THE EFFECTS OF A CONCEPTUAL CHANGE MODEL ON STUDENTS ACHIEVEMENT, RETENTION AND ATTITUDE TO BIOLOGY CONCEPTS.

BY

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A Ph. D. Thesis submitted in partial fulfillment of the requirement for the Degree of Doctor of Philosophy in Science Education

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DECLARATION

I, OYEDOKUN, Comfort Abiola certify that this thesis has been written by me and that it is a record of my own research work. It has not been presented in any previous thesis for a higher degree or published in a book. All quotations are indicated by quotation marks and indentation and the sources of literature are duly acknowledged in the references.

Comfort Abiola Oyedokun.

CERTIFICATION

The under-signed certify that they have read and recommend to the Faculty Board of Education the acceptance of this thesis entitled "The Effects of a Conceptual Change Teaching Model on Students Achievement, Retention and Attitude to Biology Concepts" submitted by Comfort Abiola Oyedokun in partial fulfillment of the requirements for the award of degree of Doctor of Philosophy in Science Education,(Ph.D.) of A.B.U. Zaria.

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DEDICATION

This thesis is dedicated to God for granting me the good health and wisdom to undertake the study,

and

the memory of my beloved parents, Pa Joseph and Ma Rebeccah Adeoye who sacrificed so much for my education.

ACKNOWLEDGMENT

I am indeed very grateful to God for making this study a reality. Truly He keeps and guides.

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ABSTRACT

In this study, the effects of two instructional strategies -Conceptual Change Teaching Strategies and the Traditional Teaching Strategies on Students Achievement, Retention of biology concepts and students Attitude to biology as a course of study were compared. Science students in the Senior Secondary year one in two co-educational schools in Zaria suburban areas were the subjects for the study. The two secondary schools were randomly selected. The study sample was divided into two groups-experimental group and control group each with a sample size of 76 students. The experimental group was taught using the Conceptual Change Teaching Model while the control group was taught using the Traditional Method'. The students pre-conceptions of biological concepts -- photosynthesis and cellular respiration-- were analyzed using the Multiple Choice Assessment Test (MCAT) and Instructional Attitude Questions (IAQ) before instruction. The Conceptual Change Teaching Model was developed from it - using the constructivist ideas. The effectiveness of the Conceptual Change Teaching Model with the experimental class was compared with the effectiveness of the Traditional Method in the control class. A pre test -treatment - post test design was used for the study.

Four hypothesis formulated in the null form based on research questions were tested. A t-test- statistics was used to analyze the data obtained. The results showed that;

1. Students in the experimental class taught using the Conceptual Change Teaching Model performed better on post tests than the students in the control class taught using the Traditional Method.
2. The use of Conceptual Change Teaching Model is associated with greater understanding and higher learning success.
3. Students in the experimental class showed higher cognitive achievement, more positive attitude and consequent higher retention level compared with Students in the control class..

The results as itemized support claims for the usefulness of Conceptual Change Teaching Model.

Based on these findings recommendations such as incorporation of the Conceptual Change Teaching Model into the pre-service teaching program ; inculcation of the Conceptual Change Teaching Model in school science curriculum practices right from primary to the university level and in service training for science teachers in the use of the CCTM were made.

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CHAPTER ONE

THE PROBLEM

1.0 Introduction.

Over the years, science instruction in Secondary Schools in Nigeria has had rather limited success (Dada, 1986) (Appendix A) due to the nature of science, the methodology science teachers adopt and the effect of pre-existing knowledge on instruction, (Hewson et al, 1983; Duit,1990; and Igwebuike, 1991). This is a rather disturbing situation and a challenge to science educators.

In schools, science teachers tend to assume that when a subject is taught verbally, then it will be learnt by students who have heard or read it in the way the teacher intends, (Freyberg and Osborne, 1985). However, predicting individual student's responses based on this assumption could be misleading. It is desirable that teachers find out what their students have already learnt and the ideas the students hold about the science instruction to be taught because students' ideas based on cultural and experiential inclinations could have compelling consequences on their learning. Students' ideas prior to classroom exposure have been described by a variety of terms; 'misconceptions' (Novak, 1983), 'Children's Science' (Gilbert, et. al. 1982), 'alternative framework'

(Hewson,1980), 'Preconceptions' (Osborne et. al. 1985), 'naive belief' (Garamazza et. al., 1981), 'Mini-theory' (Claxton, 1987) and 'untutored beliefs' (Hills, 1989). For this study, the term preconception is adhered to because of the nature of the study. It denotes the ideas students bring to the classroom before any teaching is done.

The preconceptions held by students often-times are the result of interaction between the cultural and social beliefs of the society the students are exposed to. This agrees with the assertion of Freyberg and Osborne (1985) that within the broad development and ability - related limits, students will process information differently according to their experiences rather than their age. The results of this processing may be scientifically acceptable and some may not. This processing constitutes the students' preconceptions before learning. Therefore, it is not an over emphasis when Driver and Easle (1978) and McDermott (1984) affirm that students come to the science classroom with a number of preconceptions some of which could be incompatible with currently accepted scientific knowledge. This could inhibit the learning and understanding of certain scientific concepts being taught,(Champagne et al. 1982)).Preconceptions can be seen as creative construction by the individual students and should play an important role in science learning.

In Nigeria, as well as in other developing countries of the world, many science curricula do not explain to teachers the cognitive pre-requisite knowledge that students have about the lesson to be taught and ways in which students conceptual framework could most readily be modified. Rather, what is assumed by many science curricula developers is that the learner possesses no significant knowledge of a topic which could have any bearing on the learning prior to the teaching. More often than not, science teachers assume that students have a blank mind which can be modified by them.

However, students' minds are not 'blank slates' because students come to science classes with their own ideas (preconceptions) about topics to be taught. Also, students approach materials presented in science classes with previously acquired ideas. Such features influence what is learnt from new

experiences in a number of ways such as;

a) the observations students' make of events,

b) the interpretation they offer for such observations and,

c) strategies that students use to acquire new information ; Hodzi, (1993).

Therefore, learning involves the interaction of new knowledge with the existing knowledge so that the new

knowledge is assimilated into the existing knowledge. This is embodied in the constructive perspective to learning.

A challenge to science educators therefore is how to design classroom instruction that effectively addresses individual students' pre-conceptions in order to promote scientific understanding. Cognitive approaches to learning claim that learning is an active and constructive process that depends upon the mental activities of the learner. However, much of current teaching is still grounded in an epistemology based on an objectivist view of knowing and learning. (Tobin et. al., 1987 and Tobin, 1990a). Teachers who teach from such a point of view prefer tightly controlled classrooms dominated by lectures, whole-class teacher-centered interaction and demonstration, (Tobin, 1991). This is the prevailing traditional method of science teaching/learning. Hodzi (1993) has observed that the activities students are required to carry out are usually selected by the teacher or teacher guided materials and such a selection is not always done with a clear understanding of the pre-conceptions that the students bring to the classroom. The selection of activities and materials by curriculum developers without an awareness of students previous knowledge does no justice to the potential abilities of either students or their teachers. Thus, if concept learning requires

students to give up previously held concepts that are at variance with the concepts to be taught, then an atmosphere must prevail in which students feel free to express their preconceptions. Teachers would also have to find out the learners existing conceptual framework (preconceptions) and the extent of the modifications needed for learners to appreciate what is being taught. This is based on the constructivist strategy which determines exactly what the student does know for the particular topic so that appropriate students activities can be designed for knowledge restructuring.

In science education, the issue of knowledge restructuring is embodied in conceptual change teaching models in the constructivist perspectives (Duit, 1991). The conceptual change instructional strategies seek to improve differences that exist between students, preconception and the scientific meaning of the same concepts (Osborne and Witrock, 1983; Anderson et al, 1986; Champagne, 1988; Roth, 1989; Treagust and Fetherstonhaugb, 1990; Zeitsman and Clement, 1990).

A salient educational issue concerning concept-change theories of teaching and learning is how best to implement it in the classroom. A major consideration is the time required for the determination of student preconception. According to Duschell and Gitomer (1991), frameworks that

help to understand how knowledge restructuring occurs and how one can build a learning environment to facilitate this knowledge restructuring raise important philosophical and pedagogical questions and issues about how conceptual change occurs. Equally begging for clarification is the body of the characteristics of knowledge growth that ought to be a part of curricula and learning environment .Posner et al. (1982) proposed a theory which describes the cognitive pre-requisites necessary for the conceptual change process. These include:

1. A learner must experience dissatisfaction with his/her existing conception.

2. A new conception must be seen as initially plausible, intelligible and useful in solving problems which the current conception cannot solve and have application for a fruitful research.

3. The new conception must be preferable to the old viewpoint on the grounds of preconceived elegance, parsimony and /or usefulness.

4. The new idea must be coherent and internally consistent.

These conditions suggest the need for both active, direct instruction by a knowledgeable and skillful teacher and students active participation in the development of his or her own understanding.

Any learning which requires considerable changes in the learners pre-conceptions at variance with scientifically acceptable ones would require the learner to be an active learner who could take a major responsibility for his own learning behavior. Human learning is a very active construction process and goes beyond storing pieces of knowledge provided by the teacher. It is an active construction of knowledge on the part of the learners themselves based on their already existing conception. Thus, provocative questions, linking science concepts with common-place phenomena can provide students opportunity to see the concept as capable of solving real life problems.

One of the greatest assets of effective teachers would seem to be an ability to be able to analyze student preconception since students knowledge including his preconception is a pre-requisite to successful learning. Such analysis are generally not provided in typical traditional classroom situations (See Chapter 2). The current educational practice does not provide for an effective adaptive instruction. Also, most teachers do not perceive their students' conceptions nor do they identify their conceptual framework before teaching. Duschell et al; (1991) have suggested that when teachers have philosophical and psychological models for selection and

sequencing of instructional tasks, they would be able to prescribe more effective or meaningful learning strategies. If however student pre-conceptions are not analyzed by teachers before instruction, they generally remain intact, virtually unaffected by school science teaching, (Duschell et. al., 1991).

One of the overriding objectives of science teaching is that students learn scientific concepts in a meaningful manner. Ausubel (1963) and Okebukola (1990) have also ascertained that meaningful learning results when a person consciously and explicitly ties new knowledge to relevant concepts or proposition they already possess. Concept-mapping could be a potent tool in linking new knowledge to already acquired concepts. Meaningful learning can take place only when the new material to be taught is carefully linked to the learners pre-instructional conceptions. Therefore, any inquiry-based method of teaching which does not find out or analyze the learner's preconceptions of the material to be taught before the learning process could result in failure.

Over the past decade, there has been a considerable desire by science educators to improve science achievement through more effective teaching strategies, (Driver et al.,1982; Novak et. al., 1983; Awodi,1984; Novak et. al., 1984; Alaiyemola et. al.,1990; Duschell et. al.,1991;

Igwebuike,1991; Lagoke, 1992; Martins, 1994.) Other experimental studies in this field of science education include those of Driver et. al. (1983); Anderson et. al. (1990); Okebukola (1990) and Brown (1993).

Ausubel (1968) and Balogun et. al. (1983) have claimed that for improvement in academic achievement of students, teachers ought not to only provide both a conducive learning environment but to also employ good teaching techniques and strategies. Thus according to Ausubel, a teacher should know what the students know, ascertain these, and teach them accordingly. Campbell (1971) also found out that the interactive methodology teachers employ is a critical factor for students higher levels of achievement in both cognitive and affective areas.

Smith et. al. (1993) and Hewson et. al. (1983) reported that a significant improvement in science achievement is a result of instructional strategy which makes explicit use of students prior knowledge. This agrees with Ausubel's assertion. These studies show a direction through which one could positively help students irrespective of their level of ability to attain better understanding of science concepts.

However, it would seem that to benefit from any science teaching, students ought to have developed the

right type of attitude towards science. Simpson (1978) quoted by Brown and Story (1979) found that positive attitudes in science generally accounts for between twenty and twenty-five percent of the variation in academic achievement in science. Also, research findings of Brown and Story (1979), Balogun et. al. (1983) and Mkpa (1984), are in line with contemporary view of science teaching and learning. The main point emphasized by the researchers is that the pupils' attitude exert a significant influence on their learning. Teaching strategies used can also influence the attitudes of students positively or negatively towards a subject. Negative attitude could lead to low expectations about their academic achievement. Considerable amount of evidence abound to show that negative attitude seriously hamper the total classroom functioning of a pupil in the learning of science, Fraser et. al. (1983): Alaiyemola et. al.(1989); Thus there is a relationship between attitude and academic achievement in any subject. An enhanced science learning could lead to positive changes in attitude of students to science. A strategy that would build confidence in the learners during instruction would go a long way in achieving positive attitude and higher academic achievement of the students.

Ausubel, et. al. and Hanesian (1978) emphasized that students preconceptions play an important role in the assimilation of new knowledge. Also preconception determine the longevity and qualitative content of what is learned and remembered. An instructional strategy based on students' preconceptions could therefore bring about better internalization of concepts taught and could lead to longer retention of scientific concepts taught.

This study intends to analyze students preconception of some biological concepts before they are taught and to develop a model that could bring about a conceptual change. The study also intends to compare the effectiveness of the conceptual change instructional model with the traditional method of science teaching in terms of students achievement, attitude and retention of biology concepts.

1.1 Statement of the Problem.

The problem is that of recurring poor student performance in biology and the continued search for a way or teaching methodology to solve this problem. In the present study, the effects of a conceptual change model on students achievement, retention of biological concepts and attitudes of students to biology at the Senior Secondary

School are investigated. Specifically, the study focuses on the following questions:

1. To what extent can students preconceptions of some biology concepts that are at variance with scientific ones be changed using a conceptual, change method of instruction in the classroom?.

2. Is there any difference in science achievement of SS1 students exposed to the conceptual change teaching strategy and those taught using the traditional teaching strategy?.

3 Does the teaching of biological concepts using the conceptual teaching strategy result in:

a) greater retention of biological concepts than when teaching using the traditional teaching strategy.

b) a more positive attitude towards the learning of biology than when teaching using the traditional teaching method?

1.2 Null Hypothesis.

The following four null hypothesis based on the research questions were tested:

1. There is no significant difference between the students achievement mean scores of biology concepts

when taught using the Conceptual Change Teaching Model and when taught using the Traditional Method.

2. There is no significant difference between the students achievement mean scores pre-instruction and post instruction of biology concepts using the Conceptual Change Teaching Model and using the Traditional Method.

3. There is no significant difference between students achievement mean scores of biological concepts immediately after instruction (post test) and the repeated post instructional tests (post - post test) using the Conceptual Change Teaching Model and using the Traditional Method. (The difference between the post and repeated pose achievement means score in a measure of retention).

4. There is no significant difference between student attitude towards the Conceptual Change Teaching Model and the Traditional Methodology.

1.3 The Significance of the Study.

Ausubel (1968); Driver et. al.; (1978); Osborne and Wittrock (1983); and Shuell (1987) have established the fact that cognitive science is making some considerable impact on science teaching and learning. The researchers in their different studies revealed how pupils learn

school science through exploration, description and teachers' usage of students' pre-conceptions or prior knowledge during instructions. However, in the Nigerian experience, the traditional method still predominates (Igwebuike, 1991). The traditional method does not probe the learner's preconceptions before science is learned and this could have a negative effect on students' achievement in science. Thus there a need for a teaching strategy that probes learners preconceptions with the intention to change the naive ones and thereby promote learning, understanding and interest in biology.

Helping students to understand and use the conceptual schemes of science could be complicated by the fact that students enter instruction with other non-scientific conceptual schemes of their own (Clement, 1982; Driver et. al., 1983; Helm and Novak, 1983; Bishop et. al., 1986; Anderson et. al., 1987). To help students learn science in a meaningful way would then mean realigning, re-organizing, or replacing existing conceptions to accommodate new ideas. This is the focus of the conceptual change model that will be used in this study.

There is a need in science teaching to develop conceptual understanding in students rather than encouraging memorization and avoiding conceptual issues in favor of procedures and activities. According to Smith et.

al.; (1993) the conceptual frameworks that students develop as they learn science make remembering a consequence of understanding. When students understand a concept quantitatively, they can easily understand and remember it and therefore, be able to apply the knowledge to solve problem.

Biology concepts are of importance in, the sense that they help man to understand himself and his environment; therefore, there is a need to make investigations into ways by which students could attain meaningful learning of some biology concepts. The conceptual change model used in this study is intended to bring about such meaningful learning and thereby, improve students performance, achievement and retention level.

There is the need to ensure that students are not left with their own erroneous ideas of scientific concepts from which they form their own conclusions, or be forced to accept facts that are often couched in technical language but are not related to the student's personal experiences in or out of the classroom. According to Hodzi (1993) scientific knowledge is not something which can be simply transmitted from teachers to students. Rather, it involves the type of social setting of a classroom situation where there is interaction between the learner and the teacher on discussions of ideas students hold from

common experiences. This could help students to construct more effective, complete and useful ideas than the one they currently hold. This could therefore lead to positive attitude towards learning of biology as a subject and increased level of retention.

It is to be expected that the findings of this present study will help to foster a new approach in curriculum and text development strategies which could allow for greater student understanding and greater learning success. Also, since the pre-conceptions of the learner will form the basis of instruction, it is hoped that this strategy of teaching would encourage the participation of students, increase students' self-confidence and enhance greater interest in science.

CHAPTER TWO

REVIEW OF LITERATURE

2.0 Introduction

The diverse literature reviewed for the purpose of this study is discussed under the following sub-headings:

(i) Students Pre-conception and Learning.

(ii) Constructivism

(iii) Conceptual Change Models

(iv) Traditional Teaching Method

(v) The Effect of Instructional Strategies on Students achievement.

(vi) The Effect of Instructional Strategies on retention

(vii) The Effect of Instructional Strategies on attitude.

2.1 Students Pre-conceptions and Learning

The literature reviewed on students' pre-conceptions and learning shows that over the past decade, interest in the ideas students have about natural phenomena and the implications for science teaching has grown (Hewson, 1983; Driver, et. al., 1985; Osborne and Freyberg, 1985; Hills, 1989). These ideas have been described in a variety of terms such as 'Misconceptions' (Novak, 1983); 'Children's Science (Gilbert, Osborne and Fensham, 1982; Bell et al, 1985); alternative frame work (Hewson, 1985); Roenick

(1981); Driver (1986); 'Pre-conceptions" (Osborne and Freyberg, 1985); 'Naive belief' (Caramazo, McClosky and Green, 1981); 'Mini-theories' (Claxton, 1987) 'Untutored beliefs' (Hills, 1989); 'Intuitive notions' (Bar, 1989); 'Informal knowledge' (Prawal, 1989) and 'Isolated ideas' (Champagne, Klopper and Anderson, 1979).

The plethora of terms used to describe students conceptual framework reflects both the nature and variability which characterizes student conceptions. The survey of the different terms indicate that a key factor for success in meaningful learning is the framework of relevant concepts the individual student possesses prior to instruction. In this study, these views are referred to as pre-conceptions due to the nature of the study denoting the ideas students hold of the scientific concepts to be taught.

These pre-conceptions could be resistant to change on account of traditional instructional approaches (Viennot, 1979; Gunstone et. al., 1981; Sjoberg and Lie, 1981; Clement, 1982; Linn, 1983; Halloune and Hesterel, 1985; Anderson and Smith, 1987; Schneps, 1987; Linn and Burbulas, 1988). Also, the preconceptions have been found to affect pupils' interpretations of their science activities, inhibiting learning, and determining how any new information is systematically selected, interpreted

and finally incorporated into the learner's existing cognitive structure. The retention ability of scientific concepts and principles by students could also be affected ; It could increase or decrease(Novak, Ausubel and Heinston, 1978). Evidence abound from a number of investigations that students hold common pre-conceptions in a range of subject areas including physical phenomena such as propagation of light, simple electrical circuits, forces and motion and chemical changes. Also, potentially capable of being held as preconceptions are biological topics concerned with growth and adaptation (Driver, 1983; Gilbert and Watts, 1983; Driver, Guensene and Tiberghien, 1985). If the pre-conceptions of the students are ignored, little can the learners be helped to learn, and if conceptual understanding is desired, then, issues of pre-conceptions need to be addressed since they are always operative in any meaningful learning (Smith, 1994).

An interpretation of scientific method suggests that science teachers need only to give pupils the opportunity to explore events and phenomena at first-hand and the students should be able to make generalizations or arrive at principles for themselves. However, Driver et al's (1985) position suggests that the students should make generalizations from first-hand experiences. But these generalizations may not be the one the teacher has in mind

because of pupils inability to abstract and understand the principles of the prescribed activities. When such happens, the generalizations are regarded as children's errors of inaccurate observation or illogical thinking (Martins, 1994).

If science teachers want to develop an understanding of the concepts and principles of science in the classroom, then more is required than simply providing theoretical facts and connections which will not be discovered by students through lectures. Science teachers would have to reconsider the purpose of teaching/learning so that pupils are not left in a state of confusion at the end of a science lesson. The process of meaningful learning becomes very important when considering students' conceptions as Driver (1982) suggests:

> Not only do students have to comprehend new models and principles presented to them, they have to make the intellectual leap of possibly abandoning an alternative framework (pre-conception) which until that time had worked for them.

This implies that the new material to be learnt should be carefully linked to the learners

pre-conceptions, thereby students would be able to internalize new information and ideas. In the present study, the sequence of instruction is geared towards helping students make the intellectual leap of abandoning their pre-conceptions that might not be commensurate with the scientifically accepted ones. The order of instructions also intended to make sense of science of concepts.

Quite a number of researches have been conducted on students pre-conception and learning (Ausubel, Novak and Hanesien, 1978; Gilbert, et al; 1982; Anderson, 1984; and Trumper et. al. 1990; Trumper and Gorsky, 1993). One thing in common with the authors from the literature reviewed is that they emphasized the importance and use of students' pre-conceptions in their subsequent learning and cognitive achievements. Thus, the pre-conception that students hold could be advantageous or disadvantageous in formal science program. Anderson (1984) and Driver et. al.(1989), have accurately observed that what children are capable of learning depends in part on what they have in their heads as well as on the learning content in which they find themselves. Therefore, it would seem that the way a new information is assimilated would depend both on the nature of the information and the structure of the learners' schemes. Ausubel et. al.(1978) also contended

that preconception determines the retention quality of what is learned . An issue here would be the extent to which the students' pre-conception is restructured during instruction.

2.2 Constructivism

Literature reviewed indicated that along side the changes in curriculum development over the years is a shift from the old philosophy of science of empiricism and rationalism to a new one. Jegede (1990) using Kuhnian's terms, referred to this as a revolution. The new philosophy is now Constructivism. Nussbaum (1983) graphically represented the various philosophical frameworks as in the figure below.

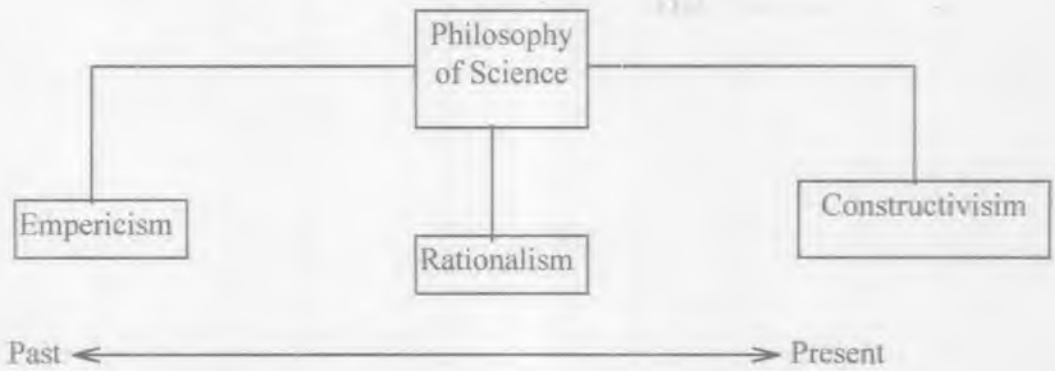


Fig. 1 Various Philosophical Frameworks (Nussbaum, 1983).

The constructivistic view of learning has become a leading idea in science and education in general since the last decade (Duit, 1990). Basically, it views learning as

a process in which students actively construct their knowledge of the situation at hand based on the already existing previous knowledge, conceptions or misconceptions. Head (1982) and Pine and West (1986) point out that students may hold two conflicting views at the same time one being the scientifically acceptable one used at school, the other being conception or misconception used in everyday life. In effect, the knowledge a child brings to a particular learning situation may or may not be the right type. Bearing this in mind, and for learning within the constructivist view to take place, the child must be able to construct reality and restructure existing memory in order to prepare himself for the new information.

This view however, is not a new one in education. As far back as early nineteenth century, the German philosopher (Herbart (in Miller, 1979), hold a similar view. He called the process by which knowledge are related to familiar conceptions which the students has already acquired "apperception". This is similar to Piagetian process of assimilation. Piaget (1953) described the equilibrium of learning as consisting of twin process of assimilation and accommodation i. e adding a new found knowledge to an old existing one and thus taking the new one in and attaining a state of equilibrium. To Piaget, learning is a delicate balance between these two processes.

Van Glassfield (1983) and Wittrock (1985) shared two views with Piaget - that learning is an active "construction process" and that learning is possible only on the basis of already acquired knowledge. Gagné (1970) was also aware of the necessity of relating the unfamiliar to the familiar. He viewed learning mainly as a "continuous claim of enlargements". The constructivistic view of learning also accepted that much learning may be based on this "enlargement" view point. There is however one point of difference between these two views; whereas the 'enlargement' view sees learning as a continuous claim of "knowledge growth" within which one step precedes another, the construcivistic view sees learning as a completely new construction of the already known, always referred to as "conceptual change". The idea of conceptual change carries a similar ideology with the Kuhnian paradigm shift of 1970 in the history of science. The conceptual change aspect points out that learning must be seen as a process of restructuring the existing knowledge. The constructivist strategy in learning is based on firstly determining exactly what the student does know for the particular topic so that appropriate students activities can be designed.

There have been many empirical researches and reports on constructivism (Ausubel, 1963; Wittrock, 1974,

1977; White, 1988; Driver, 1980; Shayer and Andey, 1981; Driver et al, 1983; Pope and Gilbert, 1983). Wittrock, (1974, 1977) contended that learning with understanding focuses on the proposition that learners must themselves actively construct or generate meaning from sensory inputs of sight, sounds etc. This idea complements that of Kelly (1969) who emphasized that man understands himself, his surroundings and his potentials by constructing ideas about these things and testing the usefulness of these constructions against such criteria as the useful predictions and control of events.

The constructivist framework has been examined in science curriculum development. For example Hand and Treagust (1989), examined the teaching strategy of conceptual conflict (constructivism) in curriculum development. The curriculum involved the topic "Acids and Bases" taught to tenth grade students of average age of 15-16 years. There was a need to first determine the students knowledge about the topic to ascertain the area of student misconception.

Interviews structured around the concepts required to be covered by the program were conducted for the research. Through this interview, students knowledge was ascertained and five misconceptions about acid and bases were identified and used as the basis of the teaching

strategy involving conceptual conflicts to the class. The other class was taught the same topic in a conventional manner by another teacher using a non-constructivist strategy (traditional method). Students were later tested at the completion of the topic to determine the success of the constructivist strategy design. This was done in 1987 and 1988 and compared. Using a post test only design. It was observed that there was a greater degree of meaningful learning using the constructivist approach. In addition, the constructivist strategy produced better results of student learning than the traditional (conventional) method.

The result of this study showed that a curriculum development strategy using ideas of constructivism allows for greater student understanding and greater learning success. Hand and Treagust (1989) reported that this process has a possible advantage of increasing the students' self-confidence in relation to science, generate a more active participation in science activities and lead not only to greater understanding but also greater interest in the subject. Students do become much more involved in their own learning (Head, 1988).

In the light of the above advantages of learning within the constuctivist framework and the realization to make science teaching and learning more effective,

applicable and understandable to students, it becomes very important for teachers and curriculum developers to initiate the development and implementation process of science curriculum that would help learners to construct their own knowledge.

2.3 Conceptual Change Models.

Early views on Conceptual Change Models were advanced by Posner et. al. (1982). These were based on Kuhn's (1962) and Lakato's (1970) epistemological arguments that scientific knowledge grows and develops through cyclic periods of consensus (Kuhn's normal science episodes) and descensus (Kuhn's revolutionary science episodes). Two fundamental types of changes are apparent here - weak and radical knowledge restructuring. The weak knowledge restructuring derived from Kuhn's idea of alternations during "normal science" and Lakatos' idea of changes to soft core of a research program. This type of change operates with the same exemplars, (paradigm) while strong radical knowledge restructuring is akin to Kuhn's revolutionary science in which new exemplars (paradigm) are adopted. The learner's pre-conceptual framework is unacceptable and must be replaced. Kuhn's (1970) revolutionary science or paradigm shift has become a

leading idea of constructivist view of Conceptual Change learning strategies.

Posner, et. al.; (1982) have applied the Kuhn's philosophical approach of knowledge change to education. Specifically, they prescribed conditions to be met for a paradigm shift:

1. Existing ideas must be found to be unsatisfactory,
2. The new idea must be intelligible, coherent and internally consistent.
3. The new idea must be plausible and fruitful in solving problems which the current conceptions cannot and have implications for a fruitful research program.
4. The new idea must be preferable to the old viewpoint on the grounds of perceived elegance, parsimony and/or usefulness.

The application of the theory of Conceptual Change strategies of Posner et. al.(1982), the various Kuhnian and Lakatosian version to learning is however limited in that it embraces a hierarchical model of knowledge acquisition, assuming that changes in a theory brings simultaneous changes to other theoretical, methodological and aims within the conceptual framework. This puts much emphasis on the theoretical status of conceptual framework over the considerations of how changes in methodology

could affect changes in conceptual framework. This holistic view to conceptual change even in the sciences is faulty for it does not show how scientific consensus and desensus take place. It emphasizes the role of consensus in science over desensus, overlooking the role of aims and methodology in bringing about conceptual change (Laudan, 1984). Changes in conception occur via changes to parts and not to the whole (Kuhn's 1970). Thus, for the process of conceptual change to be understood and applied, one must appreciate the complex nature of knowledge restructuring.

In the constructivist perspectives, conceptual change occurs through cognitive conflict referred to as revolutionary change process (Gilbert et. al., 1983). It shows the same feature with Piagetian assimilation and accommodation processes. It also highlights Kuhn's, (1970) paradigm shift which involves re-organization of ideas which might require eliminating much of what has been constructed and re-constructing new schemes of knowledge. This perspective has been a main feature of Conceptual Change teaching models which could remove cognitive dissonance (Duschil et. al., 1991). A careful look at both Kuhn's epistemological framework and the constructivist's view to conceptual change reveals that science educators need to consider changing their

methodology to reflect the aims of the instruction. The focus of this present study is to develop a teaching methodology that could bring about conceptual restructuring in students of biology which can have consequences on the achievement, retention and attitude of students to biology concepts. From the literature reviewed, some number of researchers have put up models that could affect conceptual change (Driver, 1980; Posner, et. al.,1982; Nussbaum and Novack, 1982; Osborne et. al.; 1983, Laudan, 1984; Champagne, et. al; 1985; Stenhouse, 1986; Hashweh, 1986; and Roth et. al. 1987)

In a reticulate model of Laudan (1984) represented in a triadiac-network, (Fig. 2) aims, methodology and theory were related. This indicate mutual justification taking place among all the three levels of scientific commitment. No one of the three levels is more fundamental than the others. Aims, methodology and theory are related and depend on one another. In the reticulate model, Laudan (1984) gave a broader analysis of conceptual change. The notion of change is one in which changes to aim, methodology and theory do occur separately but within a specific period of time. Aims, methodology and theory are related in a triadiac network - indicating mutual justification taking place among all the three

levels of scientific commitment. This could be represented in a figure diagram as shown below ;

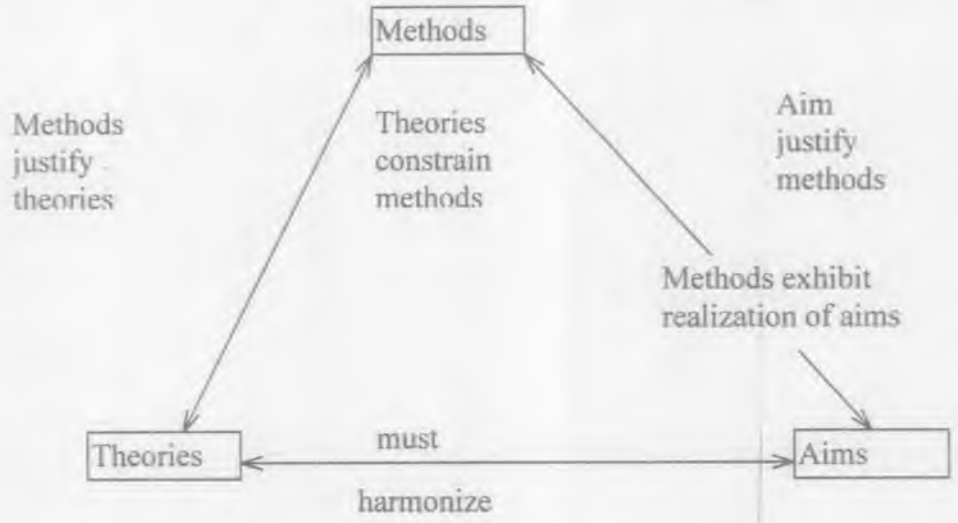


Fig. 2 The Triadiac Network of justification from Laudan (1984 pg.63)

The Laudan's epistemological framework is a pointer to the need for science educators to include changes not only in theory but also in methods and aims in the process of conceptual change.

Champagne, et. al.,'s (1985) model for conceptual change was based on ideational confrontation. The main features of this model are:

1. Students' awareness of their pre-conceptions through discussions, argument and interpretation of events.

2. Presentation of scientific explanation of events and relationships.

3. Comparing students' interpretations with scientific explanation.

This model seems to fulfill the four conditions for conceptual change by Posner et. al. (1982), in the constructivst perspective. Students could be encouraged to become dissatisfied with their existing conceptions by being aware of their own ideas, asking for explanations of familiar and discrepant events. At the same time they could be engaged in debating alternative conceptions. It calls for science teacher's active participation: the teacher elicits pre-conceptions, asks for explanations, points out discrepancies and encourages debate and deliberations.

This Champagne et al's (1985) model is similar to Nussbaum et. al.'s (1982) model for conceptual change which also involves students awareness of their pre-conceptions, engagement in conceptual conflicts which eventually would lead to conceptual change. In this present study, the pre-conceptions of students would be highlighted, discrepancies would be noted between their ideas and the acceptable scientific ideas, dissonance would be created and instruction given could change their preconceived ideas to the accepted ones.

Hashweh's (1986) models of conceptual change (Fig.3) holds the view that in the process of meaningful learning,

new knowledge interacts with existing concepts and is assimilated into them. This could alter the form of both the anchoring concept and the new assimilated knowledge. The idea may be successful in dealing with a R1 domain, and may not be successful in explaining some particular domain of the real world, R2. It cannot be used to describe a second part of the world, R2. Conflict 1 could be resolved by adopting conception 2, which better explains R2, but does not explain conflict 2. In science however, C1 is a special case of C2 viz.: C1 represents R1 and C2 represents R1 + R2. C1 is derived from limited experiences and may conflict with the scientific framework which is much more general. From this model, an instructional strategy based on Socratic-like dialogue using analogies and comparable events was developed. The strategy focused on making students aware of their individual pre-conceptions and their limitations after this eliciting stage. Students were presented with two different comparative events. These two were the generative phase in which students were expected to create the new framework. At the end of the instruction, students would be expected to abandon their pre-conceptions, changing them for the expected scientifically acceptable framework. This instructional strategy could lead to an evolutionary change.

Stenhouse (1986) used Kuhn's ideas of paradigm shift for a conceptual change model, - the Model of Paradigm Shift (Fig. 4). The conditions of Posner (1982) and Hewson (1985) for conceptual change are the main emphasis of this model. The contention was that once the conditions have been satisfied, conceptual change takes place - leading to a paradigm shift. However, before the shift, learners are confronted with an accumulation of evidences. contrary to their current pre-conception (existing paradigm). This would lead to arguments, discussions of the significance and problem-solving value of a concept until there is conviction. The perceived situation has been represented through the single diagram below.

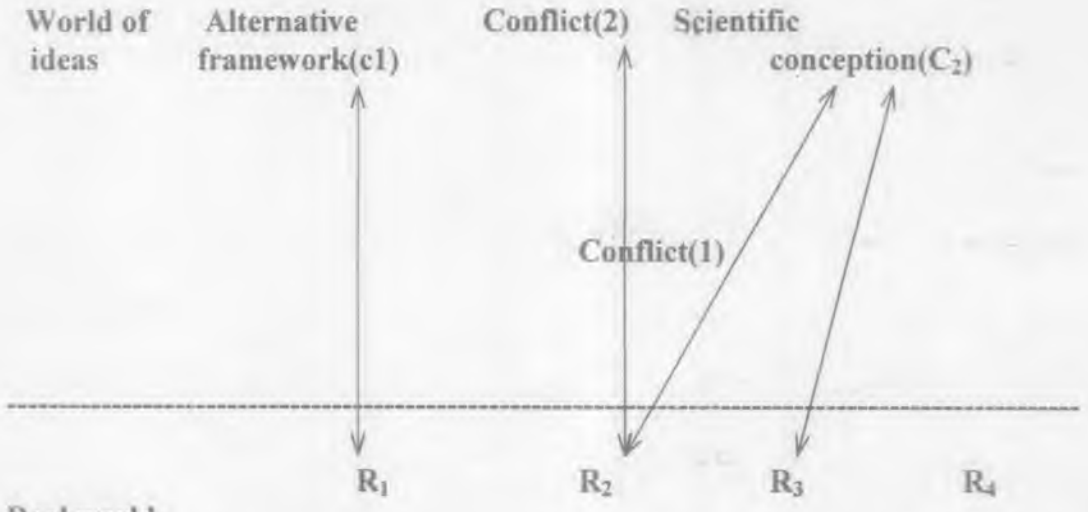


Fig. 3 Hashweh's model of conceptual change Key

C1 = Preconception R1 = A domain of the world
C2 = Scientific conception
R2 = Some other domain of the world
R3 = Other domain of the world R4 = Some other domain of the world

The scientific concepts, are assessed by comparing the old concepts with the new concepts obtained through trials, experimentation and verification. This lead to a conceptual conflict. The new scientific concepts are adopted.

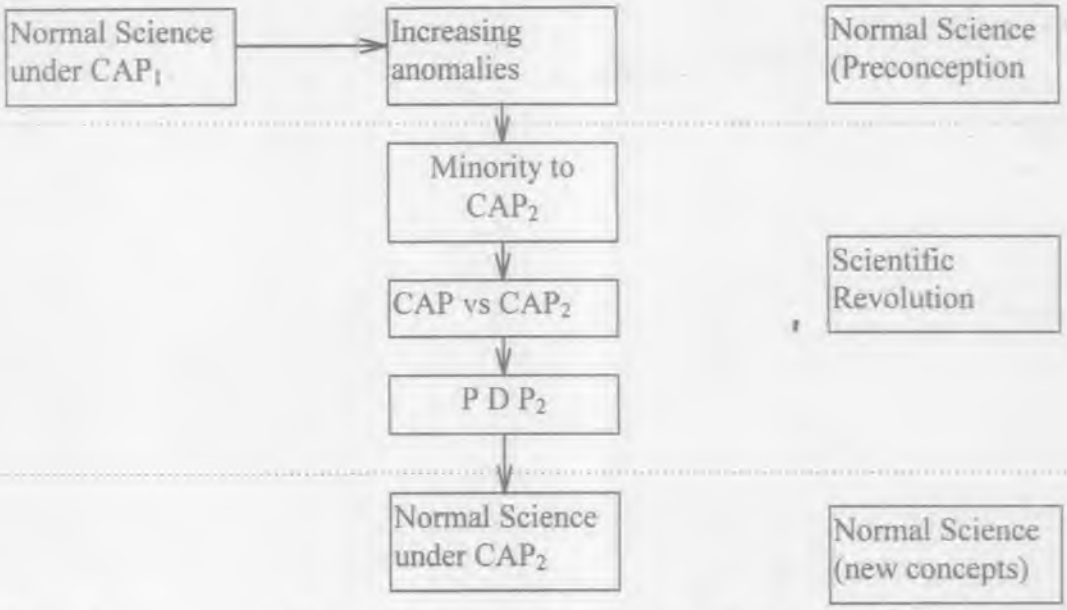


Fig 4. The Model of Paradigm Shift (from science Education, 70,4, p9413 - 425)

Key:

CAP = Common Assumption Paradigm (assumptions, beliefs about rules, techniques accepted as subject matter.)

CAP_1 = Old CAP

CAP_2 = News CAP

PDP_2 = Public Demonstration Paradigm.

Osborne and Wittrock (1983) have combined their ideas about generating meaning and information processing to

produce a generative learning model which is characterized by:

i An interaction of the learner's memory store and processing strategies with input available from the environment by selectively selecting and attending to some inputs and ignoring other inputs. Students can only make sense of things they can actively select and attend to certain sensory inputs and ignore others.

ii The input selected and attended to by the learner of itself has no inherent meaning.

iii The learner attend to the selected inputs. These selected inputs have no meaning, unless

iv The learner links the input and those parts of his/her memory store that are considered relevant. Often-times, the links are made to aspects of memory store not intended by the teacher.

v The learner retrieves information from memory store and uses this information to actively construct meaning from the sensory input.

vi The learner may test the constructed meaning against memory and sensed experiences

vii The learner may subsume constructions into memory. At times, the learner may readily accommodate alongside ideas already stated. At other times, a considerable restructuring of ideas and re-interpretation

of experiences may be required to successfully subsume a new construction.

viii The learner will place some status on the new construction. This may be done sub-consciously.

Frequently, new constructions and previously existing ideas in memory will be held simultaneously and over-time the status of one view may increase while the other decreases (Lagoke, 1992). An indication of this is that for teachers to be able to help learners learn the way teachers intended, it is important for the teachers to appreciate the learners existing framework of ideas and analyze the extent of the modification needed for the learner to appreciate what is being taught. In this way, conceptual change learning which is advocated through constructivism would be achieved.

Driver (1980) in collaboration with some science teachers, proposed 2 models of teaching for conceptual change using the constructivist approach. The first model is characterized by several stages.

1. A scene-setting orientation activity:

Students attention and interest in the topic is aroused. At this time, the class spends time discussing and reviewing their own ideas or models.

2. The elicitation stage :

This is usually conducted first in small groups. Each group is expected to represent their ideas and conceptions about the topic of subject matter on a poster or by other means. The poster is presented to the whole class for discussion. At this stage also, similarities and differences in students' prior ideas are identified and clarified. The posters remain displayed as a record during the rest of the unit of work. This may later be commended or commented on.

3. The restructuring stage:

This is considered the heart of the scheme. It involves the use of a wide range of strategies. The lesson sequence gives students opportunities to try out and apply their revised conceptions in a range of ways such as practical construction tasks, imaginative writing tasks and conventional textbook problems to solved.

4. Clarification and Exchanges:

At the end of the lesson sequence, the learners are given opportunity to review the extent and ways in which their thinking has been changed with the process of learning. The earlier posters may then be modified or new ones constructed and compared with the earlier ones.

5. Evaluation:

For the effectiveness and success of the model, (Driver, 1980) warned that students efforts should not be evaluated too early by the teacher or by other students, otherwise, students would not experiment in their thinking, but would want to be told like this, the knowledge construction process would be short-circuited. In this present study, the researcher intends to adopt this model for teaching some biology concepts. For the easy adaptation of the model and for its clarity.

The second conceptual change model proposed by Driver and his associate teachers represents various teaching strategies that could be used to encourage the constructions of new concepts. They are

i Broadening the range of application of a conception. Students' prior conceptions may be a resource which can be extended.

ii Differentiation of a conception. Students see conceptions as global and not well defined. Therefore, particular experiences are necessary to help students differentiate their notions.

iii. The process of unpacking of a conception problem which cannot be solved directly but requires a deeper problem to be addressed is used. In the

process of explaining the deeper problem, the learner conflict in ideas is resolved.

iv. The construction of an alternative conception. In some cases, students' prior ideas are incommensurate with the scientific conception. This model attempts to shape students notion into the scientific ideas and students are given the opportunity to evaluate the scientific model in relation to their prior ideas.

An interesting thing emphasized in the set of models is that of changing the meaning of one's experience and thereby making sense of science concepts. Science instruction in this present study is being aimed at bringing about conceptual change in students and any conceptual change resulting from instruction is learning which could have effect on students' achievement, attitude and retention level.

Roth et. al. (1987) have also proposed a set of four teaching strategies for changing pre-conception:

i Eliciting and responding to students misconceptions.

ii. Focusing on explanations.

iii. Probing after students' responses.

iv. Balancing open-ended and closed discussions.

Each of these sets of strategies relates to Posner et. al.(1982) conditions for conceptual change. Dissatisfaction with existing conceptions may be encouraged through making students aware of their own ideas, asking for explanations of familiar and discrepant events and debating pre-conceptions. An interesting feature of the set of teaching model is that both teachers and students are cognitively active and engaged. Conceptual change occurs through cognitive conflict and restructuring which is a main feature of conceptual change teaching strategies and could remove cognitive dissonance (Duschel et. al., 1991).

The different conceptual change models discussed above could have implications for students' learning with consequences in attitude to, achievement in and retention of scientific concepts. This is more so when appropriate tools are used in the classroom to affect them.

2.4 The traditional Methods of Science Teaching

The traditional method of Science Teaching is synonymous to lecture method, the talk and chalk method and the expository teaching style. It is characterized by learners being passive listeners in the classroom while the teacher is the actor. In passive learning, students often sit quietly in rows copying diagrams from a book,

notes from the board or listening passively to a teacher telling, reading, or demonstrating using science apparatus. In a science classroom, students do not control the activities, and often have little involvement in either the process or the results of the activities. The teacher in a traditional science teaching method setting is the primary focus and students are the doers. The knowledge to be learned is presented by the teacher who also defines concepts for the students.

In describing the traditional method of science teaching, Watts et. al.(1989) have used the term 'transmission approach'. A teacher who employs this approach usually sees knowledge as existing in form of content and criteria performance only and himself as an 'authority' in a subject. The teacher's task is to evaluate and correct learner's performance according to criteria which the teacher is the guardian.

The learner in a traditional method of science teaching is an 'uninformed acolyte' for whom access to knowledge without the authority of a teacher would be difficult because he must qualify himself through tests of appropriate performance; 'a tabular raiser' of repute (Driver, 1986). Teachers using the transmission mode merely 'transfer' (Fox, 1993). They see knowledge as a commodity which can be transferred by the act of teaching

from one 'container' to another. Also, they tend to express their view of teaching in terms of 'imparting knowledge' conveying information, 'giving the facts' or putting over ideas in the talk and chalk style. Galton et al; (1979) have called science teachers adopting this traditional approach to science teaching 'informers'. They presented an array of unequivocal facts in lessons and direct students to book sources for fact finding. Moreover, students constantly refer to teachers for the purpose of acquiring and confirming facts. A transmissions (traditional) approach to science teaching and a passive mode of learning science predominates in most science classrooms (Watts et al, 1989; and Hodzi, 1993).

The traditional method of science teaching could be advantageous as an instructional strategy in:

1) facilitating early completion of the curriculum by the science teacher.
2) It is less expensive and it affords greater number of students in a classroom at a time.
3) It could promote meaningful learning if the new knowledge is linked to relevant existing concepts in the learner's cognitive structure. In contrast to this view however, Carin et. al.(1989) have ascertained that if the new knowledge is arbitrarily incorporated into cognitive structure

of the learner, rote learning takes place. This results in a narrow limited education - a major draw back of the traditional science teaching method.

In recent times, current perspectives in cognition and learning portray the learner as actively constructing internal modes of the world which he uses in making sense of the new experiences. Whether the new information presented is meaningful understanding or rote learning for students would depend on how relevant one makes it for them and how well it matches their level of cognitive development. Thus it is important to know how much students know before a scientific concept is presented to them. This is the constructive perspective as opposed to the traditional method of teaching.

In this study, the researcher attempts to use both the Traditional Method and the Conceptual Change teaching model in the constructivist perspectives on different groups of students and to compare the effect of the two teaching strategies on students' achievement, retention and attitude to some biological concepts.

2.5 Instructional Strategies and Students' achievement

A large proportion of the literature reviewed showed that emphasis in science education is no longer on

the transmission of factual knowledge (a characteristic feature of traditional teaching method) but on teaching students how to learn (Anderson et al, 1970). The introduction of inquiry - based program into schools prompted the teaching of science through the inquiry approach. By this approach, students were expected to acquire scientific knowledge through the scientific processes of observing, comparing, classifying, experimenting, communicating and inferring as they try to find out things for themselves.

2.5.1. Contributions from Recent Studies:

Schneider and Renner (1980) compared the understanding of science content by students who were taught by the inquiry method and students taught by the traditional lecture method. The inquiry method resulted in greater gains in intellectual development of the students tested. Intellectual development was measured by student's achievement in Piagetian tasks. This shows that the inquiry method was better than the traditional approach in promoting intellectual development for the concrete operational students.

Awodi (1984) compared the biology achievement of Nigerian Secondary School biology students when taught either by the inquiry method or the traditional (lecture) method. The students were guided through the lessons by

the nature of teachers' questions and were also encouraged to ask questions. The result indicated that inquiry teaching improved the quality of science instruction with the consequent higher achievement in science by Nigerian Science Students.

Similarly, Martin (1994) tested the effect of lecture (viz.: traditional approach) and inquiry strategies on the cognitive performance of integrated science students. The mean achievement scores of the lecture and the inquiry groups were compared. The + t-value obtained was significant at p = 0.05. It was observed that the inquiry group performed better than the lecture groups in the p o s t instructional achievement test. The studies of Awodi (1984) and Martins (1994) indicated that inquiry teaching strategy could afford students greater achievement in their science lessons than the traditional teaching method.

In another study, Odubunmi et al; (1991) investigated the effect of laboratory and lecture (traditional) teaching method on the cognitive achievement of integrated science students. The study involved 210 students from six classes randomly selected schools. Students were randomly chosen from form two of each school. Three classes of 105 students formed the experimental group and the other three classes formed the control group. Each of

the groups (experimental and controlled) included a unisex female class, a unisex male class and a mixed class. The study was designed as a two-group pretest - treatment - post test format. Two treatments were applied, the talk and chalk method and the laboratory method. The ability level were established on the basis of the performance of students on an ability test. An analysis of covariance was employed in the data and t-test statistics was used to determine the significant difference between the means of the different groups.

The results showed that high achievers of both groups had identical achievement but the low achievers in the experimental groups performed better than their counterparts in the control group. Also, the males prefer laboratory method to lecture method when compared to the female counterparts. The study revealed that females in the control classes performed better than males of the same group. The studies of Odubunmi et al; suggests that it is possible to enhance students science achievement through the use of a laboratory (another form of inquiry teaching) teaching method as opposed to the talk and chalk method. Also, low achievers can be encouraged to perform better through the laboratory (inquiry) method.

2.6 Conceptual Change teaching Strategy and Students Achievement:

In recent times , much emphasis has been shifted on the need to use instructional strategies which take into account students' existing conceptions. This could enhance meaningful learning for what the learner already knows could influence his learning the new material (Ausubel, 1968). The inquiry method of instruction does not probe the learner's preconceptions before scientific inquiries are made. Though, students could achieve better using this strategy, a probing strategy would appear to help students to achieve better.

Alaiyemola (1988) use this probing strategy to study the effect of a meta-cognitive strategy on students anxiety and achievement in biology. The study attempted to find out if the meta cognitive strategy of learning through concept mapping will enhance science learning and achievement thereby reducing anxiety towards the learning of science. The SS1 students of Ahmadu Bello University Demonstration Secondary School were the subject for the study. The experimental - control group research design was used. The experimental group was familiarized with concept mapping heuristic for two weeks while the control group was left alone, at the end of which the two groups were pre-tested in achievement and anxiety respectively.

The experimental group was then exposed to four weeks of teaching using the concept mapping heuristic, while the control group was taught by using the lecture method/ expository/ traditional approach. The treatment consisted of teaching selected concepts in nutrition in green plants, respiration and excretion in living cells and some biophysical and biochemical activities in cells. At the end of the treatment period, the post test was administered to both the experimental and control groups on both anxiety and achievement.

T _tests, Analysis of variance (ANOVA) and covariance (ANCOVA) were used in analyzing the tests results. The analysis of data revealed no significant differences between the control and experimental groups in the pre and post achievement tests. However, t-values of differences in means of both groups indicated significant differences within the groups in the pre and post achievement test scores. The study shows that though the difference in achievement on class basis is not significant, when individual performance was analyzed, the instructional strategy which tries to' find out what student know has made a positive effect on student understanding of concepts taught thereby affecting their achievement.

In another study, Hewson et. al.(1983) studied students pre-conceptions and instructional strategies to effect the learning of scientific concepts. Specifically, the study investigated the effect of an instruction which make use of certain scientific concepts. The instructional strategy and materials used were specially designed for a particular student population using their previously identified prior knowledge. In addition, the theoretical principles for conceptual change was incorporated.

Ninety form two students (Grade nine equivalent in U. S. A.) of mixed abilities and various ethnic groups were involved in the study. They were boys and girls with age ranging from 13 to 20 years(x-= 16yrs) from two different neighboring schools.

The experimental - control group design was used. The control group had 44 students and the experimental group had 46 students. Both groups were administered the pre-test to establish their conceptual similarities.

The instructional strategy involved:

(1) the identification of student prior conception of the subject matters to be taught using clinical interviews on floating and sinking to specify prior knowledge concerning mass;

(2) the development of instructional materials using students prior knowledge and the theoretical principles of conceptual change;

(3) the application of the strategy of instruction to the specific group of students whose prior knowledge concerning these concepts had been previously identified, and

(4) the evaluation of the effectiveness of the experimental strategy compared with a traditional strategy used as a control.

The experimental group was treated with an instructional material aimed at increasing the number of scientific conceptions possessed by students. In addition another measure was taken at decreasing the number of alternative conceptions. The experimental material consisted of the Science Education Project (SEP) core materials which were within special teaching materials. Teaching strategies of integration, differentiation, exchange and conceptual bridging were used. The conceptual bridging was first used in form of a question to establish the relevant mental set in the minds of the students. Then, pre-conceptions were addressed using differentiation and exchange strategies. Lastly, the pre-conceptions were addressed using an integration strategy.

The control group was also treated with control materials consisting of the SEP core materials in conjunction with the prescribed textbook. The integration strategy was extensively employed using expositions, discussions, experimentation or demonstration (features of traditional method). These were designed to integrate new conceptions with existing conceptions either inductively or deductively in a logical development of ideas. The two groups of students were both taught by a qualified teacher at different times. The control group was first taught using control materials, then the experimental group. The teaching sequence for the experimental group was for a period of 2 weeks in which the students first completed the pretest, then they were taught the instructional materials and finally they completed the post-test. Total teaching time for the control group was 5 hours and the experimental group six hours. Non parametric statistics were used to analyze the data. The median test was used to find the similarity between the pretest group prior to instruction. Also, the difference between pretest and post test scores of each of the groups was found. The analysis of the effects of instruction on control and experimental groups was performed on the differences between each students' pre and post test scores of each

sub-test. These were calculated and expressed as a percentage of the medium scores on the sub-test.

The result showed that the chi-square values were not significant for each of the subsets at $p > 0.05$. The mean change scores of the experimental and control groups for each of the conceptions showed that the experimental group gained more scientific concepts and lost more alternative conceptions than the control group. The median test showed that there was significant differences between the pre and post tests for all conceptions. The experimental group achieved significantly greater positive change scores than the control group on the subsets for the three scientific concepts as a result of instruction. Also, a significant achievement of greater negative change scores than the control group was recorded in the sub-test for alternative conceptions of mass and volume as a result of instruction ($X2(1) = 18.0$, $p < 0.001$, and $X2 (1) = 8.7$, $p<0.005$) for the two conceptions respectively.

The study of Hewson et. al.(1983) suggests that it is possible to enhance students science achievement through the use of instructional strategy aimed at changing the students' pre-conceptions about scientific concepts.

The instructional strategy for conceptual change used in this present study is similar to that of Hewson et. al.(1983). The design permit greater student involvement

in the teaching-learning process in a classroom. Also, the teaching strategy diagnoses students preconceptions in order to incorporate the elements that are associated with conceptual change. This approach to teaching is employed not only to facilitate learning but also to build up favorable attitudes towards science. When students are helped to make the leap after a meaningful learning of concepts, they not only achieve better cognitively, they can also retain and exhibit favorable attitude towards science.

2.7 Instructional Strategy and Students' Retention

Retention which is the ability to retain things experienced or learned has been an area of focus to some science educators in recent years (Adamu, 1992; Lagoke, 1992; Ezenwa, 1993; Adeniyi, 1997). Retention can be described as a form of reaction to what has been presented in the past, in other words, it is a result of orientation or attitude which marked an original perception.

Barlett(1932) in Adeniyi(1997) emphasized the imaginative aspect of retention when he writes of an imaginative reconstruction built out of ones attitude toward past reaction or experiences. He argued that this was possible as a result of the effect of ones capacity to turn round upon his own schemata. Thus, retention and what is

retained depends on the individual frame of reference. Barlett also opined that retention can hardly be exact even in the rudimentary case of role learning. The problem therefore is how to maximise the level of retention and future recall of what is learned. This issue can not be properly attended to until one has an insight into the factors contributing to retention.

Factors Influencing Retention:

Retaining the effects of learning could be possible if learning is coded into memory. Appropriate coding of incoming information provides the index that may be consulted so that retention takes place without an elaborate search in the memory lane.

The nature of the materials to be coded contributes to the level of retention. Materials are related to the quality of retention in terms of their meaningfulness, familiarity, concreteness, and image evoking characteristics (Adeniyi, 1997). Generally, common, familiar, meaningful and structured material are more easily retained than unrecognizable, haphazard data. There should be less problem in retaining organized, meaningful material as this can be analyzed without difficulty. Also, easier to retain are words associated with concrete objects and events because they can be represented. The

image evoking words also provide a means of rehearsing the target word while it leaves a visual trace even when the word is no longer in view. On the other hand, abstract ideas are difficult to retain because they are difficult to represent in memory and therefore difficult to generate for retrieval. However in adapting these assumption on the nature of materials to memory search one should be cautious .While there are no evidence to disprove for instance the facilitating effect of meaningfulness to retention, the relation between familiarity and retention is a function of the test administered. When it comes to the test of recognition, unfamiliar words are easier to recognize than familiar ones. In recall test however, familiar words are easier to recall than unfamiliar ones.

Generally, it appears that the level of arousal and emotionality generated by the learning material could affect the rate of retention. There are however, diverse opinions on this. Cross (1974), and Ezenwa (1993) and Adeniyi(1997) suggested that a material which evokes pleasant emotional association is more readily retained and can last throughout the whole span of life. On the other hand, people attempt to repress and intentionally block memories of materials and events that involves anxiety and pain.

Paivio (1968) and Adam (1992) arrived at a similar conclusion when they found significant correlation between read emotionally and paired associate recall with unemotional stimulus words leading to better retention. Kleinsmith and Kaplan in Adeniyi (1997) arrived at a different conclusion while studying the effect of emotional and less emotional words on retention. The researchers measured changes in galvanic skin response (GSR) during the learning of emotional word like 'vomit' and less emotional one like 'swim'. Recall was tested after 2 minutes,20 minutes and one week. The first trial showed that the recall of low arousal words was about four times that of the high arousal pair. However on later trials, while the recall of low arousal pair declined that of high arousal pairs improved. The finding suggests that there is the tendency for those words that produces a greater G.S.R. response to show less rapid forgetting. What may be derived from the different opinion is that the reactions of people depend on how much they are personally affected. While it is possible to tolerate the memory of events that only involve G.S.R response, efforts are made to intentionally forget occurrences that have personal meaning in form of pains and anxiety.

Characteristics that differentiate learners play significant roles in the functioning of retention. Items

like interest, existing knowledge, intelligence, goals, rewards, ego involvement, curiosity and anxiety state affect the amount of invest the individual can put into understanding the learning materials. Yet, the more a person knows about the meaning of an item stored in his memory, the more the item can be retrieved.

Other differences are related to thinking styles which attract a good discussion in Cross (1974) and Martins (1994). It has been observed that fast learners are superior in both short term memory (STM) and long Term Memory (LTM) delay recall tasks. Sharpers according to Cross were found to have a well differential memory compared with the more blurred memory schemata of levelers so that information is more freely available to sharpers.

Retention level also differs among individuals. Age could be a factor in this instance as retention increases from infancy throughout the teenage years (Cross, 1974). This period is followed by a slow recession in middle age. The age dimension howbeit should not impose a limitation while dealing with secondary school learners since age range per class is always low. At any rate, the whole essence of the call for a good instructional strategy is to encourage an improvement in the learners level of retention.

The context in which retention activity takes place is another argument put forward as impeding or facilitating retention (Lagoke, 1992 Adamu, 1992 and Ezenwa 1993;). A change of context may result in the disorganization of ones already associated with subject teacher and lecture room, thus creating a different schemata from those whose traces were established during learning.

Though the concept of schemata is sketchy and difficult to examine, experimentally, it does explain a good alteration which makes the present thought structure unable to incorporate the information stored earlier on. This information presented on the context of learning and testing is of relevance to education as it particularly relates to examination practices.

What is evident from this discussion is the presence of a large array of conditions, events, influences and personalities that come to play when learning and testing is going on in the classroom. It is not possible to eliminate all these variable but at least, efforts can be made to reduce their influence during classroom interactions. A good instructional strategy is a good control measure. If left uncontrolled, there is the possibility that the learner will experience a heightened rate of forgetting.

A number of empirical researches have been done on retention and instructional strategy in recent years. Lagoke (1992) tested the retention ability of two groups of students (experimental and control) each from different schools in her study. The experimental group was taught using the analogical linkages strategy for teaching Biological concepts while the control group was taught using the Traditional Teaching Methods. The pre-test - post - post test research design was used. In separate analysis of the post-post test scores for each of the groups a p value of 0.001 was obtained for each of the groups. Using the differences in means of scores of post test and post-post test of experimental and control groups to compare the retention level, a P value of 0.009 which is significant of 0.05 level was obtained. The result of analysis showed that the students in the experimental group who were taught with analogies performed significantly better and they retained more of the biology concepts taught than their counterparts in the control group where teaching was not enriched with analogies.

Ezenwa (1993) also compared the effectiveness of the concept mapping and the guided discovery teaching strategies on students retention of some chemistry concepts. To test the retention ability of students taught using two teaching strategies, the mean scores and

the standard deviation of the concept mapping and guided discovery groups were used to calculate t-test. The result of the t-test analysis revealed a significant difference in performance between the post test and post-post test of the guided discovery group. There was a significant, difference between the concept mapping and guided discovery groups post-post tests score.

It follows that the concept mapping method enables students to have better understanding of concepts taught and retain more knowledge of the chemistry concept than the guided discovery method. In this present study an attempt is being made to compare the effectiveness of the Conceptual Change Teaching Method and Traditional Teaching Methods as relating to their achievement, retention and attitude on two different groups of students.

2.8 Instruction and Students' Attitude:

There has always been an interest in the development of positive attitude towards science (Macmillan et al; 1979). According to them, the objective of any science curriculum includes fostering favorable feelings towards science as well as imparting cognitive knowledge. The leading methods of teaching science in Nigerian schools are traditional and it seemed that teachers have

maintained them because these methods seem to dish out those facts necessary for the learner to pass the prescribed examinations but not necessarily to understand the concepts involved in the disciplines (Gbamanja, 1986). Attitude plays a major role in student's learning (Gardner,1975; Levin and Fowler, 1984). Attitude is viewed as representing the underlying disposition and motivational urge for leaning (Hassan,1985). The attitude an individual has influences science learning and use of scientific information to a considerable degree. Part of this study is to determine if the use of Conceptual Change Teaching Strategy would result in students developing a favorable attitude to Biology.

Student's Attitude Towards Science:

Measuring students science achievement is not the only way to evaluate student's and instruction. Attitude plays a major role in students learning (Gardner, 1975; Mukhurjee, 1978; Levin and Fouler, 1984; Ajewole, 1991). Various definitions have been proffered for attitude. Moore and Sutman (1970) defined attitude as an opinion or position taken with respect to a psychological object in the field of science. Gagne,(1970) defined attitude as an internal state that influences the personal actions of an individual. Combs (1971) considered attitude as a

regulation of all behavior. Ones behavior at any time according to Combs are not causes but consequences of what is going on with in the individual. Mukherjee (1978) asserts that attitudes are organized through experiences and impart a direct influence upon the individual. Brown et. al. (1964) views attitude as representing the underlying disposition and motivational urge for the learner. Attitudes, interests, appreciation are all terms used to describe what educators call "the affective domain". It is a continuum from positive to negative. A person may dislike or like something or possess varying degree of neutrality, It is this predisposition to respond positively or negatively that characterizes a person, s attitude.

For the present study, the term attitude is used to refer to one's feeling, thought and predisposition to behave or respond in some particular manner. Attitudes are best expressed when individuals make statement about their opinion (Mukherjee,1978). Students reaction to a subject is influenced by his attitude to it. According to Alao (1985) learners attitude to a subject is influenced by both internal and external factors. Some of these internal and external conditions must be satisfied before attitudes are changed. The internal conditions are ,the individual skills and certain amount of relevant information which

the learner must possess about concept to new attitude will be directed. The external conditions are mainly the human models appeal to which the object attitude is applicable. Attitude is an important outcome of science teaching (Haledyne et. al.,1983; Bajah,1986). For one, the attitude which an individual has influences to a considerable extent his learning of science and his use of scientific information (Ajewole,1991) The possession of favorable attitude towards science is an important characteristics of a scientifically literate person (Balogun,1985).

The study of student attitude to learning and instruction is important. Schbei(1984) hold the view that attitude study is necessary for a teacher who expects to understand why his efforts are sometimes so well rewarded and sometimes so seemingly hopeless. Gadner (1969) likewise explained that attitude research is important because decisions which students make are strongly bound with their attitudes, such as career choice. It is therefore not surprising that many studies in Nigeria and elsewhere have not only focused on the attitude of students and teachers toward science but also on the relationship of those attitudes with performances.

Studies by Orisasseyi (1977) and Jegede (1984) concentrated on attitude towards physics. Babatunde

(1982), Soyinbo (1982)and Ajewole (1991) investigated students attitude towards Biology. On the while, attitudes were reported to be positive. Although correlation of attitude to performance was low. Alao (1985) showed that the attitudes to any of the basic sciences is positively correlated to performance. Among American high school students, attitude was found to have a direct effect on science achievement . It is not surprising that individuals who are majoring n science and who are themselves scientists have a good attitude towards science (Hirschorn, 1974)

An international study by Kelly (1978) found that attitude was significantly related to achievement in science even when ability was taken into account. McMillian and May (1979) and Baker (1985) found that science achievement as reflected by grades did not influence attitude to science. They interpreted this to mean that students receiving poor grades could have a more positive attitude than those with good grades.

Simpson (1978) ascertained that favorable attitude to science generally account for between 20% and 25% of the variation in academic achievement in science. Although students differ in degree in their attitudes towards different subjects taught in the school curriculum, a

person generally performs better in any discipline to which he is favorably disposed.

Brown et al; (1979); McMillan et. al.(1979), in their different studies found that students using activity oriented techniques exhibited more favorable attitudes towards science than those taught using conventional textbook (traditional) method. Also teacher personality and interrelationship are very crucial in the attitude formation of students. When science educators teach with this perception, the attitude students need in order to benefit from the teaching of science could be developed.

Studies have shown anxiety as a deterrent to learning in general (Morris et al. , 1976; Doffenbacher, 1978; Vinelli et. al., 1979; Frasser et. al., 1983; Jegede and Okebukola, 1987; Jegede, 1987). These researchers in their independent studies have revealed that anxiety and student achievement negatively correlates. Frasser et. al., in explaining this postulate that anxiety leads to sympathetic over activity of the brain with the resultant depression in learning. It would appear that science teachers should avoid events that could boost the anxiety levels of students such as exerting influence and emphasizing competition.

Method of instruction could affect performance of students and attitude (Piburn and Baker,1991). Studies by

Anderson , (1970) ; Dickinson, (1979) ; Story and Brown, (1979) have shown that students attitude towards science seem to improve through the use of some instructional procedures and models. This lends support to Nwagwin's (1976) assertion that attitude must be learned and may be modified later by instruction. Disinger and Mayor (1974) investigated the influence of some teachers background characteristics and some instructional variables on changes in attitude toward science. They reported that no single set of teacher and class characteristics could be found to associate with changes in students attitude but rather instructional variables seem to be more related to attitude. The number of instructional strategies that can be employed in teaching are as many as there are students and teachers but the instructional strategies of interest in this study is the Conceptual Change Teaching Model (C C T M) and Traditional Teaching Method.

Odunbunmi et. al.(1983) determined attitudes of some Nigerian students towards integrated science. The class two students offering integrated science in Oyo State of Nigeria were the target population. In all, 660 students comprising 379 boys and 281 girls from 22 schools were involved in the study which was to find the differences between various groups in their response to questions before and after instruction. Precautions were taken not

to involve the teachers so that the attitude of the students would not be influenced. All the students also had reasonable facilities which could have provided enough practical experiences. A Lykert-type attitude questionnaire was constructed and validated by a number of specialists in science education who vetted the questionnaire and trial - tested them before they were administered to the students.

Means and standard deviations were computed for all categories of students responses to establish their favorability in attitudes towards science. The T-test statistics was also computed to find differences in students responses. The result showed significant prior and post instruction differences in the means of the different groups pre-test and post-test scores. It indicates the students favorable attitudes towards integrated science after the instruction. The overall mean for students view on their involvement in their integrated science is above average. When the girls and boys were compared, males had more favorable attitudes towards science than females.

This study suggests that the teaching strategies employed can influence the attitude of students towards a subject. Also, the process of science ought to be employed rather than just teaching it as a body of fact.

Talton and Simpson (1987) found that classroom environmental variables correlated at significant level with attitudes towards science learning. In contrast, Jegede and Alonge (1987) found that students of their study do not seem positively disposed to science inspire of the fact that a great number of the students were relaxed and happy to be in the science lessons. Therefore, for improvement in students achievement, it seems apparent that science teachers should not only provide a conducive learning environment, but also employ good teaching techniques and strategies that will enhance students develop the right type of attitude to science.

Ajewole (1991) investigated the effects of guided discovery and traditional instructional methods on the attitude of students to Biology. The study sample consisted of 240 Form (iv)Biology students randomly drawn from six secondary schools in Oyo state of Nigeria. The students were assigned into two groups the experimental and the control group. The experimental group was taught using guided- discovery method and the control group was taught using the expository method. The major instrument was the 40 item Scientific Attitude Questionnaire using five point scale. Analysis of the data showed that the experimental group (guided discovery) evinced a significantly more favorable attitude to biology than the

control group. The study also revealed that there was no significant difference in the attitude of male and female students exposed to the two teaching methods. The above results is consistent with the findings of Johnson (1976), Brown and Story(1979) Ajewole (1987) and Balogun (1985) which showed that students `taught using discovery method showed a more positive attitude toward science than those exposed to the expository method.

A conflicting result was reported by Fraser (1979) that instructional methods and gender do not affect student attitude. However, Babikian (1971) found that expository and laboratory methods for teaching concepts were significantly more effective than the discovery method for teaching science concepts to students with respect to recognition of concepts and application of concepts to numerical problems. Some other research reports by Novick and Dauduani (19760 and Hassan (1985) revealed no change in attitude. Gabel and Rubba (1979) and Tolman (1979) reported a positive significant change in students attitude due to their enrollment in some new courses. The change in attitude might be perhaps due to the method of instruction rather than change of course.

Ezenwa (1993) investigated the effect of concept mapping strategy and guided discovery on student attitude to chemistry. The study sampled a total of 240 SS1

Chemistry students randomly selected from 3 schools in Minna, Niger state. 2claases were randomly selected from each school. In each school the two classes were randomly assigned to concept- mapping and guided discovery groups. The concept-mapping groups were taught using he concept-mapping strategy while the guided-discovery groups were taught same chemical concepts using guided discovery strategy. A post-test on the chemistry concepts was administered at the end of the teaching treatment period to both groups to evaluate the effectiveness of instruction. The pre-test and post-test are the same.

Analysis of the data showed that the experimental group taught using concept-mapping strategy demonstrated a more favorable positive attitude to chemistry than the guided discovery group exposed to the guided discovery strategy. This means that concept-mapping strategy had a direct influence on students' attitude. The more favorable attitude of students to chemistry learning is attributed to students interest in constructing meaningful relationship between concepts. It could be that the students have noticed that concept-mapping activities aided knowledge retention and better performance. In a related study, Ajewole(1991) found that students exposed to discovery method showed a more favorable attitude to science than students taught with expository method.

Ajewole compared discovery and expository methods while the present study compared Conceptual Change Teaching and Traditional (expository) Strategies.

There is the need to improve teaching methods, and classroom environment that will enhance science learning. The need to devise new strategies for science teaching to meet the changing needs of the society and students could be a suggestion. In this present study, the researcher attempts to devise a teaching methodology with its focus on students' pre-conceptions and how to change those that are not commensurate with scientifically acceptable ones. It is hoped that the new teaching strategy will enhance science learning, induce in students favorable attitude towards science, increase their level of retention, and improve their performance and achievement.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This study tries to find the effects of a Conceptual Change Teaching Strategy on students achievement, attitude and retention of some biology concepts and to compare these with that of Traditional Teaching Methods.

The procedure for the study is summarized under the following headings:

1. Research Design
2. Population
3. Sampling Strategy
4. a Instrumentation

   b Pilot Test
5. Validation of the research instruments
6. Reliability determination of research instruments
7. Selection of Topics for teaching
8. Teaching Procedure - the CCTM - The Traditional Model
9. Analysis of data
10. Final Administration of the research instruments

3.1 Research Design:

The simple 2 group - design of Rose and Smith (1971) was the research design chosen for this study. The design consisted of two groups. The experimental (E_1) group and the control group (E_2). The experimental group (E_1) was given the experimental stimulus (D) in terms of the strategy and instructional material used. The strategy included analyzing the students pre-conceptions and using a conceptual change teaching model of Driver (1980) (as stated in chapter II). These were withheld from the control group (E2) who were taught in the traditional way. Both the experimental and control groups were pre and post tested to assess the change that occurred in terms of their performances, attitudes and retention of the scientific concepts taught.

The school for each group were selected randomly. This design was based on the assumptions that the uncontrolled events act equally on both groups viz.

$$E1 - E2 = W.$$

W is the experimental stimulus and is the factor which explains difference in achievement of concepts after instruction. An advantage of this design are:

i.) The pretest scores gave an indication as to whether the two groups (E_1 and E_2) were about equal in the concepts they hold prior to instruction).

ii.) It allowed the calculation of individual and group mean pretest and post test scores. This gave an indication of the effect of the experimental stimulus.

iii) It allowed for the determination of the level of retention.

3.2 Population

The study was carried out in two co-educational secondary schools namely Government Day Secondary School Shika and Government Day Secondary School Bassawa. All the schools are located on the outskirts of Zaria metropolis in Kaduna state. The schools were chosen for the study as they represent the types of schools commonly found in Kaduna State in particular and Nigeria in general.

The schools prepare students along the pattern stipulated in the National Policy on Education (1995). Students were distributed into the Junior Secondary (JS classes 1-3) and Senior Secondary (SS classes 1-3), The institutions have bias neither towards the gifted nor

towards the educationally disadvantaged students, as such the population represent that found in normal conventional school system.

The target population for the study was all the Senior Secondary 1 (SSI) students of the above named institutions. The total population of Three Hundred and Eighty (380) students include two hundred and Eighty (280) boys and one hundred (100) girls distributed among the schools. The age range of the students was between 13 and 17 years but about 90% of the total fall between 14 and 16 years. The students were regarded as suitable for the study by the virtue of their age and academic experience. The science teachers in the various schools also testified to the suitability of the students serves as subjects.

3.3 . Sample, Sampling Procedure, and Sample Size:

A total sample of 152 students was randomly selected from the 380 students population. The sample size is consistent with the population sample ratio recommended in Krejae and Morgan (1970). The final sample was eventually restricted to the subjects who completed the whole exercise and fully participated in the research by:

a) attending classes regularly.

b) sitting for both pre-test and post-test and the repeated post-test

c) completing Multiple Choice Assessment Test Questionnaire and the Attitude Questionnaire and who did not revise during the retention interval.

A simple random technique was adopted for the study. The subjects from the 2 schools were first matched by equating them on their achievement scores in the pre-test. (See table 3:1) using a t-test statistics. The subjects were thereafter randomly divided into two groups control and experiment.

The sample size made up of 118 boys and 34 girls included 76 subject from Government Secondary School Shika and 76 subjects from Government Secondary School Bassawa . These are from two arms of the SS1 year group randomly selected from the several arms of the SS1 in each of the schools. The internal validity was ensured by randomizing the classes in the two schools into the controlled and the experimental conditions. The Government Secondary School Shika was the experimental class while the classes at the Government Secondary School Bassawa formed the control class. The two schools were about 25 kilometers apart and each of the two schools was taught using different methods simultaneously. This was to minimize students interaction

3.4 Instrumentation :

For the research, the following instruments were used.

(i) Multiple choice assessment tests - pre and post and repeated-post tests.

ii) Instructional Attitude Questionnaire (IAQ).

These validated instruments, after pilot tested and modified were administered.

3.4.1. Multiple Choice Assessment tests (MCAT) I & II

The MCAT I- the pre test was meant to help determine whether both the experimental and control groups were roughly equal in ability before instructions. Also, it helped to analyze students' pre-conceptions of topics to be taught. The pretest was administered to both groups before exposing the experimental group to the special instructional strategy. MCAT II was the post test which determined the performance of the students after the instructions. Also, it helped to determine what change took place in students conception in terms of their performance. The post test was also administered to both groups. The same MCAT questions - after pilot tested were used for both pre and post tests and the repeated post-test however with slight re-arrangement in the post test (Appendix B). Each of the tests lasted for one hour. The repeated post test was administered to the two groups.

This helped to determine and compare the retention level of the students in each of the groups.

3.4.2. The Instructional Attitude Test (IAQ)

The purpose of this instrument was to determine whether the students have favorable or unfavorable attitude towards the teaching using the Conceptual Change Teaching Model. It is specifically for the students in the experimental group.

The questionnaire is constructed and based on a 3 point scale of agree, undecided and disagree. The same attitude questionnaire was administered before and after instruction (Appendix B).

3.4.3. Pilot Testing of Instrument (MCAT Items)

Twenty nine Senior Secondary school science students in their first year (viz. SS1) participated in the trial of the original test consisting of forty items at the beginning of the second term of the school. A secondary school - Chindit Government Secondary School in Zaria metropolis was contacted by the researcher and permission was sought from the principal to carry out the study. This was to rule out the possibility that the information would be known to the subject of the study. A forty-

minute period was estimated as being sufficient for the administration of the test.

The help of a science teacher from the school was used. The teacher helped in the administration of the test after he was given some orientation concerning the conduct of the examination. Specific instructions written on top of the question papers were read and explained to students. Any problem that arose during the test including inadequacy of the time specified for the test was noted. At the end of the examination, all test papers were collected from the students.

3.4.4 Item Analysis:

The data obtained as a result of the pilot administration of original MCAT was fed into a computer which carried out an item analysis to determine the indices of difficulty and discrimination of each item. Item analysis relating to the study included discrimination index, facility index and student responses to each item. The discriminating index indicates the discriminating power of each of the text items, differentiating between good and not so good - performers. On the other hand, the facility index indicates the item difficulty level or the ease of answering an item. The two test we considered important because a test item that can

not differentiate between performance of the bright and not so bright students is not good for educational testing neither are the items too difficult or too easy.

The difficulty index was calculated using the formula

$$\text{Difficulty index} = \frac{R}{T} = F.I$$

(difficulty index is synonymous to facility index)

R = The number of correct responses

T = A total number of students

A range of .30 to .80 was used in selecting items for the final MCAT instrument as recommended by Payne (1968).

The discrimination index was calculated using the formula;

$$P_1 - P_2$$

P_1 = Proportion in top 27% responding correctly.

P_2 = Proportion in bottom 27% responding correctly.

The criteria suggested by Ebel in Oyebanji,1978;p 51) in evaluating discrimination indices were used in selecting items

Table 1. Item Difficulties (F.I) and Discrimination Indices D. I. (P_1-P_2) for the Trial Multiple Choice Assessment Test Instrument

Item	F.I.	(D.I) Discrimination Index (P_1-P_2)	Item	F.I	(D.I) Discriminating Index (P_1-P_2)
1	.90	0.25	22	0.45	0.50
2	1.00	0.00	23	0.28	0.38
3	0.97	0.13	24	0.41	0.63
4	0.69	0.13	25	0.10	0.00
5	0.72	0.25	26	0.07	0.25
6	0.41	0.50	27	0.17	0.38
7	0.71	0.38	28	0.21	0.25
8	0.52	0.25	29	0.14	0.13
9	0.34	0.38	30	0.21	0.13
10	0.34	0.63	31	0.34	0.50
11	0.31	0.13	32	0.14	0.13
12	0.38	0.25	33	0.24	0.00
13	0.38	0.50	34	0.10	0.13
14	0.28	0.38	35	0.17	0.25
15	0.07	0.13	36	0.21	0.00
16	0.34	0.13	37	0.21	0.25
17	0.38	0.00	38	0.62	0.63
18	0.48	0.13	39	0.10	0.25
19	0.17	0.13	40	0.55	0.13
20	0.41	0.13			
21	0.55	0.25			

Ebel (1965) evaluated items with discrimination indices of .40 and above as very good; .30 to .39 as reasonably good; .20 to .29 as marginal items usually

needing and being subject to improvement while below .19 as poor items to be rejected or improved by revision. The results of the computer analysis giving F. I. (D. I.) for each item and $P_1 - P_2$ (discriminating indices) for the correct response is presented in Table I

The following items were chosen for the final instrument.

Trial Instrument - Items;

1,5,6,7,8,9,10,12,13,14,21,

22,23,24,25,26,27,31,35,37,3

8,39.

Modification as necessary were carried out on items which did not completely satisfy the laid down regulations (See Table 2) and these were added to chosen items to make up the forty questions.

Table 2 A Summary of Operations carried out on Selected Trial Items

Operation on Items	Item Numbers Chosen
Unmodified	1,5,6,7,8,9,10,12,13,14,21, 22,23,24,25,26,27,31,35,37,3 8,39.
Slightly rewritten	19,20,29,30,32,34,40
Completely rewritten	2,25,33,36

The 40 items making up the final instrument were arranged in order of difficulty from the least difficult to the most difficult as recommended by Harryson in Oyebanji, (1978; p56). The alterations therefore took care of the question that were too simple, too difficult or rather ambiguous. This attempt along with the panel of judges' remarks, contributed to the adequacy, effectiveness and validity of the instrument designed for this study.

The distracters for each items were considered effective to the extent to which students choosing wrong alternatives were equally distributed among the distracters.

3.5 Validation of Instrument:

The content validity of this MCAT test was assessed by a panel of judges consisting of three science educators, two with Ph.D. in science education and one biologist. They analyzed and rated each item in the instrument as to how they conformed with subject specification they were testing. They were also to check the appropriateness of the items in terms of the reading difficulty level for the students who took the test and the clarity of statement. Their useful and constructive suggestions led to re-framing and elimination of some

questions which were found to be either sub-standard or ambiguous. Out of the fifty test items presented, five needed to be re framed while ten were rejected. This along with the item analysis of the pilot testing confirms the validity of the instrument. The plan for the Conceptual Change Teaching Model (CCTM) was also given to a panel of experts consisting of some lecturers both at the Biological Sciences and Department of Education, Ahmadu Bello University, Zaria, for face validation. Their suggestions led to the modification of the strategy and concept association in photosynthesis and cellular respiration units.

The IAQ was validated by a 4-man panel of experts. Their suggestions led to re framing and elimination of ambiguous attitudinal statements that were not clear. From a thirty item on the questionnaire presented for face validation, only 21 were later retained. The same IAQ was administered to the experimental group and control group for comparison (pre and post instruction).

3.6 Reliability Determination of Research Instruments:

The reliability of a test is the degree to which a test and its scores reflect true or non-error variance, that is, the degree to which repeated measurements using the test yield nearly the same results when administered

to similar groups. The present study employed the Kudar - Richardson Formula 20 in calculating the reliability coefficient of the test (Multiple Choice Assessment Test; MCAT).

$$r = n\left(\frac{1-\sum PQ}{\delta^2_X}\right)$$

Where

n = number of items in a test

p = proportion passing, (1) an item

q = proportion failing (0) an item

δ^2_x = Variance in test scores

These were obtained from the pilot testing of the MCAT. The results were fed into a computer. Computer analysis gave the reliability coefficient for the test items (MCAT) to be 0.58.

Denga, (1987) rated reliability coefficient of about 0.55 as good enough for a test designed to measure intelligence which reflects on performance in a test. Also 0.58 is approximately 6.0. The reliability coefficient obtained therefore is acceptable.

The index of reliability often depends on the method used and the instrument used as well as the type of construct measured.

3.7 Selection of Topics for Teaching:

The following topics, Nutrition and Cellular Respiration in plants were selected for this study after due consultation with the biology teachers in the selected schools for the study.

(1) Nutrition in plants - Photosynthesis

(2) Respiration - Cellular Respiration.

These topics were selected because they have not been taught to the students but are nevertheless in the SSI syllabus and scheme of work.

3.8 Teaching Procedure- Conceptual Change Teaching Model(CCTM).

The teaching model for conceptual change of Driver (1980) was adopted with some slight modification after being validated by a panel for this study. [Appendix F] Driver model is preferred because of its clarity, and because it allows students to construct new idea after instruction which can be compared with the pre-instructional ideas. The new concept is thus studied in relation to the already known. This is the fundamental issue in a constructivistic approach to learning.

Driver's model consists of these operations:

a) Orientation

b) Elicitation of ideas

c) Restructuring of ideas

d) Clarification and exchange

e) Exposure to conflict situations

f) Construction of new ideas

g) Evaluation

h) Application of ideas

i) Review change in ideas and comparison with previous ideas.

For the purpose of this research, the first and second have been merged under one heading - to read, orientation and elicitation of ideas. Likewise third and the fifth to read Exposure to conflict situations and Restructuring of ideas. They have been merged to simplify and take care of the overlap in the operations. Also, eighth and ninth have been subsumed under the seventh operation which is evaluation. Thus evaluation includes application of ideas and review of changes in ideas. Therefore, we now have these operations.

a) Orientation and Elicitation of Ideas (by concept mapping).

b) Exposure to conflict situations and Restructuring of Ideas

c) Clarification and Exchange

d) Construction of new ideas

e) Evaluation, application of ideas and review of change in ideas

f) Comparison with previous ideas.

This CCTM model is chosen for the research because it took a constructivistic view of science learning which has already been explained in chapter 2.

3.8.1. Orientation and Elicitation of Ideas:

This involves some activities in which students interest in the topic to be taught was aroused. The class spent time reviewing their own ideas or conception of subject matter to be taught. Later the class was split into four groups and each group represented their ideas on a poster as concept maps and this was placed on the wall. The pre -test M.C.A.T. was also given to the students. By these , their pre-instructional ideas of the target concepts were identified.

3.8.2. The Restructuring Phase:

At this stage, the lesson sequence which gave students opportunities to try out their pre-conceptions was presented. This involved practical construction tasks.

3.8.3. Clarification and Exchange:

At the end of the lesson sequence, students in the experimental class were given the opportunity to review the extent and ways in which their ideas have changed.

3.8.4 Construction of New Ideas:

The ideas (concept maps) were modified and new ones were constructed and compared with earlier ones.

3.8.5 Evaluation, Application and Review of changes in ideas:

This was to evaluate the effectiveness of the experimental strategy on learning of scientific concepts, to see the effect of the instruction on students attitudes. The ideas were applied and reviewed.

3.8.6. Comparison with Previous Ideas:

This involved comparing the old ideas (pre-instructional ideas) with the new ideas (post instructional ideas). This was an indicator of the effectiveness of the strategy of instruction.

3.9 The Traditional Teaching Methods:

The teaching of the scientific concepts was done by the researcher who provided theoretical facts by telling, demonstrating and using chalk board to the controlled group. Students copied notes made by the researcher and students referred to textbook sources for further information (Appendix G).

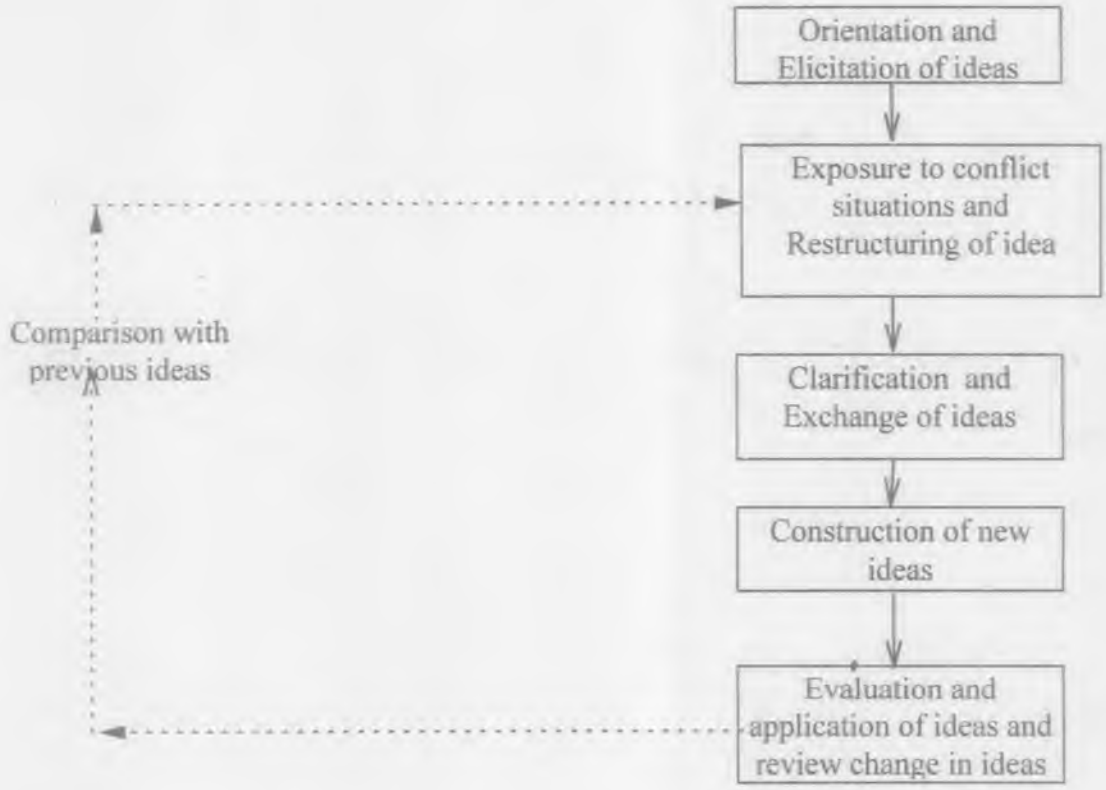


Figure 5 :A Six-Step Conceptual Change Teaching Model (Adapted from Driver (1980)

At the end of the lesson, students were evaluated by means of questions drawn from the instruction given by the researcher. All experiments were performed by the researcher who demonstrated these to the class and gave the conclusion of experiments.

3.10 Final Administration of the Research Instrument:

To remove any teacher effect and bias, the researcher did the teaching of both the experimental and control

groups. The help of the biology teachers in the sampled schools were solicited for in the administration of the pre and post MCAT pilot tested, and the students questionnaires on attitudes (the IAQ).

The contact session for both experimental and control groups lasted six weeks. The first one week was for orientation and elicitation of ideas during which both the researcher and students got adjusted to each other. The students spent time discussing and reviewing their own ideas on the subject to be taught. The pretest (MCAT 1) was administered during this period to the two groups to determine their equivalence in ability.(see Table 3:1) Also, students constructed concept map I. There were three weeks of intensive teaching (the restructuring phase after students preconception was identified) followed by one week break. During this break, the researcher was present in the classes to help the regular teachers in their teaching. The contact session was 40 minute period, and 3 periods per week. The three weeks was the time specified for teaching the units from the scheme of work in the curriculum. The purpose of the one week break was:

i. to delay the post-test, and

ii. to see if the instructional strategy have helped students retain the concepts they were taught.

The last week was for revision (review how the instruction has changed their preconceptions) and the administration of the delayed post-test (MCAT II) and IAQ II. Two weeks later, the post test was repeated for both groups as recommended by Broker (1974) Haist et al., (1992). The Data collected were analyzed as presented in chapter four.

Table 3:1 Two Independent Sampled T-test for Equality of means of Pre-test Achievement Score for the Experimental versus the Control.

Groups	No in Sample	$\bar{X}$	S.D.	DF	T-Value	critical	p
Experimental	76	11.55	3.24	150	-0.19	1.96	0.23
Control	76	12.25	3.93				

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION.

4.0. Introduction.

The results of the analysis of data obtained in this investigations and discussions on hypothesis testing are contained in this chapter. The level of significance adapted for the analysis is $p \leq 0.05$. This level of significance formed the basis for acceptance or rejection of each hypothesis.

4.1 Data Analysis and Results :

Four pairs of data were obtained in the course of this study on participating students in the two groups (experimental and control). They were:

1. Achievement scores pre test.
2. Achievement scores post test.
3. Achievement scores repeated post (post post) test.
4. Rating scores of students attitudes to Biology and instructional strategy used.

The instruments used for data collection were:

1. MCAT [Multiple Choice Assessment Test] pre test
2. MCAT [Multiple Choice Assessment Test] post test
3. MCAT [Multiple Choice Assessment Test) repeated post (post post)test

4. The pre and post Instructional Attitude Questionnaire.

The concept map heuristic was also used as a supportive tool to elicit students ideas on the topics to be taught.

The achievement scores pre-test, post tests and post post tests were compiled and recorded for each student. The students total rating scores on the 21 Instructional Attitude Questionnaire items were also summed up.

The subjects were the SS1 (Senior Secondary one) students from Shika Government Secondary School which form the experimental group and Bassawa Government Secondary School which form the control group. The equivalence of the two groups was determined from the pre-test scores of the two groups using the t-test independent samples at $p \leq 0.05$ level of significance. See table 3.1 .The different null hypotheses for the study were restated and the data analysis performed to test each hypothesis is presented together with the result of hypothesis testing.

4.1.1 Hypothesis 1

There is no significant difference between students achievement mean scores when taught using the Conceptual Change Teaching Model and when taught using the Traditional Method.

The data required to test hypothesis 1 were the post-test achievement mean scores for the Experimental Group and the Control Group. From the scores of students in both groups, the mean and standard deviation were obtained. . The hypothesis was tested by adopting the t-test statistics. The level of significance is set at $p \leq 0.05$. The t-test statistic was performed to determine equality of means of the two groups in the post-test. In this case, the test of equality of means is to test the effectiveness of the two teaching strategies. See table 4. 1

Table 4: 1. Two independent sample t-test for equality of means of the post test achievement scores for the experimental group versus control group.

Group	No. In Sample	$\bar{X}$	SD	T. Value	Critical t	p
Experimental	76	19.97	3.39	10.03	1.96	0.00
Control	76	13.61	4.37			

From Table 4.1 the t value obtained was found to be significant with p value = 0.00 at a level of significance of $p \leq 0.05$, 150 degree of freedom. Therefore hypothesis 1 is rejected. There are significant differences in the 2 groups post achievement mean scores with group 1 having a higher mean scores of 3.36 than the Control Group. The CV for the experimental group is also an indication of the

strategy homogeneously improved the performance of the subjects in the group. The CV is small after instruction in the experimental class as opposed to the higher coefficient of variation (CV) in the control group. These results indicate that the students in the experimental group where the CCTM strategy was employed performed significantly better than their counterpart in the control group. In effect, teaching using the CCTM proved a better strategy for teaching Biology.

4.1.2 Hypothesis 2

There is no significant difference between student achievement mean scores pre-instruction and post instruction of Biology concepts using the Conceptual Change Teaching Model and the Traditional Method.

The data required to test this hypothesis were students achievement pre-test mean scores and post test mean scores within each group. From the scores of the two groups (CCTM and Traditional method groups) the mean and standard deviation were obtained. Also, the co-efficient of variability was computed.

The hypothesis was tested by using the t-test statistics. The mean achievement scores for the CCTM group was compared with the corresponding mean achievement scores of the Traditional Method group in the pre and post tests.

The t-test statistics were performed to determine the equality of means of each of the groups (see table 4:2)

Table 4:2 Two paired sample t-test for equality of pre-test and post test achievement mean scores for the experimental group and the control group.

Group	Mean Score		S.D		Diff in Mean	S.D	T. Value	P
	Pre	Post	Pre	Post				
Experi-mental	11.55	19.97	3.24	3.39	8.41	3.71	19.79	0.00
2 Control	12.25	13.61	3.93	4.37	1.36	3.62	4.52	0.00

The Coefficient of Variability (CV) for both the experimental and control groups was computed for pre and post test using the formula

$$CV = \frac{SD}{\text{Mean Score}} \times 100$$

$$CV \text{ (experimental pretest)} = \frac{3.24}{11.50} \times 100 = 28.03\%$$

CV (Control Pretest) = 32.08%

CV (Experiment Post) = 16.98%

CV (Control Post) = 32.12%

From Table 4.2, the mean scores of the pre-tests compared with the post tests mean scores for each of the groups is significant at the chosen limit of 0.05 with p value of 0.00 for each group. Therefore the null hypothesis is rejected. Also, the Co-efficient of Variability of the post test is lower for the experimental group than the control group when compared. This result shows that the instructional strategies used in the experimental groups homogeneously improved student performances both within the groups and between the groups. Also the t values of the differences in means of both groups indicate significant differences within the groups in the pre and post achievement test scores. For the experimental group the achievement test mean score is 50% while that of the control group is 34%. This further shows that the instructional strategy which tries to find out what students know has made a positive effect on students' understanding of concept taught thereby effecting their higher achievement

A look at the 2 sets of scores (pre & post) for each subject within each group (App. B) shows an overall higher increment in their post test achievement scores - that of experimental being higher than the control.(50% and34% respectively)

4.1.3 Hypothesis 3

There is no significant difference between students achievement mean scores of Biology concepts immediately after instruction (post test) and the repeated post instructional test using the Conceptual Change Teaching Model and the Traditional Teaching Method (The difference between the post and repeated post achievement mean score is a measure of retention).

The data required for testing this hypothesis are the students mean achievement test scores from the repeated post test (post-post test) of the 2 groups (experimental versus control groups) and the immediate post test achievement scores of the two groups . From the scores of students in both groups, the mean and standard deviation were obtained. The t-test was computed to test the hypothesis with significance level set at $p \leq 0.05$.

From the analysis of the repeated post test achievement mean scores for the experimental groups versus the control group a p value of 0.00 was obtained which is significant at p value of $p \leq 0.05$. (Table 4.3a) . Using the differences in means of the post test and repeated-post test of experimental versus control groups to compare the retention ability a p value of 0.00 was found significant for the experimental while for control it is insignificant (Table 4:3b). Therefore there is significant

difference between the two groups repeated-post test achievement scores Hence the null hypothesis is rejected.

Table T 4:3a Two sample t-test for equality of means of repeated post test achievement scores for the experimental versus control.

Groups	No in sample	X	SD	Pooled Variance		df	p
				t value	critical t		
1.Expe-rimental	76	19.00	3.70	8.83	1.98	150	0.00
2.Control	76	13.34					

Table 4.3b: A two paired sample t-test analysis for comparing the achievement scores of the experimental versus the control group in the post and repeated post tests.

Groups	No in sample	Mean Score		SD		Diff. in Mean scores	t value	DF	p
		Post	Post Post	Post	post Post				
1.Experi-mental	76	19.97	19.00	3.39	3.70	.97	2.92	75	0.035
2. Control	76	13.60	13.34	4.37	4.18	.26	0.94	75	

This shows that students in the experimental group who were taught by the CCTM performed significantly better and retained more of the biology concepts taught better than their counterparts in the control group after instruction

4.1.4 Hypothesis 4:

There is no significant difference between students attitude towards the teaching of biology concepts using the Conceptual Change Teaching Model and the Traditional Teaching methodology.

The data required for testing this hypothesis were the students responses to the statements (positive and negative statements) based on a three point scale of agree, undecided and disagree. The frequencies of each response to each category before and after treatment were determined and values from this were used in t-test statistic.

Table 4.4a: Two paired sample t-test analysis for comparing the attitude scores of the experimental versus the control group in the pre tests.

Group	No. In Sample	$\bar{X}$	SD	DF	t value	critical t	p
Experimental	76	15.61	3.32	150	1.52	1.96	0.00
Control	76	16.54	3.65				

From the above table 4.3a.there is no significant difference in the attitude of the students to biology as a course and the instruction been used. However after instruction, there is a significant difference in the attitude of students with a p value of 0.00 at p 0.05 level of significance (table 4.3b.). Hence Hypothesis 4 is rejected. There is significant difference in students attitude towards Biology as a course after instruction using the CCTM.

Table 4.4b: Two paired sample t-test analysis for comparing the attitude scores of the experimental versus the control group in the post tests.

Group	No. In Sample	- X	SD	DF	t value	critical t	p
Experimental	76	21.88	3.75	150	15.70	1.96	0.00
Control	76	12.41	3.69				

4.2 Summary :

Comparison of students achievement mean scores on the experimental pretest and control pretest revealed no significant differences in the student ideas of the biological concepts to be taught (See table 3.1). This

suggests that the two groups were equivalent in performance. They were drawn from the same population. The concept maps of the biological concepts produced by students before instruction as a supportive tool at identifying students preconceptions confirmed their equivalence in ability and pre knowledge (See Appendix E).

In testing hypothesis I, comparison of the post test achievement mean scores of the experimental versus control group showed that the two groups differed significantly in mean achievement test scores. This result suggests that there were differences in the instructional strategies employed in the experimental and control classes. Both groups showed an over all improvement in their achievement scores over their pretest mean scores. Also the concept maps of students after instruction in the experimental class confirmed that the experimental teaching strategy had a significant effect on students' achievement.

For hypothesis 2, comparison of the pre and post test achievement mean scores within the groups and between the experimental versus the control showed that the two groups differed significantly in the mean scores. When the pre and post within each group was compared. It was observed that experimental group performed better than the control group(appendix E).

In hypothesis 3, comparison of the repeated-post test achievement mean scores of the experimental versus

traditional groups showed that there was a significant difference in the mean achievement scores of the two groups. The result of hypothesis 3 testing suggest that there were differences in the retention ability of the students in the two groups. The overall performance of the experimental group in the post-post test in terms of their mean score was 19.00 (48%)while that of the traditional group was 13.44.(34%). The group with the high achievement mean score is the experimental group in which the CCTM was employed. Thus as far as the repeated-post test achievement was concerned, hypothesis 3 is rejected.

In hypothesis 4, analysis of the students' post instructional attitude towards the strategies employed suggest that there was significant difference in the attitude of students in the two classss after treatment. The t value after instruction was higher. Also the difference in mean scores for the experimental group was higher than the control group; this leads to the rejection of hypothesis 4.

4.3 Discussion

The major aim of this study was to analyze the effect of an instructional strategy which is essentially a conceptual change teaching strategy on students achievement, retention and attitude toward biology. Students' performances when taught using this strategy were

compared with the performances of students taught using the traditional teaching strategy which is the dominant mode of teaching in Nigerian science classroom.

The result of analysis of the pretest mean scores of the two groups in this study revealed that there was no significant differences in the pre-test mean achievement scores This result suggests that both the Traditional and the CCTM groups were drawn from the same population at the beginning of the study. However, a comparison of the post tests achievement mean scores of the two groups in hypothesis one testing indicated a significant difference at $p = 0.05$ resulting from the instructional strategies that the two groups were exposed to. Also, within each group, the pre-test, post test achievement mean scores for the traditional (control) group was 12.25 and 11.55 for the CCTM (experimental) group while the post test scores for the traditional group was 13.61 compared with the CCTM score of 19.97. This data suggest possible effect on students achievement of teaching strategies employed in this study. The CCTM significantly raised the achievement of students mean scores thus having a positive effect on students understanding of concepts taught. Therefore, it is evident from this study that in science, instruction could have significant effect on achievement of the individual students.

The conceptual change model using ideas of constructivism apart from being helpful in finding out students' pre-conceptions of science topics to be taught also helped students change their ideas of the science concepts taught. This allows greater learning success with the resultant effect in students cognitive achievement compared with the traditional method.

This result agree with those of Hewson et al (1983) and Smith et al (1993). They in their various studies investigated the effect of an instruction which made explicit use of students prior knowledge. The instruction to the experimental group included strategies which addressed students pre-conceptions using conceptual change strategies while the control group were taught in the traditional way. These researchers reported that a significant improvement in science achievement of the experimental group over the control group was the result of instructional strategy which made use of students pre-conception.

Considerations of the nature of learners' preconceptions and how they differ from the learning goals is necessary in order to identify appropriate pedagogical strategies. Strategies for promoting conceptual change need to be investigated in the context of particular domains of knowledge. Therefore general prescriptions of the conceptual change process by itself are not enough;

information about the nature of the conceptual change to be promoted is necessary in designing instructional sequence. In this study, analyses were done to indicate the nature of the conceptual change required in different areas of the subject matter, then appropriate strategy was devised and evaluated. The findings of this analysis implies that the strategy employed by a science teacher is an indispensable determinant of the successful implementation of any curriculum material.

The finding of this study also confirms an earlier findings of previous studies (Zietman and Hewson, 1986) which provided evidence that instructional strategies specifically designed to lead students from their existing conceptions to new conceptions were significantly more effective than the traditional teaching strategies. It would appear that the reason the experimental students were able to acquire the scientific conception was that their preconception at variance with the scientific ones have been reduced even if not completely eliminated in the course of instruction. Head and Treagust (1989) also reported that a conceptual change strategy had a possible advantage of increasing students' self-confidence in relation to science learning, generated more active participation by students and led to greater understanding and interest with greater achievement when compared with the traditional method of science teaching. It is

evidenced in this study therefore that using the traditional teaching strategies had limited success in bringing about conceptual change in the students. Also a probable reason for poor performance in the control group lies with the continued presence of the naïve conce0ptiobns in their frame work. It seemed that teachers employing the traditional strategy are unaware of the tenacity with which students hold on to their own conceptions concerning the subject matter taught. This could be resistant to change via traditional instructional approaches (Clement,1982; Halloune and Hesterel,1985; Anderson and Smith,1987; Gunstone, Champagne and Klopfer,1981; Linn and Burbulus,1988).

In a typical CCTM classroom, students are seen interacting with themselves and with the instructional materials. There is a cognitive conflict created by the teacher's elicitation of ideas and this conflict needs resolving. Thus students are more involved in the teaching-learning process as opposed to the traditional method where students are passive listeners while the teacher is the main actor. In this study, the conceptual change teaching model was used so that the teacher also directed the experimental class in a specified way with consequences of knowledge restructuring. Conceptual change pedagogy is grounded in constructivist leaning theory, recognizing that powerful theories are brought to the classrooms and affect

the learning of new material. According to Nworgu,(1997) this is a reform in science teaching and entails replacing the traditional methods which do not aid conceptual understanding with conceptual change instructional mode.

The detected impact of the very short instruction with the experimental group relating to photosynthesis and cellular respiration in this study is educationally very significant. It has important implication for curriculum design. Apart from providing an assessment of the instructional impact on the whole group, it also increases the dynamics of the picture by tracing the conceptual change within the individual learner comparing their pretest scores with the post test scores. The fact that instruction (CCTM) in the present study did not cause a compete transition for the entire group but rather accomplished this task partially is not discouraging rather it is considered by the researcher a promising result.
This study also demonstrate that curriculum design variables are also critical factors in effective teaching and learning.

The result of hypothesis three testing shows that conceptual teaching model led to higher retention ability than the traditional method. The significant differences in the level of biological concepts retention with the CCTM group does not mean that the students did not retain any knowledge rather the knowledge retained was not significant

compared to the knowledge gained immediately after treatment. It could also be that The traditional strategy helped students just to pass examination only leaving them with poor retentive knowledge of what they have learned there-after. The significant performance of the CCTM group could be due to the fact that the strategy enabled the students to have the concepts organized and summarized in a compact diagrammatic form which could easily be remembered at a later time. It could also be that CCTM activities helped to make knowledge of the concepts clear and meaningful to the students. This knowledge in a clear meaningful organized form could have attributed to the improved retention ability of the experimental group. The findings also agrees with the assertion of Ausubel, Novak and Hanesian (1978) who emphasized the importance of students preconception in assimilating new knowledge. Students preconceptions when analyzed, known and restructured through an instruction could determine the longevity and retention quality of what is learned and remembered. Students could recall scientific facts on previous experiences without having to memorize the facts. The correlation between immediate and delayed post test indicates the basic practical problem in retention to be that of ensuring learning is appropriate in the first place.If some effect pass without leaving any effect on the learner nothing subsequently can be done to make the person

to either retain ; thus the need to foster immediate retention so as to increase the probability of remembering in the long run.

There was significant difference in student's attitude at $p \leq 0.05$, when the experimental group was compared with the control group. The experimental group showed a more positive response to the instructional strategy employed and their attitude towards biology as a course of study was more positive than the control group after treatment, although analysis of the pretest attitudinal scones showed no significant difference at p 0.05,when the experimental group was compared with the control group. This positive attitude is reflected in the student achievement scores. This finding is in agreement with earlier studies of Simpson (1978), Fraser et al (1983), and Odunbumi et al (1991). These researchers in their different studies reported that there is relationship between attitude and achievement. According to Simpson, favorable attitude to science generally account for between 20% and 25% of the variation in academic achievement in science. Odunbumi et al also of the ascertained that a student would perform better in any subject favorably disposed to. The present study suggests that good teaching techniques and strategies would encourage students to develop the right type of attitude to biology instructions. The results of this study also suggest that the instructional strategies which the

science teacher employs in the classroom situation can influence student's performance in terms of achievement and retention. When students are helped to make the leap in acquiring meaningful learning of concepts, they can also retain the concepts and exhibit favorable attitude.

CHAPTER FIVE

SUMMARY, GENERALIZATION, LIMITATIONS , CONCLUSION AND RECOMMENDATIONS.

5.0 Summary

This study was an attempt to compare the effect of two instructional strategies namely the Conceptual Change Teaching Model and the Traditional Teaching Method on students achievement , retention of biology concepts and students' attitude to biology as a course of study as well as the instructional strategies employed. The subjects for the study were the SS1 students of Shika Government Secondary School and the Bassawa Government Secondary School, all on the outskirts of Zaria metropolis. The achievement, retention and attitude were examined in relation to the teacher's instructional strategies.

Four hypothesis were tested - namely:

(1) There is no significant difference between the students achievement mean scores of biological concepts when taught using the Conceptual Change Teaching Model and when taught using the Traditional Method.

(2) There is no significant difference between students' achievement mean scores of biology concepts pre and post instructions when taught

using the Conceptual Change Teaching Model and when taught using the Traditional Method.

(3) There is no significant difference between students achievement mean score of biological concepts immediately after instruction (post test) and the repeated post instruction test (post-post test) using the Conteptual Change Teaching Model and the Traditional method. (The difference between the post and repeated post achievement mean score is a measure of retention).

(4) There is no significant difference between students' attitude towards the teaching of Biology concepts using the Conceptual Change Teaching Model and the Traditional Method.

A Forty item Multiple Choice Assessment Test (MCAT) instrument with five options was developed and pilot tested. Alternations made to the items took care of questions that were ambiguous, too simple or rather too difficult. This attempt along with the panel of judges consisting of three science educators from the department of Education, A. B. U. Zaria and one biology lecturer in the biological sciences of A.B.U. remarks contributed to the adequacy, effectiveness and validity of the instrument as representative of the science content and within the

comprehension of the students who took the test. Also used was a twenty-one items Instructional Attitude Questionnaire. This was also pilot tested and validated by the panel of judges who also determined the adequacy of the instrument before the treatment.

The study adopted a pretest - treatment - post test design which consisted of teaching the experimental group by the conceptual change teaching strategy and the control group by the traditional method. To test the first 2 hypothesis of the study, a t-test statistic was employed to compare students achievement in the pretest of each group compared with its post test. The results showed that there was no significant difference between the groups mean achievement scores in the pretest. However, in the post-test, a significant difference was observed at $p \leq 0.05$ between the two groups pre and post tests when compared. Also there was a significant difference between the post test of the two groups achievement mean scores when compared using the t-test statistics.. The significant increase in student achievement was a result of the CCTM instructional strategy which made explicit use of students prior knowledge. The teaching /learning process implicit in the

instructional strategy had some effect on the individual students as expressed on the achievement mean scores.

The CCTM employed to teach the experimental class led to higher retention than the traditional group as evidenced in hypothesis 3 testing. The students in the experimental group acquired meaningful learning of concepts; they not only achieve better cognitively they also retained the concepts and exhibited favorable attitude..

Significant difference in students attitude towards the method of instruction (CCTM) suggest that the teaching strategies employed by the teacher while encouraging students to learn meaningfully by resolving their cognitive conflict during instruction also helped student make the necessary leap required in changing their pre-conceptions that are at variance with the scientifically acceptable ones to acceptable ones. Understanding requires essentially that students abandon their own ideas for new ones.

The idea of concept-mapping employed in this study as a supportive measure assisted the learners and teachers to know students pre-conceptions before and after instruction. By engaging students in concept-mapping exercise students were able to see that concepts do not

exist in isolation. Each concept was seen in terms of its relationships to many others to be properly understood.

It is evident from this study that the CCTM has achieved positive effects on students' achievement, attitude and retention. It would require a consistent use of the CCTM for students to completely abandon their old ideas (this is reflected in the post versus post-post tests results).This consistency might have been achieved if more time was available for the study.

Findings from the study have shown that achievement and retention of biological concepts could be promoted when students are taught using the CCTM. Also, attitude to biology appear to be improved through the use of CCTM. The most important contribution of this research lies in its description and illustration of how Conceptual Change Teaching Model could lead to students achievement, retention of biology concepts and attitude towards biology.

5.1 Generalization:

Within the limitations of the present study, the following generalizations are made:

(1) Student achievement is affected by the instructional strategy employed by the teacher in the science classroom.

(2) With an appropriate teaching strategy such as the CCTM within the constructive perspective, students could achieve more, retain more and develop more attitude to biology as a course of study.

(3) Students who show a positive attitude towards the strategy employed by the science teacher are likely to achievement higher in biology than the students who are not.

5.2 Limitations.:

The following limitations were identified in this study;

(1) The study samples were limited to two co-educational schools in the outskirts of Zaria metropolis - Shika Government Secondary School and Bassawa Government Secondary School. Therefore, the results and conclusions are restricted to the population from which it was drawn. Further studies would have to be undertaken before conclusion can be extended to the entire Nigeria population.

(2) The primary prediction of this study was that meaningful learning of biology concepts would be promoted when students are exposed to the conceptual change teaching model. While data

gathered are in support of this prediction, the inherent design of the study (the same researcher did the teaching in both schools) would appear to limit the generalizations of the findings.

Despite the limitations of this study, the overall results appear to have important implications for curriculum development, science educators and science education in general. It is against this background that the following conclusions and recommendations are made.

5.3 Conclusions and Recommendations:

In this study students pre-conception of the subject matter to be taught were determined and this was used to plan a curriculum of instruction aimed at changing students pre-conception that were naïve to the acceptable scientific facts. The conceptual change teaching strategy (CCTM) grounded in constructivist learning theories that was developed (see Appendix F) and used in teaching the experimental group students. The effects of the CCTM method were compared with the Traditional Teaching Methods used on the control group students.

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

1) The use of the Conceptual Change Teaching Model (CCTM) helped to improve the quality of instruction thus leading to better performance by the students.

2) The use of Conceptual Change Teaching Model is associated with greater understanding and higher learning success.

3) The use of the CCTM helped students not only to perform better but also to retain more of the concepts taught than their counterparts in the Traditional Teaching Methods class.

4) The CCTM approach to teaching biology used in this study has positively influenced the students attitude to biology as a course. The students liked the instructional strategy and would like its inculcation in biology teaching.

Although more research in the area of Conceptual Change Teaching Model is necessary in Nigeria, it is worth recommending from the results and conclusions of the study that:

(1) that a schedule for learning about and using the CCTM strategy for instruction purposes be incorporated into the pre- service teaching programs in our Colleges of Education and

Universities because teachers teach as they were taught.

(2) however effective and empirically well established certain teaching approaches may be, unless research findings are implemented, they are of little value to the educational world. It behooves the Federal Government and all those concerned to put efforts together at improving science instructions in schools by inculcating the CCTM strategy in school curriculum practices right from primary to university level.

(3) in evaluating the success of the strategy, attention be paid to longer-term effectiveness of it.

(4) the students rating of teachers instructional strategies should be used to complement the normal assessment of pre-service teachers while on teaching practice.

(5) in service training for science teachers in the use of Conceptual Change Teaching Method will be a worthwhile venture.

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APPENDICES

Appendix A: Statistics of Results in GCE O'Level and WAEC Examinations.

TABLE 1 PERFORMANCE OF CANDIDATES IN SSCE(1991 - 1995)

SUBJECT	CHEMISTRY		BIOLOGY		PHYSICS		AGRIC SCIENCE	
YEAR	NO SAT	% IN GRADES 1 - 6	NO SAT	% IN GRADES 1 - 6	NO SAT	% IN GRADES 1 - 6	NO SAT	% IN GRADES 1 - 6
1991	116,256	18.4	285,690	25.5	96,742	17.6	220,221	21.9
1992	140,856	19.0	355,582	28.1	122,809	16.4	270,562	30.0
1993	170,537	25.0	481,034	18.7	152,275	24.5	378,607	38.5
1994	161,252	23.7	508,384	11.4	146,000	14.7	395,278	33.1
1995	153,188	36.7	453,353	18.9	120,768	18.9	361,973	41.3

Source: WAEC (Statistics of Entries and Performance)

G.C.E. 'O' Level Examination May/June 1983 – 1985
Statistics of Results by Subject/Grades Year (Nigeria)

					Number and percentage of candidates that sat and obtained the given grades 1 to 9										
SUBJECT	YEAR		ENTRY	TOTAL	1	2	3	4	5	6	7	8	1 – 6	1–8	9
GENERAL SCIENCE	1983	NO	545	388	2	2	7	2	3	11	16	23	27	66	321
		%		71.19	0.51	0.51	1.80	0.51	0.77	2.83	4.12	5.92	6.95	17.01	82.93
	1984	NO	285	164	0	0	0	0	0	1	3	6	1	10	154
		%		57.54	0.00	0.00	0.00	0.00	0.00	0.60	1.82	3.65	0.60	6.09	93.90
	1985	NO	141	42	0	0	0	0	0	0	0	0	0	0	42
		%		29.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
PHYSICS	1983	NO	66.960	60,531	57	141	1,050	1,006	1,363	5,202	5,277	7,066	8,819	21,162	39,369
		%		90,39	0.09	0.23	1.73	1.66	2.25	8.59	8.71	11.67	14.56	34.96	65.01
	1984	NO	69,072	62,668	0	174	1,828	1,837	2,607	8,154	7,241	7,650	14,690	29,581	33,087
		%		90.72	0.14	0.27	2.91	2.93	4.16	13.01	11.55	12.20	23.44	47.20	52.79
	1985	NO	68,844	63,062	151	350	2,762	2,233	2,617	8,190	6,457	7,423	16,303	30,183	32,879
		%		91.60	0.23	0.55	4.37	3.54	4.14	12.98	10.23	11.77	25.85	47.86	52.13
PHYSICS ALT.	1983	NO	2,209	1,977	67	74	271	115	112	335	224	205	974	1,403	576
		%		89.58	3.38	3.73	13.69	5.81	5.65	16.92	11.31	10.35	49.21	70.89	29.10
	1984	NO	2,247	2,135	22	27	162	114	112	298	226	223	735	1.184	951
		%		95.01	1.03	1.26	7.58	5.33	5.24	13.95	10.58	10.44	34.42	55.45	44.54
	1985	NO	2,588	2,439	40	62	318	157	176	363	232	236	1,116	1,584	855
		%		94.24	1.64	2.54	13.03	6.43	7.21	14.88	9.51	9.67	45.75	64.94	35.05
CHEMISTRY	1983	NO	126,946	113,473	190	292	2,039	1,736	2,221	7,438	9,855	13,553	13,966	37,374	76,099
		%		89.38	0.16	0.25	1.79	1.57	1.95	6.55	8.68	11.94	12.30	32.93	67.06
	1984	NO	125,247	112,729	780	1,294	6,259	3,728	4,728	11,990	3,009	68,007	28,779	45,895	66,834
		%		90.00	0.69	1.14	5.55	3.30	4.19	10.63	7.10	8.07	25.52	40.71	59.28
	1985	NO	124,866	114,380	1,203	1,103	4,601	2,361	3,803	9,359	9,946	11,911	22,630	44,487	69,893
		%		91.60	1.05	0.96	4.19	2.06	3.32	3.18	8.69	10.41	19.78	38.89	61.10

CHEMISTRY															
ALT	1983	NO	2,116	1,849	22	26	103	57	64	163	245	288	435	968	881
		%		87.38	1.18	1.40	5.57	3.08	3.46	8.81	13.25	15.57	23.52	52.35	47.64
	1984	NO	1,925	804	38	53	166	70	92	197	125	113	616	854	950
		%		93.71	2.10	2.93	9.29	3.38	5.09	10.92	6.92	6.26	34.14	47.33	52.66
	1985	NO	2,283	2,150	160	98	256	77	119	209	167	208	919	1,294	856
		%		94.17	7.44	4.55	11.90	3.58	5.53	9.72	7.76	9.67	42.74	60.18	39.81
BIOLOGY	1983	NO	299,413	276,990	352	664	4,379	2,549	4,397	12,401	13,714	19,203	24,747	57,659	219,331
		%		92.51	0.12	0.23	1.58	0.92	1.58	4.47	4.95	6.93	8.93	20.81	79.18
	1984	NO	319,859	299,034	596	1,084	5,628	4,001	5,245	14,353	24,011	36,001	31,707	91,725	207,301
		%		93.48	0.19	0.36	1.88	1.33	1.75	4.86	8.02	12.04	10.60	30.67	69.32
	1985	NO	373,507	350,476	929	1,620	8,050	5,985	6,597	17,930	20,193	43,023	41,111	112,526	237,95
		%		93.83	0.26	0.46	2.29	1.70	1.88	5.11	6.10	12.27	11.73	32.10	67.89
BIOLOGY ALT	1983	NO	3,887	3,627	31	52	221	103	152	415	373	425	974	1,772	1,855
		%		93.31	0.85	1.43	6.09	2.85	4.19	11.44	10.28	11.71	26.85	48.85	51.14
	1984	NO	4,176	4,001	38	88	310	184	142	334	378	462	1,126	1,965	2,036
		%		95.80	2.19	2.19	7.74	4.09	3.54	8.34	9.44	11.52	28.14	49.11	50.88
	1985	NO	4,464	4,350	19	46	225	153	142	378	459	527	963	1,949	2,401
		%		97.44	0.43	1.05	5.17	3.51	3.26	8.68	10.55	12.11	22.13	44.80	55.19
AGRIC. SCIENCE	1983	NO	81,190	76,819	0.09	388	4,186	3,238	4,419	12,185	10,868	12,877	24,489	48,234	28,586
		%		94.61		0.50	4.44	4.21	4.75	15.86	14.14	17.76	31.07	62.78	37.21
	1984	NO	107,872	103,232	0.01	87	2,390	2,647	5,152	16,536	23,628	25,312	26,823	75,763	27,469
		%		95.69	73	0.08	2.31	2.56	4.99	16.01	22.88	24.51	25.98	73.39	26.60
	1985	NO	148,472	142,633	28	118	2,578	2,065	3,845	13,156	22,799	10,171	21,790	74,760	67,873
		%		96.06	0.01	0.08	1.80	1.44	2.69	9.22	15.98	21.15	15.27	52.41	47.58
HEALTH SCIENCE	1983	NO	61,371	46,139	197	159	691	475						1,942	38,197
		%		89.81	0.42	0.34	1.49	1.02	0.93	3.34	4.22	5.41	7.57	17.21	82.78
	1984	NO	67,506	61,775	66	70	369	194	321	923	2,666	5,861	1,954	10,631	51,144
		%		91.51	0.10	0.12	0.59	0.31	0.52	1.42	4.55	9.48	3.16	17.20	82.79
	1985	NO	78,892	72,245	67	76	401	226	389	1,030	2,967	5,831	2,197	10,995	61,250
		%		91.57	0.09	0.10	0.55	0.31	0.53	1.43	4.10	8.03	3.04	15.21	84.78

APPENDIX B

MULTIPLE CHOICE ASSESSMENT TEST (MCAT)

INSTRUCTION: Answer all the questions in the questions paper. Read each question carefully along with all the five responses to the question. Choose the response among A,B,C,D,E options which best answer the question. Record your answer on the answer sheet provided. Shade through the letter that best responds to the question only.

1. Which of the following do living things need for feeding?

   A. Nutrients B. Oxygen C. Grasses D. Energy.

   E Light

2. Photosynthesis is the process by which plants

   A. manufacture their food

   B. manufacture mineral salts

   C. absorb water from the ground

   D. absorb carbon dioxide from atmosphere

   E. absorb water and mineral salts

3. There are two parts to photosynthesis. These are:

   A. Light and dark reaction

   B. Dark and ATP formation

   C. Water and Oxygen

D. Carbon and water reaction

E. Light and oxygen reaction

4. When the green plant is hidden away from sunlight, the leaves become pale because:

A. Plants need sunlight to be green

B. Plants need only water to be green

C. Plants become green through the mineral salts

D. Plants green color is absorbed by sunlight them.

E. Plant need temperature to become green.

5. Which of the following is not essential for photosynthesis?

A. Water B. Carbon dioxide C. Light energy

D. Chlorophyll E. Food reserve

6. The main path of entry of carbon dioxide into the leaf is through the:

A. Epidermis B. Mesophyll C. Stomata D. Phloem

E. Vascular bundle

7. The photosynthetic process is usually represented by the equation:

A. $6CO_2 + 6H_2O \xrightarrow{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2$,

B. $4CO_2 + 3H_2O \xrightarrow{\text{Chlorophyll}} C_6H_3O_6 + 6O_2$

C. $CO_2 + H_2O \text{ -----> } CH_2 + 2O_2$

D. $2CO_2 + 4H_2O \text{ -----> } C_6H_{12}O_6 + O_2$

E. $6H_3O_2 + CO_2 \text{--------} \rightarrow C_6H_{12}O_6 + O_2$

8. The dark reaction of photosynthesis consists of:

A. The combination of the carbon dioxide molecules from the air with the free hydrogen ion.

B. The combination of the carbon monoxide molecules from the air with the free hydrogen ion.

C. The combination of the carbon tetrachloride molecules from water with the free hydrogen ion.

D. Splitting of water by hydrogen ion

E. The release of oxygen to the air.

9.Which of the following takes place during photosynthesis.

A. Solar energy is converted to kinetic energy in the leaves.

B. Solar energy is converted to chemical energy in the leaves.

C. Chemical energy is converted to solar energy in the leaves.

D.Carbon dioxide is converted to oxygen and potential energy.

E.Potential energy of the sun is converted to the kinetic energy of ,leaves.

10. When carbon dioxide molecules combine with the free hydrogen ions, which of the following materials is formed:

A. Carbohydrates B. disaccharide

C. Polysaccharides D. Fructose E. Amino acids

11. The function of chlorophyll in the leaf during photosynthesis is:

A. Absorption of water

B. Absorption of carbon dioxide

C. Release of oxygen

D. Absorption of light energy

E. Release of energy

12. A + water $\xrightarrow[\text{chlorophyll}]{\cdots\cdots}$ B+ C .The substance A represents

A. Oxygen B. Nitrogen C. Carbon dioxide

D. Hydrogen E. Air

13. B and C are:

A. Starch and Protein B. Light and energy

C. Carbohydrate and oxygen D. Water and Oxygen

E. Nitrogen and Magnesium

14. Organisms which can manufacture their own food from simple in organic sources are called:

A. Autotrophs B. Heterotrophs C. Holozoic

D. Saprophytes E. Parasites

15. When the stomata on the leaves of a plant were sealed up with vaseline in an experiment, photosynthesis ceased because:

A. Light failed to penetrate the leaves

B. Mineral salts failed to enter the leaves

C. Oxygen could not diffuse into the leaves

D. Carbon dioxide could not diffuse into the leaves

E. Water could not pass in the leaves

16. Which of the following food substances contain just these elements-carbon, oxygen, hydrogen and nitrogen?

A. Sugar B. Fat C. Starch D. Protein

E. Oil

17. To test for starch in a green leaf, the leaf is usually boiled to:

A. burst the starch grains.

B. Kill the protoplasm of the leaf

C. Kill the germ on the leaf

D. Extract the chlorophyll

E. Make the leaf clean

18. The first product o f photosynthesis is:

A. Glucose B. Starch C. Glycogen D. Fat E. Protein

19. Considering the equation $CO_2 + 6H_2O$ + Energy----→ $C_6H_{12}O_6+6O_2$, Oxygen is derived from:

A. The water molecules

B. The carbon dioxide

C. Both carbon dioxide and oxygen

D. The radiant energy from the sun

E. The atmosphere

20. Carbohydrates is manufactures in plants by a process called:

A. Oxidation B. Respiration C. assimilation

D. Photosynthesis E. Chemosynthesis

21. The proportion of carbon dioxide in the atmosphere around us is kept constant by the fact that:

A. The amount of carbon dioxide removed by green plants from the air during photosynthesis is balanced by the amount replaced by respiration.

B. Carbon dioxide circulates in the atmosphere continually

C. Carbon dioxide is released to the air from rockets, planets and industrial smoke.

D. Continuos flow of carbon dioxide in the air.

E. Carbon dioxide is released during photosynthesis..

22. The presence of starch, not glucose is often used as a means for testing for photosynthesis because:

A. Only starch is formed during photosynthesis

B. The Glucose formed is immediately transformed to starch

C. The leaves of plants do not contain glucose

D. The glucose is easily broken down on heating

E. The glucose cannot be detected by food tests

23. Which part of spirogyra directly takes part in the manufacture of food?

A. Pyrenoid B. Mucilage C. Nucleolus

D. Chloroplasts E. Cytoplasm

24. Organisms which can manufacture their own food from simple inorganic sources are called:

A. Autotrophs B. Heterotrophs C. Holozoic

E. Saprophytes E. parasites

25. Spirogyra is said to have hototrophic type of nutrition. This means that:

A. When spirogyra feeds, it usually uses the hollow space in the center.

B. Spirogyra is unable to make its own food, it relies on others for feeding.

C. Carbon dioxide is an essential part of its food production even in a dark place.

D. In the presence of sunlight, spirogyra can make carbohydrates from water.

E. Spirogyra can make its own food in the presence of necessary materials.

26. Because Euglena is a green filamentous alga and can manufacture its own food, one can conclude that Euglena:

A. Is a saprophyte B. Feeds holozoically only

C. Feeds holophytically

D. D. Feeds both holophytically and holozoiclly

E. Feeds parasitically and holophyticaly

27. An association of an organism with other organism to the mutual benefit of both partners are called:

A. Symbiosis B. Predation C. Carnivorous

D. Parasites E. Commensalism

28. In which of these ways do plants get their nitrogen requirement:

A. Fixation of atmospheric gaseous nitrogen

B. From water and mineral salts.

C. Combination of hydrogen and oxygen through gas explosion

D. Conversion of nitrates into nitrogen gas.

E. Breakdown of proteins into nitrogen oxides

29. By which of the following reactions is nitrogen fixation achieved?

A. $2N + O2 \rightarrow 2NO$

$2NO + O_2 \rightarrow 2NO_2$

B. $2NO_2 + H_2O \rightarrow HNO_3 + HNO_2$

HNO_3 combined with bases $\rightarrow$ Nitrates (present in the soil)

C. $2NH_3$ + Thunder storm----$\rightarrow NO_3$

D. $N_2 + Ca(OH)_2$ ------NO_3.

E. $NO_2 + CO_2 \longrightarrow NO_3$

30. Which of these living organisms fix nitrogen:

A. Blue - green algae B . Symbiotic bacteria

C. Some free - living bacteria D. Yeast E. Lichen

31. Nitrification is the progression of:

A. Ammonia - Nitrites - nitrates

B. Ammonia - Nitrogen - nitrites

C. Ammonia - Nitrous - nitric acid

D. Nitric acid - ammonia - nitrates

E. Ammonia - nitrous acid - nitric acid - nitrates

32. Which of the following is the best definition of respiration?

A. The oxidation of carbohydrate to produce carbon dioxide and water only

B. A series of chemical changes whereby food is oxidized through the action of enzymes to release energy

C. The breakdown of food substances to release energy and oxygen.

D. The breathing in of oxygen and the breathing out of carbon dioxide

E. The building up of food substances using energy

33. Which of the following statement is not correct about respiration?

A. Most flowing plants have distinct respiratory organs.

B. Respiration takes place in green plants during the day time

C. Respiration takes place in both aquatic and terrestrial plants

D. Respiration involves the oxidation of food substances

E. The primary sources of energy during respiration is sun.

34. While respiration takes place in all living cells of the green plants, photosynthesis occurs only in:

A. Chlorophyll cells B. The leaves C. Mesophyll cells.

D. All plant cells. E. The protoplasm ,

35. The products of respiration are carbon dioxide and water, while that of photosynthesis are:

A. Water and oxygen B. Oxygen only

C. Sugar, oxygen and water D. Water and sugar E. Oxygen and sugar

36. Which of the substances release the greatest amount of energy during aerobic respiration?

A. Glucose B. Fat C. Protein D. ' Starch E. Vitamins

37. Tissue respiration is a process in which:

A. Energy is released from food

B. Gaseous exchange occurs.

C. Oxygen is utilized by the cell

D. Oxygen replaces carbon dioxide

E. Water and carbon dioxide are produced

38. Land plants obtain their nutrients from the soil through:

A. Root hairs. B. Stems C. Lenticels

D. Stomata E. Epidermal layer.

39. In living tissues, oxygen reacts with carbohydrates to release energy for all activities. This reaction is known as:

A. Inhalation B. Cellular respiration

C. Kreb's cycle D. Glycolysis

E. Anaerobic respiration

40. In tissue respiration, much energy is liberated because oxygen is utilized in the:

A. Formation of carbon dioxide

B. Production of ADP

C. Oxidation of food substances

D. Transport of oxygen

E. Formation of carbohydrate

I A Q

Personal details:

Name:

Name of School:

Gender - Male_____ Female_____

Age - 10yrs - 15yrs
> 15yrs - 20yrs
> 20 years

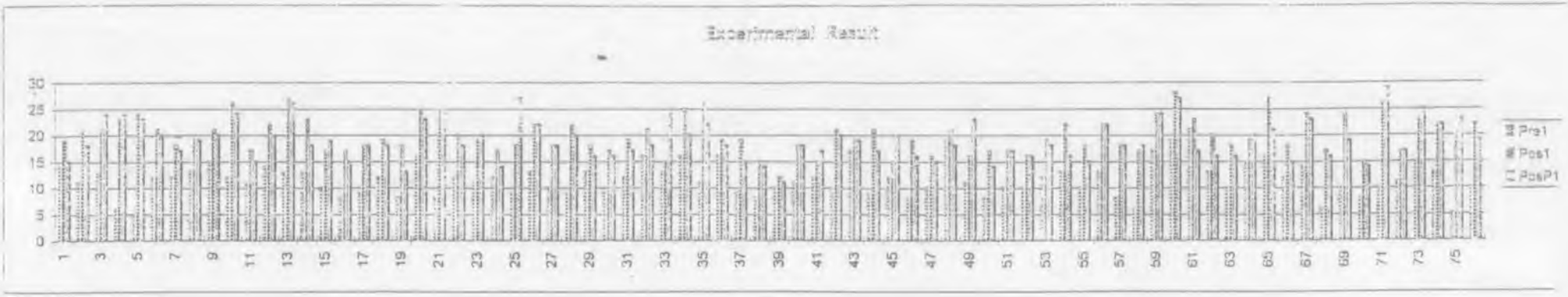
Type of school - Boys only
- Girls only
- Co-educational

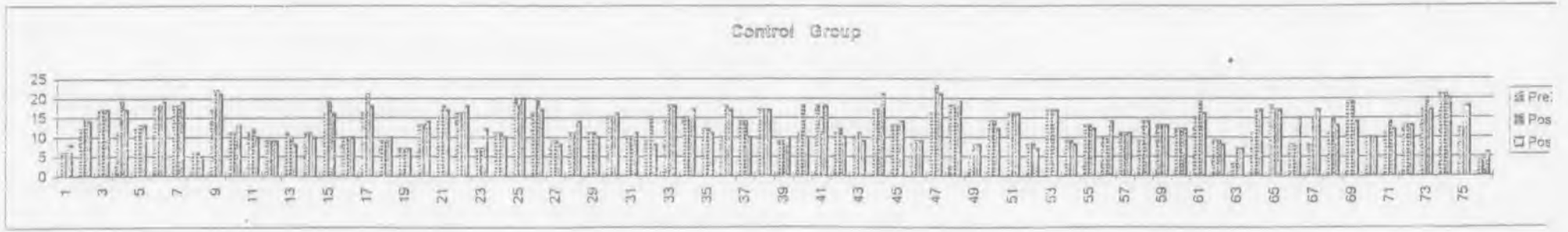
Attitude towards Biology:

	Statements	**Responses**		
		Agree	Undecided	Disagree
	I study Biology because			
1	I want to pursue a career that requires adequate knowledge of Biology			
2	my parents advised me to take biology			
3	all my friends are studying biology			
4	of the prestige biology based careers enjoy in the society			
5	I would like to identify myself with the science students in the school			
6	it tells me more about myself and my environment			
7	because it is the best of all science subjects			
8	W A E C regulations and requirements demand for biology			
9	it relates with real life			

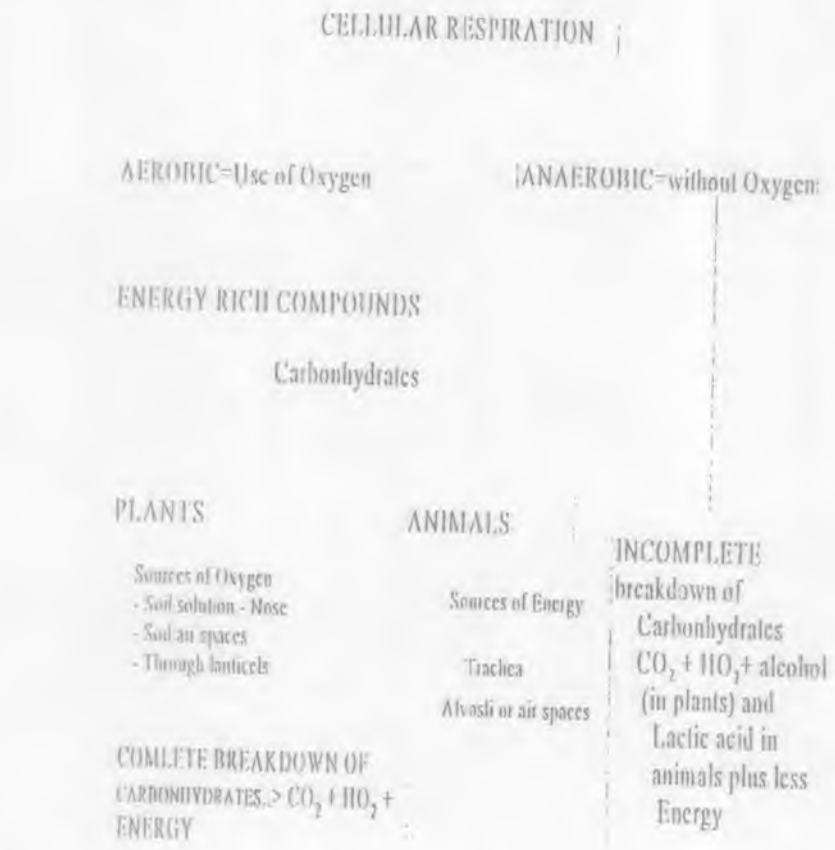
	The teachers approach in teaching biology has			
10	increased my interest in biology			
11	made biology concepts more difficult to understand			
12	given me the opportunity to apply my day to day experiences to learning biological concepts			
13	helped me to be more active in class			
	The biology lesson for the past few weeks			
14	has been boring			
15	taken too much time in relation to the benefit derive			
	The approach the teacher used in teaching the biology concepts			
16	has helped me to see the logical concepts not as difficult as I thought they were to understand			
17	is preferred to other approaches and should continue.			
18	makes me to like biology and gives me a sense of greater achievement capability			
19	allows the sharing of ideas which has helped me to appreciate the significance of biology to my existence			
20	has helped to change my view of the biological concepts taught.			
21	should be incorporated into the science curriculum for all secondary schools in the state			

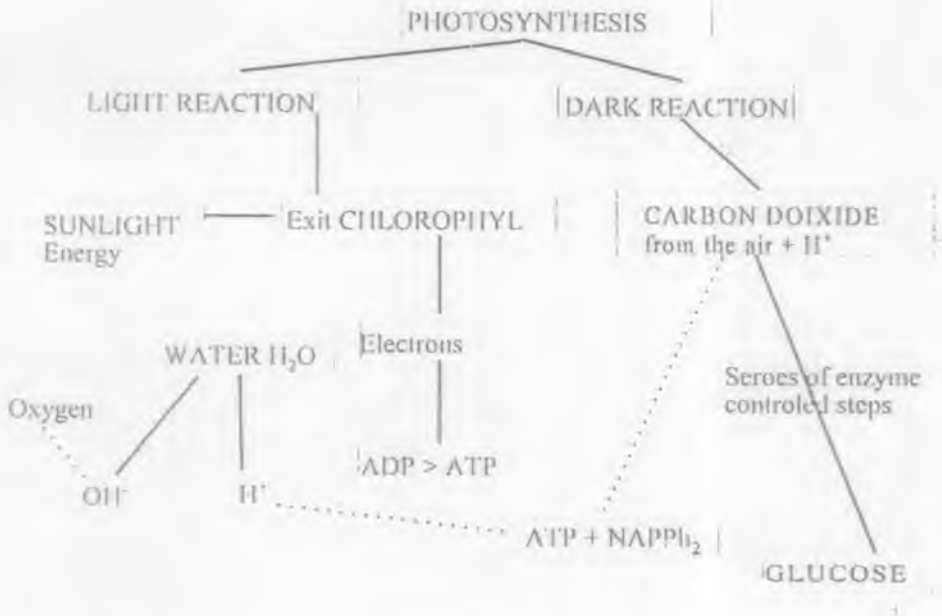
Appendix C: Comparison of Conceptual Change for the Experimental versus the Control Group





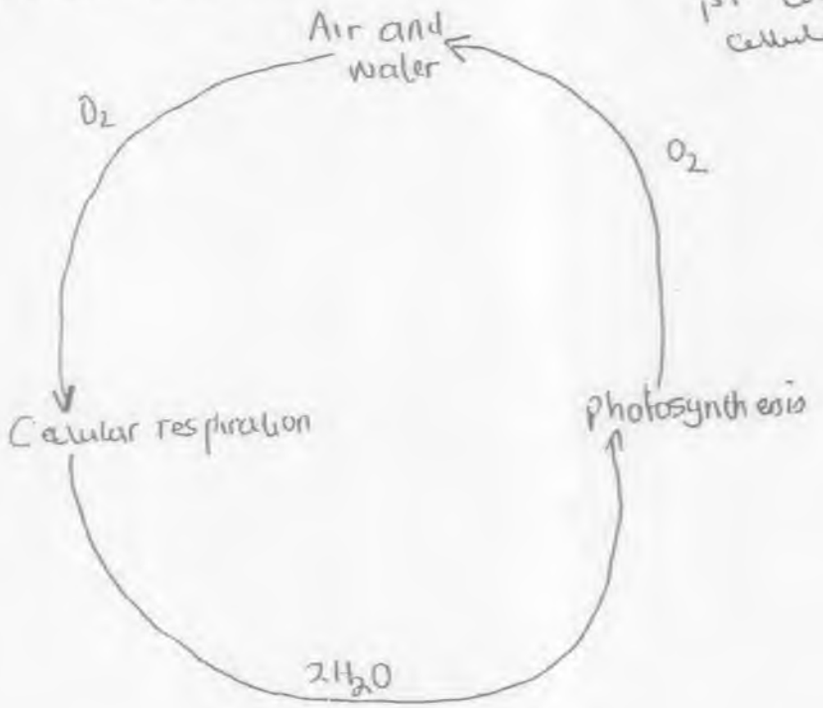
APPENDIX D: Concept Maps of Photosynthesis and Cellular Respiration





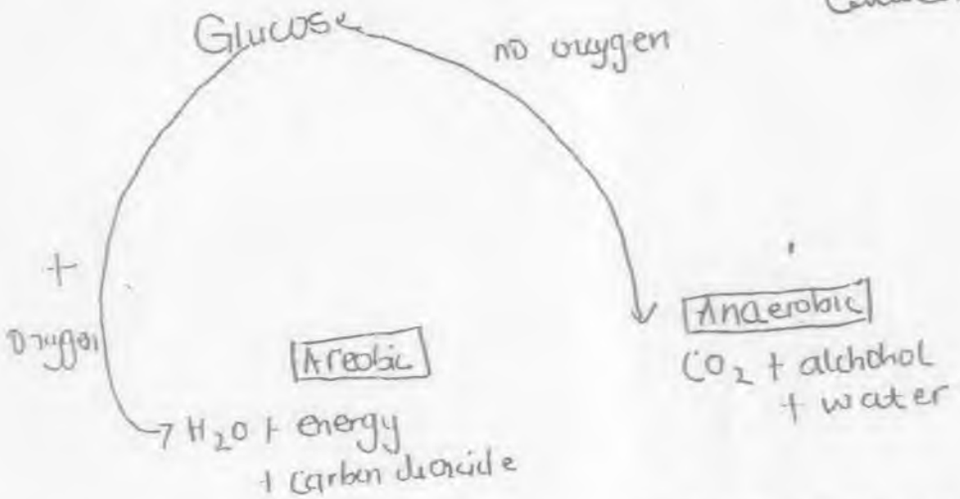
Appendix E: Students Concept Maps

1st Concept Map on Cellular Respiration



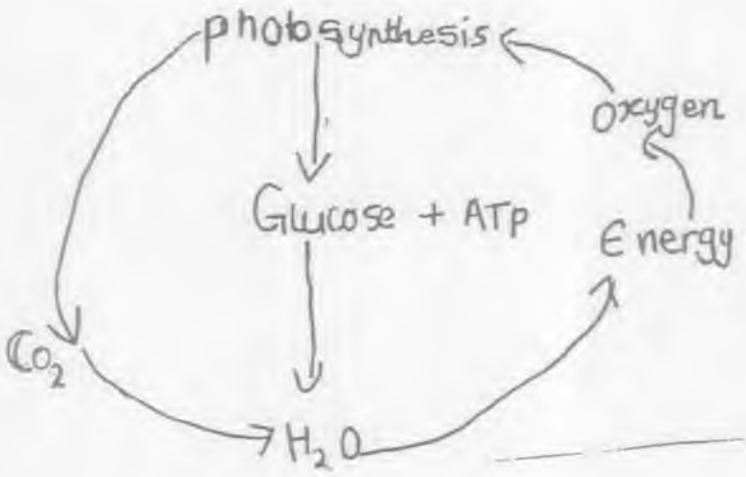
The Oxygen cycle

2nd Concept Map on Cellular Respiration



The cellular respiration takes place in all living cells plant and animal and we have 2 types of respiration External respiration and Internal respiration

1st Concept Map on photosynthesis



2nd Concept Map on photosynthesis

Photosynthesis :-

Light Reaction

Dark Reaction

Sun

Sunlight Energy
+
Chlorophyll

Water —— OH + [illegible] + CO_2 → Glucose

H^+

APPENDIX F

Teaching Plan for the Conceptional Change Teaching Model CCTM

TOPIC 1: PHOTOSYNTHESIS

STAGE I : Orientation and Elicitation

Step I :- Orientation and Elicitation

Step 1: - The target concept is introduced to students in the experimental classroom.

Student will be asked various question to elicit their ideas on the topic (photosynthesis). Students, will then be split up into four groups A,B,C,D, and each group of students would represent their ideas of photosynthesis in form of concept maps and these after they might have been collected will be placed on the boards in the classroom.

Step 11

The multiple choice assessment test 1 would be given to the students to answer within the specified period of time. These would be collected marked and carefully looked through by the researcher. The student responses to these questions would reveal their pre-existing on the concepts to be taught. Their pre-conception before teaching would be determined to highlight on the lesson sequence.

No responses or view expressed by students here would be rejected or accepted at this stage.

Step 111:-

Practical oriented activities would be conducted by students. This would enable hem observes the phenomenon using experiences which illustrate the particular concepts.

These activities, are discrepant events since they are designed to counter the preconception of the students.

Activity 1:

A potted plant that was kept outside the classroom would be contrasted with a potted plant that was kept in the cupboard for seven days. Students would note the conditions under which the plants were kept. They would be asked to give reasons for the differences in the plants.

Activity 11:

The first plotted plant kept outside the classroom would be brought in and kept in the dark cupboard for 48 hours. After, students would note the differences in the leaves coloration and growth. Also, students would be asked for reasons for the differences in the plants.

Activity 3: Test for starch.

* A leaf from the plant in the cupboard would be covered with a black stripes and the potted plant would be placed outside for six hours.

- Students would then bring in the leaf for starch test following this procedure.
- Boil the leaf in water for five minutes.
- Then rinse the leaf in ethanol (students would note any change in leaf coloration).
- The leaf would be rinsed in water.
- The leaf would be spread on a white tile, then
- Iodine solution would be added.
- Student would note the coloration of the boiled leaf on contact with the iodine solution of the boiled leaf.
- Students would explain why the reaction of iodine solution differed for the different parts of the leaves.
- Also, student would give reasons for boiling the leaf in water for five minutes only.

Activity 4: To show that carbon dioxide is necessary for photosynthesis.

A leaf of a plant would be covered and another leaf is left ordinarily in the strong light in a free carbon dioxide atmosphere. The two leaves would be tested for starch.

Also, students would note the reaction of iodine solutions on each of the leaves.

- Students would explain the differences in the reaction.

STAGE 2: The Restructuring Stage

Step 1,

These would be discussions of the results of the activities and students experiences in stage 1. The students would be led to arrive at scientifically accepted concepts. It is through the discussions of the activities that the concepts would emerge. The researcher through skillful questioning would lead students to arrive at the following concepts.

- Leaves are the major sites of food production in plants.
- Photosynthesis can occur in all plant cells containing chlorophyll. In higher plants most photosynthesis occurs in the leaf.

■ A leaf is composed of several distinct cell layers. The upper layer of a leaf is the upper epidermis. Beneath the epidermis is a layer of palisade cells. Beneath the palisade cells are the spongy layer.

■ The palisade and the spongy cells contain chlorophyll.

■ Photosynthesis occurs in the palisade and spongy cells of a leaf.

■ The leaf structure is adapted for photosynthesis

STAGE 3: Clarification and Exchange

At the end of the lesson, students' attention would be drawn to the initial ideas they expressed and to re-examine the initial ideas in the light of the activities and discussions that followed. This is to create dissatisfaction with the students' prior conceptions that were naïve. Students would at this stage state which of the ideas they have dropped and those that they cling on to. Students also would review how their ideas have changed.

At this stage, students would draw out the second concept map and compare them with the previous ones. Also, the multiple choice Assessment Test (MCAT 11) would be given to students after instructions.

STAGE 4: Construction of New ideas.

At this stage students should be able to give reasons for the ideas they drop and the ones they still cling on to.

Their response to the MCAT 11 and concept map as a support would indicate how much of the construction has occurred.

STAGE 5: Evaluation and application of ideas and Review changes in ideas.

For evaluation purposes, the administered post-test (MCAT 11) was used to evaluate the effectiveness of the model in terms of students achievement. The IAQ is also for evaluation. One hour each was allotted for answering the different tests.

In application, students would provide instances of the concepts in reality. E.g. On a farm, plants that grow under another treed tends to grow so tall and thin, while the leaves are yellow in color, whereas, the plants that grow in the open air is the direct sunlight have more sturdy growth and the leaves are very green in color.

To review change in ideas, the delayed post-test would be administered two weeks after the post instructional text.

STAGE 6: Comparison with previous ideas.

■ The students responses in the two tests MCAT I and MCAT 11 would be compared there would be discussion and questioning for comparative purposes.

TOPIC 2: Cellular Respiration

Stage 1: Orientation and Elicitation Stage

Step 1: Target concept would be introduced to student the experimental class students would be splitted up into the four groups A,B,C,D also that of photosynthesis)

Each group of students would be given the MCAT to answer, also the students would be asked to express their ideas of cellular respiration in form of concept map.

Step 11

The MCAT would be marked and also, the concept maps would be collected and placed on board in the classroom.

From the MCAT and concept mapping students idsas before teaching would be determined. Their pre-conceptional ideas would form the basis of the lesson sequence.

As was done for the photosynthesis teaching, no students views or responses expressed would be rejected or accepted at this stage.

Step 111 - Practical Orientated Activities

These activities would be carried out by students. These are activities also designed to challenge or counter the students initial conceptions. They would be as follow.

Activity (1). To test that carbon dioxide is given off by plants:

Students would follow the following sequence in the conduction of the experiment.

- A young leaf from a plant is put in a plastic bag which is air-tight
- The plastic is kept upright.
- An indicator (bicarbonate) is kept inside the plastic bag with the young leaf.
- The green young leaf is kept in the dark to prevent photosynthesis.

Students would explain the difference in the bicarbonate (lime water) color.

STAGE 11: The Restructuring Phase.

There would be discussions of the result of the activity and also students experiences in stage 1 as was done for photosynthesis. Also, students would be led to arrive at

scientifically accepted concept. Through the discussion, of the activities, the concepts would emerge. Through skillful questions the researcher would lead students to arrive at the following concepts in cellular respiration.

Respiration is the chemical breakdown of food to release energy needed to maintain life and carry out other activities.

Respiration occurs in every living cell of every living organism and continues throughout the life of a cell. Thus Cell Respiration is sometimes called tissue respiration or internal respiration. This differentiate it from external respiration.

There are two types of cellular respiration-aerobic and anaerobic. The aerobic respiration requires oxygen while the anaerobic does not require oxygen.

Nearly all plants, most and bacteria respire in the aerobic way.

In the presence of oxygen the sugar molecules (carbohydrate) is broken down completely to the waste products, carbon dioxide, water and energy for life. It occurs in every living cell .

In plants the two processes of photosynthesis and respiration go on simultaneously.

Stage 3: Clarification and exchange of Ideas.

This would follow the same pattern as outlined for the photosynthesis lesson.

Students at this stage state which of the ideas they have dropped and those that they still cling on to. Also students should be able to give reasons for the ideas they drop and the ones they have not.

Stage 4:Construction of new ideas.:

This would also follow the same pattern as outlined for photosynthesis.

Stage 5: Evaluation, Application and Review of Ideas.

The M. C. A. T. Post test would be used to evaluate the students ideas after instruction in terms of their achievement. I. A. Q. would also be used as an evaluative tool for the effectiveness of the teaching strategy both on the effective and affective domain

In application, students would also provide instances of the concept in reality .e.g.(1) In brewing an alcohol, yeast is introduced into the base material which is usually carbohydrate, there is evolution of carbon dioxide and alcohol. As the yeast cells multiply and respire, carbon dioxide is produced but alcohol is also produced instead of

water; this the anaerobic respiration where glucose is only partially broken down. (2) When a rat is kept in a closed cage for about 2 hours and afterwards released, the rat is weak and inactive, but after awhile in an open place ,its activity increases and it runs away ; this is aerobic respiration. In the closed cage ,no oxygen therefore there is no respiratory activities to produce the energy required but when released, there was sufficient oxygen for the aerobic respiration and subsequent higher energy produced and the more active the rat becomes.

To review change in ideas, the delayed post test achievement scores would be used to review how students conception has changed and the extent of its retention would indicate the degree of the change.

Stage 6: Comparison with Previous ideas:-

Students' achievement test mean scores in both pre and post instruction would be compared. There would also be discussions and questions for comparative purposes.

APPENDIX G

Teaching Note

Second week

Unit 1 - Trapping Energy

Sub Unit 1. The leaf - Internal Structure.

Leaves are the major sites of food production in plants.

Photosynthesis can occur in all plant cells containing chlorophyll.

In higher plants, most photosynthesis occurs in the leaf. A leaf is composed of several distinct cell layers. The upper layer of a leaf is the upper epidermis. Its main function is to protect the other layers of the leaf.

Beneath the epidermis is a layer of palisade cells. They are long cells arranged vertically.

Beneath the palisade cells are the spongy layer.

The palisade and the spongy cells contain chlorophyll.

Photosynthesis occurs in these cells of a leaf.

Located throughout a leaf are two types of vascular tissues (xylem and phloem.

Xylem cells carry water and minerals.

- Phloem cells carry food.
- The veins of the leaves connect with the veins of the stem which are continuos with those of the roots.

- Through the vein, water and minerals move from roots to leaves and food is carried from leaves to other parts of the plant.
- The lower layer of a leaf is the lower epidermis. It contain stomata. The stomata are surrounded by guard cells which regulates its opening and closure.
- All the materials necessary for glucose production enter the leaves.
- Carbon dioxide from the air enters a leaf through the stomata and is distributed in the watery film surrounding the cells.
- Water enters the leaf through xylem vessels that originate in the roots of the plants.
- The leaf structure is therefore adapted for photosynthesis.
- Phloem cells transport glucose to all parts of the plants that cannot produce glucose.
- Oxygen (produced during photosynthesis) and some water escape from the leaf through the stomata.
- Besides the materials needed for photosynthesis energy is needed to put the materials together.
- This energy is sunlight.
- Plants have morphological adaptations in leaves being positioned on a plant where they receive the most sunlight it can receive.

Sub Unit 11:

Light

Introduction: To understand how radiant energy is used to make glucose, one must learn about light.

- Light is a form of radiant energy . Al l radiant energy travels in waves.
- The distance between consecutive crests of waves is called wave lengths.
- Different wave lengths of light have different colors.
- The colors of different wavelengths are red orange, yellow, green blue and violet, Red light has the longest wove length of the visible spectrum, and violet light has the shortest wavelength. Ultraviolet and infrared wavelengths on the ends of the visible spectrum are invisible to human.
- Whenever light energy is absorbed, it is changed to another form of energy,
- A solar cell traps light energy and changes it to electric energy.
- Not all light is absorbed when it strikes an objects. Some are reflected.
- The portion of the spectrum reflected is the color of an object.
- Reflection and absorption of light are important concepts in understanding the rapping of light in photosynthesis..
- The absorption spectrum of chlorophyll in an in tact chloroplast is somewhat different in that more green wavelengths are absorbed.

Sub Unit 111:

Chlorophyll and other pigment's

- Organism that make glucose contain the pigment chlorophyll that traps light energy and changes it to chemical energy.
- There are several types of chlorophyll, but chlorophyll a is the most important in photosynthesis.
- In plants, chlorophyll is found in chloroplasts.
- The photosynthesis parts (leaves) of autotrophs usually appear green because chlorophyll usually appear green because chlorophyll reflects most of the green portion of the spectrum.
- Because certain wave lengths are absorbed by the chlorophyll, the spectrums produced is called an absorption spectrum.
- These absorbed wave length are changed from light energy to chemical energy.
- The only portion of light absorbed by chlorophyll is significant.
- Other wave lengths (blue & green wavelength) of light are also important in photosynthesis, chlorophyll a, chlorophyll b, and carotenes probably interact to trap wavelengths necessary for photosynthesis.

Unit 2 -

Photosynthesis:-

Definitions:- Photo - Light; Synthesis - building up photosynthesis is a complex process by which an autotroph makes food.

- It is a set of many separate reaction.
- It is the process by which light energy is absorbed and then converted to the chemical energy of glucose.
- There are two main reaction of photosynthesis.

The Light Reaction

The Dark Reaction

Sub-unit 1

Light Reaction:

- Light Reaction involves a series of changes dependent on light.
- Light is absorbed by chlorophyll molecules

Sunlight is the source of energy and chlorophyll traps the light energy.

- The absorption spectrum of red and blue light are the most effective.
- By a series of steps he light energy is converted to the chemical energy of ATP molecules.
- Water molecules brought from the soil by the xylem vessels are split into hydrogen ion and oxygen by the sunlight energy.
- Oxygen given off during photosynthesis comes from water molecules.

$$12H_2O \xrightarrow{\text{Sunlight Energy}} 12H_2 + 6O_2$$

hydrogen Oxygen

- This process is called proteolysis
- The oxygen is given off as a by-product.

The hydrogen ions are used in later steps of photosynthesis

- The light reactions of photosynthesis don not involve carbon - dioxide and no glucose is produced.
- In the light reactions of photosynthesis, light energy excites electrons. In the returning of these electrons to their ground sate, energy is given off as A.T..P. This energy is used in the dark reactions.
- Light reaction occurs on the lamellae of the chloroplast where chlorophyll is located.
- During photosynthesis, the light reactions provide for chemical energy for synthesis of glucose during the dark Reactions.

Sub Unit 11

The events of the light reactions are a preparations for the dark reactions.

- The dark reactions do not have to occur in the dark, they simply do not require light,
- The dark reaction occur in the stoma of the chloroplast.
- In the dark reactions, carbon -dioxide and hydrogen are combined to form glucose,

- The carbon-dioxide is absorbed from he atmosphere. It is subsequently released back into the atmosphere by respiration.
- Glucose is made of carbon, hydrogen and oxygen ,- the same elements found in carbon dioxide and water.
- The hydrogen comes from water molecules.
- The combination requires energy, the energy comes from ATP, both the A.T.P. and hydrogen used in the dark reactions come from the light reaction.
- The raw inorganic material for photosynthesis are therefore, water and carbon dioxide is the presence of sunlight energy and chlorophyll.
- The product of photosynthesis are carbohydrate and oxygen.

$$6CO_2 + 6H_2O \cdots\cdots\cdots\rightarrow 6CH_2O + 6O_2$$

$$6CO_2 + 6H_2O \xrightarrow[\text{Sunlight energy}]{\text{chlorophyll}} C_6H_{12}O6 + 6O_2$$

glucose

Diagram Relating the events of the light and Dark Reactions to the overall equation for photosynthesis.

- Glucose transported to other areas cf a plant can be stored as starch or converted to cellulose, the substance contained in cell walls.

Unit 3:

Cell Respiration:

- Respiration is the break down of chemical food to release energy needed to maintain life and carry out other activities.
- Respiration occurs in every living cell of every living organism and continues throughout the life of a cell. Thus cell respiration is sometimes called tissue respiration or internal respiration. This differentiates it from external respiration.
- There are two types of cellular respiration-aerobic and anaerobic.
- The aerobic respiration requires use of oxygen, while anaerobic does not.

(1) Aerobic Respiration:

- Most organisms respire by oxidizing a simple sugar like glucose to carbon dioxide and water.
- Nearly all plants, most fungi and bacteria respire in this way.
- In the presence of oxygen, the sugar molecule (carbohydrate) is broken down completely to the waste products, carbon dioxide, water and energy.
- The process can be summarized by the following equation:-

$C_6H_{12}O_6 + 6O_2 \cdots\cdots\cdots\blacktriangleright 6CO_2 + 6H_2O + Energy$

- In most organisms ,the energy for life come from chemical reaction between food and oxygen. This reaction occurs in every cell of the body.
- The reaction goes on slowly.

- It is controlled by many different enzymes in the cell of living organisms.
- In plants the two process of photosynthesis and cell respiration goes on simultaneously.
- In plants all the carbon dioxide produced in respiration is used up in photosynthesis, therefore, it does not escape from the leaf. The oxygen released is also used for the plants respiratory needs.
- In the dark ,photosynthesis stops, then the leaf gives out carbon dioxide and uses up atmospheric oxygen.

(2) Anaerobic Respiration.:

- Oxygen is not involved.
- Glucose is only partly broken down.
- Examples of anaerobic organisms are yeast and some bacteria; they live

when oxygen is little or in short supply.

- Yeast break down glucose to carbon dioxide and then ethanol which is an alcohol.

$$C_6H_{12}O_6 \longrightarrow 2C_2OH + 2CO_2 + 210KJ$$

glucose ethanol

- The amount of energy released is much less than that released when the same amount of glucose is completely oxidized. Thus

anaerobic respiration is much less efficient than aerobic respiration.

In the absence of oxygen, most plant and animal tissues can respire anaerobically for a while.