is
   A. Dominance
   B. Hybrid vigour
   C. Independent assortment
   D. Mitosis

19. A colour blind man marries a normal woman. The probability of them producing a colour blind child will be
   A. 0.00
   B. 0.75
   C. 0.25
   D. 0.50

20. Which of the following traits is not controlled by genes?
   A. Tongue rolling
   B. Eye colour
   C. Ability to play piano
   D. Sickle cell anaemia

END OF TEST

A) MENSAH JENNIFER

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF SCIENCE EDUCATION
GENERIC MOCK EXAMINATION TEST (GAT)
FOR HWIEMEN SENIOR HIGH SCHOOL
PRE-TEST

02

1. What is the probability of getting a baby with blood group B, if a woman of blood group A marries a man of blood group AB?
   A. 0%
   B. 25%
   C. 50%
   D. 75%

2. A cross between a pure breeding tall pea plant 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. 3:1
   C. 9:1
   D. 1:1:1

3. How would an individual who is a carrier of haemophilia be represented?
   A. X^HX^H
   B. X^HY
   C. X^hY
   D. X^hX^h

4. The F_1 generation of a cross between a red cock and a white hen were all red because the genes for the
   A. White colour did not segregate
   B. Red colour were dominant
   C. White colour were dominant
   D. Red colour were recessive

5. Which of the following conditions represents co-dominance?
   A. AB blood group
   B. Dwarfism
   C. Polyploidy
   D. Sickle cell anaemia

6. Which of the following traits is sex linked?
   A. Albinism
   B. Colour blindness
   C. Night blindness
   D. Tongue rolling

7. Two alternative forms of the same gene are known as
   A. Allele
   B. Genotype
   C. Heterozygote
   D. Phenotype

8. Women with Rh negative may experience miscarriage because
   A. They have poor circulatory system
   B. The blood of the foetus mixes with theirs
   C. The foetus is deprived of nourishment
   D. Disease in the woman during pregnancy

9. An individual that has identical alleles for a trait is
   A. A carrier
   B. A hybrid
   C. Heterozygous
   D. True-breeding

10. Which of the following about sex linked characters is true?
   A. The characters are less frequent in females
   B. The characters are less frequent in males
   C. Genes for such characters are dominant
   D. Genes for such characters do not assort independently

11. Chromosome aberration known as deletion is said to have occurred when part of a chromosome
   A. Becomes detached and then jointed
   B. Breaks away and is lost
   C. Breaks away and attaches itself to another chromosome
   D. Breaks away and attaches itself to non-homologous chromosome

12. Which of the following notations implies that an individual is a carrier of the sickle cell trait?
   A. AB
   B. AO
   C. AS
   D. SS

13. Two TL plants were crossed and all the F1 plants were tall. Some of the F2 plants were tall and others short when the F1 plants were selfed. The possible genotype of the original parental plants were
   A. TT and TT
   B. TT and Tt
   C. Tt and tt
   D. Tt and Tt

14. If an albino child is born to parents with pigmented eyes and skin, then the parents' genotypes is
   A. Homozygous
   B. Heterozygous
   C. Homozygous
   D. Polyploidy

15. The most crucial factor in the determination of sex in a baby is the
   A. Type of sperm the mother takes during pregnancy
   B. Chromosomes contributed by the father
   C. Nature of nutrition the mother receives
   D. Chromosomes contributed by the mother

16. A dominant gene is one
   A. Which is prevalent in all populations
   B. That suppresses the effect of its alternative form
   C. That is resistant to mutation
   D. Which occurs in healthy individuals

17. Dwarfness may lead to
   A. Sterility
   B. Poor offspring being produced
   C. Reduced individuals in population
   D. More offspring being produced

18. One of the genetic phenomena that causes [illegible]
   A. Dominance
   B. Hybrid vigour
   C. Independent assortment
   D. Mitosis

19. A colour-blind man marries a normal woman. The probability of them producing a colour-blind child will be
   A. 0.00
   B. 0.125
   C. 0.25
   D. 0.50

20. Which of the following traits is not controlled by genes?
   A. Tongue rolling
   B. Eye colour
   C. Ability to play piano
   D. Sickle cell anaemia

END OF TEST

Name: [illegible]
Sex: F

07

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF SCIENCE EDUCATION
GENETIC ACHIEVEMENT TEST (GAT)
FOR DWIDIEM SENIOR HIGH SCHOOL
PRE-TEST

1. What is the probability of producing a child with blood group O, if a woman of blood group A marries a man of blood group AB?
   A. 0%
   B. 25%
   C. 50%
   D. 75%

2. A cross between a pure breeding tall pea plant 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. 1:1:1

3. How would an individual who is a carrier of haemophilia be represented?
   A. X^HX^H
   B. X^hY
   C. X^HY
   D. X^HX^h

4. The F1 generation offspring of a cross between a red cock and a white hen were all red because the genes for the
   A. White colour did not segregate
   B. Red colour were dominant
   C. White colour were dominant
   D. Red colour were recessive

5. Which of the following could best represent co-dominance?
   A. ABO blood group
   B. Dwarfism
   C. Polyploidy
   D. Sickle cell anaemia

6. Which of the following traits is sex-linked?
   A. Albinism
   B. Colour blindness
   C. Night blindness
   D. Tongue rolling

7. Two alternative forms of the same gene are known as
   A. Alleles
   B. Genotype
   C. Heterozygous
   D. Phenotype

8. Woman with *Rh* negative may experience miscarriage because
   A. They have poor circulatory system
   B. The blood of the foetus might clump
   C. The foetus is deprived of nourishment
   D. Disease suffers the woman during pregnancy

9. An individual that has identical alleles for a trait is
   A. A carrier
   B. A hybrid
   C. Heterozygous
   D. Free floating

10. Which of the following about sex-linked characters is true?
   A. The characters are less frequent in females
   B. The characters are less frequent in males
   C. Genes for such characters are dominant
   D. Genes for such characters do not assort independently

11. Chromosome aberration known as deletion is said to have occurred when part of a chromosome
   A. Becomes detached and then joins
   B. Breaks away and is lost
   C. Breaks away and attaches itself to another chromosome
   D. Breaks away and joins itself to another chromosome

12. Which of the following genotypes would show that an individual is a carrier of the sickle cell trait?
   A. AA
   B. AO
   C. AS
   D. SS

13. Two tall plants were crossed and all the F1 plants were tall. Some of the F2 plants were tall and others short when the F1 plants were selfed. The possible genotype of the original parental plants were
   A. TT and TT
   B. TT and Tt
   C. Tt and tt
   D. Tt and Tt

14. If an albino child is born to parents with pigmented eyes and skin, then the parental genotypes is
A. Double recessive
B. Heterozygous
C. Homozygous
D. Polyploidy

15. The most crucial factor in the determination of sex of a baby is the
A. Types of drugs the mother takes during pregnancy
B. Chromosomes contributed by the father
C. Nature of nutrition the embryo receives
D. Chromosomes contributed by the mother

16. A dominant gene refers to a gene
A. Which is prevalent in all populations
B. That suppresses the effect of its allelomic form
C. That is resistant to mutation
D. Which pastes in healthy individuals

17. Outbreeding may lead to
A. Hybrid vigour
B. Less offspring being produced
C. Identical individuals in populations
D. More offspring being produced

18. One of the genetic phenomena that causes variation is
A. Dominance
B. Hybrid vigour
C. Independent assortment
D. Mitosis

19. A colour blind man marries a normal woman. The probability of them producing a colour blind child will be
A. 0.00
B. 0.125
C. 0.25
D. 0.50

20. Which of the following traits is not controlled by genes?
A. Tongue rolling
B. Eye colour
C. Ability to play piano
D. Sickle cell anaemia

END OF TEST

Agyei Gifty (F) 28/09/2016

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF SCIENCE EDUCATION
GENETIC ACHIEVEMENT TEST (GAT)
FOR BWIDIEM SENIOR HIGH SCHOOL
PRE-TEST

1. What is the probability of producing a child with blood group O, if a woman of blood group A marries a man of blood group AB?
   A. 0%
   B. 75%
   C. 50%
   D. 25%

2. A cross between a pure breeding tall pea plant 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. 3:1
   C. 3:1
   D. 1:1:1

3. How would an individual who is a carrier of haemophilia be represented?
   A. X^HX^H
   B. X^HY
   C. X^hY
   D. X^HX^h

4. The F_1 generation of a cross between a red cock and a white hen were all red because the genes for the
   A. White colour did not segregate
   B. Red colour were dominant
   C. White colour were dominant
   D. Red colour were recessive

5. Which of the following conditions represents co-dominance?
   A. ABO blood group
   B. Dwarfism
   C. Polyploidy
   D. Sickle cell anaemia

6. Which of the following traits is sex linked?
   A. Albinism
   B. Colour blindness
   C. Night blindness
   D. Tongue rolling

7. Two alternative forms of the same gene are known as
   A. Alleles
   B. Phenotype
   C. Heterozygous
   D. Phenotype

8. Women with Rh negative may experience still birth because
   A. They have poor circulatory system
   B. The blood of the foetus might clump
   C. The foetus is deprived of nourishment
   D. Disease inflicts the woman during pregnancy

9. An individual that has unequal alleles for a trait is
   A. A [illegible]
   B. A hybrid
   C. Heterozygous
   D. [illegible]

10. Which of the following about sex-linked characters is true?
   A. The characters are less frequent in females
   B. The characters are less frequent in males
   C. Genes for such characters are dominant
   D. Genes for such characters do not assort independently

11. Chromosomal aberration known as deletion is said to have occurred when part of a chromosome
   A. [illegible]
   B. Breaks away and is lost
   C. Breaks away and attaches [illegible] chromosome
   D. Breaks away and attaches itself to non-homologous chromosome

12. Which of the following genotypes [illegible] carrier of the sickle [illegible]?
   A. [illegible]
   B. [illegible]
   C. [illegible]
   D. [illegible]

13. Two tall plants were crossed and all the F1 plants were tall. Some of the F2 plants were tall and others short when the F1 plants were selfed. The possible genotypes of the original parental plants were
   A. [illegible] and [illegible]
   B. [illegible] and [illegible]
   C. [illegible] and [illegible]
   D. Tt and Tt

14. If an albino child is born to parents with pigmented eyes and skin, then the parental genotypes is
   A. Double recessive
   B. Heterozygous
   C. Homozygous
   D. Polyploidy

15. The most crucial factor in the determination of sex of a baby is the
   A. Types of drugs the mother takes during pregnancy
   B. Chromosomes contributed by the father
   C. Nature of nutrition the embryo receives
   D. Chromosomes contributed by the mother

16. A dominant gene refers to a gene
   A. Which is prevalent in all populations
   B. That suppresses the effect of its alternate form
   C. That is resistant to mutation
   D. Which occurs in healthy individuals

17. Outbreeding may lead to
   A. Hybrid vigour
   B. Few offspring being produced
   C. Identical individuals in populations
   D. More offspring being produced

18. One of the genetic phenomena that causes variation is
    A. Dominance
    B. Hybrid vigour
    C. Independent assortment
    D. Mitosis

19. A colour blind man marries a normal woman. The probability of them producing a colour blind child will be
    A. 0.00
    B. 0.125
    C. 0.25
    D. 0.50

20. Which of the following traits is not controlled by genes?
    A. Tongue rolling
    B. Eye colour
    C. Ability to play piano
    D. Sickle cell anaemia

END OF TEST