EFFECTS OF COOPERATIVE LEARNING STRATEGY WITH MODELS ON ACADEMIC ACHIEVEMENT AND RETENTION OF BIOLOGY CONCEPTS AMONG PRE-NATIONAL DIPLOMA STUDENTS IN KADUNA STATE

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2012

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A DISSERTATION SUBMITTED TO THE SCHOOL OFPOSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULFILMENT FOR THE AWARD OF DOCTOR OF PHILOSOPHY IN SCIENCE EDUCATION

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NOVEMBER, 2012.

DECLARATION

I hereby declare that this dissertation entitled 'Effects of Cooperative Learning Strategy and Models on the Achievement and Retention of Biology Concepts among Pre-National Diploma Students in Kaduna State' has been written by me. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for a higher degree or published in a book.

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Olarewaju, Rebecca Ronke		2012
	……..	…….
Name of Student	Signature	Date

CERTIFICATION

This dissertation entitled' **EFFECTS OF COOPERATIVE LEARNING STRATEGY WITH MODELS ON ACADEMIC ACHIEVEMENT AND RETENTION OF BIOLOGY CONCEPTS AMONG PRE-NATIONAL DIPLOMA STUDENTS IN KADUNA STATE** by Olarewaju, Rebecca Ronke, meets the regulations governing the award of the degree of Doctor of Philosophy of Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to the memory of my late father, Pa B. A. Adeboye,

Who, against all odds at the time, was determined to educate ‘a girl’.

May his gentle soul rest in peace.

ACKNOWLEDGEMENTS

I give praise to God and appreciate Him for the successful completion of this research work.

With gratitude and deep appreciation, I also wish to acknowledge the following, for their various contributions: My supervisors, Dr. A.I. Usman, for his understanding, commitment, motivation, encouragement, ever ready assistance, and guidance throughout the work. Dr (Mrs) S.B Olorukooba, not only for her academic and scholarly input but also for her motherly compassion, counseling, guidance and concern all through; and Prof. C. Bolaji, for his advice, professional and academic input to put the work in shape.

I also thank Professor A.A.M Shaibu, for his interest and scholarly contribution. I thank Prof. J.S. Mari, Dr S.S. Bichi, Dr (Mrs) F.K. Lawal, Dr (Mrs) T.O. Lawal, and Dr (Mrs) B. Abdulkarim, for their involvement and assistance and Prof. E.Y. Gyuse for the input from her wealth of experience and scholarly expertise. I am grateful to Dr (Mrs) R.G. Ayo, Dr (Mrs) J.O. Olajide, Mrs L. Adeoye, and Dr (Mrs) M.A. Lakpini , for their love and concern demonstrated in various forms.

Mrs.Ezekwu of School of Forestry, Kaduna and Mr. Kutman of Cheltech, Zaria are appreciated for their assistance in data collection. Mr. John Obiometa of Institute for Agricultural Research, Ahmadu Bello University, Zaria, and Mr Ojo of Iya Abubakar Computer ABU Zaria for analyzing the data at different stages; including the authority of Division of Agricultural Colleges, for releasing me to undertake the study.

I appreciate Barrister and Professor (Mrs) Duro and Funmi Bankole, Professor and Mrs Franscis Sowemimo, Professor & Mrs P.K. Oyebanji, Professor (Mrs) C.O Adegbite, and Dr and Mrs D.S Abolude, for their prayer support; in addition to Mr. and Mrs Tunde and Moji Afolayan. Dr & Mrs J.O. Popoola, and Dr. T.O. Fadiji &family for their prayers and encouragement; Usman

Abdu of Division of Agricultural Colleges Headquarters, Samaru, and Samuel Salama for typing and formatting part of the work. I thank Absalom Ezugwu for his personal involvement and assistance in the final editing and typesetting the work.

I am grateful to My 'Jewels of inestimable value,' Opeyemi, Temilolu, Deolu, Tomilayo, Olukunbi and baby Tomiwa, for their motivation and moral support; To Kunbi, my co-typist and teacher, I am indebted. My in-laws, particularly Ola Peters for his sacrifice and encouragement. The arrival of Funmike Olarewaju, Jason Ola Peters, Bisayo Abimbola, and Omolade Olarewaju on board was a great motivation to completing this work, and I say, 'I love you all.' Kehinde Adeboye, Gbenga Olarewaju, Yunusa Ishaya, and Amos Habila, are appreciated for their positive contributions. Finally, to my darling husband Professor Joseph Durotoye Olarewaju, for his prayer support, advice and encouragement which went a long way and I say, 'thanks'. Glory be to God.

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ABBREVIATIONS

BAT	-	Biology Achievement Test
CLS+M	-	Cooperative Learning Strategy with model
CLS	-	Cooperative Learning Strategy without model
L+M	-	Lecture method with model
L	-	Lecture method
STAD	-	Student Team Achievement Division
STAN	-	Science Teacher Association of Nigeria
Pre- ND	-	Pre Diploma
SSSCE	-	Senior Secondary School Certificate Examination

OPERATIONAL DEFINITION OF TERMS

Cooperative Learning Strategy:	A learning technique in which the learners and members of varying abilities in an interdependent group collaborate share and delegate responsibilities, practice and communicate with each others.
Retention:	The ability to store information which can be easily recalled from the short term memory and long term memory.
Study Teams:	Long-term groups with stable membership whose primary responsibility is to provide members with support, encouragement and assistance in competitions a learning session's requirements and assessment.
Models:	Models are aspects of media for educational teaching and include concreted objects through which realities can be represented, communicated and appreciated in educational instruction.

ABSTRACT

The purpose of this study was to determine the effects of Cooperative Learning Strategy with Models on Academic Achievement and Retention of some Biology Concepts among Pre-ND students in Kaduna State. A randomly selected sample of 100 students from the four Federal Monotechnical Colleges in Kaduna State made up the subjects for the study. These subjects were divided into four groups; three experimental and one control. A pretest administered to the subjects established their equivalent ability. Quasi experimental control design was adopted. The instrument used for data collection, the Biology Achievement Test (BAT) was developed by the researcher and validated by biology education specialists. The BAT has reliability coefficient (r) .89. The subjects in the experimental groups were exposed to treatment, while the subjects in control groups were taught using the traditional lecture method, for a period of six weeks in each case. Six research questions were raised while six null hypotheses were formulated and tested using t test statistics at $P \leq 0.05$ level of significance. The major findings from this study included a significant difference in achievement of biology concepts between the experimental groups and the control group in favour of the experimental groups. There was a significant difference in the retention of biology concepts between the experimental groups and the control group in favor of the experimental groups. The experimental groups retained biology concepts better than the control group. Based on these findings, it was recommended, among others, that lecturers should be encouraged to use models along with cooperative learning strategy in the teaching of biology concepts in tertiary institutions.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

Science and technology are potent sources of social and economy changes. Zopperson (2002) in Mankilik (2007) considers science as an important tool for effective development. In support of this, Bessong (2002) states that many countries of the world, including African countries, seem to have accepted science and technology as corner stone for national development. Ajeyalemi (1991) equally states that the role of science, technology, and mathematical education to national building could not be over emphasized. It is an important instrument for reduction and removal of illiteracy and poverty. It is a very strong instrument for developing a culturally and socially tolerant people, who exercise ethical and moral considerations in local, national and international affairs. It plays a vital role in economic development and is indispensable for personal and community health, and has been described as the basis for building the country's knowledge and economy. Therefore, in virtually all the countries of the world, educational planners, and policy makers are faced with the problem and task of how to improve the quality of education offered the citizenry (Onimisi, 2003).

The importance attached to science education has drastically changed the objectives of education in many nations including Nigeria. Onwu (2004) thus proposed a research agenda that focuses on the production of knowledge and improved understanding that is linked to the relevance of progress of science, technology and mathematics education, among others. In Nigeria, great emphasis is placed on science as a school subject at all levels of education up to the tertiary level. Accordingly, the National Policy on Education (FME, 2007) states that universities and other levels of Education system will be required to pay greater attention to the

development of scientific orientation. To this end, more colleges of technology and polytechnics will be opened in a bid to improve technological and science education.

The performance in science subjects is very poor at the secondary schools, (Adeyegbe, 1993; Eguabor,2001; West African Examinations Council Chief Examiner's Report, 2005). This problem has been consistent over the years as is reported by Olayiwola (1993), Ojerinde (1998), Ajagun (2000) and Oloruntegbe, (2000). The failure in science and biology, in particular, appears to be getting worse annually with the report presented by West African Examinations Council to the governing Council of Science Teachers Association of Nigeria in March 1998.

Table 1.1 Statistics of Biology results in May/June SSCE (1999-2006)

YEAR	TOTAL ENTRY	TOTAL CREDIT (1-6)	% GRADES (1-6)
1999	745,439	207,232	27.80
2000	620,565	119,769	19.30
2002	917,041	278,122	30.30
2003	931,219	392,249	42.10
2004	838,945	253,483	30.20
2005	1,072,607	383,349	35.74
2006	1,152,045	567,152	49.23

Source: WAEC Annual Reports (1999-2006)

Biology is a life science that involves the study of plants and animals. The contents range from microscopic organisms to the biosphere in general, encompassing the earth's surface and all living things. Some of the branches of biology include anatomy, morphology, cytology, genetics, entomology, parasitology, and so on. The teaching and learning of biology is very important to the development of any nation. To develop a nation includes the preparation of the populace for

important careers in medical, para-medical, agricultural, industrial, population, wildlife control, and environmental management studies, to mention but a few. Biology has a universal application in agriculture, human and veterinary medicine, development of vaccines and drugs for the prevention and curing of diseases. Biology has a close connection with agriculture. Agriculture is a biological production, which depends on the growth and development of plants and animals in a given environment (Okwo &Tartiyus, 2004). Biology is one of the core courses being offered at the Pre-National Diploma (Pre-ND) level in Colleges of Agriculture and other monotechnical colleges.

The poor performance in science in the senior secondary school certificate examination (SSSCE) including biology led to the introduction of remedial programmes in the monotechnics and polytechnics in Nigeria. The aim of which was to help those students with weak passes to improve on their poor performances before they were admitted to the direct National Diploma programmes.

The Pre-National Diploma (Pre-ND) course was designed to upgrade the Senior Secondary School Examination results to credit level passes as a prerequisite to undergoing National Diploma. In essence, the Pre-National Diploma Pre-ND programme prepares students for the various Diploma courses in Technical Schools. The students are to remedy their O-Level subjects where they had performed poorly and in most cases in the science subjects. The Pre-ND programme introduces the candidates to vocational training, which may lead to the acquisition of entry-level skills for employment purposes within the proposed field of study. Biology is one of the core courses being offered in the Pre-ND. However, despite the importance of biology in the diploma programme, the performances of the Pre-ND students have been poor still and as such,

many have been asked to withdraw. Examples of such poor performances are as shown in Table1.2

Table 1.2 Summary of Results of Performance of the Pre-ND students (2001 to 2010) in Monotechnical Colleges

Year	No. of students	Pass	Fail	% Failed
2000/2001	205	80	125	61
2001/2002	220	50	170	77
2002/2003	612	136	476	78
2003/2004	544	240	304	56
2004/2005	385	140	245	64
2005/2006	204	100	104	51
2006/2007	236	116	120	51
2007/2008	296	132	164	55
2008/2009	272	144	128	47
2009/2010	280	108	172	61
2010/2011	160	45	115	72

Examination Offices; Monotechnical Colleges, Kaduna State (April, 2011)

The poor performance which has continued to the post-secondary level of education has evoked much research efforts aimed at evolving means of redressing the situation. Science education researchers like Akubuilo (2004 a), attributed the poor performance of students in biology to socio-economic background of students, teachers and pupils' attitudes towards science, unqualified science teachers, inadequate instructional and infrastructural facilities, poor quality teaching and low morale of teachers. In addition, Olayiwola (1999), identifies problems such as low morale and poor preparation of teachers, overcrowded classroom, inadequacy of laboratory and workshop facilities, poor attitude of students to work, gross underfunding and inadequacy of rewards for excellence in science teaching and learning, biology inclusive. As multidimensional

as the problems associated with poor performance are, efforts are being made to find solutions to the recurring failure rate among science students. One of such efforts is on the issue of instructional methods which has attracted a lot of researchers. Adamu &Ahmed (1999) view the use of inappropriate teaching methods as a major cause of students' poor performance in science examinations. Most of the methods used in teaching have been described as inappropriate and uninspiring (Igboegwu, 2012). Teaching methods are those methods the teacher uses for instruction to impart knowledge to learners. Some popular methods include lecture, discussion, demonstration etc. James (2000), Usman (2001), and Bichi (2002) reveal that the prevailing teaching method in Nigerian schools is the lecture method. Although Okwilagwe (2002) reveals that the lecture method allows a great deal of information to be passed to the learner and favours handling of large classes, it does not stimulate students' innovation, inquiry and scientific attitudes. He went further to say that teaching strategies that can help the development of reasoning, acquisition of skills as well as skills process through scientific approach, are conspicuously lacking. Rather, lecture method encourages students to cram facts which are easily forgotten. This method, according to Usman (2001) and Bichi (2002) has been found to be inappropriate and ineffective for achieving the high objectives of biology programmes. Therefore, there is the need to search and incorporate modern instructional strategies. Hence the desire and efforts of educators in recent years to improve science achievements through more effective, learner-centered instructional strategies (Danmole & Femi-Adeoye, 2004).

Ajewole (1990), worked on cooperative learning, Otuka (1991) did a research on discovery expository instructional methods, and Ojo (1992) worked on and laboratory, think-and-do, acquisition and development of process skills and classroom interaction patterns. However, the performances of students in the secondary school certificate examination and

Pre-ND examinations in biology continue to be poor. This researcher then set out to find out the effects of another activity-based strategy on the performance of Pre- ND biology students.

The works of Esan (1999), Adeyemi (2002), Amosun (2002) and Olorukooba (2002) reveal that cooperative learning strategy seems more useful than other instructional strategies as it has more positive effects on students' achievement and retention of information.

The potency of cooperative learning strategy in facilitating students' performance in sciences and related subjects has also been advocated (Olorukooba 2002). Cooperative learning instructional strategy involves a situation in which students work together cooperatively and interdependently in small groups towards a group goal. Chang and Mao (1999) in his study found that cooperative learning strategies improved the students' performance. These earlier researches showed that the use of cooperative learning strategy was more effective in the learning of biology concepts yet there is still evidence of poor performance in the subjects by the pre-ND biology students as shown in Table 1.2. Thus, the pedagogical approach in imparting knowledge to learners has become inadequate to their needs. This has created a gap to be filled by this research work. Therefore this study set out to find out the effect of cooperative learning strategy with models on the academic achievement and retention of biology concepts at the post secondary level of education using the pre-ND diploma students in Kaduna State.

Cooperative learning is described as the instructional practice of placing students into small groups and having them work together toward a common goal. Each group member learns new materials and helps other group members learn important information. Cooperative learning strategy consists of social interactions between students based on equal partnership in the learning experience, as opposed to fixed teacher-learner roles. Lessons are designed around tasks, problems and projects, which students work through in small mixed ability groups.

Proponents of cooperative learning claim that the active exchange of ideas within small groups not only increases interest among the participants but promotes critical thinking. There is persuasive evidence that cooperative teams achieve at higher levels of thoughts and retain information longer than the students who work quietly as individuals. The shared learning gives students an opportunity to engage in discussions, take responsibility for their own learning, and thus become critical thinkers (Totten, Sills, Digby &Russ, 1991).

None of the earlier studies on the use of cooperative learning strategy included the use of models in addition. This is a multimedia instructional strategy.

Multimedia instructional strategy has been described by Oyediran, Agoro and Fabiyi (2004) as the use of more than one instructional materials and instructional methods to carry out classroom instruction for the purpose of education. Adewuyi (1994) opined that, objectives of any educational process determine methods and materials needed for achieving such objectives. The materials used for enhancing instructional effectiveness are aspects of media employed for achieving the instructional objectives.

Clark (2009) found that a group of students taught using multimedia tool combined with cooperative learning had an increased student satisfaction and better students' learning. Oyediran et al (2004) also found that pupils taught with discussion method combined with the use of concrete models and diagram performed better than those taught using discussion method only. Furthermore Afolabi (1995) described instructional media as the system component that may be used to disseminate information or message and idea which makes communication possible in the teaching and learning process. Thus teaching effort and consequential learning may not be effectively or efficiently led to the attainment of the desired objectives unless communication between the teacher and the learner is effective. Due to the massive failure and the consequential

withdrawal of pre ND students, it is then left for teacher to use all the resources at his disposal including multimedia instructional strategy to ensure the success of the teaching- learning process.

This study therefore used models with cooperative learning strategy to see the effects on the performance of the Pre- ND biology students as against the use of cooperative learning strategy without models. Models are aspects of media for educational teaching and include concreted objects through which realities can be represented, communicated and appreciated in educational instruction. Example of models include: mental model, analogical model, theoretical models, and mathematical models.

Stone (1996) stresses the importance of learning methods as he indicates that the major difficulty in sciences is the method by which subjects were customarily taught without regard to instructional materials. Instructional materials have been found to enhance the quality of the learning experience of learners in many ways. Betiku (2000) explains that the term instructional material comprise all available and accessible, theoretical, practical and skill oriented resources, which facilitate the learning, acquisition and evaluation of vocational technical skills, According to him, they integrate all the devices that assist teachers in transmitting the facts, skills, attitudes and knowledge to the learners within the instructional system and as may be applied in the world of work.

During cooperative learning, aids may be used as soon as formal contacts have been made with a group of prospective learners and the use of audiovisual methods including models, at an early stage such as during the lesson presentation do much to help consolidate a regular study group by providing materials to stimulate thought and discussion.

Nnaobi (2003) stated that one major factor contributing to the poor performance of students in science is the lack of teaching materials and equipment. Models are teaching aids used in science and technology instructions to represent reality in order to enhance the effectiveness of teaching and learning. Scientists and science teachers often develop models that are useful in communicating the ideas of the abstract concept to the learners in a more tangible or concrete way in order to enhance comprehensions. With good models such as analogy, abstract concepts are made concrete for learners to grapple with and comprehend. Adenipekun (2008) has called upon teachers to use analogical models to explain difficult and process oriented concepts. Models are therefore very important for effective science and technology instruction. Njoku (2004) on the use models found the use of models to improve the teaching and learning of science subjects at secondary school level. The effective use of appropriate models facilitates the attainment of objectives of science and technology. Therefore, this study made use of models with cooperative learning strategy to teach the concepts of osmosis, plasmolysis and transpiration to the Pre-ND biology students. With models, students will learn more, interact with each other more and they will be able to conceptualize the concepts better than cooperative learning without models. Using models will help in concretizing the concepts to the students. The aim therefore, was to determine whether the use of models plus cooperative learning strategy would improve students' performance and retention.

Literature reveals that retention of concept is an essential factor in determining students' achievement in given task or activities carried out. According to Oyedokun (1998), retention can be described as a form of reaction to what has been presented in the past. When concepts are taught, the wish of the teacher is that the concepts taught should be remembered. Retention has been defined as the ability to remember things (Hornby, 2005). Retention of concepts learnt

would help in reflective thinking and the use of the retained concepts can be used in creative ways to solve novel problem. Ochonogor (1997), said that in depth retention and achievement in science, technology and mathematics is an important need that is becoming highly felt by the Nigerians populace. Research studies have shown that improved instructional strategies lead to the improvement of the learner's achievement and retention. Studies on retention test in sciences especially biology are very scanty. Most often, studies that are centered on the effects of teaching approaches and students' achievement in sciences do not include the measurement of students' retention. However, the very few studies that have included students' retention test have revealed the effects of teaching strategies on retention. Orji (1996) in his study showed that problem solving model enhanced students' retention of physics concepts. Lawal (2009) also revealed in her study that the use of activity-oriented teaching strategy, like conceptual change instructional strategy, aided retention of concepts learnt among students. In the present study, therefore, it was intended to determine the effects of models on performance and retention among Pre-ND students.

1.2 Statement of the Problem

The consistent poor performance of students in biology at the Senior Secondary School Certificate (SSCE) up to the Pre-ND level leaves one in doubt about the effectiveness of the teaching method popularly used by biology teachers for teaching the subject. Tertiary institution lecturers use lecture method for teaching (Mankilik, 2007).There is very little interaction among the students and between the teacher and students. The use of talk-and-chalk method of teaching leads to memorization of facts and concepts. There is the need to find out the effectiveness of other teaching methods, relative to the traditional method.

Olorukooba (2002), Adesoji and Ibrahim (2009), found that the use of cooperative learning strategy improved the performance of students. Recent records still revealed low performance in biology by Pre-ND students. The use of multimedia learning strategy has been advocated by researchers, such as Afolabi (1995), and Salawu (1999). Abimbade (1997) and Njoku (2004) found that the use of models improved the teaching and learning of science subjects at secondary school level. With models, students learn more, interact with each other better and can conceptualize the concepts better than cooperative learning strategy without models. The aim in this study therefore was to improve the performance and retention of biology concepts by the Pre-ND biology students using cooperative learning strategy with models. Omosewo (1999) concludes that any study carried out on teaching methodology cannot be a wasted effort. This is because the teaching-learning situation must be crowded with reputable method before an effective communication can bring about ideal permanent change. No study, to the best knowledge of this researcher, has been conducted on students' performance in biology at the tertiary level especially considering the methods employed in teaching. Therefore this research was conducted to study the effectiveness of an enhanced method of teaching; that is, lecture method with models.

Gokhale (1995) equally observed that most of the research studies on cooperative learning have been done at the primary and secondary levels, while majority of the research in cooperative learning has been done in non-technical disciplines. As yet, there is little empirical evidence on its effectiveness at the College level. There is the need to investigate the effectiveness of the use of an enhanced cooperative learning strategy at the post secondary level particularly among the Pre-ND biology students. The application of cooperative teaching and learning strategy has been able to improve the performance of students at the primary and secondary level of education.

This study was conducted to find out if the application of cooperative learning strategy with models would help to improve the achievement of the Pre-ND biology students whose performance in biology have been very poor.

1. 3 Objectives of the Study.

The objectives of the study are to:

1. determine effects of cooperative learning strategy with models on the achievements in biology concepts among pre National Diploma science students.
2. investigate effects of cooperative learning strategy with models on retention of biology concepts among pre National Diploma science students.
3. determine effects of cooperative learning strategy on the achievements in biology concepts among pre National Diploma science students.
4. investigate effects of cooperative learning strategy on retention of biology concepts among pre-National Diploma science students.

1.4 Research Questions

For the purpose of this study, the following research questions were raised and answered.

1. What is the effect on the performance scores of Pre-ND students taught biology using cooperative learning strategy with models (CLS + M) and their counterparts taught using cooperative learning strategy (CLS) without models?
2. What is the effect on the performance mean scores of Pre ND students taught biology using cooperative learning strategy with models (CLS + Model) and their counterparts taught using lecture method without models (L)?

3. What is the effect on the performance mean scores of Pre-ND students who taught biology using lecture method with models (L+M) and their counterparts taught using lecture method (L) without models?
4. What is the effect on the retention ability of preliminary diploma biology students who were taught using cooperative learning strategy with models (CLS +M) and those taught using cooperative learning strategy (CLS) without models?
5. What is the effect on the retention ability of preliminary diploma biology students who were taught using cooperative learning strategy with models (CLS + M) and those taught using lecture method without models (L)?
6. What is the effect on the retention ability of preliminary diploma biology students who were taught using lecture method with models (L + M) and those taught using lecture without models (L)?

1.5 Null Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance.

Ho1: There is no significant difference in the academic performance mean scores in biology between students taught using cooperative learning strategy with models, and those taught using cooperative learning strategy without models.

Ho2 There is no significant difference in the academic performance mean scores in biology between students exposed to cooperative learning strategy with models, and those exposed to lecture method without models.

Ho3 There is no significant difference in the academic performance mean scores in biology between students who are taught using lecture method with models, and those who are taught using lecture method without models.

Ho4 There is no significant difference in retention ability of biology concepts between students taught using cooperative learning strategy with model, and those taught using cooperative learning strategy without models.

Ho5 There is no significant difference in the retention ability of biology concepts between students taught using cooperative learning strategy with models, and those taught using lecture method without models.

Ho6 There is no significant difference in retention ability of biology concepts between students who learnt by lecture method with models, and those taught using lecture method without models.

1.6 Significance of the Study

The findings of this study would hopefully, uplift the standard of biology education as detailed in this section

a. The Pre-ND programme is a stepping-stone into the National Diploma in Agriculture program. The achievement of students at this level therefore becomes very important in later achievement in the National Diploma (ND) programme. Students who are often taught with the lecture method are already scared of the course. Therefore, it was hoped that the use of cooperative learning strategy with model to teach them would motivate them to be more relaxed as they would be able to learn in a more conducive environment and interact with one another using concrete models.

b. Students who register for Pre-ND programme are mostly deficient in one or more subjects, including biology at the WAEC or GCE examination. Such students essentially have academic challenges that could be solved by utilizing the findings of this study.

c. Lecturers might find the use of cooperative teaching strategy with models to enhance better interaction among students.

d. The NBTE is responsible for the curriculum of the Pre-ND programme and as such, the findings of this would hopefully be of interest to the body and other stakeholders in the diploma programme by introducing cooperative learning strategy with models in the curriculum as an innovation. It was hoped that the Pre-ND students can achieve better through the use of cooperative learning strategy with model and thereby build a better and more solid foundation for their diploma programme.

e. Overall, this study by adoption could contribute ideas for improving teaching in Biology in those institutions where Pre-ND programmes are being run all over the country.

f. Bodies such as Science Teachers Association of Nigeria (STAN), National Board for Technical Education (NBTE) and States Education Resource Centre would hopefully benefit by considering the findings of this study in developing instructional methods.

g. Of late, there have been calls for the overhauling of higher education curricula in Nigeria (Olukoju 2011). This cannot be achieved if students are not taught with appropriate instructions and materials. A study as this should throw light into areas where the overhauling of the education curricular should be.

1.7 Basic Assumptions

The basic assumptions for this study were as follows:

1. Qualified science teachers teach the students under study.
2. The students under study were using the same syllabus and were being taught using appropriate methods of instructions.
3. Students in the study sample had had adequate coverage of biology lessons via the traditional Pre-ND methods, such as lecture method, but had not been exposed to biology instructions through effective learning methods such as cooperative learning strategy with models.
4. The teachers were aware and had been using instructional materials such as charts in the teaching and learning of biology.

1.8 Delimitation of the Study

The following delimitations were imposed on the study.

The study was limited to the Pre-National Diploma Biology Students in Federal Monotechnical Colleges located in Kaduna State of Nigeria. Both male and female students of average age of twenty years were involved. The curriculum contents were limited to only three biology concepts of Osmosis, Plasmolysis and Transpiration, of the entire syllabus. The use of model was limited to the presentation of curricula content only, as the four groups were exposed to pretest, post and post posttest using pencil and paper approach.

Despite these limitations, the findings were significant particularly the use of models to enhance students' learning of biology concepts by the Pre-National Diploma students.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

The focus of this study was to investigate the effectiveness of cooperative learning, cooperative learning strategy with models, lecture method, and lecture method with models on performance and retention in biology among Pre-National Diploma students. The chapter is presented under the following sub-headings:

- Theoretical Framework
- Science Teaching Instructional Strategies
- Concept of Co-operative Learning Strategy
- Elements of Cooperative Learning
- Group Work in Cooperative Learning Models of Cooperative Learning
- Goal and Reward in Cooperative Learning
- Models of Cooperative Learning Strategy
- Studies on Cooperative Learning Strategy and Academic Achievement
- Use of Models and Academic Achievement
- Types of Models
- Studies on the use of Models in Learning
- Studies on Multimedia Learning Strategy
- Effects of Learning Strategy on Retention of Science Concepts
- Implications of the Literature Reviewed for the Present Study

2.2. Theoretical Framework

Cooperative learning with models in teaching and learning situation is based on constructivist theory of learning. Learning theories linked with constructivism that is very relevant in cooperative learning strategy with models is that of Lee Vygotsky (1978), namely, 'Theory of scaffolding and its zone of proximal development'. It emphasizes on the role of active involvement in learning in relation to the child's environment. The teacher acts as a facilitator who encourages students to discover principles for themselves and to construct knowledge by working to solve realistic problems. This implies that the students must take some responsibility for their learning. This is because they have to be actively involved in teaching and learning process. Cooperative learning strategy with models creates enabling environment for students to learn from themselves. Therefore, while students learn by interacting with each other within the environment using cooperative learning strategy; they in addition, interact with the concrete objects. When students cooperate, they share the process of constructing their ideas, instead of simply laboring individually. (Rysavy & Sales,1991). Furthermore, in multimedia learning, people use three different methods for perceiving the world: auditory, kinetics and visual.

As in other aspects of learning, most of us have developed a favourite mode of perception for learning about the world. This favourite mode affects how we learn in different situations (Felder and Silverman, 1988; Murr, 1988). Kinesthetic learning includes taste, touch, smell and feelings. Passing objects around during a lecture not only spices up the class but also incorporates kinesthetic learning. Touch can be useful for example to understand the smoothness of objects. Visual information appears to be easier to understand and place into memory than words (Kiewra, 1987).One of the basic tenets of learning theory is that learning is more thorough and is

retained better if multiple modes are used to input and process the information. The use of cooperative learning strategy and models is a multimedia learning strategy

The purpose of this study was to investigate the effectiveness of cooperative learning strategy with model on the achievement and retention of biology concepts among the Pre- ND students in Kaduna State.

2.3. Science Teaching Instructional Strategies

The method of teaching could be regarded as the vehicle through which a message is delivered (Salawu 1999). With the strong link between science achievement and teaching strategies, it behoves science and technology teachers and educators to device teaching methods among other factors as the centerpiece of improving science outcomes, reversing the current negative trend in science achievement through instructional strategies. A competent science teacher must acquaint himself or herself with science methodology and be well groomed in the application of the various methods for effective teaching of science. The problem of devising effective teaching techniques has preoccupied many science educators for a long time. In recent years, this problem has come into sharper focus as a decline in students' performance in science is becoming more and more evident in many countries around the world (Okebukola & Jegede, 1988). The prevailing teaching method in Nigeria is the lecture method. This instructional method, according to scholars, is mainly authoritarian in nature. Teaching methods, which can help the development of reasoning, skills and processes through scientific approach, are conspicuously lacking. James (1991) observed that teachers who provide good classroom conditions, good teacher–student relationship and of course apply good teaching methods might improve the academic achievement of students, thereby motivating them to score high marks.

Lecture method is the prevailing method of disseminating knowledge at virtually all levels of academics in Nigeria. It is the traditional method, the expository method or the talk and chalk as well as conventional method of teaching. The teacher does the bulk of the talking as he presents large body of facts and principles to many students in a teacher- centered mode. Lecture method provides careful, lucid presentation of materials. Participants see the professional mind at work, and it effectively conveys large amount of information in a short space of time. This is why it is so appealing to our teachers. Although the method is an accepted format by educational community teachers and students, it is an efficient means of distributing a vast amount of knowledge. It allows a great deal of information to be passed to the learner and favors handling of large classes. The use of lecture method is only encouraged when new information is to be passed quickly to a large group, and to illustrate how at least one person is able to wrestle with a large amount of information, integrate, and make sense out of it. Science teachers use mostly the lecture method for imparting information.

However, under the lecture method, the teacher, simply becomes only the expositor and drillmaster while the learner remains the listener and a storehouse of facts that can be retrieved by the teacher when needed (Usman, 2001). This results in poor performance by the students. Therefore, the lecture method is not effective for teaching and learning scientific concepts. The search for improved strategies as an alternative to lecture method for teaching and learning of science is a continuous process.

One way to learning is to combine a lecture with opportunities for the students to reflect on and use the material actively. Skills such as being able to think critically, inquire into value, and work in groups can be acquired along with the lecture information if active and cooperative learning technique supplements the lecture. This study was an attempt in to find the effects of an

activity based strategy particularly a multimedia learning strategy on the achievement and retention of biology concepts among the Pre-National Diploma students.

2.4. Concept of Cooperative Learning Strategy

The term 'Cooperative Learning' refers to an instructional method in which students at various performance or ability work together in small groups toward a common goal (Gokhale, 1995). The students are responsible for one another's learning as well as their own. Therefore, the success of one student helps another student to be successful. Through cross modeling and role-playing, students are encouraged to draw on their individual experiences and background knowledge to create a common product. The social context created by the cooperative approach allows students to shape ideas, modify them by listening to peers, question, express doubt, and jointly design and implement plans. Slavin (1990) states that the social dividends include positive interdependence, heterogeneity, and shared visions and responsibilities. The authentic learning environment of cooperative strategies also enhances potentials for transfer to team based activities in professional practice (Johnson & Johnson, 1994). The concept of cooperative learning strategy has also been described, as a social situation in which the goals of separate individuals are so linked together that an individual can attain his/her goal only if the other persons with whom he/she is cooperatively linked to attain theirs as well. As an instructional technique, cooperative learning strategy requires students to work together in small groups (usually 4-6 members), and are rewarded for their performance as a group. The concept of cooperative learning therefore, stems from the prevailing principles that learners in a cohesive group, work mutually together for the attainment of set educational objectives. The underlying principle here is that there is social cohesion and the willingness of members of the group to

work together. The cooperative learning technique works on this principle to encourage students working in groups to achieve lesson objectives in science under the guidance of the teacher.

Johnson and Johnson (1999) also define cooperative learning as the instructional use for small groups in which pupils/students work together to maximize and gain from each other. In cooperative learning, pupils are expected to help, discuss and argue with each other, assess each other's current knowledge, and fill any gaps in each other's understanding (Slavin, 1995). Students who participate in cooperative learning have been shown to perform significantly better on critical thinking than students who studied individually.

Bruffee (1995) sees cooperative learning as a set of processes that help people interact in order to accomplish a specific goal or develop a product, which is usually content specific. Kagan (1989) describes cooperative learning as a small group of learners who work together as a team to solve a problem, complete a task or accomplish a common goal.

When students are in a cooperative learning environment, it is assumed that they seek information and understanding through active mental search without discrimination in gender or ability and the learning is long term (Lefrancois, 1994). Proponents of cooperative learning claim that the active exchange of ideas within small groups not only increases interest among the participants but promotes critical thinking. According to Johnson and Johnson (1986), there is persuasive evidence that cooperative teams achieve at higher levels of thoughts and retain information longer than the students who work quietly as individuals.

Some studies have recommended the efficacy of cooperative structures in that they lead to increase cohesiveness among the students involved, which are beneficial in classes that are diverse in ethnic composition, ability level or because of the inclusion of mainstreamed handicapped students (Crooks, 1988).

2.4.1. Elements of Cooperative Learning Technique

There are many different cooperative learning strategies; however, all of them have certain elements in common as established by Johnson, Johnson and Holubec (1991). These elements are the ingredients necessary to ensure that when students work in groups, they work cooperatively. Cooperative learning is not simply a synonym for students working in groups. A learning exercise only qualifies as cooperative learning to the extent that certain elements are present.

Positive interdependence: - Team members are obliged to rely on one another to achieve the goal. If any team members fail to do their part, everyone suffers the consequences.

Individual accountability: - All students in a group are held accountable for doing their share of the work and for mastery of all of the material to be learned. Each member of a team is assessed individually. Teammates work together, but the learning gains of individuals form the basis of a team score.

Equal opportunities for success: - Individual improvement over prior performance is more important than reaching a pre-established score (90 percent on a test, for example). A student who moves from 60 percent on a test one week to 68 percent (8 percent improvement) the next week contributes just as much to a group as a student who moves from 82 percent to 90 percent (also 8 percent improvement).

Face-to-face promotive interaction:- Although some of the group work may be parceled out and done individually, some must be done interactively, with group members providing one another with feedback, challenging one another's conclusions and reasoning, and perhaps most importantly, teaching and encouraging one another.

Appropriate use of collaborative skills: - Students are encouraged and helped to develop and practice trust-building, leadership, decision-making, communication, and conflict management skills.

Group processing: - Team members set group goals, periodically assess what they are doing well as a team, and identify changes they will make to function more effectively in the future. Teams work to earn recognition for the improvement of each member of a group. The members of a group must perceive that they are part of a team and that they all have a common goal. Group members must realize that the problem they are to solve is a group problem and that the success or failure of the group will be shared by all members of the group. To accomplish the group's goal, all students must talk with one another to engage in discussion of all problems; finally, it must be clear to all that each member's individual work has a direct effect on the group's success. Teamwork is utmost important.

However, the ultimate success of cooperative learning is based on a single and very important principle: Students must be taught how to participate in a group situation. Teachers cannot assume that students know how to behave in a group setting.

These elements are the guiding principles of cooperative learning strategy which contribute to the success as a teaching and learning strategy. The present study also includes implication and effect of cooperative learning strategies and models on the achievement and retention of biology concepts by the pre national diploma students.

2.4.2. Group Work in Cooperative Learning

Cooperative learning is the instructional use for small groups in which pupils/students work together to maximize and gain from each other (Johnson and Johnson, 1994). In cooperative learning, pupils are expected to help, discuss and argue with each other; assess each other's current knowledge; and fill any gaps in each other's understanding (Slavin, 1995).

Grouping is a forum for socialization and children learn through interaction with both peers and the members of staff (French, 1990). A number of research work done on group work reveals its positive impact on learning. Galton & Williamson (1992) emphasize that groups function best when they are of mixed ability and group work has significant social and emotional effects. Developing group methods for learning is important as teachers mirror and reinforces the values of democratic society (Reynolds, 1994). The idea that people working together can accomplish more than people working alone is a well-established principle in social psychology (Galton, 1990). Learning groups involve more than an exchange of information and ideas but the relationships established in such groups to a large extent affect or determine how much is learnt and the quality of what is learnt (Reynolds, 1994)

Using groups for learning is likely to be more effective than if it is limited to more individualistic approaches. Kutnick (1990) affirms that when pupils work together effectively with one another it may help ease teacher dependence and provide bases for autonomy. However, there are required ways in which students in small groups verbally seek help, respond to requests for help and otherwise interact with each other (King, 1990).

Group work has several advantages over individual work; the presence of others increases motivation, group judgments are more reliable; groups learn faster than individuals learn and produce more and better solutions to problems.

Various empirical reports have also suggested the positive effects of group work in mathematics and science classrooms. Good, Groews, Mason, Slavins, and Cramer, (1990); Kempa and Ayob, (1995) reveal in their studies that small groups allow students to be learners that are more active and enable teachers to introduce more thinking and more challenging content into the curriculum. Kutnick (1990), also found that students are involved in a systematized nature of interaction and when students' interaction is positively utilized, it lays the background for cognitive development

Students' achievement and understanding of concepts improved while learning in groups with structured materials, on general inquiry skills, and problem solving ability. Group discussion helped low ability students performance. They benefit from the interaction with high ability students, which was facilitated by the group activity. Solomon (1994), while proposing the merits of group discussion in science classrooms, points out that the practical and paper work in science, which used to be strictly and salient activities is now outdated. Students need to work together for investigative activities.

Grouping is an important aspect of cooperative learning. However, Edwards and Knight (1994) caution against the style of simply placing children into groups without adequate control. The study and control of interaction processes, which take place among peers, is very important. In the present study students taught using cooperative learning strategy were grouped into fours and fives and worked together in pairs.

2.4.3. Goal and Reward in Cooperative Learning.

Cooperative learning refers to a situation in which students work together to achieve a common goal, and rewards depend not on doing better than someone else but on doing well with someone else (Lefrancois, 1994). Students learn through interdependence and cooperation with one another (Slavin, 1990). According to Parker (1985), students within small group's cooperative learning are encouraged to share ideas and help each other learn. They pool resources, share discoveries, justify their thinking and comment on each other's ideas.

Arends (1991) referred to the ingredients of cooperative learning as those of the task and reward structures while Slavin (1989) regards them as group goal and individual accountability.

Cooperative learning is often distinguished from other instructional approaches based on the reward structure, which is incorporated into the various models. According to Lefrancois (1994), in a cooperative situation, the individual is rewarded are inversely related to those others receive. However, there is no relationship among individual rewards in the individualistic learning environment. Slavin (1985) affirms that the interdependence in cooperative learning motivates individuals to encourage one another to do whatever helps the group to succeed.

Arends (1991) reported that many studies conducted across diverse settings suggest that under cooperative conditions where individuals are rewarded for group success, there is interdependent relationships, strong motivation to complete a common task, considerable friendliness among group members, a high effective communication process that tends to promote maximal generation of ideas and greater mutual influence. In the present study, the students were individually rewarded for the work done cooperatively in different groups.

2.4.4. Models of Cooperative Learning

A record of a variety of developed and tested cooperative learning models abound in literature (Guskey, 1990; Slavin, 1990; & Arends, 1991). Some models framed after these were observed to have achieved the instructional objectives in the area of academic achievement, improved race relations and social skills (Arends, 1991). However, all the models have the same basic components and characteristics. The different varieties were proposal by researchers from their various investigations. Owen (1985), Slavin (1985,) Arends (1991) and Lefrancois (1994) described some of the models as; Student Teams Achievement Division (STAD) (Owen, 1985); Teams Games Tournament (TGT) (Slavin, 1985); Team Assisted Individualization (TAI). Others are, Cooperative Integrated Reading and Composition (CIRC); Jigsaw I and II; Learning together; and Group investigation and the reciprocal teaching approach.

i. **Student Team Achievement Divisions (STAD):** Students are assigned to permanent four member learning teams that are mixed on the basis of gender, ethnicity and performance level. Lessons are presented in a traditional manner, but students work together to ensure that all team members master materials. Students work in pairs but on the worksheets tested individually and each student's score is compared to his or her past average. Team points are awarded based on the degree to which members exceed their earlier performance.

ii. **Teams-games-tournaments (TGT):-** TGT approach is identical to STAD, except students compete with those teams who are at the same performance level. Low and high achievers from each team compete with their counterparts and the top scorers in these "tiered" tournaments win points for their teams.

iii. **Jigsaw II: -** The Jigsaw approach is like STAD except that each student is assigned expository material and each team member is randomly assigned to become expert in some aspect of the assignment i.e. they change teams at random. If the topic is a country, for example, one member might specialize in history, another in geography, another in economics and so on. Students interact with members of other teams who have the same specialization and then return to impact the content that have gathered to their teammates.

iv. **Team Accelerated Instruction (TAI):-** Students study individually but are assigned to teams whose members check and help each other. Students are tested individually, but team rewards are given based on the number if individual assignments and tests those members complete. The method is useful in highly structured subjects where success depends on mastering pre-requisites.

v. **Student Teams-Achievement Divisions (STAD)**

The model adopted for the present study was the Student Teams-Achievement Divisions (STAD).

It was originated by Robert Slavin (1990) and his colleagues at Johns Hopkins University.

The STAD model underscores many of the attributes of direct instruction, and it is a very easy model to implement in the science classroom. As in the entire cooperative learning models to follow, STAD operates on the principle that students work together to learn, and are responsible for their teammates' learning as well as their own as derived from Kutnick's (1990) contact theory.

Arends (1991) identified some important steps which the teacher should follow in a cooperative learning model. These include: Provision of instructional objectives, Presentation of information, Organization of students to work in learning teams, assisting of team work, Study testing of students and recognition of achievement.

Phase I Class Presentation

The class presentation is a teacher-directed presentation of the material concepts, skills, and processes that the students are to learn. Carefully written and planned objectives should be stated and used to determine the nature of the class presentation, and the team study to follow.

Key concepts should be identified as well.

The presentation can be a lecture, lecture/demonstration, or audiovisual presentation. You also could follow the lesson plans in your science textbook, including the laboratory activities in this phase of STAD. Several lessons would be devoted to class presentations.

Phase II: Team Study

In STAD teams are composed of four students who represent a balance in terms of academic ability, gender, and ethnicity. The team is the most important feature of STAD, and it is important for the teacher to take the lead in identifying the members of each team. Slavin (1990) recommends rank ordering your students in terms of performance. Each team would be composed of high and low ranking student and two near the average. The goal is to attempt to achieve parity among the teams in the class. Teams should also be formed with sex and ethnicity in mind. Each team should be more or less an average composite of the class.

Team study consists of one or two periods in which each team masters material that you provide. Team members work together with prepared worksheets and make sure that each member of the team can answer all questions on the worksheet. Students should move their desks so that they face each other in each small team. Give each team two worksheets and two answer sheets (not one for each student). In the STAD model the following team rules are explained and posted on the bulletin board:

1. Students have the responsibility to make sure that their teammates have learned the material.

2. No one is finished studying until all teammates have mastered the subject.

3. Ask all teammates for help before making the teacher.

4. Teammates may talk to each other softly.

It is important to encourage team members to work together. They work in pairs within the teams (sharing one worksheet), and then the pairs can share their work. A principle that is integral, not only to STAD, but to all cooperative learning models is that students must talk with each other in team learning sessions. It is during these small group sessions that students will teach each other, and learn from each other. One of the ways to encourage deeper understanding is for students to explain to each other their answers to the questions. The teacher moves from group to group asking questions, and encouraging students to explain their answers.

Phase III: Test

After the team study is completed, the teacher administers a test to measure the knowledge that students have gained. Students take the individual tests and are not permitted to help each other.

Phase IV: Team Recognition

Team averages are reported in the weekly recognition chart. Teachers can use special words to describe the teams' performance such as science stars, science geniuses, or Einsteins.

Recognition of the work of each team can occur by means of a newsletter, handout, or bulletin board that reports the ranking of each team within the class. Teacher reports outstanding individual performances.

2.5. Studies on Cooperative learning Strategy and Academic Achievement in Science.

A number of instructional strategies have been successfully used to improve students' achievement in science. Henderson (1994) affirmed that sensitive and controversial issues in science could be most appropriately taught when cooperative group approach is utilized. Recent findings suggest that sixth-grade students who were in cooperative groups for their science class showed higher achievement levels and indicated higher levels of satisfaction than students in whole group conditions (Maheady, Harper & Sacca, 2002). More brilliant contributions to scientific knowledge take place whenever pupils talk together (Solomon, 1994); hence, the practice of group work for effective science teaching is an important feature of any science teaching strategy.

The studies on cooperative learning techniques which have repeatedly shown increased academic performance include those of McClintock and Sonquist,(1976); Lazarowitz and Ackerman, (1980), Hertz-Lazarowitz, Sharan, & Steinberg, (1980); Madden and Slavin, (1983); Slavin and Karweit, (1984); Sharan, Hertz-Lazarowitz , and Ackerman (1986); and Potthast, (1999).

Hudgins (1960) found that fifth grade students working in groups made higher scores on math tests than students who worked individually. Whicker, Bol, and Nunnery (1997), studied

secondary pre-calculus classes and concluded "cooperative learning promotes mathematics achievement" In undergraduate college statistics classes, groups using cooperative learning scored higher on tests (Pothast, 1999).

Mcclintock and Sonquist (1979) studied undergraduate college sociology students and found students participating in cooperative groups received higher than average grades on term papers than working individually. They also concluded that group's performance was often better than what could have been expected of the best student in the group. Lazarowitz, Lazarowitz, and Baird(1994) reported significantly higher gains in both normative and criterions measures of academic testing for students in cooperative learning groups In other studies, cooperative learning strategies were found to improve student performance (Chang & Mao, 1999) and cognitive achievement (Okebukola & Ogunniyi, 1984) in science classes. Augustine, Gruber, and Hanson (1990) reported higher achievement resulting from cooperative groups in a wide variety of subject areas including spelling, social studies, health and language.

Other studies also reported that students in cooperative groups were able to master and retain information better than students in individual or competitive situations (Humphreys,Johnson, &Johnson, 1992). Duren and Cherrington (1992) observed significant improvements in long-term retention of problem solving strategies of students participating in cooperative learning groups. They reported students in cooperative groups were more willing to tackle a problem longer, made qualitative strategies and corrective feedback and attempted to use learned strategies 7% more often than independent practice classes.

Johnson, Johnson, and Zaindman (1981) hypothesized that the effects of cooperation would increase the more students worked together, encouraged and tutored each other and rehearsed materials being learned. Whicker et al (1997) came to a similar conclusion but felt it might take

some time for the benefits of cooperative learning to become apparent. They reported that although there were increasing group differences on the second chapter test administered after four weeks, the groups did not significantly differ until the scores on the third chapter test were compared, 6 weeks after the cooperative learning technique was initiated.

Studies have also shown that cooperative techniques are more effective with higher levels of learning on Bloom's taxonomy. These include Sharan et al.(1980) Johnson, Meruyama, Johnson, Nelson and Skon(1981); Good,et al (1990); and Mervarech, (1999). Sharan et al (1980), found that the fundamental goals of cooperative learning are to promote processes of learning which are intellectually more complex and richer than the presentation recitation model. Their study showed little of Bloom's taxonomy. However, the small groups were able to build more high level concepts on the basis of low level information than were peers in the classrooms. Mevarech (1999) showed more pronounced differences in performance at higher cognitive levels while Chang and Mao (1999) found that cooperative learning was more effective at enhancing the high achieving students. Augustine et al (1990) reported heterogeneous groups generally improved performance for both low achieving and high achieving students and groups promoted critical thinking, although the reasons for improved cognitive abilities resulting from cooperative learning are not totally understood. Webb, (2008), as cited in Hooper, (1992), proposed that individuals received more attention from group members than a teacher can provide and a process of generating explanations required deeper processing of information.

Properly structured cooperative learning activities are associated with positive educational outcomes (Jacobs & Ball, 1996). Okebukola (1988) found that cooperative learning technique featuring intra group cooperation with inter group competition is a very effective way of improving students' achievement in science in large class situations. Other researches include

that of Sherman (1988). He carried out a study with 60 high school students who learned ecology compared with two instructional modes; Group Investigation (GI) versus individualistic learning. He found that both methods were effective in learning an investigative approach. He concluded that in order for students learning in the GI method to achieve significantly higher scores, teachers involved in such instruction should be trained more in-depth in this mode of instruction. Studies in cooperative learning in Africa include that of Keraro,Wachanga,and Orora (2007) from Kenya. They investigated the effects of using the cooperative concept mapping teaching approach on secondary school students' motivation in biology. A non-equivalent control group design under the quasi-experimental research was used in which a random sample of four co-educational secondary schools was used. The four schools were randomly assigned to four groups. Each school provided one Form two class. The study sample comprised of 156-second grade students inn all the secondary school cycle in Gucha District, Kenya. Students in all the groups were taught the same biology content but two groups, the experimental groups, were taught using the cooperative concept mapping approach while the other two, the control groups, were taught using regular teaching methods. Both the experimental and the control groups were pre-tested prior to the implementation of the cooperative concept mapping intervention. After four weeks, all four groups were post-tested using the student's motivation questionnaire (SMQ). Data were analyzed using the t-test, ANOVA and ANCOVA. The results show that students exposed to the cooperative concept mapping approach have significant higher motivation than those taught through regular methods. The results further indicated that there was no statistically significant gender difference in motivation towards the learning biology among secondary school students exposed to cooperative control mapping. The researchers conclude that cooperative

control mapping is an effective teaching approach, which biology teachers need to incorporate in their teaching.

In Nigeria, Okebukola (1988) also found that rural school students preferred cooperative learning and that urban school students preferred competitive learning. Okebukola's explanations were that the ecocultural factor and the environmental influence affect student's preferences for cooperative or competitive learning settings. His conclusion was that 'students will do equally well in cooperative and competitive conditions so long as they are placed in the learning setting which matches their preferences. The present study will be taking place in an environment different from that one earlier mentioned to see the possibility of either similarity or differences in their findings. In another study, Okebukola and Jegede (1988) used a sample of high school students (n = 145, 84 boys, 61 girls) studying biology, chemistry, physics, mathematics and English. Students learned topics related to the photosynthesis process using the concept-mapping strategy. Meaningful learning was compared by students cognitive preferences and learning modes. The cooperative group students who preferred Principles, Questions, and Recall achieve significantly higher results compared to the individualistic group. In Applications, there were no differences between the two groups. Thus, student's cognitive pgg significantly influence the meaningful learning through concept mapping, and the cooperative mode of learning was found to be superior over the individualistic approach. Similarly, Alebiosu (1998) investigated the effects of two cooperative learning models (Student Team Achievement Division-STAD and Jigsaw II) on senior secondary school students' cognitive achievement, attitude towards chemistry and achievement in practical skill in chemistry. The researcher used 252 students in intact classes from nine secondary schools randomly selected to the treatments and control groups. Data collected both before and after treatment were analyzed. The result

showed among others that the treatment group performed significantly better in cognitive achievement, attitude and in practical skill. Olorukooba (2002) studied the effects of cooperative instructional and traditional method of instruction on academic achievement of students and their retention of chemistry concept and the attitude of male and female students towards cooperative instructional strategy. The study comprised of 137 experimental subjects that were taught using cooperative instructional method and 127 controls, and were taught using the traditional lecture method. The findings showed that the experimental group performed significantly better in the achievement test, than the control group. Based on the findings, the use of cooperative instruction was recommended in the teaching of chemistry.

Adesoji and Ibrahim (2009) studied the effects of Student Team Achievement Division strategies (STAD) and mathematics knowledge on learning outcome in chemical kinetics. The result shows that STAD cooperative learning strategy had the potential to improve students' learning outcome in secondary school chemistry. This finding provided empirical support to earlier findings of Fu-yun-yu, (1998), Popoola (2002), and Omosehin (2004) that established that cooperative learning strategy promoted better achievement and productivity than the conventional lecture method.

The main objective of this study was to study the effectiveness of cooperative learning strategy with models on the achievement in biology. None of these studies referred to used cooperative learning strategies with model. Moreover, this study was in a different environment. Furthermore, there is no empirical evidence on the use of the proposed learning model. Therefore, it was intended in the present study to combine cooperative learning strategy with models to see the effects on the achievement in the learning of biology concepts by pre-national diploma students.

2.6. Use of Models in Science Learning

Instructional materials such as audiovisual aids, correctly used, have a real and significant part to play in the creation of an ideal training situation. Direct experience is the best teacher. Although audiovisual aids are only a substitute for direct experience, they make use of the two channels of learning: sound and vision. Almost invariably a well conceived visual or audio-visual aid will provide the most satisfactory method of communicating a new idea. A large percentage of all the things we learn are the direct result of visual and audiovisual experiences. Therefore, no one concerned with communication of principles and ideas or with teaching and training in any form can afford to neglect the use of audiovisual methods.

A model as an instructional material has been defined by Wenham (1972) is an imaginative picture theory of the processes, which give rise to observed natural or manufactured phenomena. According to him, models are constructed in the effort to understand the behavior of the physical world and the causes of such behavior. Models are three-dimensional representations or real objects. They may be full-size copies of rare and precious items, or scale models of the kind more normally used for teaching purposes. Sectional or cutaway models may also be employed to show internal details and features of objects which would be difficult to understand if presented in any other way.

Models as instructional aids are caricatures of reality; and if they are good caricatures, they portray some of the features of the real world. According to Njoku (1998), models are ideas, or human imaginations, which attempt to explain why aspects of the physical, natural or manufactured world remain as they are or behave as they do. They are representations of objects or events or functional processes or a complex interrelationship among the structures of a system. Good instructional models are presented in such a way that they enhance understanding

and application of ideals or information towards problem solving. A model has also been described as a simplified representation of a system, which concentrates attention on specific aspects of the system (Ingham & Gilbert, 1991). Models enable aspects of the system or objects and events or ideas which are either complex or abstract or on a different scale, to be rendered either visible or more readily visible. Models, are recognizable three-dimensional representation of real things .The thing represented may be infinitely large like the earth, or as small as an atom. It may be an inanimate object such as a building, a monument, or a mineshaft, or it may be a living organism such as paramecium, an eye, or the human heart. The model may represent something as intricate as a jet engine, a nuclear powered submarine or a spacecraft. It may be complete in every detail or considerably more simplified than the original. Some models are smaller than the real size for the sake of space or economy; others may be extensively enlarged to permit convenient study. Generally, original characteristics of a real object are carefully reproduced in the model. Models are three dimensional representations of real objects. They may be full-size copies of rare and precious items, or scale models of the kind more normally used for teaching purposes. Sectional or cutaway models may also be employed to show internal details and features of objects which would be difficult to understand if presented in any other way.

Biology can sometimes be difficult, particularly when describing things that we cannot see or abstract concepts that we cannot fully comprehend the first time round. Some students have the notion that biology is boring, and that to get one through, the subject requires only memory work. Others find the subject irrelevant. To overcome these views, Tim (2004) recommends the use of analogies to make learning biology the exact opposite of what many perceive it to be: simple exciting, relevant and comprehensible. An analogy is also described a comparison of something unfamiliar with something familiar in order to explain a shared principle.

Like a bridge that spans the gap between what a teacher wants a student to learn and what the student already knows, an analogy builds on the framework of the learners' existing knowledge so that they are not starting from scratch.

Models have been particularly useful in developmental biology over the past 30 years (McLachlan 2003). At first, underlying control mechanisms were poorly understood, but over time, a wealth of detailed information became available to provide an increasingly detailed knowledge of underlying mechanisms, at levels from genes through cells to organs, organisms and populations. Models allow students to explore phenomena hard to perceive directly because of their scale, accessibility, expenses or other considerations. A model may allow students to 'experiment' in ways, which would be impracticable in real life, as well as give them a deep understanding of competing hypotheses of development. Farrant (1971), on the use of models, observed that models save teacher the lengthy explanation about those things which were strange to children. All the impressions a picture and chart can give, model can do even better. In addition to that they bring a sense of reality to what is taught. They create memorable impressions and bring lesson to life. Wilkins (1978) says models make phenomena for which they represent more easily comprehensive and more accessible.

2.6.1. Types of Models

Models are of various types depending on the nature of what they represent and the problem they are intended to solve in the teaching – learning situation. Scientists and science teachers often develop models that are useful in communicating the ideas of the abstract concepts to the learners in more tangible or concrete way in order to enhance comprehension. For instance, the "solar system model" of the atom showing the electrons in concentric orbits around a central

nucleus is a highly simplified way to explain the complex relationships between parts of the atom to beginners grapple with and comprehend. Models are therefore very important for effective science and technology instructions.

There are various kinds of models through which realities can be represented, communicated and appreciated in science and technology instruction. Some of these are mental model, scale models, analogue models and mathematical models.

Mental models

Mental models are used to describe and explain phenomena that cannot be experienced directly. Scientists use mental models to think through abstract ideas and theories. Mental models become expressed models when they enter the public domain through action, speech, and writing. They are often represented as analogies and metaphors.

Scale Models

Scale models are likenesses of material objects, systems or processes, whether real or imaginary, that preserves relative proportions. Such models reflect the structure of the original object or system or process on an enlarged or reduced scale. Because scale models are constructed for given purposes, they indicate and emphasize faithful representation of those aspects of the original that are relevant to the intended use. Hence, scale models have associated with them conventions of interpretation relating the model to the original. Examples of scale models are models of the Solar Eclipses (in Physics and earth sciences), parts of anatomical structures like the human skeletal system and organ models (in biology), models of houses, machinery, cars, airplanes etc (in technology) and models of the blast furnace or the Solvay Tower or Fractionating Tower (in chemistry and technology), and models of tractor, harvester, miller in agricultural engineering.

Analogue Models

Analogue models represent some material object, system or process designed to produce as faithfully as possible in some new medium, the structure or web of relationships in the original (Black, 1962). Teachers could also use analogical models to explain difficult and process oriented concepts. Analogical models are parallel or systems used to support the process of reasoning and they serve as mental model for understanding a new domain (Adenipekun 2008). They are used to create meaning, foster understanding, solve problems and generally to enhance learning. They compare with parallels, metaphors and simile, which are used to think of one thing in terms of another.

Mathematical Models

Mathematical models usually represent relationships between phenomena or concepts.

Although Mathematical models are abstract, they are highly prized for the simplification they introduce into complex relationships among phenomena, and the relative ease with which they can be manipulated and applied in problem solving

2.7. Studies on Multimedia Learning Strategy.

Aids correctly used will arouse a new interest among students and possibly influence, if not change attitudes towards both the teacher and the subjects. They will make his work more effective. Multimedia instructional strategy has been described as the use of more than one instructional materials and instructional methods to carry out classroom instructions for the purpose of education (Oyediran et al,2004). During cooperative learning, aids may be used as soon as formal contacts have been made with a group of prospective learners. The use of audiovisual methods including models, at an early stage, such as during the lesson presentation

do much to help consolidate a regular study group. It provides materials to stimulate thought and discussion. Concrete models have a distinct appeal to learners and attract close attention better than charts and pictures. Models save teacher the lengthy explanation about those things which were strange to learners, models bring a sense of reality to what is taught, they create correct impression and bring lesson to life, their impressions is much more memorable than any material used in teaching, models make phenomena for which they represent more easily comprehensive and more accessible, models as a teaching aid can be locally produced or purchased. It can be teacher or student made. For the purpose of this study, models are described as teaching aids that include diagrams, charts, graph, textbooks, objects and specimens. It is a visual material of teaching.

Few studies are available in the area of use of models in researchers in education in Nigeria. However, Halilu (2006) investigated the use of instructional materials including models on the performance of primary three pupils in Kankia local government area of Kaduna sate. Quasi experimental design was employed; a sample of 234 primary three pupils randomly selected and used out of a total of 600 pupils; 117 were the experimental while 117 were control. Aids such as charts, flash card, real objects were used. The control group learnt only through lecture methods. The result of the posttest showed that the experimental group achieved significantly better than the control group. He thus recommended the use of instructional aids in the teaching, and learning in our schools. Okwoh and Tartiyus (2004) studied the effect of position of diagram and cognitive style on biology achievement of pre-national Diploma students. They found that a teacher led lesson, verbal message synchronized with diagram presentation for pre-ND students studying biology. They therefore encouraged lecturers to illustrate their points with diagrams presented at the points where they synchronies with the verbal code. However, Njoku, (1998)

stated that in spite of their importance in science and technology instruction, models are a largely neglected medium in Nigerian schools. The intention of this study was to investigate the effectiveness of cooperative strategy with models on the achievement in biology among the pre national diploma students.

Njoku, (2004), further observed that both teachers and students expressed some difficulties in the use models for effective teaching and learning of science and technology concepts. Teachers of science and technology are to be aware of these difficulties and he further suggested ways of eliminating these difficulties for the purpose of effective science and technology teaching and learning. However Adeniran (2006) equally observed that the mean percentage index of teachers who produce and utilized instructional material frequently to teach biology stood at 9.83% and 25.6% respectively. The implication of this finding is that instructional materials including models are sparsely produced and used in Nigeria schools. Therefore, the present study includes the use of models in the learning of biology concepts.

Oyediran, et al, (2004) investigated the use of multimedia approach to the teaching of some difficult topics in integrated science. Some topics were identified as difficult, based on students' performance in each topic contained in Junior School Integrated science syllabus. A multi media approach (that is combination of an instructional method accompanied by the use instructional material, which are model and diagrams), was devised to ameliorate the problem. The sample consisted of sixty junior secondary III students from four selected secondary schools. The data collected and were analyzed using t-test at 0.05 alpha significant levels. The result of the finding revealed that the students exposed to the multimedia approach performed significantly better than the control group that were taught using chalk and talk method. It was recommended that each school should have a learning resource centre that will be well-equipped for teachers to get

relevant materials for their lessons. With this in place, the issue of difficult topics in Integrated Science will be a thing of the past.

Similarly, Amato, Damico, and Dibellenterile (1989) as reported in Alebiosu (1998) explored an approach to group instruction whereby alterable variables of instructional strategies were combined in an attempt to achieve the effects associated with one to one tutoring. The design incorporated enhanced student classroom participation and advance organizers. It was reported that while the cognitive achievement of low aptitude learners was improved, there was no adverse effect on cognitive achievement of middle and high aptitude learners. James (2000) studied the effects of four instructional strategies on pre-service NCE student's achievement in biology. The strategies include a combination of concept mapping and reflective writing method, reflective writing and lecture method, concept mapping alone and lastly lecture method. The result shows that there were significant differences in the achievement. A combination of concept mapping and reflective writing appeared to have come first, followed by a combination of lecture method and reflective writing, then concept mapping alone while the least was the lecture method. He then encouraged the use of combination of different teaching strategies for effective biology learning. Hence, the attempt to combine cooperative learning strategy with models in the present study.

Akinsola (2004) investigated effectiveness of mastery learning, cooperative learning combined mastery learning, and cooperatives learning strategy on student's achievement in integrated science. The subjects consisted of two hundred (200) Junior Secondary Schools selected from four schools in Ibadan Nigeria. The data collected were analyzed using analysis of covariance (ANOVA) and Duncan post – hoc analysis. Result from his study revealed that combined

mastery learning and cooperative learning strategy was found to be more suitable in facilitating achievement in integrated science in the Junior Secondary School.

It was concluded that facilitating instructional strategies are sure avenue of increasing achievement in integrated science. Akubuilo (2004b) also studied the effects of problem solving instructional strategies on students' achievement and retention in biology with respect to location in Enugu state. The study revealed that combined strategy is more effective in academic achievement. The studies above have shown the relevance of combined strategies in the learning of biology concepts at different academic levels. However, none of the above studies include the effect of multimedia approach on the achievement and retention in biology at the post secondary level of education. There is the need to study the effects of multimedia approach to learning at a higher educational level. This research therefore was set out to study the effects of cooperative learning strategy with models on the achievement and retention of biology concepts among pre-ND students.

2.8. Effects of Learning Strategies on Retention of Science Concepts

Retention is the ability to retain and consequently remember things experienced or learned by an individual later (Bichi, 2002). Retention of concepts is an essential factor in determining students' achievement in a given task or activities carried out. Students must retain information from classes in order to benefit from the learning. The instructors' jobs are not finished until they have assisted the learner in retaining the information. In order for participants to retain the information taught, they must see a meaning or purpose for that information. They must also understand and be able to interpret and apply the information. This understanding includes their ability to assign the correct degree of importance to the materials.

The amount of retention is directly affected by the degree for original learning. As the degree of original learning is greatly affected by the instructional method, therefore retention largely is affected by the instructional method. Simply stated, if the participants did not learn the material well initially, they will not retain it well either. When teaching is characterized by rote learning meaningless memorizing and emphasis on verbalism, students make ineffective learning, and the facts thus learned are not long retained, nor do they seem to have much effect in changing behavior. Thus, when teaching is organized in such a way that students can apply principles, solve problems and interpret experimental data, learning becomes effective and the facts thus learned are long retained with the passage of time. Suleiman (2007) reported that better retention and recall of what is learned is achieved as more senses are involved, more so, as students see and do things by themselves. Retention by the participants is directly affected by their amount of practice during the learning. Instructors should emphasize retention and application. Raghubir (1979) in his study found that when students were provided with the learning outcome, they retained and recalled the knowledge.

Lagoke (1992) investigated the retention ability to two groups of students. The experimental group was taught biological concepts using the analogical linkage strategy while the control group was taught same concepts using the lecture teaching method. The results showed that the experimental group performed significantly better and retained more of the biology concepts taught than their counterparts in the control group retain.

Similarly, Ezenwa (1993) found that the concept mapping and guided discovery strategy enabled the students have better understanding and better retention of chemistry concepts. Anaso (2008) also found that the use of small class sizes in teaching chemistry concepts helps students of different abilities retain learnt concepts better than the medium and large classes.

The concern of this study was to find out the effect of multimedia learning strategy on the achievement and retention of biology concepts. The results might be able to help overcome their learning difficulties and thereby improve their performance leading to better retention of the concepts learnt.

2. 9 Implication of Literature Reviewed for the Present Study

This study has reviewed the literature on the previous works done relating to the problems which students have with learning biological concepts. Of particular interest is the failure of the traditional method of teaching to enhance students' learning and achievement. Many research works have been done on the use of cooperative learning strategy to help learning and retention of science concepts including biology. Researchers have also found that the use of models improves learning and retention of concepts. However the problem of learning biology concepts persists. From the literature reviewed, cooperative learning strategy among others facilitates students' academic achievement regardless of grade level or subject matter. It is found to be helpful in students' retention, and improve relations. However, most of the research works done on the use of cooperative learning strategy to assist learners, were at the international level. Also, these research works were done using primary school pupils and secondary school students. Okebukola (1984) focused on the secondary school students and used different biology concepts from the present study. The study by Olorukooba (2002) was among secondary school students with chemistry as the learning subject and did not include the use of models. Research work is scanty on multimedia learning strategy, particularly cooperative learning strategy with models.

Oyediran, et al (2004), and Akinsola (2004), did their researches in integrated science. Akubuilo (2004b) investigated the use of problem solving with models. All the available researches were

done at the primary and secondary school levels. Yet, there is little empirical evidence on its effectiveness at the tertiary level or technical colleges. The researchers did not include the use of cooperative learning strategy with models. However there is the need to research into instructional strategies which could enhance the achievement and retention of biology concepts. Therefore, the purpose of this study was to use cooperative learning strategy with models in the teaching and learning of biology concepts to see the effects on the academic achievement and retention of biology concepts of pre diploma students. There is no evidence that this strategy has been used by any other researcher before.

CHAPTER THREE

METHODOLOGY

3. 1 Introduction

In this chapter, the methodology used for the study is described. The main aim of the research was to investigate the effects of cooperative learning strategy with models on the achievement and retention of biology concepts by the Pre National Diploma Students in Kaduna State. The chapter is organized and presented in the following sub-headings

- Research Design
- Population of the Study
- Sample and Sampling Technique
- Selection of Topics for the study
- Instrumentation
- Validity of Instruments
- Pilot Testing
- Reliability of the Instruments
- Pre-experimental Activities
- Data Collection Procedure
- Data Analysis

3.2 Research Design

The study used quasi experimental control group design. This includes three experimental and one control groups. The Students Team Achievement Division (STAD) cooperative technique was adopted for both the cooperative learning strategy with models and cooperative learning strategy without models. This is a type of research involving pretest and posttests, in which independent variables are manipulated to see their effects on the dependent variable. While the experimental groups were subjected to treatment, the control group was exposed to lecture method. All the subjects were biology Pre-ND students in different monotechnic colleges in Kaduna State but were randomly assigned to experimental and control groups after the pretest. The design of the study is illustrated in the following sketch:

$E_1 \longrightarrow T_1 \longrightarrow X_1 \longrightarrow T_2 \longrightarrow T_3$

$E_2 \longrightarrow T_1 \longrightarrow X_2 \longrightarrow T_2 \longrightarrow T_3$

$E_3 \longrightarrow T_1 \longrightarrow X_3 \longrightarrow T_2 \longrightarrow T_3$

$C \longrightarrow T_1 \longrightarrow Xc \longrightarrow T_2 \longrightarrow T_3$

Fig 3.1 Design of the Study

C = Control Group

E_1 = Experimental Group 1

E_2 = Experimental Group 2

E_3 = Experimental Group 3

X_C---------- Treatment for Control Group

X_1----------Treatment for Experimental Group 1 T_1 ---------- Pretest

X_2---------- Treatment for Experimental Group 2 T_2---------- Posttest

X_3----------Treatment for Experimental Group 3 T_3 ---------- Post posttest

The three experimental groups E_1, E_2 and E_3 were exposed to different treatments as follows: E_1 group was exposed to cooperative learning strategies with models; E_2 was exposed to cooperative teaching strategy without models, while E_3 was taught using the lecture method with models. Control group was exposed to lecture method without models. A posttest and post posttest were also administered to all the groups two weeks after the posttest. This was to determine the retention of knowledge.

3.3 Population

The study population comprised of the pre- ND students of all the Federal Agriculture and Technical Colleges offering Pre-ND biology in Kaduna State of Nigeria. The schools and the number of students enrolled in 2010/2011 session were 149 students (male and female) from four institutions as shown in Table 3.1.

Table 3.1 Population of the Study

S/No	Name of Institution	Location	Pre ND Student Enrolment
1	Samaru College Of Agric. A.B.U. Samaru, Zaria.	Zaria	34
2	College of Agric and Animal Science A.B.U, Kaduna.	Kaduna	30
3	School Of Chemical And Leather Technology, Zaria.	Zaria	36
4	Federal Forestry Mechanization, Afaka, Kaduna	Kaduna	49
	Total		**149**

All the colleges under the study belong to the Federal Government of Nigeria. The choice of these colleges was based on their common source of funding, the same admission requirements, being equipped by the same body, and having the same accreditation body, The National Board of Technical Education.

All the subjects had completed Senior Secondary School Education and were going through a one year Pre–National Diploma Programme. The success of this programme qualifies the candidate for admission into their different institutions to pursue National Diploma Programmes. The subjects had to go through Pre-National Diploma programme due to their inability to qualify for direct entry into diploma programmes. The average age of the students was 20 years.

3.4 Sample and Sampling Technique

From the population of 149, the sample size of 100 students was selected for the study (Table 3.2). The sampling of the students was done by random sampling procedure. This was carried out by the use of 'Ticket Sampling Technique' whereby subjects were to pick "yes" or "no" written and concealed in small pieces of papers. The candidates who picked "yes" participated while the ones that picked "no" were dropped. The schools used were all Federal Agriculture and Technical Monotechnic Colleges. This was an intact sample due to the uniformity, the number of variables, and the number of available schools. Therefore, all the schools in the population constituted the sample. All the participating students were given a pretest. Because of the pretest which showed no significant difference in the performance of the students, the schools were then randomly shared into experimental and control groups.

Table 3.2 Sample for the Study

S/No	Name of Institution	Location	Pre ND Student Sample
1	Samaru College Of Agric. A.B.U. Samaru, Zaria.	Zaria	25
2	College of Agric and Animal Science A.B.U, Kaduna.	Kaduna	25
3	School Of Chemical and Leather Technology, Zaria.	Zaria	25
4	Federal Forestry Mechanization, Afaka, Kaduna	Kaduna	25
	Total		**100**

3. 5 Selection of Biology Concepts used in the study

The three concepts used in this study were osmosis, plasmolysis and transpiration. These concepts were selected for many reasons. They attracted activities, and so were ideal for the present study. They lend themselves to the use of models which were either teacher or students' constructed. They are life science and closely related physiological processes operating and vital to the survival of green plants. The green plants on the other hand are the energy producers for human survival.

These concepts are being taught at all levels of education and under different courses of study in Agriculture, Biology, Home & Rural Economy, and Biochemistry. Finally, these concepts were perceived as difficult to learn by the students (Akinmade, 1987; Olarewaju, 1996).

Akinmade (1987) in his studies found that form III secondary school students had problems learning some biology concepts, flowering plants inclusive. Olarewaju (1996) also observed that SSS III secondary school biology students perceived the concept of transport system in plants difficult to learn and this includes osmosis, plasmolysis and transpiration.

3.6 Instrumentation

The data collecting instrument was the Biology Achievement Test (BAT)

The researcher, based on the contents of the biology concepts taught, constructed the Biology Achievement Test (BAT). The test was initially made up of 50 multiple choice items and covered all the areas of the concepts taught. Each multiple choice item consists of a stem, four options of one key and three distracters. Each correct answer attracts one mark totaling 50 marks altogether. Three senior lecturers from science education section in Department of Education A.B.U, Zaria, and three lecturers from the sample schools, teaching biology validated the BAT and the marking scheme. These experts gave both face and content validity of the instruments such as, the conformity of the test items with subject specification, clarity and appropriateness of the items, in terms of level of reading difficulty, ability of the items to actually test basic ideas in osmosis, plasmolysis and transpiration and possible errors in the suggested answers.

Based on the critique and suggestions from the judges, the researcher made amendments such as reframing some of the items before the final 50 items used for pilot testing.

3.7 Pilot Study

The Biology Achievements Test was pilot- tested at Ameer Shehu Idris College of Advanced Studies, Gaskiya, Zaria, using the preliminary biology students. They had similar programme with the schools to be used for the main study. Forty nine students participated in the exercise.

The aim of the pilot study includes the following;

1. To provide further information such as the reliability of the instruments for the research.
2. To find out the weaknesses of the design and effect corrections where applicable before the main study.
3. To assess the clarity of the items.
4. To find out the workability of the design of the study, in a field setting.
5. To determine the appropriate time duration needed to carry out the main study and for the subjects to write the tests.
5. To establish the characteristics of the instrument of such as the item analysis, item difficulty, and facility indices.
6. To test the workability of the hypotheses formulated for the study based on data generated from a smaller but identical sample selected for the main study.
7. To establish the difficulty and discrimination level of the items.

The test was administered twice at two weeks interval.

Scores on the items were analyzed to determine the reliability of the instrument. Facility or difficulty indices (F1) and the discrimination indices (D1) were also determined.

3.7.1 Reliability of Instrument.

The reliability coefficient of a test is the consistency with which the test repeatedly measures what it is intended to measure. Test and retest method was adopted in determining the reliability of the BAT. Pearson-product moment correlation coefficient was used to test the reliability of the instrument in addition to programmed computer analysis. The reliability coefficient was found to be .859 (Appendix Five).

3.7.2 Facility indices (F1) and discrimination indices (D1)

The facility index of an item in a test is defined as the correct responses the percentage of the candidates that got an item right (Wood 1990) in Olorukooba (2001). This was calculated using the following formula F1 = R/T by Satterly (1986)

Where: F1 = facility index, R = number of correct responses, T = total number of students.

Test items with facility indices in the range of 30-70% are usually recommended for use Timothy (2001).

The discrimination index is the power of each of the items to distinguish between high ability and low ability students. This was calculated by using the scores obtained by the top 27% and bottom 27% of the respondents.

$$D = \frac{RU - RL}{\frac{1}{2} N}$$

D= discrimination index

RU= number among upper 27% of respondents who scored the item correct

RL= number among the lower 27% respondents who scored the items correct

N= total number of respondents

Discrimination indices ranging from 30 to 49 are regarded as moderately positive, while those below 0.19 are regarded as poor.

Some of the test items did not satisfy the recommended values of item discrimination and facility indices. Based on this outcome, amendments were made such as reframing some of the questions and dropping some, and finally the 40 test- items used for the main study were obtained (Appendix One). The distribution of the test-items is as shown in Appendix Three. The facility and discrimination indices of the final 40 test-items are as shown.

(Appendix four).

3.8 Pre-Experimental Activities

3.8.1 Development and Validation of Learning Instructional Guides

The researcher developed Learning Instructional Guides used in implementing the different learning strategies in the study.

i. Cooperative Learning Strategies with Models (Appendix Nine)
ii. Cooperative Learning Strategy without Models (Appendix Ten)
iii. Lecture Model Learning Strategy with Models, (Appendix Eleven)
iv. Lecture Method without Models (Appendix Twelve)

Each learning strategy guide contained equal number of lesson units to cover the biology topics osmosis, plasmolysis, and transpiration, included in the research.

These guides described how members of each group were treated in the process of carrying out the study. In developing the learning guides, some of the biology textbooks consulted and used included the following:

1. Biology: A New Approach for Senior Secondary Schools and Colleges by E. O. Egbo B. W. Publishers Lagos.
2. New Modern Biology by S. T. Ramalingam (1993) Africana – FEP Publishers Limited.
3. Modern Biology for Secondary Schools Practical and Work Book (1978) By Justina Fletcher FEP International Private Ltd.

The textbooks were the same with those in secondary schools, the Pre-ND and other preliminary programmes, where the aim was to rectify deficiency in science.

The researcher, with a letter from Education Department of Ahmadu Bello University (Appendix eight), visited the selected colleges to seek their support and cooperation. This was to ensure the success of the study. The researcher also had discussions with the pre- National Diploma biology lecturers in the participating schools and made necessary arrangements for the study. They were acquainted with the objectives, nature and requirements of the study.

3.8.2 Orientation of Students.

Classes Taught Using Cooperative Strategies with Model.

The students in this group were encouraged to learn the social skills and rules guiding the principles of cooperative skills and manipulation of models. They were encouraged to interact with themselves and practice the following skills.

Constantly check their work with other students in their groups and agree.

Help each other and as such helping themselves and learning better.

Discuss their work with one another so as to improve individual and group performance.

Realize that the goal of the strategy was for every student in the group to learn the material.

Interact physically and verbally to be able to maximize the benefits of cooperative learning.

Call the group members by their names in the course of interaction.

Listen to each other when talking.

Observe the models and relate these models to the topics being treated.

Learn how to use and manipulate instructional models in their different cooperative groups.

Relate their models to the concepts being taught.

Classes Taught Using Co-Operative Strategy without Models.

The cooperative experimental subjects had orientation activities on cooperative learning techniques. The students learnt the social skills and rules guiding the principles of cooperative skills. They were encouraged and motivated to interact among themselves. These skills were just like the first group but they were not to use of models.

Classes Taught Using Lecture Method with Models.

Models were to be provided for this group while lecture method was the mode of instruction. The students were not to be grouped but made to understand that the use of models was an important aspect of the instructional strategy. Therefore serious attention was to be paid to the use of models even as the lecturer instructs using the lecture strategy. They were to examine and interact with the models.

Classes Learning With Lecture Method

This group is the control group and the mode of instruction was the lecture method only. They needed to be punctual to the class, be very attentive to the lecturer, ask and answer questions when asked. There was no use of models and no grouping.

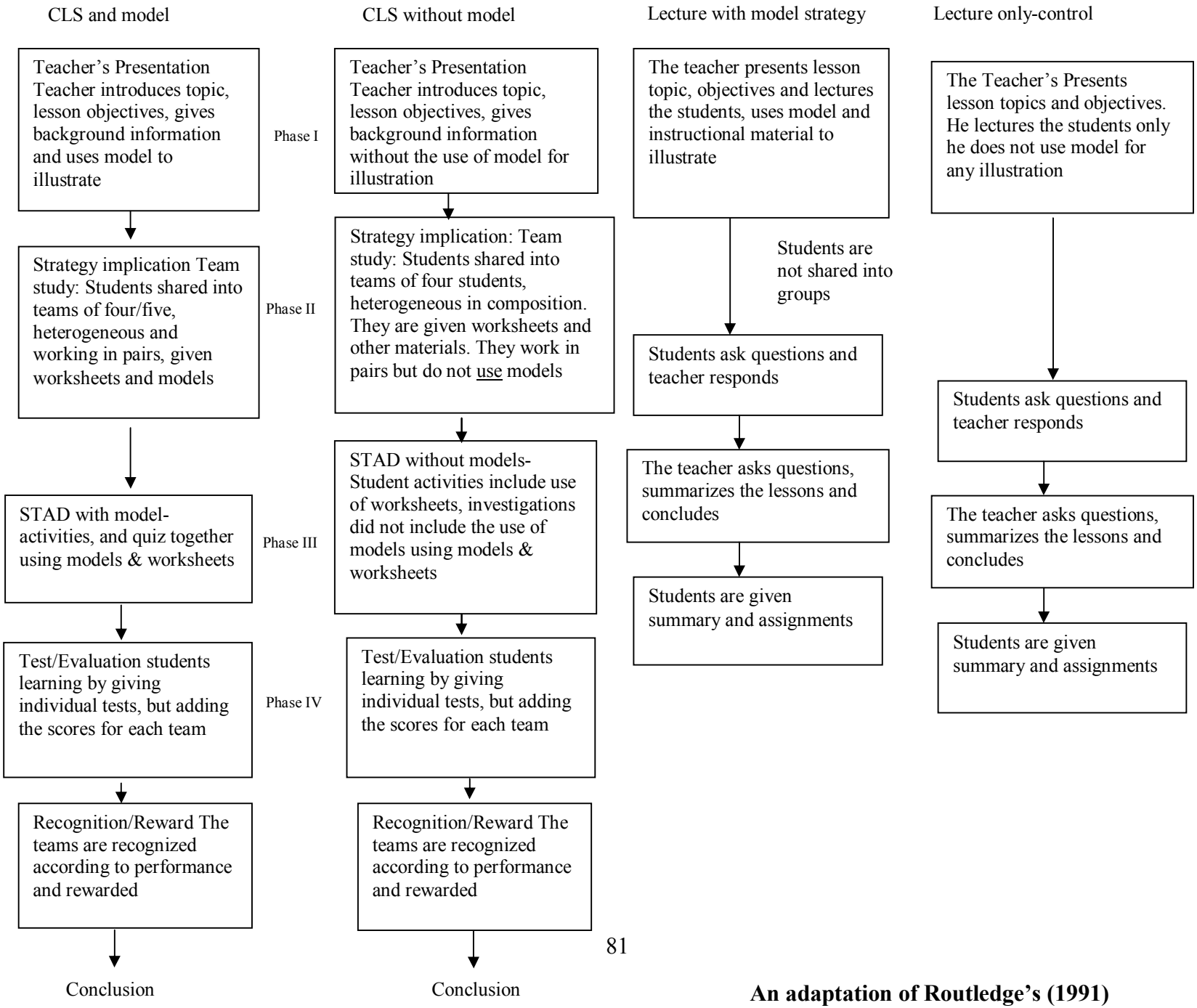
3. 9 Data Collection Procedure

The Biology Achievement Test (BAT) was administered to all the groups as a pretest before the treatment. The test lasted one hour and the students were to answer all the questions. This was to

measure the knowledge of biology and the equivalent ability of both experimental and control groups before the treatment. After the pretest was the treatment with the experimental groups. The treatment lasted for six weeks. Each group was given treatment as shown in Fig 3.2.

After the treatment was the post test and two weeks later the pot posttest. The post and posttest was to find out the effects if any of the treatments on the experimental groups. The same test was used as a posttest and post posttest though the questions were reshuffled after each application to avoid the students cramming the questions.

Fig 3. 2. Skeletal Diagram Illustrating the Instructional Strategies for the Study



An adaptation of Routledge's (1991)

3.10 Administration and Treatment

There were four groups involved in the study, three experimental groups and one control group.

1. The first experimental group was taught using cooperative learning strategy with models
2. Group Two was taught using of cooperative learning strategy without models.
3. Group Three was taught using lecture method with model.
4. Group Four was taught using Lecture Learning method without models.

Experimental Group I – Cooperative learning strategy with Model

This group was taught using cooperative learning strategy with models. The STAD technique of cooperative learning was adopted. The learners were grouped into permanent learning groups of four members each; where members were taught in cooperative manner (Guskey 1990). The grouping was heterogeneous in terms of ability and gender, based on the pretest diagnostic test scores. This means that each group consists of members with high, average and low scores. For the cooperative experimental group, the lessons took place in a laboratory with a special sitting arrangement that facilitated easy interaction (Appendix 7) and can conveniently accommodate the sitting arrangement of the various groups. The arrangement of the seats becomes very important as it influences the level of interaction of the members of each group (Adeyemi 2002). However, the experimental group I, were given models of the concepts being learnt such as models of osmosis, process of transpiration. The group was taught using the plan as contained in Appendix Nine. Members were given role cards, which state the roles of each members of the group at any point in time. These roles were rotated each session to give opportunity to everyone to function or experience each role. For each period of cooperative lesson, the teacher presents

the objectives, followed by teaching which is basically giving background information. The use of cooperative learning strategy does not mean abandoning teacher –fronted mode; it means combining various modes of learning. (Cohen, 1994). The students were then given worksheets and work together within each team to make sure that all members of the team learn the concepts taught.

Students asked questions from the teacher to clarify issues and teacher responded accordingly, and vice versa. Each group was encouraged to work together, to assist each other to master the topic under discussion, as they would be jointly rewarded based on level of performance of individual member. They studied worksheets on the learning materials, practiced the exercises, identified discrepancies, checked and drilled each other and reached consensus and prepared themselves for the assessment, which were done individually, but they were collectively be rewarded.

To encourage the cooperation among the subgroups, they were advised to practice cooperative learning skills such as calling each other by name, asking questions to group members. They were also reminded of the necessity to work together during the learning process, help others and ask others for assistance. The teacher was going round the groups and assisting the subjects where necessary thus acting as a facilitator in the learning process.

The learners used the models provided in their course of interaction, discussion, and doing the exercises on the worksheets. They were also assessed at the end of each lesson.

The activities of the worksheets were completed, marked after each lesson. The actual treatment lasted for 6 weeks of 2 periods per week, after which the cooperative learning subjects sat for post test and post test after two weeks interval.

Experimental Group II – Cooperative Learning Strategy without models

This is the cooperative learning strategy without models group. In this study, the Student Teams Achievement Division model of the cooperative learning was also adopted but without the use of models. The period of teaching also lasted for 6 weeks double periods. The posttest was given after the treatment and the post posttest was administered after two weeks.

Experimental group III – Lecture with Model Learning Strategy

This group was taught using lecture method with model. Here the class was not divided into groups at any stage of the lesson period. Like in the other groups, the group was given pretest and was heterogeneous in composition in terms of strength, gender and ability. The pretest was followed by the six-week learning, whereby the class was exposed to the same topics with the other groups.

Control Group – Lecture Method

In this group, the lecture teaching and learning method prevailed. The subjects like the other groups of the experiment, had been given pretest, and the group was also found to be heterogeneous in terms of strength, ability and gender. The group was not shared into groups, not exposed to cooperative teaching learning strategy and not provided with models, or any form of learning aid, safe the chalkboard being used by the teacher.

In each period of teaching, the teacher used chalk and talk method. The teacher presented the objectives of the lesson; the students listened and jot notes. Difficult concepts were explained in a more generalized way to the class. The period of teaching also lasted for 6 weeks double periods after which posttest and post posttest were administered.

3.11 Data analysis

The tool for collecting the data was the Biology Achievement Test (BAT). Each item of the BAT was scored one point, with the maximum point being 40 marks. Data collected and used in the data analyses were the posttest and post posttest scores of the experimental, and control groups. The mean and standard deviations were calculated for these scores after the treatment and were used to answer the research questions and to test the null hypotheses which were stated earlier on in chapter one of the work.

The confirmation or rejection of the hypothesis was at $P \leq 0.5$ level of significant difference.

Null Hypothesis 1

Ho1 There is no significant difference in the achievement means scores in biology between students taught using cooperative learning strategy with models, and those taught using cooperative learning strategy without models.

t-test statistical analysis was used to test this hypothesis.

Null Hypothesis 2

Ho2 There is no significant difference in the achievement means scores in biology between students exposed to cooperative learning strategy with models, and those exposed to lecture method without models.

t-test statistical analysis was used to test this hypothesis.

Null Hypothesis 3

Ho2 There is no significant difference in the achievement means scores in biology between students who are taught using lecture method with models, and those who are taught using lecture method without models.

t-test statistical analysis was used to test this hypothesis.

Null Hypothesis 4

Ho4 There is no significant difference in retention ability of biology concepts between students taught using cooperative learning strategy with models, and those taught using cooperative learning strategy without models.

t-test statistical analysis was used to test this hypothesis.

Null Hypothesis 5

Ho5 There is no significant difference in the retention ability of biology concepts between students taught using cooperative learning strategy with models, and those taught using lecture method without models.

t-test statistical analysis was used to test this hypothesis.

Null Hypothesis 6

Ho6 There is no significant difference in retention ability of biology concepts between students who learnt by lecture method with models, and those who learnt by lecture method without models.

t-test statistical analysis was used to test this hypothesis.

CHAPTER FOUR

ANALYSIS, RESULTS AND DISCUSSION.

4.1 Introduction

This study investigates the effects of cooperative learning strategy with model on the achievement and retention of biology concepts among the Pre-National Diploma students in Kaduna State. This chapter deals with analysis of data, presentation and discussion of the results in relation to the hypotheses stated in chapter one. The data were analyzed using computer Software Package for Social Sciences (SPSS).

The hypotheses were retained or rejected at $P \leq 0.05$ level of significance. The chapter is presented in the following subheadings:

Data Analysis

Summary of findings

Discussion of the Results

4.2 Data Analysis

The data obtained from the four groups in respect of different learning strategies were used in answering the research questions and testing the hypotheses. The summary of the data obtained were analyzed and the results presented in Tables 4.2.1. - 4.3.6.

4.2.1 Research Question One

What is the effect on the performance mean scores of Pre ND students taught biology using cooperative learning strategy with models (CLS + M) and their counterparts taught using cooperative learning strategy (CLS) without models?

The results showing the performance of the subjects taught using cooperative learning strategy with models (CLS + M) and those taught using cooperative learning strategy (CLS) without models are as shown in Table 4.2.1.

Table 4.2.1 Descriptive Statistics Summary of mean scores in the Cooperative Learning Strategy with models and Cooperative Learning Strategy without models.

VARIABLES	N	Mean	SD	Std Error
CLS+ MODEL	25	30.32	3.30	0.66
CLS ALONE	25	27.08	3.17	0.63

The cooperative learning strategy with models (CLS + M) group had a post test mean score of 30.32, while the group taught using cooperative learning strategy without models had mean score of 27.08. It indicates that the group taught using cooperative learning strategy with models had a higher mean score than the group taught using cooperative learning strategy without models.

4.2.2. Research Question Two

What is the effect on the performance mean scores in biology of Pre ND students taught biology using cooperative learning strategy with models (CLS + Model) and their counterparts taught using lecture method without models (L)? The results showing the performance of the subjects

taught biology using cooperative learning strategy with models (CLS + M) and those taught using lecture method without models are as shown in Table 4.2.2.

Table 4.2.2 Descriptive Statistics Summary of Posttest Mean Scores in Cooperative Learning Strategy with Models and Lecture Method without Models

VARIABLE	N	Mean	SD	Std Error
CLS+ MODEL	25	30.32	1.30	0.66
LECT ALONE	25	25.52	3.39	0.67

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The CLS + M) group had a posttest mean score of 30.32 in biology, while lecture method without models group had a posttest mean score of 25.52. This indicates that the preliminary diploma biology students taught using cooperative learning strategy with models (CLS + Model) had a higher mean score than those taught using lecture method without models (L).

4.2.3 Research Question Three

What is the effect on the performance mean scores of Pre ND students taught biology using lecture method with models (L+M) and their counterparts taught using lecture method (L) without models?

The results showing the performance of the subjects taught using lecture method with models (L+M) and those taught using lecture method (L) without models are as shown in Table 4.2.3.

Table 4.2.3 Descriptive Statistics Summary of Posttest Mean Scores in Lecture Method with Models and Lecture Method without Models

	N	Mean	SD	Std Error
LECT+ MODELS	25	29.80	2.95	0.59
LECT ALONE	25	25.52	3.39	0.67

From Table 4.2.3, the mean scores of the students taught biology using lecture method with models and those taught using lecture method without models are 29.80 and 25.52 respectively. The group taught biology using lecture method with models had a higher mean score than the group taught using lecture method without models. The students taught using lecture method with models achieved higher than students taught using lecture method without models.

4.2.4 Research Question Four

What is the effect on the retention ability in biology of Pre ND students taught using cooperative learning strategy with models (CLS +M) and those taught using cooperative learning strategy (CLS) without models?

The results showing the performance of the subjects taught using cooperative learning strategy with models (CLS +M) and those taught using cooperative learning strategy (CLS) without models are as shown in Table 4.2.4.

Table 4.2.4. Descriptive Statistics Summary of Post Posttest Mean Scores in the Cooperative Learning Strategy with Models and Cooperative Learning Strategy without Models

	N	Mean	SD	Std Error
CLS+ MODEL	25	29.24	2.83	0.56
CLS ALONE	25	23.12	4.18	0.83

The students taught biology concepts using cooperative learning strategy with models had 29.24 post posttest mean score, while the students taught biology using lecture method without models had 23.12 post posttest mean score. The higher mean score of students taught using cooperative learning strategy with models indicates they had a higher retention ability of the concepts taught.

4.2.5 Research Question Five

What is the effect on the retention ability in biology of Pre ND students taught using cooperative learning strategy with models (CLS + M) and those taught using lecture method without models (L)?

The results showing the performance of the subjects taught using cooperative learning strategy with models (CLS + M) and those taught using lecture method without models (L) are as shown in Table 4.2.5.

Table 4.2.5 Descriptive Statistics Summary of Post Posttest Mean Scores in Cooperative Learning Strategy with Models and Lecture Method without Models.

Variable	N	Mean	SD	Std Error
CLS+ MODEL	25	29.40	2.83	0.53
LECT ALONE	25	22.76	4.35	0.87

The results from Table 4.2.5 shows that 29.24 post posttest mean score of students taught biology using cooperative learning strategy with models is higher than 22.76 post posttest mean score of the students taught using lecture method without models. The higher mean score of students taught using cooperative learning strategy with models indicates they had a higher retention ability of the concepts taught than students taught using lecture method without models.

4.2.6 Research Question Six

What is the effect on the retention ability in biology of Pre- ND students who were taught using lecture method with models (L + M) and those taught using lecture without models (L)?

The results showing the performance of the subjects taught using lecture method with models (L + M) and those taught using lecture without models (L) are as shown in Table 4.2.6.

Table 4.2.6. Descriptive Statistics Summary of Post Posttest Mean Scores in Lecture Method with Models and Lecture Method without Models

	N	Mean	SD	Std Error
LECT+ MODELS	25	29.36	2.87	0.57
LECT ALONE	25	22.76	4.35	0.87

From Table 4.2.6, the post posttest mean score of 29.36 by students taught using lecture method with models is higher than 22.76 post posttest mean score of the students taught using lecture method without models. The higher mean score of students taught using lecture method with models indicates that there is a difference in the retention ability of the two groups. Students

taught using lecture method with models had a higher retention ability of the concepts taught. This result provides answer to research question six.

4.3 Testing the Hypotheses

4.3.1 Null Hypothesis 1

Ho1: There is no significant difference in the academic performance in biology between students taught using cooperative learning strategy with models and those taught using cooperative learning strategy without models. To test this hypothesis, the posttest scores of the two groups were subjected to t test analysis at $P \leq 0.05$ and the results are as presented in Table 4.3.1.

Table 4.3.1. t- test Analysis of mean score between Cooperative Learning Strategy with models and Cooperative Learning Strategy without models.

Variable	N	Means	SD	SE	Tvalue	df	P	Remarks
CLS+models	25	30.32	3.30	0.66				
					3.53	48	0.001	Sig
CLS	25	27.08	3.17	0.63				

Table 4.3.1 shows the result of the independent *t* statistics. The results also showed that there is significant difference between the group taught using cooperative learning strategy with model and the group taught using cooperative learning strategy without models in their achievement means score in biology. The calculated significant value of 0.001 is less than the 0.05 level of tolerance. Therefore, the hypothesis which states that there is no significant difference in the achievement means scores in biology between students who are taught by cooperative learning strategy with model and those taught using cooperative learning without models is rejected.

4.3.2 Null Hypothesis 2

Ho2: There is no significant difference in the achievement mean scores in biology between students exposed to cooperative learning strategy with models and those exposed to lecture method without models.

To test this hypothesis, the posttest mean scores of the two groups were subjected to t test analysis. The result is as presented in Table 4.3.2.

Table 4.3.2. t- test Analysis on mean scores between cooperative learning strategy with models and lecture method without models.

Variable	N	Means	SD	SE	t value	df	P	Remarks
CLS+models	25	30.32	3.30	0.66	5.07	48	.000	Sig
Lecture method	25	25.52	3.39	0.67				

Table 4.3.2 shows the result of the independent *t* statistics with P value of 0.000 which is less than 0.05. This shows a significant difference between the two groups. Therefore the null hypothesis is rejected.

4.3.3 Null Hypothesis 3

Ho3: There is no significant difference in the achievement mean scores in biology between students taught using lecture method with models and those taught using lecture method without models.

To test this hypothesis, the posttest mean scores of the two groups were analyzed using t test of $P \leq 0.05$ statistical analysis. The result is as presented in Table 4.3.3.

Table 4.3.3. t- test analysis on mean scores between the lecture method with models group and lecture method without models.

Variable	N	Means	SD	SE	T value	Df	P	Remarks
Lecture+models	25	29.80	2.95	0.59	4.75	48	.000	Sig
Lecture only	25	25.52	3.39	0.67				

Table 4.3.3 shows the result of the independent *t* statistics. The P value of 0.000 is lower than 0.05. Therefore the hypothesis which states that there is no significant difference between students taught using lecture method with models and students taught using lecture method without models is rejected.

4.3.4 Null Hypothesis 4

H_o4: There is no significant difference in the retention ability mean score in biology between students taught using cooperative learning strategy with models and those taught using cooperative learning strategy without models.

To test this hypothesis, the mean score of post posttest of the students taught using cooperative learning strategy with models and those taught using cooperative learning strategy without models were analyzed using *t* test analysis. The result of the analysis is as presented in Table 4.3.4.

Table 4.3.4 t test Analysis of post posted mean scores between cooperative learning strategy with models cooperative learning strategy without models

Variable	N	Means	SD	SE	t value	df	P	Remarks
CLS+models	25	29.24	2.83	0.56	6.05	48	.000	Sig
CLS-models	25	23.12	4.18	0.83				

From Table 4.3.4, the result of the *t* test analysis shows that the P value of 0.000 is less than 0.05 at df of 48. This shows that there is a significant difference in the retention ability of biology by students taught using cooperative learning with models and those taught using cooperative learning without models. The hypothesis is therefore rejected.

4.3.5 Null hypothesis 5

Ho5: There is no significant difference in the retention mean score in biology between students taught using cooperative learning strategy with models and those taught using lecture method alone.

To test this hypothesis, the post posttests mean score of the group of students taught using cooperative learning strategy with models and the students taught using lecture method without models were compared using *t* test analysis. The results of the analysis are as presented in Table 4.3.5.

Table 4.3.5. t test analysis on the post posted mean scores on cooperative learning strategy with models and lecture method without models.

Variable	N	Means	SD	SE	t value	df	P	Remarks
CLS+models	25	29.24	2.83	0.56	6.24	48	0.000	Sig
Lecture method	25	22.76	4.35	0.87				

The P value 0.000 obtained is less than 0.05. This indicates that there is significant difference in the post posttest scores at $P \leq 0.05$ level of significance. Due to the significant difference which exists in the post posttest mean score; the null hypothesis is therefore rejected.

4. 3. 6 Null Hypothesis 6

Ho6: There is no significant difference in the retention mean scores in biology between students taught using lecture method with models and those taught using lecture method without models.

t test statistics was used in analyzing this hypothesis. The results of the analysis are as presented in Table 4.3.6.

Table 4.3.6 t- test analysis on the Difference in the retention ability on students taught using lecture method with models and students taught using lecture method without models.

Variable	N	Means	SD	SE	t value	df	P	Remarks
L+models	25	29.36	2.87	0.57	6.33	48	0.000	Sig
L-models	25	22.76	4.35	0.87				

Table 4.3.6 shows the result of the t test analysis of the post posttest of the students taught using lecture method with models and those taught using lecture method without models. The 0.000 P value obtained is found to be significant at 0.05 level of significance. This signifies that the retention ability of the students when taught biology concepts using lecture method with model is higher than when taught using lecture method without models. The null hypothesis is therefore rejected.

4.4 Summary of findings

In the course of the study, the following findings were made

1. There is a significant difference in the academic achievement and retention of biological concepts by students exposed to different learning strategies.
2. The students taught biology concepts using cooperative learning strategy with models (CLS+M) achieved significantly higher than the students taught using cooperative learning strategy (CLS) without models.
3. The students taught biology concepts using cooperative learning strategy with models (CLS+M) achieved significantly higher than the students taught using lecture method without models.
4. There is a significant difference in the academic achievement of students taught using lecture method with models and students taught using lecture method without models. Students taught using lecture method with models achieved significantly higher than students taught using lecture method without models.
5. There is a significant difference in the post posttest mean score of students taught using cooperative learning strategy with models and students taught using cooperative learning strategy without models. The students taught biology concepts using cooperative learning strategy with models (CLS+M) had a higher level of retention of biological concepts than the students taught using cooperative learning strategy (CLS) without models.
6. There is a significant difference in the post posttest mean score of students taught using cooperative learning strategy with models and students taught using lecture method without models in favor of the former. The students taught biology concepts using cooperative

learning strategy with model (CLS+M) had a higher level of retention of biology concepts than the students taught using lecture method without models.

7. There is a significant difference in the post posttest mean scores of students taught using lecture method with models and students taught using lecture method without models in favor of the former. Students taught using lecture method with models had a higher level of retention of biology concepts than students taught using lecture method without models.
8. The use of cooperative strategy with models significantly promotes students' academic achievements and retention of biology concept.

4.5 Discussion of the Results

The main purpose of this study was to find out if the application of cooperative learning strategy with models is effective in improving the learning and achievement of biological concepts. The study also investigates the effects of the cooperative learning strategy with model on retention of these concepts. Before the commencement of the treatment, it was established that the subjects had equivalent knowledge of biology through the pre test. Therefore the observed differences in the results are due to the treatments. The results of the analysis of data on the questions and null hypotheses are hereby discussed.

4.5.1 Effect of Instructional Strategy on the Academic Achievement of Biology Concepts

A. Cooperative learning strategy with models and cooperative learning strategy without models.

The result of the analyses as presented in Tables 4.2.1 and 4.3.1 showed that the students taught using cooperative learning strategy with models had a higher mean score than the students taught using cooperative learning strategy without models. It also revealed a significant difference in the posttest mean scores of the students exposed to cooperative learning strategy with model (CLS + M), and those exposed to cooperative learning strategy without models (CLS) in favor of the former group. The results revealed a significant difference in the academic achievement of subjects in the posttest scores of subjects exposed to cooperative learning strategy with model (CLS + M) and those exposed to the cooperative learning strategy(CLS) without models.

This result revealed that subjects exposed to cooperative learning strategy with models performed significantly better than the subjects exposed to cooperative learning strategy without models. With this finding, it implies that cooperative learning strategy with the use of models is more effective in the learning of biology concepts. This indicates that the use of cooperative learning strategy with instructional materials such as models is effective in improving the learning of biology concepts. The use of models has helped in improving the performance of the students.

This finding is in agreement with Oyediran et al (2004) in their findings which revealed that students exposed to teaching accompanied by the use of concrete model and diagrams , achieved better than those taught using ordinary chalk and talk method. Johnson and Johnson (1986) also found that Cooperative Learning Strategy combined with computer assisted instruction promotes greater quantity and quality of daily achievement, more task-related student-student interaction.

Aniashi, Anake, and Ayuk (2008) assert that how much one learns and remembers is a matter of how strong the personal involvement felt by the child is, in one case, and the absence of it in the other. With the use of models, students were more actively involved in the learning and therefore achieve better. The use of concrete models stimulates discussions and better interaction than cooperative learning without models.

B. Cooperative learning strategy with models, and lecture method.

The results of the analyses as presented in Tables 4.2.2 and 4.3.2 showed that the students taught using cooperative learning strategy with models(CLS +M) had a higher mean score than students taught using lecture method (L) only. There is also a significant difference in the achievement mean scores of the two groups. (CLS + M) group also performed significantly better than the students taught using lecture method (L) without models. This indicates that the use of cooperative strategy with models is effective in the learning of biology concepts. The results further confirm the superiority of the use of cooperative learning strategy with models over the use of lecture in this study.

Empirical evidence resulting from this study indicates that there is an improvement in academic performance when cooperative learning strategy is used with models in the learning of biology concepts. Inyang and Mkpanang (2004) outlined the trend in the teaching of science to include greater student involvement in the teaching and learning act, and utilization of a multiplicity of learning materials.

This result is similar to the findings of some other studies. Slavin and Karweit (1984) indicated significant achievement main effects for Teams when they used the STAD in factorial experiments on mathematics achievement in general mathematics class.

Johnson and Johnson (1986) also revealed in their study that cooperative learning promoted higher achievement and the discovery of superior cognitive reasoning strategies than competition. Koury (1990) indicated that the peer-tutoring cooperative learning approach significantly increased the performance at junior and senior high school levels. Studies by Okebukola (1984) and Okebukola and Ogunniyi (1984) both claimed a greater utility of cooperative learning strategies both to foster some aspects of student's individual differences and to enhance students' achievements. Ojo (1992) concluded that chemical problem solving skills are best enhanced by cooperative learning environment. Findings by Olorukooba (2006) revealed that students who were taught by the cooperative learning strategy performed significantly better in the achievement test than the control group who were taught by traditional method. However, the results of some other studies casts doubt on the hypothesis that cooperative learning helps in the achievement of students. Not all the studies have revealed findings in favor of cooperative learning. Okebukola (1984) found that students in competition groups readily outperformed their peers in cooperative groups. Ryan & Wheeler (1977) also found that subjects performed better in competition than their counterparts in cooperative conditions. Rice (1990) did not find any significant difference on the dependent variables relative to treatment, reasoning ability level, initial science comfort level and learning mode preference, when two classes were taught by a more conventional lab-lecture method and those utilizing cooperative learning. The findings on the effectiveness of cooperative learning strategy on the academic achievement, is inconclusive. In another study, Courcier and Stephans (1993) found no significant group effect of cooperative learning strategy on student's achievement in mathematics. However, cooperative learning strategy with models in this study was more effective in improving the academic performance of learners. This may be as a result of the additional use of models. With models and cooperative

learning strategy, students were able to interact with one another, observe, feel, and manipulate the concrete models thereby making the learning of the concepts less abstract and more real to life.

C. Lecture method with models and lecture method without models.

The results of the analyses as presented in Tables 4.2.3 and 4.3.3 showed that the students taught using lecture method with models had a higher mean score than students taught using lecture method (L) only. There is also a significant difference in the achievement mean scores of the two groups. Lecture method with model group also achieved significantly better than the students taught using lecture method (L) without models. This indicates that with the use of models, the lecture method has been improved and this can be adapted to enhance students learning of biology concepts.

The findings conform to that of Halilu (2006). His study revealed that students taught with lecture method with aids such as charts, models and flash cards achieved significantly better than the group that learnt with lecture method without these aids models. Akubuilo (2004b) stated that in an attempt to ensure purposeful results oriented science delivery in schools, strategies such as activity oriented, guided discovery, cooperative learning, demonstration, think and do, modified lecture and many others have been employed by science teachers.

House (2006) equally reported that the use of active learning strategies (including physical models and applying course materials to clinical case studies) during a microbiology course resulted in increased student enjoyment for learning science. In addition, the use of active learning materials during oceanography course produces significant learning and enhanced student interest (Yuretich &Leckie 2001) in House (2006).

It has been empirically established in this study that the use of models has significantly improved the academic performance of Pre ND students. The use of models has significantly improved achievement of learning because it makes the learning more concrete and there are better interactions through the activities involved. With models, students were active and participated more in the learning process than in the lecture method only.

4.5.2. Effect of Instructional Strategy on the Retention of Biology Concepts.

A. Cooperative learning strategy with models and cooperative learning strategy without models.

The results of the analyses are as presented in Tables 4.2.4 and 4.3.4. There was a higher retention ability by the students taught using cooperative learning strategy with models (CLS+M) than students taught using cooperative learning strategy without models (CLS). The results of the analysis of Null Hypothesis 4 showed that there is a significant difference in the post posttest mean scores of the students exposed to cooperative learning strategy with models (CLS + M), and those exposed to cooperative learning without models (CLS) in favor of the former. The Pre-National Biology students retained significantly higher when taught using cooperative learning with models (CLS + Model) than when taught using cooperative strategy without models (CLS). The use of the multimedia strategy has enhanced the retention of biology concepts by the students exposed to the use of these models than students exposed to cooperative learning strategy without models (CLS). Lagoke (2000) also reported that that the use of analogy arouse students' interest and imaginations and therefore lead to understanding and retention of concepts. These findings are in agreement with House (2006) who found that the multimedia technology has been used to enhance middle school science in an electronic learning community

of Baltimore. On the contrary, Abu & Flower (1997) found no significant difference in the achievement, retention and attitude of home economic students taught by STAD and the control group. However, the differences in the findings may be as a result of environmental differences. Therefore, with the empirical evidence in the above studies and this present study, it is shown that the use of model is necessary for retention of biology concepts.

B. Cooperative learning strategy with models, and lecture method only.

The results of the analyses presented in Tables 4.2.5 and 4.3.5 showed a higher post posttest mean score by the students taught using cooperative learning strategy with models than students taught using cooperative learning strategy without models. There is also a significant difference in the post posttest mean scores in biology of preliminary diploma students who learnt by cooperative learning strategy with models (CLS + Model) and those who learnt by lecture method only (L) in favor of students who learnt by cooperative learning strategy with models (CLS + Model).

The significant difference in the data further indicates that students have increased retention ability of biology concepts when exposed to learning biology through cooperative learning strategy and model (CLS +M), than learning through lecture method alone (L). Based on the works of Meyer (2003) in House (2006), retention is improved through words and pictures rather than through words alone. Visual aids help to clarify and reinforce the spoken message. The combination of hearing and seeing the message, more than doubles comprehension, and retention. The findings of Owolabi (2007) showed that analogy improved students, performance and retention.

Chianson, et al (2011) also found that students who were subjected to the cooperative learning strategy were able to retain the concepts of circle geometry more than those students who were taught using the conventional learning approach.

The significant difference in the data indicates that students have higher retention of biology concepts when exposed to learning biology through cooperative learning strategy with model (CLS + M) than learning through lecture method (L) method. This implies that the use of cooperative learning strategy with models in this study has enhanced the retention of biology concepts better than the use of the lecture method. These findings are also in agreement with Kvam (2000) who, found that active learning can help retention for students with average or below average scores.

The Pre-National Biology students exhibit significantly higher retention ability of biology concepts through cooperative learning strategy with model (CLS + Model) than lecture method without models (L). This answered the research question five asking: 'What is the difference in the post posttest mean scores in biology of preliminary diploma students taught using cooperative learning strategy with models (CLS + Model) and those taught using lecture method without models (L).

C. Lecture method with models, and lecture method only

The results of the analyses of the post posttest mean scores as presented in Tables 4.2.6 and 4.3.6 showed that there is a difference in the retention ability of students who were taught using lecture method with models (L+M) and those taught using lecture method without models. The retention ability is higher when lecture method is supplemented with models rather than lecture method without models (L).

The results also indicate a significant difference in the retention ability of the two groups. The students who learnt with lecture method and model (L+M) retained significantly higher than students who learnt with lecture method only (L).

The Pre-National Biology students showed significantly higher retention ability, learning with lecture method plus model (L+M) than with lecture method (L) without models. This answered the research question six, asking: ' What is the difference in the post posttest mean scores of the students taught using lecture method plus model (L+M) and those taught using lecture method without models (L)? The use of models actually helps to improve learning with lecture method. This implies that an activity based strategy can be used to improve lecture method.

Akuibuilo (2004) reported that any instructional model, which elicits adequate students' participation, has a profound effect on students' retention ability.

The result supported Anyagh (2006) who discovered that the ability to remember takes place more effectively when experiences are passed across to the learner via an appropriate instructional method. This indicates that the lecture method does not encourage retention of biology concepts.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.1 Introduction

This chapter contains the summary of the study, the procedure and findings. Also included are the conclusions, recommendations, limitations and suggestions for further studies

5.2 Summary of Work

This study investigated the effects of cooperative learning strategy with models on the achievement and retention of biology concepts among the Pre-national Diploma Students in Kaduna State. Student Team Achievement Division Cooperative Learning Strategy was used to compare cooperative learning strategy with models, with the other strategies in the study.

The study population comprised all the Monotechnical colleges in Kaduna state. The sample consisting of 100 Pre National Diploma biology students was assigned to different groups. Six hypotheses were developed and tested. The research instrument, Biology Achievement Test (BAT) consisting of 40 multiple choice items with a reliability coefficient of .859 was developed and used in collecting the data. This was used for the pre-test, posttest and the post posttest. The pre-test was designed to determine the equivalence of the subjects before the treatment; the posttest was to find out the effect of treatment on the subjects while the post posttest was to examine the retention level of the subjects after the treatment or lack of treatment. The treatment involved teaching the same topics, Osmosis, plasmolysis and transpiration to four groups using one of the following strategies in each group:-

1. Cooperative Learning Strategy with model (CLS + M).
2. Cooperative Learning Strategy without model (CLS)

3. Lecture Method with Model (L+M)
4. Lecture Method without Model (L)

The data collected were analyzed using t test statistics to test the six hypotheses raised. The results and discussions are as presented in chapter four of this study. A confidence limit of 0.05 levels was adopted for retaining or rejecting the hypotheses.

5.3 Summary of Findings

The summary of findings from the study is as follows:-

1. There is a significant difference in the academic performance of students with regards to learning strategies.
2. The students taught biology concepts using cooperative learning strategy with model (C+M) had the highest posttest mean scores. The students taught biology concepts using cooperative learning strategy with model (C+M) performed significantly better than students taught using cooperative learning strategy without model (C).
3. The students taught biology concepts using cooperative learning strategy with models (CLS +M) achieved significantly higher than students taught using lecture method without models (L).
4. The students taught biology concepts using lecture method with models (L+M) achieved significantly higher than students taught using lecture method without models (L).
5. The students taught using lecture method only (L) had the least posttest mean score and so the least achievement in biology concepts.
6. There is a significant difference in the retention ability of biology concepts among students taught using different learning strategies.

7. The students taught using cooperative learning strategy with model (CLS +M) had the highest retention ability of biology concepts.
8. The students taught using cooperative learning strategy with model (C+M) had a significantly higher retention ability of biology concepts than students taught using cooperative learning strategy without model (C).
9. The students taught using cooperative learning strategy with model (CLS +M) had a significantly higher retention ability of biology concepts than students taught using lecture method without models (L).
10. The students taught using lecture method with model (L +M) had a significantly higher retention ability of biology concepts than students taught using lecture method without models (L).
11. The students taught using lecture method only (L) had the least retention mean score indicating the least retention ability of biology concepts.

5.4 Conclusions

From the findings of this study, the following conclusions were made:-

1. Academic achievement of biology concepts is related to the use of instructional strategies employed to teach them.
2. Academic achievement of biology concepts can be enhanced by the use of effective instructional strategy.
3. Retention of biology concepts can be enhanced by the use of effective instructional strategy.
4. The use of models with a teaching strategy such as cooperative learning strategy or lecture method enhanced the learning of biology concepts by the students.

5. The use of models with a teaching strategy such as cooperative learning strategy or lecture method enhanced the retention of biology concepts by the students.
6. Cooperative learning strategy with model if used properly is effective in the teaching and learning of biology by the pre National Diploma. This strategy has positive effects on students' achievement and retention of biology concepts.
7. Finally, biology teachers should note that activity based multimedia learning enhances learning. Interaction with other learners in the cooperative learning environment and the use of models promotes retention of concepts learnt.

5.5 Contribution to Knowledge in Science Education

The concern of this study was to explore the effectiveness of cooperative learning strategy with models on achievement and retention of biology concepts among the Pre Diploma students. The findings of the study have significant contributions and great implications for educational practices. It was found that the students taught using cooperative learning strategy with models had significantly higher post and post posttest mean score than those in other groups that is cooperative learning strategy without models, lecture model with models and lecture method without model. This implies that the use of cooperative learning strategy with model in teaching and learning of biology at the Pre-diploma level has the potential to enhance students' academic achievement and retention of biology concepts. The strategy allows active classroom participation. It also enhances retention ability of the students. This might be due to the interaction among the students and between the students and the teachers in addition to the physical contact with the concrete objects of the study that is the models. Though the use of cooperative learning strategy has been found to enhance learning and retention, this is greatly

increased by the use of models. It promotes students' participation in classroom activities than the lecture method of teaching. Students were actively involved in the process of learning and knowledge construction. Therefore, based on the outcome of this research, the use of models is essential in the learning of science concepts.

5.6 Recommendations

Based on the findings and conclusions of the study, the following recommendations are made:-

1. The need for teaching learning strategy involving students' interactive participation, such as cooperative learning strategy, as well as use of model, should be encouraged in schools particular at the tertiary institutions where this is often neglected.
2. The use of models should be encouraged in the schools, since they enhance better retention ability of biology concepts by the Pre diploma students.
3. Lecturers at the tertiary institutions should be encouraged to adopt the use of new innovative such that has been found and thereby break away from the lecture methods.
4. Workshops should be organized for lecturers and teachers about how to facilitate learning through the use of cooperative learning strategy and models.
5. Lecture method should be improved by the use of models in the teaching and learning of biology concepts by the Pre National Diploma students.
6. Resources and facilities such as laboratory etc should be provided for effective use of cooperative learning strategy with models.
7. Both students and lecturers should be encouraged to learn how to use and preserve models.

8. Training of teachers in the art of model making and use in their teaching especially where there are no sophisticated instructional materials like computers.

5.7 Limitations of the study

The following limitations are noted in the study;-

1. The study was limited to only the four federal monotechincal colleges in Kaduna state because they are all that are available in the state. Thus the findings may not be generalisable to other public and private institutions.

2. The schools are scattered in different parts of the state while the researcher did all the teaching.

5.8 Suggestions for Further Studies

1. A similar study can be carried out in similar institutions in the other parts of the country. Such studies may include undergraduate, polytechnics and colleges of education students to see if a similar result would be obtained.
2. Similar studies can also be replicated using instructional materials other analogies.
3. The study can also be replicated at the secondary school level to see what the result would be.
4. The study can be replicated to include gender differences and general attitude of students towards the use of cooperative learning strategy with models.
5. Other models of cooperative learning strategies could be employed in further studies.
6. To this researcher, literature review confirmed scarcity of research report on the effectiveness of the use of cooperative and model teaching methods particularly with the Pre-ND students. It was hoped, therefore, that the findings of this study would provide valuable information as a foundation for the subsequent studies.

7. Further studies could involve one that would spread over a longer period. This would show how long the learners have to stay together in order to interact for effective learning and achievement.

REFERENCES

Abimbade,A, (1997) *principles and practices of educational technology*. International Publishers Ltd.

Adamu, M. & Ahmed, U. (1999) *Use of selected methods of teaching in enhancing academic achievement of slow learners in biology* .Unpublished B.Sc (Ed) Project Ahmadu Bello University.

Adenipekun, O. (2008, August 1st) Strategies for effective science teaching. *Vanguard Online Edition.*

Adeniran, M.A. (2006). Strategies and utilization of improved biology instructional material and student achievement and attitude in Ekiti State secondary schools, Nigeria. *International Journal of Research in Education 3(2)* 90-98.

Adesoji, F. A. & Ibrahim T. L. (2009). Effect of studies team-achievement division strategy and mathematics knowledge on learning outcome in chemical kinetics .Uluslararasi Sosval Arastrarmalar Dergisi. *The Journal of International Social Research* . 216,15 – 25.

Adeyegbe, S.O. (1993). The senior science curricula and candidates performance: An appraisal of the first cycle of operation. *Journal of Science Teachers' Association of Nigeria. 28* (1&2), 3-12.

Adeyemi, S. B. (2002). *Relative effects of cooperative and individualistic learning strategies on students' declarative and procedural knowledge in Map work in Osun State.Unpublished* Ph.D. thesis. Dept. of Teacher Education, University of Ibadan, Ibadan

Adewuyi, J.O. (1994). Instruction of teaching methods. In Mobolaji Ogunsanya (Ed). *Basic process education*. Ibadan: Adesanya Graphic Press.

Afolabi, A.O (1995). A case for instructional materials in the teaching-learning process. *Workshop Proceedings organized by Department of Curriculum and Instruction.* St. Andrews College of Education, Oyo.

Ajagun, G.A. (2000). A study of the performance of students in the senior secondary certificate examination in selected schools in Kano State. *Journal of Education.6*(1) 10-21

Ajewole, G.A. (1990). Effects of guided discovery and expository instructional methods on students transfer of learning. *Journal of Science Teachers' Association of Nigeria. 26*(2) 59-66.

Ajeyalemi, D. (1991). Science and Technology Education in Africa. *Focus on seven Sub-Saharan Countries.* Lagos. University of Lagos Press.

Akinmade, C.T.O, (1989) Students learning difficulties in biology prospects for a solution. *Journal of Educational Studies* 1(1) 37-41.

Akinsola, M.K. (2004) *Mastery learning, cooperative mastery learning strategy and students achievement in integrated science.* Department of Teacher Education, University of Ibadan, Unpublished Ph.D Thesis, University of Ibadan, Ibadan.

Akubuilo, D.U. (2004 a). The effects of two forms of instructional treatments on process skills acquisition of senior secondary school biology students in ecology. *Nigeria Journal of Research and Production,* 5 (1) 19 -26.

Akubiulo, D.U. (2004 b) The effects of problem solving instructional strategies on students' achievement and retention to location in Enugu State. *"Journal of the Science Teachers Association of Nigeria.* 39 (1 & 2) 94-100.

Alebiosu, K. A. (1998). *Effects of two cooperative learning models on Senior Secondary Students' learning outcomes in Chemistry.* Unpublished Ph.D. Thesis. University of Ibadan, Ibadan

Amato, J. B. R., Damico, M. & Dibellenterile B. (1989) Can Instructional variables be combined effectively to enhance learning achievement? *Canadian Journal of Educational Communication 18* (2) 85 – 109.

Amosun, P.A. (2002). *Three models of group learning strategies, mathematics ability and gender as determinant of secondary school students learning outcomes in map work* Unpublished Ph.D Thesis. University of Ibadan. Ibadan.

Anaso, J.N. (2008). *Effects of class-size on the academic achievement and retention of different ability groups among chemistry students at the secondary school level.* Unpublished Ph.D Thesis. Ahmadu Bello University, Zaria.

Aniashi, S.O., Anake, E. U., & Ayuk, A. E., (2008) Motivating students' personal involvement in biology lesson by prior presentation of behavioural objectives. *Journal Of Educational Research And Policies*. *3*(1) 27-30.

Anyagh, I.P. (2006). *Effect of formula approach on students' achievement and relations in algebra.* Unpublished Masters Thesis. Benue State University. Markurdi.

Arends R. (1991). *Learning To Teach.* Mcgraw-Hill Inc.

Augustine,D.K, Gruber,K.D. & Hanson, L.R. (1990). *Cooperation Works Educational Leadership*, 47, 4 – 7.

Bessong,M.(2002). Science,technology and mathematics education for sustainable development in africa. Political and social implications. Science and technology literacy. Self identity In Akale M.A.G (Ed). *Proceedings Of The 43rd Annual Conference Of Science Teachers Association Of Nigeria And Inaugural Conference Of CASTME Africa* 2002.

Betiku. O.F, (2000). Improvisation in mathematics in FCT primary schools. How far? *Annual conference of Science Teachers' Association of Nigeria.Proceeding* 339-341

Bichi, S. S. (2002). *Effects of Problem Solving Strategy and Enriched Curriculum on Secondary School Students' Achievement in Evolution Concepts. Unpublished Ph.D. Dissertation,* Ahmadu Bello University, Zaria.

Bruffe, K. A. (1995). Sharing Our Toys: *Cooperative Learning Versus Collaborative Learning*. New York: Collier Books.

Bruner, J.S. (1969). *The act of discovery on knowing essays for left hand.* New York: Athenum.

Chang, C.Y. & Mao, S.L. (1999). The effects on student's cognitive achievement when using the cooperative learning method in earth science classrooms. *School Science & Mathematics,* 99, 374-380. Retrieved March 23,2000 from EBSO host online database.

Chiason, M.M., Kurumeh, M.S and Obida, J.A. (2010) Effects of Cooperative learning strategy on students retention in circle geometry in secondary schools in Benue State.Nigeria. *America Journal of Scientific and Industrial Research*.(c)2010. Science Hup,http://www.scihub.org/AJSIR

Clark, W.M. (2009) Using *Multimedia and Cooperative Learning in and out of class www.learningsolutionmag.com/article* retrieved 12/4/11

Courcier, L. & Stephens L. (1993). A comparison of the effect of constant cooperative grouping on mathematics achievement among seventh grade students. *International Journal of Mathematics Education in science and Technology.* 24 (5), 711 – 715

Cohen, E. (1994) Designing group work: *Strategies For Heterogeneous Classroom* (2nd ed) New York Teachers College Press.

Crooks, T. J. (1988). The impact of classroom evaluation practice on students. *Review of Educational Research*. *58*(4), 438-481.

Danmole, B.T.,&Femi-Adeoye, K.O. (2004) Effects of concept mapping technique on senior secondary school students, achievement and retention of ecology concepts. *Journal of Science Teachers Association of Nigeria 39* (1&2) 31-37.

Duren, P.E & Cherington, A. (1992). The effects of cooperative group work versus independent practice on the learning of some problem-solving strategies. *School science and mathematics,* 92, 80 – 83.

Etukudu, U.E. (2002). Effects of computer assisted instruction on gender and performance in mathematics abacus : *The Journal of mathematics Association of Nigeria 27*(1) 1-8

Eguabor, V.O. (2001). "The need for research into the effectiveness of individualized study programme in Nigeria secondary schools" *The Nigeria Teacher Today* 9(1) 7-11.

Esan A. D. (1999). *Effects of cooperative and individualistic problem-solving strategies on Students learning outcomes in secondary Mathematics.* Unpublished Ph.D. Thesis. University of Ibadan.

Ezenwa, V. I. (1993). *A comparative study of the effectiveness of concept mapping and guided discovery teaching on secondary school students' understanding of selected chemistry concepts.* Unpublished Ph.D. Thesis, A.B.U., Zaria.

Farrant, J.S. (1971) *Principles and practice of education* London. Longman.

Federal Ministry of Education. (2007) National Policy on Education. Federal Republic of Nigeria.4th Edition, Lagos. NERDC.

Felder, R.M., & Siverman, L. K.,(1988) Learning and teaching styles in engineering education.*Eng. Education.*674.290-304

Fletcher, J. (1978). *Modern Biology for Secondary Schools,* Practical and Workbook. FEP International Private Limited-Lagos

.

French, J. (1990). Social interaction in the classroom in C. Rogers & P. Kutnick (ed). *The Social Psychology in the Primary classroom.* Routledge London. 31-48.

Fu-yun-yu, Y. (1998). The effects of cooperation with inter-group competition on performance and attitudes in a computer assisted science instruction. *Journal of computers in mathematics and science teaching. 17*(4) 381-395.

Galton, M. (1990). Grouping and group work in C. Rogers & P Kutnick (ed). *The Social Psychology in the Primary classroom* . Routledge .London.

Galton, M. & Williamson, J. (1992). *Group Work in the Primary Classroom.* Routledge. London. 1-45

.

Gokhale, A. A.(1995) Collaborative learning enhances critical thinking. *Journal of Technology Education.* 7 (2) Fall *e*-Journal.

Good, T., Groews, D., Mason, D., Slavings, R., & Cramer, K. (1990). An observational study of small group mathematics instruction in elementary school. *American Education Research Journal. 24*(4), 75-782.

Guskey, T. (1990). Cooperative mastery learning strategies. *The Elementary School Journal*. *91*(1) 33-42.

Halilu, L., (2006) "The effects of Instructional material on the performance of primary three pupils in social studies in kankia local government area of Katsina state. *Journal of Educational Research and Development.*

Henderson J. (1994). Teaching Sensitive Issues on Science: the case of sex education; in Wellington J. (ed), *Secondary Science, Contemporary Issues and Practical Approaches.* Routeledge, London . 240 – 259.

Hertz-Lazarowitz, R. Sharan, S., & Steinberg R. (1980). Classroom learning style and cooperative behavior of elementary school children. *Journal of Educational Psychology,* 72, 99- 106

Hodson, D. (1994). Redefining and reorienting practical work in school science in R Levinson (ed) *Teaching Science ,*Routledge London. 159 – 163.

Hooper, S. (1922) Cooperative learning and computer based instruction. *Educational Technology Research and Development, 40* (3), 21 – 38.

Hornby, A.S. (2005). *Oxford Advanced Learners Dictionary,* International Students Edition. Oxford University Press.

House, J. D. (2006) The effects of classroom instructional strategies on science achievement of elementary school students in Japan. Findings from the third international mathematics and science study (TIMSS) *Internal Journal of Instructional Media*.

Hudgins, B.B. (1960). Effects of group experience on individual problem solving. *Journal of Educational Psychologist*, 51, 37 – 42.

Humphreys, B. Johnson, R.T. & Johnson D.W. (1992). Effects of cooperative, competitive and individualistic learning on students' achievement in science class. *Journal of Research in Science Teaching* 19, 351 – 356.

Igboegwu,E.N.,(2012) Effect Of Guided Discovery And Demonstration Teaching Methods On Achievement Of Chemistry Students Of Different Levels Of Scientific Literacy. *Journal of Research in Curriculum and Teaching* 6(1c) 445-448

Ingham, A.M & Gilbert, J.K. (1991). The use of analogue models by students of chemistry at higher education level. *International Journal of Science Education,* 13, 193 - 202

Jacobs G & Ball J (1996). An investigation of the structure of group activities in ELT course books. *ELT Journal.* 50(2), 99-107.

Jacques D. (1985). Group teaching in Higher Education. *The International Encyclopedia of Education* 4 2088 – 2099.

James, T. (1991). *Effectiveness of Inquiry versus Lecture Methods of Teaching Biology in Secondary Schools in Niger State.* Unpublished M. Ed. Thesis, Ahmadu Bello University, Zaria, Nigeria.

James, T. (2000). *Effects of Combining Reflective Writing with Concept Mapping and Lecture Methods on Pre-service N.C.E Teachers' Attitude and Achievement in Biology.* Unpublished Ph.D Thesis, Ahmadu Bello University, Zaria, Nigeria.

Johnson, R.T., & Johnson, D.W. (1986) Action research: cooperation learning in the science classroom. *Science and children* 24, 31-32.

Johnson, R.T., & Johnson, D.W. (1994a). Learning together and alone: Cooperative, competitive and individualistic learning. Englewood Cliffs, NJ: Prentice Hall.

Johnson, R.T., & Johnson, D.W. (1994b).Structuring Academic Controversy In 'Sharan, Ed. *Handbook of Cooperative Learning Methods.*

Johnson, R.T., & Johnson, D.W. (1999). *Cooperative and Competition: Theory and Research*. Edna, Minn: Interaction Book Company.

Johnson, D.W., & Johnson, R.T. (1999). Making cooperative Learning Work. *Theory into Practice. 38*(2) 67-73

Johnson, D. W., Johnson, R. T. & Holubec, E. J. (1991). *Cooperative in the Classroom.* Edina: Interaction Book Co.

Johnson, D.W.; Johnson, R.T. & Smith K.A. (1991) Active Learning. Cooperation in the College Classroom. Edna, M .I. Interaction Book Company

Johnson, D.W.; Johnson, R.T. & Zaindman, B. (1981). Oral interaction in cooperative learning groups: speaking listening and nature statement made by high, medium and low achieving students.

Johnson, D.W., Maruyama, G., Johnson, R., Nelson, D., & Skon, L. (1981). Effects of cooperative, competitive and individualistic goal structures on achievement: A meta-analysis. *Psychological Bulletin*. 89, 47 – 62.

Kagan, S., (1989) *Cooperative Learning.* Boston: Charlesbridge Press.

Kempa, R. & Ayob A. (1995). Learning from group work in science. *International Journal of Science Education*. 17(6) 743-754.

Keraro, F., Wachanga S. and Orora W. (2007): Effects of Cooperative Concept Mapping Teaching Approach on secondary school students' motivation in biology in Gucha District, Kenya. *International Journal of Science and Mathematical Education 1* (3) 111 – 124

Kiewra, K.A., (1987) Memory-compatible Instruction. *Engineering Education.*

King, A. (1990). Enhancing peer interaction and learning in the classroom through reciprocal Questioning. *American Educational Research Journal.* 27(4), 664-687.

Koury,M. A. (1990) Effects of a cooperative learning approach on students with moderate retardation, peer tournaments. Ed. *Dissertation Abstract International* 51 (6) 1986A

Kutnick P. (1990). Social development in the child and the promotion of autonomy in the classroom in C. Rogers & P. Kutnic (ed). *The Social Psychology of the Primary School.* Routledge. London & USA. 110 – 130.

Lagoke, B. (1992). Analogical Linkages between Socio-Cultural environment and Biological concept attainment by secondary school students using a constructional framework. An unpublished Ph.D. Thesis A.B.U, Zaria.

Lagoke, B. A., (2000) The efficiency of enriching biology teaching with analogy on the performance of students of different achievement levels. *Journal of Science Education.* 7, (1) 40-44

Lakpini, M.A. (2006) *Effects of a conceptual change instructional strategy on the achievement, retention and attitude of secondary school biology students with varied abilities.* Unpublished Ph.D. Thesis. Ahmadu Bello University.

Lawal, F.K.(2009) *effectiveness of conceptual change instructional strategy in. remediating misconceptions in genetic concepts among senior secondary school students in Kano State*. *Unpublished Ph.D. Thesis.* Ahmadu Bello University.

Lazarowitz, R. H., Lazarowitz,R, & Baird, J.H (1994) learning science in a cooperative setting. academic achievement and affective outcome. *Journal of Research in Science teaching* 31. 1121-1131

Lefrancois, G. (1994). *Psychology for teaching.* California: Wadsworth Publishing Company

Mclachlan, J. C. (2003) Using models to enhance the intellectual content of learning in developmental biology *International Journal of Developmental Biology 47* (2-3) 225-229.

Madden, N.A., & Slavin, R.E. (1983). Effects of cooperative learning on the social acceptance of mainstreamed academically handicapped students. *The Journal of Special Education, 17*, 171 – 182.

Maheady,L., Harper, G.F., & Sacca, M.K.(1988) Peer-mediated instruction: A promising approach to meeting the diverse needs of LD adolescents. *Learning Disabilities Quarterly.11*, 108- 113

Mankilik, M. (2007) An Analysis of Students Misconceptions of Physics Concepts Among Remedial Students In University Of Jos. *Standardizer of The Nigerian Academic 3*(2) 165-170

McClintock, E. & Sonquist, J.A. (1979). Cooperative task-oriented groups in a college: A field application. *Journal of Educational Psychology*, 68, 588 – 596.

Mevanech, Z.R. (1999). Effects of Metacognitive Training Embedded In Cooperative Settings on Mathematical Problem Solving. *Journal of Educational Research* 92,195-205.

Murr, L.E. (1988) Engineering education in the visual culture. *Engineering Education* 170

Nnaobi, A. F. (2003). Enhancing students performance using computer aided instructional (cai) in tertiary institutions. *Proceedings of the 44th annual conference Science Teachers' Association of Nigeria.* (pp 89 – 92).Abuja : STAN.

Njoku, Z.C. (1998). The role of concrete models and diagrams in effective communication in science and technology instruction. In A.O. Olarewaju, (Ed). *Proceeding of annual conference of the Science Teachers Association of Nigeria. (*pp 354-357). Oshogbo: STAN

Njoku, Z.C. (2004) Effective use of models for science and technology instruction. *Journal of Science Teachers Association of Nigeria 34* (2) 45-50

Ochonogor, E.C. (1997) Increasing Retention and Achievement In STM Through Innovative Approaches In Nigeria. *Proceedings of The 40th Anniversary Conference Proceeding Science Teachers' Association Of Nigeria.* (pp73-75)

Ojerinde, D. (1998). Underachievement in school science in Nigeria: The Way Out. *African Journal of Education. 1*(1)76-191.

Ojo, M.O. (1992). The differential effectiveness of cooperative, competitive and individualistic classroom interaction patterns on students chemical problem solving skills. *The Nigerian Teacher Today*. 1(2) 1, 121-129.

Okebukola, P. A.O (1984). *Effects of cooperative, competitive and individualistic laboratory interaction patterns on Students' performance in Biology.* Unpublished Ph.D. Thesis, University of Ibadan, Ibadan.

Okebukola, P.A.O. (1987) "Tackling the problem of large classes in Biology. An investigation into the Effects of co-operative learning techniques. *Journal of Science Teachers' Association of Nigeria.22*(2), 73-77.

Okebukola,P.A.O. (1988). The influence of preferred learning styles on cooperative learning in science. *Science Education*. *70*(5). 509-517.

Okebukola, P.A.O. & Jegede, O. J. (1988). Cognitive preference and learning mode as determinants of meaningful learning through concept mapping. *Science Education*. *72*(4) 489 – 500.

Okebukola, P.A. & Ogunniyi, M.B. (1984). Cooperative, competitive an individualistic science laboratory interaction patterns - Effects on students' achievement and acquisition of practical skills. *Journal of Research in Science Teaching,* 21, 875 – 884.

Okwilagwe, E. A. (2002). Modern trends in secondary school Geography teaching. In Ayodele *(Ed) Teaching Strategies for Nigerian Secondary Schools.* Powerhouse Press And Publishers.

Okwoh, F.A., and Tartigus, I., (2004) Effect of position of diagram and cognitive style on Biology Achievement of Pre-National Diploma Students. *Journal of The Science Teachers Association Of Nigeria, 39*(2). 88-92.

Olarewaju, R.R. (1996). Isolation and analysis of conceptual difficulties in biology among senior secondary school students in Kaduna State. Unpublished M.Ed Thesis A.B.U, Zaria.

Olayiwola, M.A. (1999) "Achieving effective sciences; technology and mathematics delivery in the 21st century: some areas for consideration". *Journal of the Science Teachers Association of Nigeria*, 34 (1&2) 16-19.

Olorukooba, S.B.(2002) *The relative effects of cooperative learning instructional strategy and traditional method on the performance of senior secondary school students*. An Unpublished Ph. D Dissertation. Ahmadu Bello University.

Olorukooba, S.B. (2006) The Relative Effect of Cooperative Instructional Strategy on the Academic Achievement of Senior Secondary School Students in Chemistry. *Journal of Educational Research and Development ,1* (2) 1 – 5.

Oloruntegbe, K.O. (2000). *Effects of teachers sensitization on students acquisition of science process skills and attitudes.* An Unpublished PhD Thesis. University of Benin.

Olukoju A. (2011). Ways to get Nigeria out of its education doldrums: An Interview by Ayo Lawal Gbenoba Nigerian Tribune 1/12/11 p. 32.

Omosewo, E.O. (1999). Impact of discovery methods of teaching of students achievement in physics. *Journal of Nigeria Association of Teachers of Technology 3*(1) 1-10.

Omoshehin, M. F. (2004). *Effects of a training programme in cooperative learning of pre-service teachers' classroom practice and pupil learning outcomes in social studies.* Unpublished PhD Thesis, Dept. of Teacher Education, University of Ibadan. Ibadan.

Onimisi, J. A (2003). The Potentials and challenges of ICT for effective Teacher Education in Nigeria. *Proceedings of the 44th Annual Conference of Science Teachers Association of Nigeria* p. 262.Abuja.

Onwu, G. O.M. (2004). Refocusing research in science technology and mathematics (stm) education : mapping out a research agenda for the future. *Proceedings of the 45th Annual Conference of Science Teachers' Association of Nigeria*.2004. Key Note Address.

Otuka, J.O.E. (1991). "The Laboratory Think and Do Approach To Science Instruction". *Journal of the Science Teachers Association of Nigeria, 27* (1) 163-167.

Orji, A.B.C. (1996). The use of vee heuristic in teaching physics concepts. *Science Teachers' Association of Nigeria. bulletin*.

Owens, L. (1985). Cooperation in the classroom: *The International Encyclopedia of Education.* 2. 103 – 1007.

Oyedokun, C.A. (1998). *The effects of a conceptual change model on students achievement, retention and attitude to biology concepts*. An unpublished Ph.D. Thesis A.B.U Zaria.

Oyediran A.M., Agoro A.A., & Fabiyi O.O. (2004). A multimedia approach to the teaching of some difficult topics in integrated Science. *Journal of the Science Teachers Association of Nigeria. 39*, (1& 2) 108-112.

Owolabi, T. (2007). The use of analogy as vehicle for achieving effective physics delivery in some selected secondary schools in lagos. *Proceeding of Science Teachers' Association of Nigeria. National Conference* 2007.

Parker, R. (1985): Small Group Cooperative Learning: *The Education Digest.* 1. 44 - 46

Popoola, A. A. (2002). Effect *Of Heuristic Problem-Solving And Programmed Instructional Strategies On Senior Secondary School Student's Learning Outcome In Mathematics In Ekiti State, Nigeria* .An unpublished Ph.D.Thesis. Dept. of Teacher Education. University of Ibadan. Ibadan.

Potthast, M.J. (1999). Outcomes of using small-group cooperative learning experiences in introductory statistics courses. *College Student Journal*, 33, 34-42. Retrieved March 23, 2000 from EBSCOhost online database.

Raghubir, P.K. (1979): The lab-investigative approach to science instruction. *Journal of Research in Science Teaching*. *16* (1), 13 – 18.

Ramlingam, S. T. (2003). *Modern Biology for Senior Secondary School*. Africana First Publishers Ltd. Zaria, Nigeria.

Reynolds M. (1994). Group work in Education and Training: Ideas in practice. Kagon Page ltd. London.

Rice D.C. (1990). Cooperative Learning in a College Laboratory Science Course For Preservice Elementary Teachers. *Dissertation Abstract Intentional*. 51 (6)

Rysavy S.D.M & Sales G.C (1991). cooperative learning in computer based instruction *Educational Technology Research and Development* 39, 70 – 99.

Salawu, I. O. (1999). *Effect of three instructional media on Students Teacher learning outcomes in selected Teaching skills.* Unpublished Ph.D. Thesis. University of Ibadan, Ibadan.

Sharan, S., Hertz-Lazarowitz, R. & Ackerman, Z. (1980). Academic achievement of elementary school children in small-group versus whole class instruction. *The Journal of Experimental Education,* 48, 125 – 129.

Sheman L. W. (1988). A comparative study of cooperative and competitive achievement in two secondary biology classrooms. The group investigative model versus an individually competitive goal structure. *Journal of Research in Teaching*. *26*(1) 55 – 64.

Slavin, R. (1985). Small group instruction. *The international encyclopedia of education*. (8th ed.) (pp 459 – 4601) New York: McGraw-Hill Book Co.

Slavin, R. (1990). Cooperative learning. In C. Rogers & P. Kutnick (Eds.). *The social psychology of the primary school. (*pp.226-246). London: Routledge, London & Kegan Paul.

Slavin, R.E. (1989) Cooperative learning and students achievement. *The Educational Digest Liv,* 6, 15 – 17.

Slavin, R.E., & Karweit, N. L. (1984). Mastery learning and student teams: A factorial experiment in urban general mathematics classes. *American Educational Research Journal, 21*, 275 – 736.

Solomon, J. (1994). Group discussion in the classroom in R. Levinson (ed) *Teaching Science.* Routledge, London. pp 76-84.

Stone, K. (1996) Learning Online Bulla Gymnesia Virtuales Online. All the time Bi-monthly E-mail Newsletter, 01 (03), 1– 13 (online) available at: http://www.cybercorp.net//gymy/bulla/b v01n03.html.

Tim, C. F. (2004). Use of analogies to teach general biology to non biology majors Triannual 8(1) Newsletter centre for development of teaching and learning.

Totten, S., Sills, T., Digby, A., & Russ, P. (1991) *Cooperative Learning*: A guide to research. New York : Garland.

Usman, A.I. (2001) *The relationship between students; performance in practical activities and their academic achievement in integrated science using NISTEP mode of teaching,* Unpublished Ph.D Thesis. ABU, Zaria.

Usman, A.I. (2007) The effects of selected methods on the academic achievement of slow learners in integrated science at the junior secondary school level. *Journal of science and mathematical education*. *3* (1) 70-77.

Usman, K.O (2002). The need to retain in science mathematics teachers for the attainment of the objective of universal basic education (UBE) *The Journal of the Mathematical Association of Nigeria* ABACUS *2*(1) 37-41.

Vygotsky, L. (1978) Mind in society. *The Development of Higher Psychological Processes. C*ambridge, Harvard University Press.

Webb, N.M. (2008).Task- related verbal interaction and mathematics learning in small groups .*Journal for research in mathematics education*. (Reston, VA). 22, 366-389.

Webb, N.M. Trooper, J.D & Fall, R. (1995) Constructive Activity and Learning in Collaborative Small Groups. *Journal of Educational Psychology 87* (3) 406-423.

Wenhan, E.J. (1972) Physics: *Concepts and models*. London; Addison-Wesley.

West African Examinations Council (1998). Chief Examiners Report. May/June.

West African Examinations Council (1999). Chief Examiners Report. May/June.

West African Examinations Council (2000). Chief Examiners Report. May/June.

West African Examinations Council (2001). Chief Examiners Report. May/June.

West African Examinations Council (2002). Chief Examiners Report. May/June.

West African Examinations Council (2003). Chief Examiners Report. May/June.

West African Examinations Council (2004). Chief Examiners Report. May/June.

West African Examinations Council (2005). Chief Examiners Report. May/June.

West African Examinations Council (2006). Chief Examiners Report. May/June.

Whicker, K.M., Bol, L., & Nunnery, L.A. (1997). Cooperative learning in the secondary mathematics classroom. *Journal of Educational Research,* 91, 42 – 48.

Wilkin, E. (1978). *Educational practice. A handbook for teachers.* Ibadan: Evans Brothers

Yuretich, R.F., Khan, S.A., Leckie, R.M., & Clement, J.J. (2001). Active learning methods to improve students' performance and scientific interest in a large introductory oceanography course. *Journal of Geo Science Education 49* (2) 111-119.

Zopperson, P.S (2002). Hybrid learning in science through the vehicle of analogy. retrieved December 10th 2003 from http://www.ages/sevengu/ml/hybrid

APPENDIX ONE

BIOLOGY ACHIEVEMENT TEST (BAT)

Dear Student,

This test is constructed to measure the academic achievement of pre National diploma students in biology concepts. This is not part of your continuous assessment. Your responses will be helpful in teaching and learning of biology concepts among pre National Diploma Students.

Section A: Bio data

Name of School: _____

Admission Number: _____

Male ( ) Female ( ) Age ( )

Section B:

Answer all questions on the answer sheet provided. Each question is followed by four options. Tick the letter corresponding with the correct answer on the answer sheet.

1. The stomata open when the guard cells are
   a. turgid b. flaccid
   c. devoid of starch d. plasmolysed

2. Most water is lost through the lower epidermis of the leaf because the area contains
   a. more epidermal cells
   b. fewer stomata
   c. more stomata
   d. fewer epidermal cells

3. Which of these media will cause a cell to become turgid
   a. hypertonic medium b. hypotonic medium

c. isotonic medium d. combination of all media

4. Which of the following is <u>not</u> a biological importance of osmosis?
   a. turgidity of plants cells
   b. absorption of water by the root hairs.
   c. movement of absorbed materials from cell to cell across the cortex
   d. translocation of starch in the plant

5. The outward pressure exerted by the contents of a cell on the cell wall is known as
   a. turgor pressure b. osmotic pressure
   c. wall pressure d. root pressure

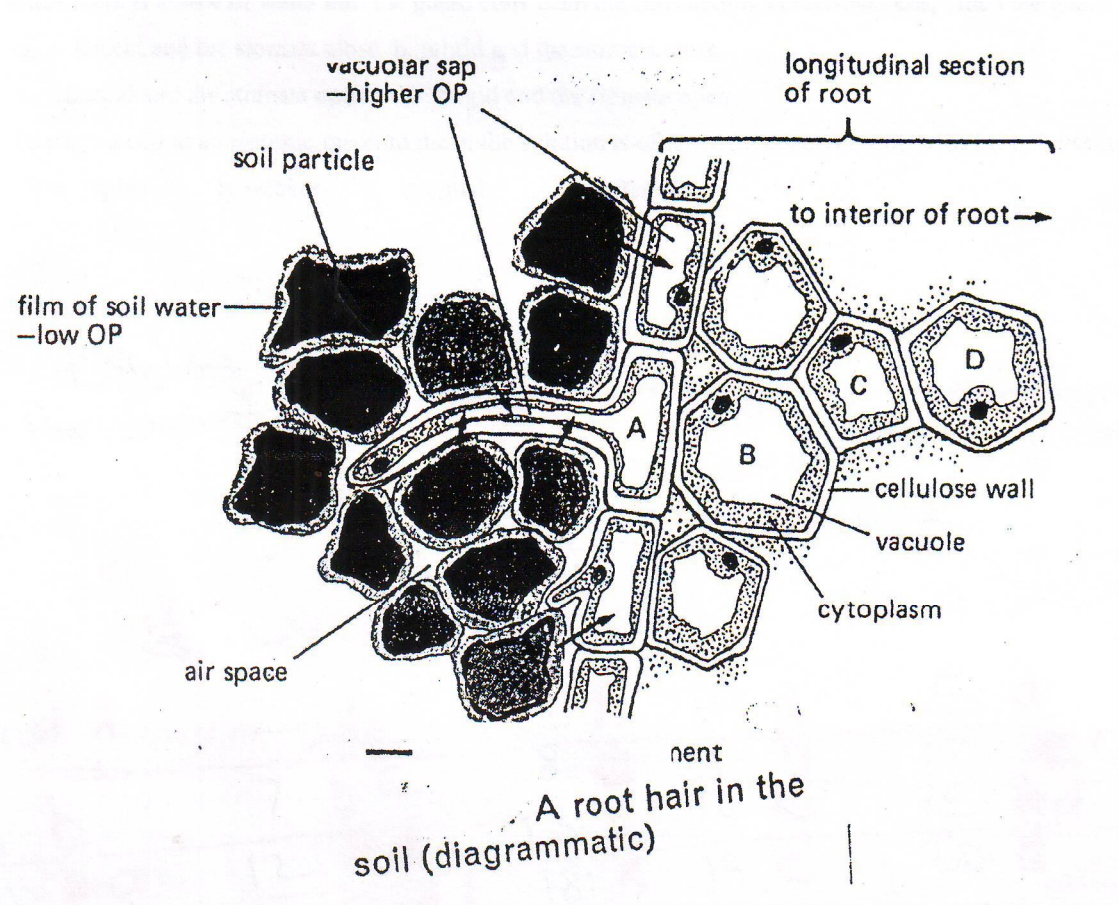
6. During transpiration water is lost in the form of
   a. solid b. vapour c. liquid d. fluid

7. Heat is lost during transpiration to
   a. increase the amount of heat in the atmosphere.
   b. lower the amount of heat in the air inside the plant.
   c. lower the amount of heat in the plant and cool the plant.
   d. increase the amount of heat in the air inside the plant.

8. When too much water is lost by transpiration, the
   a. cells become plasmolysed leading to plant wilting .
   b. plant becomes flaccid.
   c. cells become turgid leading to plant wilting.
   d. plant becomes turgid.

9. When cells are filled with water they become
   a. flaccid b. turgid c. wilted d. plasmolysed

10. Study the diagram below to answer question ten.

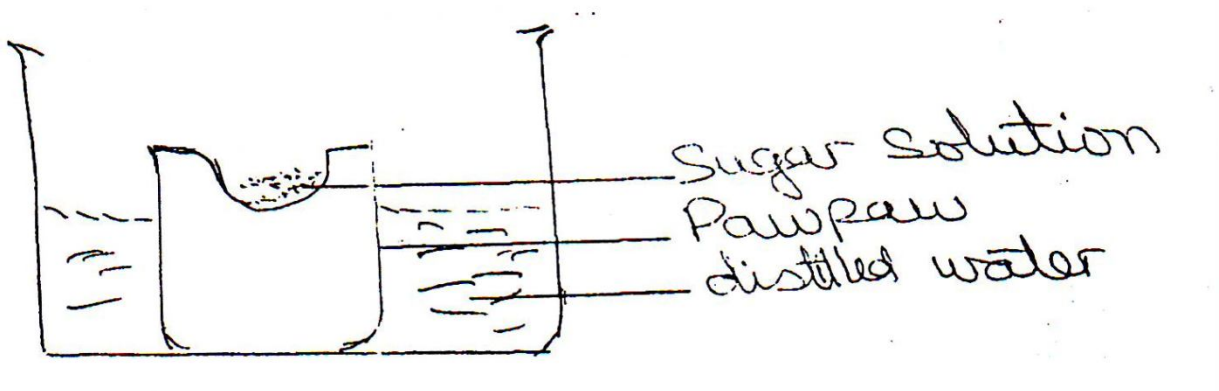


As cell A becomes turgid …….

a. cell B loses water b. water is passed on to cell B

c. nothing happens to cell B d. cell B becomes flaccid

11. Refer to the diagram below to answer question 11.



11. What do you observe after several hours?
    a. The cavity in the pawpaw will be full of liquid
    b. The cavity in the pawpaw will be empty
    c. The water level in the dish will have risen
    d. Nothing happens
12. A flow of water into the guard cell from the surrounding epidermal cells makes the guard cells
    a. flaccid and causes the stomata to close
    b. turgid and causes the stomata to close
    c. flaccid and causes the stomata to open
    d. turgid and causes the stomata to open

13. Osmotic Pressure is
    a. Pressure exerted by the solution with stronger concentration to stop the inflow of water from the weaker one.
    b. Pressure exerted by the solution with weaker concentration to stop the inflow of water from the stronger one.
    c. Pressure exerted by the solution with equal concentration to stop the inflow of water from another one.
    d. Pressure exerted by the solution with stronger concentration to increase the inflow of water from the weaker one.

14. Which of these is not a site of transpiration?

a. cuticle b. endodermis c. lenticels d. stomata

15. Which of the following is not involved in the movement of water from the soil to the leaves of a plant?

a. Osmosis b. Root pressure c. Suction pressure d. plasmolysis

16. Which of the following does not affect the rise of water up the xylem of the root and stem?

a. Root Pressure b. Capillarity c. Transpiration Pull d. Diffusion

17. Which of the following will not cause stomata to open?

a. fast flowing wind b. bright light c. low humidity d. high humidity

18. Which of these is not a function of the stomata?

a. admit oxygen into the internal tissue for respiration

b. serve as exit for excess water

c. manufacture food for plant

d. manufacture water for plant.

19. During transpiration water vapour is lost mainly through the

a. Cuticle b. Lenticels c. Stomata d. Mesophyll e. Guard cells

20. ……can be used to prove that the liquid during transpiration is water

a. calcium chloride b. anhydrous copper c. copper chloride d. cobalt chloride

21. The cells that surround the stoma are called

a. Stomata cells

b. Leaf parenchyma

c. Epidermal cells

d. Guard cells

22. Osmosis can be defined as diffusion of water molecules from

a. a dilute solution to a concentrated solution across a permeable membrane

b. an area of high concentration to an area of low concretization

c. a dilute solution to a concentrated solution through a semi permeable membrane

d. a concentrated solution to a dilute solution through a semi permeable membrane

23. A cell placed in a hypertonic medium becomes

a. plasmolysed b. turgid c. engorged d. unchanged

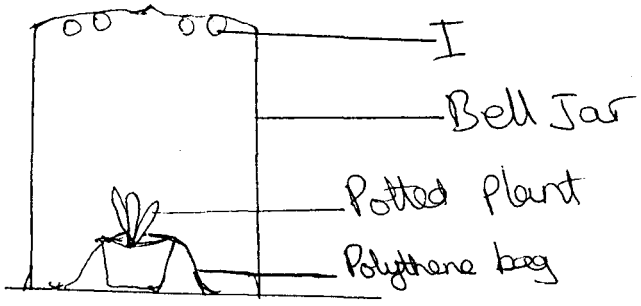
24. By what process does water move from the soil particles into the root?

a. diffusion b. evaporation c. plasmolysis d. osmosis

25. Transpiration pull is also known as

a. mechanical pull b. osmotic pull c. gaseous pull d. osmotic pressure

26. In the diagram below, the part labeled I is



a. microorganism b. a developing insect c. water droplet d. an oil droplet

27. A pupil accidentally watered a potted plant with concentrated salt solution. After some time, the plant began to wilt. The wilting of the plant is due to the fact that

a. The root have died off and can no longer absorb water

b. The salt solution causes faster rate of transpiration leading to the death of the plant cells
c. The salt solution has caused water to be lost from the plant cells leading to loss of turgor
d. The plant tissue has been poisoned by the salt which is absorbed by the plant

28. Which of the following activities would revive the plant?
    a. Covering the plant with dark paper to prevent further water loss from its surfaces
    b. Leaving the plant to adapt to the condition
    c. Exposing the plant to high concentration of oxygen
    d. Adding more water to the soil

29. Transpiration in plants results in the
    a. Closure of the stomata at night
    b. Continuous streaming of water through the plant
    c. Pale, green coloration of portions of the leaves
    d. Opening of stomata

30. Which of the following statements defines plasmolysis?
    a. Shrinking of a plant cell in a solution
    b. Shrinking of cytoplasm from an animal membrane
    c. Shrinking of cytoplasm from the plant cell wall
    d. Shrinking of the vacuole and leaving the cytoplasm attached to the cell wall.

31. Which of following is used to measure the rate of transpiration?
    a. Photometer b. Potometer c. Barometer d. Thermometer

32. A strip of potato tuber was placed in solution X, after 1 minute the potato strip had plasmolysed, we can then conclude that solution X is
    a. Tap water
    b. Very strong sugar solution

c. A very weak sugar solution

d. Distilled water

33. Which of the following can function as a semi permeable membrane?

a. Cell wall

b. Raw yam

c. Boiled yam tuber

d. Boiled potato

34. Which of these combinations contribute to the movement of water up the plant?

a. Transpiration pull, cohesion, and root pressure.

b. Evaporation pull, osmotic pull and root pressure.

c. Transpiration pull, plasmolysis and osmosis.

d. Cohesion, osmosis and plasmolysis.

35. In a potometer set up, as more water evaporates from the leaves, the level of water in the calibrated tube

a. rises b. falls c. is stagnant d. doubles

36. Turgor pressure occurs in a cell when

a. volume of its cell sap increases

b. cell loses water to its environment

c. volume of cell decreases

d. cell is put in an isotonic solution

37. What would happen if a plant transpires more water than the root can absorb?

a. Transpiration pull would increase b. Wilting would occur.

c. The plant would shed its leaves. d. The stomata of the leaves would close.

38. Which of the following statements is NOT true of osmotic process?

a. There must be a semi permeable membrane.

b. The two solutions must be of different concentrations

c. Equilibrium is reached when there is equal distribution of water molecules

d. The two solutions must be of equal concentrations at the beginning of the experiment

39. During the intake of water from the soil into the root of a plant, the liquid moves from

a. A weaker solution into a stronger one

b. An area saturated with water to one short of water

c. A strong solution to a weaker solution

d. An area of high pressure to that of low pressure

40. Seedlings put in salt solution wilt because

a. Salt solution is not good for seedling

b. The cells of the seedlings will lose their turgidity

c. The rate of osmosis is greater than that of diffusion

d. Too much water has been forced into the seedling.

APPENDIX TWO

BIOLOGY ACHIEVEMENT TEST MARKING SCHEME

1.A	2.C	3.B	4.D	5.A	6.B	7.C	8.A	9.B	10.C
11.A	12.D	13.B	14.B	15.D	16.D	17.D	18.D	19.C	20.D
21.D	22.C	23.A	24.D	25.A	26.C	27.C	28.D	29.B	30.D
31.B	32.B	33.B	34.A	35.A	36.A	37.B	38.D	39A	40.B

APPENDIX THREE

DISTRIBUTION OF BAT ITEMS

			Total
Osmosis	3,4,5,9,10,11,13,22,24,33,34,35,36,38,39	38,39	15
Plasmolysis	19,15,23,27,28,30,32,40		7
Transpiration	1,2,6,7,8,12,14,16,17,18,19,20,21,25,26,29,31,37		18
Total			**40**

APPENDIX FOUR

Answer Key, Facility (F_1) and Discrimination (D) Indices for Biology Achievement Test

	Key answer	Right scores	RU	RL	Facility Index $F_1 = \frac{R}{T} X \frac{100}{1}$	Item discriminations $\frac{RU - RL}{\frac{1}{2}N}$
1	A	17	11	3	37.77	.356
2	C	23	12	4	51.1	.356
3	B	18	12	3	40.0	.40
4	D	18	13	2	42.0	.488
5	A	20	14	3	44.44	.488
6	B	21	15	3	46.6	.533
7	C	29	14	5	64.4	.40
8	A	26	11	4	577	.31
9	B	31	15	7	68.8	.356
10	C	28	14	4	62.2	.44
11	A	27	16	5	60.0	.48
12	D	24	14	5	53.3	.40
13	B	24	14	2	53.3	.53
14	B	30	19	9	66.6	.44
15	D	25	12	3	55.5	.40
16	D	32	15	83	71.11	.31
17	D	29	18	6	64.44	.53
18	D	26	14	4	57.7	.44
19	C	33	20	6	73.3	.53
20	D	30	15	4	66.6	.48
21	D	23	10	2	51.1	.356
22	C	23	17	5	51.1	.53
23	A	28	13	5	62.2	.356
24	D	26	14	4	57.7	.44
25	A	21	14	5	46.6	.40
26	D	25	12	3	55.5	.40
27	C	29	15	4	64.4	.44
28	D	32	14	5	71.11	.40
29	B	25	11	2	55.5	.311
30	D	25	12	4	55.5	.356
31	B	21	14	2	46.6	.53
32	B	22	15	3	48.88	.53
33	B	30	11	4	66.66	.31
34	A	28	13	4	62.2	.40
35	A	34	16	6	75.5	.44
36	A	22	14	3	48.88	.48
37	B	25	15	4	55.5	.48
38	D	23	14	3	51.1	.40
39	A	27	18	10	60.0	.35
40	B	20	12	2	44.44	.44

APPENDIX FIVE

RELIABILITY OF THE BIOLOGY ACHIEVEMENT TEST (BAT) PILOT STUDY

	N	%
Cases valid	45	100.0
Exclusive	0	0
Total	45	100.0

Reliability statistics

		N	%
Cronbach's	**Part 1 value**		A
	N of items		1[b]
	Part 2		1[c]
	Total N of length		2
Correlation Between Forms			.753
Spearmen-Brown	**Equal length**		859
Coefficient	**unequal length**		.859
Guttman split coefficient			.859

a. The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item coding.

b. The item is SCORE 1

c. The item is SCORE 2

Inter-item Correlation Matrix

	SCORE 1	**SCORE 2**
SCORE 1	1.000	.753
SCORE 2	.753	1.000

The covariance matrix is calculated and used in the analysis.

Summary Item Statistics

	Mean	Minimum	Variance	N of items	Maximum	Range	Maximum/Minimum
Item part 1	21.467	21.467	.000	1[a]			
part 1	20.889	20.889	.000	1[b]			
Means part 2	21.178	20.889	.167	2	21.467	.578	1.028
Both parts							

The covariance matrix is calculated and used in the analysis.

a. The item is: SCORE 1

b. The item is: SCORE 2

ANOVA

	Sum of squares	df	mean square	F	Sig
Between people	2382.156	44	54.140		
Within people between items	7.511	1	7.511	.985	.326
Residual	335.489	44	7.625		
Total	343.000	45	7.622		
Total	2725.156	89	30.620		

Grand Mean = 21.18

a. The covariance matrix is calculated and used in the analysis

Intraclass Correlation Coefficient

	Intraclass Correlation[a]	95% Coefficient Interval
Single Measures	.753[b]	.856
Average Measures	.859[c]	.923

Two-day mixed model where people effects are random and measures effects are fixed.

Interval Correlation Coefficient

	F Test With True Value 0			
	Value	Df1	Df2	Sig
Single Measures	7.101	44.0	44	.000
Average Measures	7.101	44.0	44	.000

Two-way mixed effects model where people effects are random and measures effects are fixed.

a. Type C intraclass correlation coefficient using a consistency definition-the between variance is excluded from the denominator variance

b. The estimator is the same, whether the interaction effect is present or not.

c. This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

APPENDIX SIX

PRE ND BIOLOGY (CBB011) SYLLABUS IN TECHNICAL COLLEGES

PROGRAMME**:** Preliminary Diploma (Science and Technology)
COURSE: Biology: CBB 011 Flowering Plants, Soil Science and Genetics
DURATION: 75 Hours (2 Hour Lecture, 3 Hours Practical)
Goal: The course is designed to provide the students with a basic understanding of heredity and the inter-relationship between plants and the soil.

GENERAL OBJECTIVES:

On completion of this course, the students should be able to:-

1.0 Understand the structure of flowering plants.
2.0 Understand reproduction in plants.
3.0 Understand the mechanisms of osmosis and plasmolysis in plants.
4.0 Understand the process of transpiration in plants.
5.0 Understand the process of photosynthesis and respiration in plants.
6.0 Understand tropism in plants.
7.0 Understand the constituents, structure and characteristics of soil.
8.0 Know the various methods of soil conservation and improvement.
9.0 Understand basic concepts of genetics.

General Objectives	Performance Objectives
1.0 Understand the structure of a flowering plant.	On completion of this course the students should be able to:- **Parts of Flowering Plants** 1.1 Describe the external features of a named; dicotyledonous flowering plant (e.g. *Crotolaria, Delonix, Caesseapania, Ageratum, Tridax, Aspilia, Catuarantums* etc.) 1.2 Describe the external features of a named monocotyledonous flowering plant (e.g *Andropogon*, *Zea mays*, *Pennisetum*, *Imperata* etc) 1.3 Draw and label the plants described in 1.1 and 1.2 above. 1.4 Differentiate between the external features of a monocotyledonous and dicotyledonous plant. 1.5 Describe the functions of the different parts of the flowering plant labelled in 1.3 above 1.6Observe the internal structure of the root, stem and leaf under the microscope. 1.7 Relate the internal structure of the root,

	stem and leaf to their functions. 1.8 Differentiate between the internal structure of the different parts of a monocot and dicot (leaf, stem and root).
2.0 Understand reproduction in plants	**Reproduction in plants** 2.1 Differentiate between sexual and asexual reproduction in plants. 2.2 Identify the reproductive parts of a flower (*Allamanda, Hibiscus, Deloax, Caesalipinia, Tecoma*). 2.3 Draw and label 2.2 above (Whole flower and longitudinal section) 2.4 Explain pollination and fertilization. 2.5 Describe the methods involved in 2.4 above. 2.6 Identify different types of fruits, seeds and their method of dispersal. 2.7 Draw and label whole and longitudinal section of the following: drupe, berry, caryopsis, bean seed/groundnut seed, castor oil seed/jatropha). 2.8 List different methods of asexual reproduction i plants e.g. budding, grafting, layering, stem cutting sectioning, suckering. 2.9 Describe different types of storage organs e.g. rhizomes, bulbs, tubers, corms. 3.10 List and explain condition necessary for germination. 3.11 Distinguish between hypogeal and epigeal germination
3.0 Understand the mechanisms of osmosis and plasmolysis in plants	**Osmosis and Plasmolysis** 3.1 Define (a)Osmosis (b) Plasmolysis 3.2 Identify sites where osmosis and plasmolysis occur in plants.

	3.3 List the conditions necessary for osmosis and plasmolysis to take place. 3.4 Describe the mechanisms of osmosis and plasmolysis 3.5 Differentiate between osmosis and plasmolysis. 3.6 Carry out simple experiment to show how osmosis and plasmolysis take place in plants.
4.0 Understand the process of transpiration in plants	**Transpiration** 4.1 Define transpiration i plants. 4.2 Identify sites where transpiration takes place in plants. 4.3 Observe stomata and guard cells under the microscope. 4.4 Draw and label a stoma and its associated guard cell observed under a microscope. 4.5 Explain transpiration pull in plants
5.0 Understand the process of photosynthesis and respiration in plants.	**Photosynthesis and Respiration** 5.1 Define photosynthesis in plants. 5.2 Explain the process of photosynthesis in plants. 5.3 List the conditions necessary for photosynthesis to take place. 5.4 Carry put simple experiments to show that conditions listed in 5.3 above are necessary for photosynthesis. 5.5 Identify the parts of the plants where photosynthesis takes place. 5.6 Define respiration. 5.7 Explain how respiration takes place in all living cells. 5.8 Carry out simple experiments to show that (a) Oxygen is used up and (b) Carbon dioxide and heat are produced during respiration. 5.9 Differentiate between respiration and photosynthesis, with the aid of reversible equation. 5.10 Differentiate between respiration,

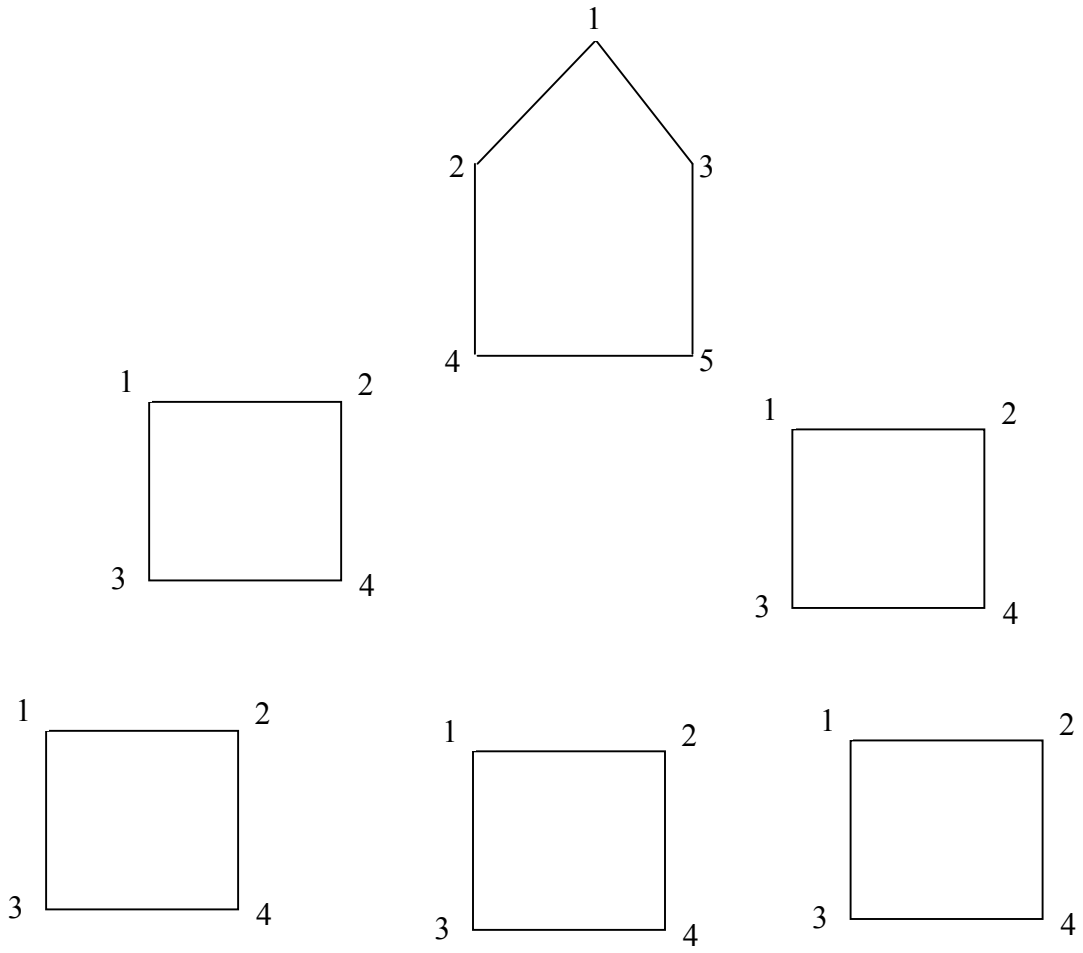
	combustion and fermentation.
6.0 Understand tropism in plants.	**Tropism** 6.1 Define tropism in plants. 6.2 List the different forms of tropism in plants. e.g phototropism, geotropism, chemo-tropism, hydrotropism, thigmotropism, tranmatropism and galvanotropism (or electropism). 6.3 Explain how each of the tropisms listed in 6.2 above takes place. 6.4 Carry out simple experiments to show that phototropism, geotropism, hydrotropism and chemotropism take place in plants. 6.5 Explain the role of auxins in plant tropisms. 6.6 Identify other types of movements in plants.
7.0 Understand the constituents, structure and characteristics of soil.	**Soil Features:** 7.1 List the constituents of the soil. 7.2 List the types of soil. 7.3 Outline the characteristics of each soil type. 7.4 Carry out simple experiments to determine soil profile by both sedimentation and digging methods. 7.5 Describe the process of soil formation. 7.6 Carry out simple experiments to relate soil structure to water retention capacity. 7.7 Determine experimentally the amount of air, water and humus i a given soil sample. 7.8 Compare capillarity and porosity of different soil samples by simple experiments.
8.0 Know the various methods of soil conservation and improvement.	**Soil Conservation** 8.1 Identify the various forms of soil erosion such as sheet, gully, wind, water and other forms by which the soil can lose its fertility by e.g. leaching, surface

	compacting (or reduction of aeration). 8.2 Describe ways of preventing soil erosion e.g vegetative protection (cover crops and trees), terracing, mulching, strip cropping and contouring of slopy ground. 8.3 Carry out a field trip to observe different forms of soil erosion. 8.4 Differentiate between the various forms of cultivation e.g. crop rotation, monocropping, mixed cropping, mixed farming, fallowing etc. 8.5 State and explain the roles of microorganisms in maintaining soil fertility (H_2O, CO_2 and Nitrogen cycles). 8.6 State the economic importance of each form of cultivation in 8.4 to soil. 8.7 Explain the importance of plant conservation (afforesting and creation of forest wildlife reserved).
9.0 Understand basic concepts of genetics.	**Basic Concepts of Genetics** 9.1 Explain the following terms i genetics (a) Gene (i) Back-cross (b) Chromosome (j) Complete and incomplete dominance (c) Dominance (k) Allele o allelemorphic pair (d) Recessive (L) Monohybrid cross (e) Hybrid (m) Dihybrid cross (f) (f) Genotype (o) Heterozygous (g) Phenotype (h) Filial generation (e.g. 1st, 2nd etc) 9.2 State and explain the mendelain laws 9.3 Sort out the results of simple monohybrid crosses using punet square. 9.4 Explain sex determination in

	mammals. 9.5 Explain the application of genetics in (a) Agriculture e.g. selection of high yielding and disease resistant varieties. (b) Health e.g. sickle cell anaemia, blood grouping, blood transfusion, haemophilia, etc.

APPENDIX SEVEN

Classroom layout of the STAD



Adapted from Galton and Williamson (1992)

APPENDIX EIGHT

Letter of Introduction

Faculty of Education
Ahmadu Bello University, Zaria

Ref. No:

Date: _____

_____
_____
_____
_____
_____

Dear Sir/Madam,

STUDENTS' FIELD RESEARCH (PERMISSION TO COLLECT DATA)

The Department of Education, Ahmadu Bello University, Zaria requires each postgraduate student to complete a research dissertation work. Our students entering the final year of their studies will be collecting data during the year.

This student therefore wishes to be allowed access to certain relevant documents and some valuable information you have. She may also need to use some periods in your school time table as well as your students. Your full assistance and cooperation is highly needed, please. The bearer, Mrs. R.R. Olarewaju is our Ph.D student. The title of her research work is "Effect of Cooperative Learning Strategy and Model on Achievement and Retention of Biology among Pre National Diploma Students in Kaduna State Technical Colleges".

Grateful for your anticipated cooperation.

Yours faithfully,

Signed 28/02/14
Dr. Alh. Isa Usman
Research Supervisor

APPENDIX NINE

LESSON PLAN

COOPERATIVE LEARNING STRATEGY WITH MODELS

Lesson one

Class:	Pre National Diploma Biology
Time:	2 hrs
No. of students	25
Sex:	Mixed
Topic	Osmosis
Sub-Topic	Understanding the mechanism of osmosis in plants

Instructional objectives

At the end of the lesson, students should be able to:

1. define osmosis,
2. identify sites where osmosis occur,
3. differentiate between permeable and semi permeable membranes,
4. list conditions necessary for osmosis to take place,
5. differentiate between isotonic, hypertonic and hypotonic media,
6. define turgidity and describe turgor pressure,
7. state the usefulness of turgidity to the plant.

Instructional materials

Models of root hairs in the soil, transparent plastic container, wire gauze, polystyrene balls (–big & small,) and water.

Potato strips, sugar solution of different concentrations, and weighing balance.

Students' worksheets.

Previous knowledge: The students have studied the process of diffusion (movement of molecules from a place of higher concentration to a place of lower concentration).

Phase I Presentation

The teacher introduces the topic, states the objectives of the lesson as above.

He presents the background information on the topic such as the definition of osmosis, where it occurs, permeable and semi permeable membranes, conditions for osmosis to take place, and different media. Terms such as turgidity and turgor pressure are explained. The students are shown the **model** of root hair in the soil and this is used to illustrate the process of osmosis. The teacher explains the use of model as a representative of the real system.

Phase II Team Study

The students are shared into cooperative learning groups. They are to observe the following cooperative activity principles, which are permanently pasted on the classroom board.

1. Students have the responsibility to make sure that their teammates have learned the material.
2. No one is finished studying until all *teammates* have mastered the subject.
3. Ask all teammates for help before asking the teacher.
4. Teammates may talk to each other *softly*.

Activity 1: Title Osmosis in living Tissue

The students are given worksheets and **models** of root hair and are given instructions as follows.

You are provided with following:

- 6 labeled cups with one cup containing 100 cm^3 of one of the following:

1 distilled water, 2m glucose solution, 4m glucose solution, 6m glucose solution, 8m and 1m glucose solutions respectively.

- 6 solid rods of potato tissues (3cm each in length), weighing balance,
- Weigh each of the potatoes before investigation.
- Put one potato tissue in each of the cups containing the glucose solution and one in the distilled water.
- Allow the cups to stand for 1 hour
- Now measure the length and weight of each and record the length of the potatoes from each cup .Tabulate your result.

(a) Which potato is the longest? _____

(b) Which potato has the least weight? _____

(c) Which solution allowed water into the potato _____

(d) When the cells of the potatoes can no longer take in more water, they are described as being _____

(e) The uptake of water through the roots occurs by _____

(f) In osmosis, water passes from a region of _____ to _____

(g) The tissue through which water moves is described as being _____ because it allows water to pass through and not the _____

(h) What type of solution around a cell would allow movement of solvent from outside to inside the cell _____

(i) Name the solution that would cause water from the cell sap to move outside the cell? _____

(j) What is the effect of an isotonic solution on a cell ? _____

Phase III Test / Evaluation

The students are given tests, which they do individually. They are not to discuss with anyone. The test is marked individually. The scores are awarded and the total for each group is added.

a. What is osmosis? .....

……

b. Name one importance of osmosis……

c. Which part of the plant does osmosis takes place? .....

d. What is a semi permeable membrane? .....

……

e. In osmosis, water moves from a place of ……concentration, to a place of …… concentration

f. Turgor pressure is ……

……

g. The pressure exerted on the cell sap by the cell wall is referred to as……

Phase IV: Reward / Team Recognition

Team averages are reported in the weekly recognition chart. The teacher can use special words to describe the team's performance such as *science stars, science geniuses, or Einstein's.*

As the winning teams are praised, others are encouraged to do better.

Conclusion

The lesson is concluded by the activity to be carried out by the students as follows;

Activity 2

Construction of a model to demonstrate osmosis

You are provided with a transparent plastic container, polystyrene beads of two sizes, tap water, wire gauze cut to size the plastic container. Use these to construct a model of osmosis as shown in the chart provided.

Lesson Two

Class:	Pre National Diploma Biology
Time:	2 hrs
No. of students	25
Sex:	Mixed
Topic	Osmosis
Sub-Topic	Understanding the mechanism of osmosis in plants

Instructional Objectives

At the end of the lesson, the students should be able to

1. define osmotic pressure,
2. describe suction pressure,
3. list the forces that contribute to the upward movement of water from the root to the other parts of the plant,
4. demonstrate the process of osmosis using plant tissue.

Instructional materials

Models of root hairs in the soil, and of a set up of osmosis process with yam tissue.

A piece of yam tuber, sugar solution, distilled water, and a trough for each team.

Previous knowledge

The students can define osmosis, list the sites of osmosis and conditions leading to the process of osmosis in plants.

Phase I - Presentation

The teacher introduces the lesson by asking questions on the previous lesson on osmosis – What is osmosis? Where does osmosis take place?

The teacher states the topic, and the objectives of the lesson as above.

He uses the **model** of the root hair to illustrate his points as he presents the background information on the topic. What is root pressure, suction pressure, mechanical pull, and the functions of each of these forces in the transportation of water in the plant.

Phase II Team Study

Cooperative Activities with model

The students are shared into their different cooperative learning teams.

They are to observe the following cooperative activity principles, which are permanently pasted on the classroom board.

1. Students have the responsibility to make sure that their teammates have learned the material.
2. No one is finished studying until all *teammates* have mastered the subject.
3. Ask all teammates for help before asking the teacher.
4. Teammates may talk to each other *softly*.

Activity I

The models of the root hair in the soil will be given to each group

You are given a **model** of osmosis process; (diagram of yam tuber being used to demonstrate osmosis), observe and compare it to the diagram of the osmosis in the root hair in the soil.

Record your observation…….....

…….1.

Observe the flow of water from the soil into the root hair (A) Movement, when much water is taken into the root hair, you describe the state of the cell as being

_____

What is the name of the pressure exerted by the cell sap on the cell wall?

_____

A cell in the above condition is said to be _____

When the cell wall is fully stretched, it exerts a pressure on the cell sap, this pressure is called _____

The water in the xylem vessels may be forced upwards by a pressure known as…….

When plant cell loses water, their turgor pressure falls and they become ……..

……

Phase III Test / Evaluation

The students are given tests, which they do individually. They are not to discuss with anyone. The test is marked individually. The scores are awarded and the total for each group is added.

1. What is osmotic pressure?.....
   ……..
2. What is suction pressure?.....
   …….
3. In the process of osmosis, the yam tissue is the ……. membrane
4. When the solutions outside and inside and outside of the yam tissues are of equal strength the two solutions are said to be ……..

Phase IV: Reward / Team Recognition

Team averages are reported in the weekly recognition chart. The teacher can use special words to describe the team's performance such as *science stars, science geniuses, or Einstein's.*

As the winning teams are praised, others are encouraged to do better.

Conclusion

To conclude the lesson, the different groups are to carry out the activity that follows.

Activity II

You are provided with a piece of yam tuber, a knife, salt solution, distilled water, and a trough. Set up an experiment just like the one in the model. Leave this for about two hours and record your observations.

Report the experiment using the format:

Title

Aim/Objective,Materials, Drawing, Procedure, Observation/Results, Conclusion

Lesson Three

Class:	Pre National Diploma Biology
Time:	2 hrs
No. of students	25
Sex:	Mixed
Topic:	Plasmolysis
Sub topic:	Understanding the mechanism of plasmolysis

Instructional Objectives

At the end of the lesson, the students should be able to

1. define plasmolysis.
2. explain the conditions for plasmolysis to take place.
3. state the practical application of plasmolysis.
4. demonstrate the process of plasmolysis in plants using spirogyra filaments and potato strips.
5. describe the effect of plasmolysis on the cell and on the plant.
6. describe how a cell and plant can be deplasmolysed.

Instructional Materials

A large model showing the process of plasmolysis in spirogyra.

Filaments of spirogyra, microscope, plain slides, 30% sodium chloride solution, six pieces of equal lengths of potato strips, different concentrations of salt solution.

Previous knowledge

Students know that when cells are immersed in a solution of lower concentration than the cell sap, there is absorption of water into the cell (e.g. potato cells) and the cells become turgid. This is also what happens to the root hairs in the soil – osmosis.

Phase I - Presentation

The teacher asks the class to define osmosis,

State the condition for osmosis to occur.

The teacher then introduces the new topic and the objectives of the lesson.

The teacher, using the **model of plasmolysis** to illustrate, gives background information on plasmolysis. The model comprised of a normal turgid cell and a plasmolysed cell of spirogyra

A phenomenon whereby plants lose water from the protoplasm with the contents pulling off the cell wall and collapsing is termed plasmolysis.

The teacher explains further that the cell has to be in a medium of higher concentration (hypertonic solution). Plasmolysis therefore is ex-osmosis.

For plasmolysis to take place the cell has to be in hypertonic solution; there should also be a semi permeable membrane.

When plasmolysed, water is lost from the protoplasm, the contents of the cell pull off the cell wall and the cell wall collapses.

Plasmolysis leads to wilting of plants cells.

However, the cell can be deplasmolysed if it is quickly returned into a hypotonic solution (i.e. lower concentration, such as distilled water.

Phase II Team Study Cooperative Activity with model

Students fall into their various cooperative learning groups, collect their worksheets III, and other working materials

They are to observe the following cooperative activity principles, which are permanently pasted on the classroom board.

1. Students have the responsibility to make sure that their teammates have learned the material.
2. No one is finished studying until all *teammates* have mastered the subject.
3. Ask all teammates for help before asking the teacher.
4. Teammates may talk to each other *softly.*

Activity I

Mount a few filaments of spirogyra in pond water and observe under the low power microscope

What do you observe? _____

What is the state of the cells as observed? _____

With a piece of blotting paper, remove the pond water and replace it with concentrated salt solution.

- What do you observe _____
- What caused the change in the spirogyra cell?_____
- _____
- What would happen if the filament of the spirogyra is placed in distilled water _____

What would happen if this state continues for a long time _____

Activity II

You are given 2 sucrose solutions of different concentrations (1m & .8m) and 2 strips of potato of equal size and weight;

Weigh each potato strip; Record the weight .

Weight	1	2	3
Before			
After			

Immerse each strip in different concentration of sucrose solution for 1 hour.

Remove the potato strips from the solution and quickly blot and weigh them.

Record your observation as shown in the table.

Which of the potato strips increase in weight? _____

Which of the potato strips decrease in weight? _____

How do you describe the condition of the potato strip immersed in higher concentration of glucose _____

1. When water enters the cell vacuole, it increases the amount of cell sap. This creates a condition, which makes the cell wall rigid and stretched. This state of the cell is known as turgidity and the cell is described as being turgid. What is the importance of this state of the cell? _____

2. What name is given to a cell that has lost water and therefore has become weak, limp and soft?

_____

3. Which of the above two phenomena is likely to happen to the plant naturally?

_____

4. How does the plant avoid the adverse effect of this state? _____

Phase III Test / Evaluation

The students are given tests, which they do individually. They are not to discuss with anyone. The test is marked individually. The scores are awarded and the total for each group is added. The students are asked these questions

1. What is plasmolysis?
2. Under what condition does plasmolysis take place?
3. What did you observe when you place spirogyra in a NaCl solution?
4. What happens when a cell is plasmolysed?
5. How can we de-plasmolysed a cell?

Phase IV: Reward / Team Recognition

Team averages are reported in the weekly recognition chart. The teacher can use special words to describe the team's performance such as *science stars, science geniuses, or Einstein's.*
As the winning teams are praised, others are encouraged to do better.

Conclusion

The teacher concludes the lesson by summarizing the main points of the lesson .

Lesson Four

Class:	Pre National Diploma Biology
Time:	2 hrs
No. of students,,	25
Sex:	Mixed
Topic	Transpiration
Sub-Topic	Understanding the process of transpiration in plants

Instructional Objectives

By the end of the lesson, the students should be able to

1. define transpiration.
2. identify the types/ sites of transpiration in plant.
3. identify the leaf as a major organ of transpiration.
4. state the functions of stomata and guard cells in the process of transpiration.
5. observe, draw and label stomata and guard cells

Instructional materials

Models of a transpiring tree and of stomata and guard cells.

Worksheets for the students. Bell jars, two twigs, (one without leaves), oil, and two glass sheets.

Previous knowledge

The students know that in the process of osmosis, water is absorbed into the plant through the root.

Phase I Presentation

The teacher asks the class questions such as

i. By what process does water enter into the roots of plant?

ii. How does the water get to the upper parts of the plant?

iii. What happens to the water in the plant – specifically in the leaves?

The teacher tells the class the topic also states the objectives of the lesson – Transpiration

With the aid of the **models,** the teacher gives background information on the lesson, which includes the definition of transpiration, sites of transpiration, structure of stomata and guard cells,

the distribution of stomata in the leaves. Others are functions of stomata in the process of transpiration, and the process of transpiration in the plant. He explains that transpiration occurs mainly through the leaves.

Phase II Team Study Students Activities

The students all go into their different cooperative learning teams. They are to observe the following cooperative activity principles, which are permanently pasted on the classroom board

1. Students have the responsibility to make sure that their teammates have learned the material.
2. No one is finished studying until all *teammates* have mastered the subject.
3. Ask all teammates for help before asking the teacher.
4. Teammates may talk to each other *softly*.

Activity I Transpiration occurs through leaves.

You are provided with **models of a tree showing the process of transpiration.** Examine the model carefully.

Water which is lost from plants in form of ……...

……. is responsible for the opening and closing of stomata.

In the model of stomata provided what is the difference between stoma A and B?

What is the role of guard cells in the process of transpiration?.....

……

Activity II

You are provided with two bell jars, two beakers, oil, two leafy shoots, and two glass sheets. With these, set up the experiment as shown in the diagram provided. Leave it in a bright room for a few hours and observe what has taken place.

Activity III

Make a labeled drawing of stomata and guard cells.

Phase III Test/Evaluation

The students are given tests, which they do individually. They are not to discuss with anyone. The test is marked individually. The scores are awarded and the total for all members of each group become the group mark.

The students are asked these questions in order to assess their understanding of the lesson.

1. What is transpiration?.....
2. Name the different types of transpiration.

   (i)…… (ii)…… and (iii)…… …

3. Where does transpiration occur in the plant?.....

   4. When the guard cells are……, the stoma opens, but when the guard cells are ……., the stoma closes.

.

Phase IV: Reward / Team Recognition

Team averages are reported in the weekly recognition chart. The teacher can use special words to describe the team's performance such as *science stars, science geniuses, or Einstein's.*

As the winning teams are praised, others are encouraged to do better.

Conclusion

The teacher concludes the lesson by summarizing the main points of the lesson . He asks the students questions. The response of the students to the questions forms the lesson summary, which the students now write in their notes.

Lesson Five	**Cooperative Learning Strategy with model**
Class:	Pre National Diploma Biology
Time:	2hrs
No. of students	25
Sex:	Mixed
Topic	Transpiration
Sub-Topic	Understanding the process and significance of transpiration in plants

Instructional Objectives

At the end of the lesson, the students should be able to

1. differentiate between transpiration stream, transpiration pull and root pressure
2. state the significance of transpiration
3. identify the side of the leaf with more stomata
4. use cobalt chloride paper in detecting the presence of water vapour
5. describe an experiment to show which of the two leaf surfaces show more transpiration.

Instruction Materials

Models of a transpiring tree and of stomata and guard cells.

Chart of stomata and guard cells

Cobalt chloride paper, 5 amaranthus leaves, cotton wool, adhesive tape, forceps, scissors, clock or watch, and glass marking pen.

Previous knowledge:

The students can define transpiration and name the sites of transpiration in the place – such as stomata, cuticle and lenticels. They know that transpiration takes place mainly from the leaves.

Phase I Presentation

The teacher starts the lesson by asking the following questions:

What is transpiration?

Name the different types of transpirations that occur in the plant

Name one important structure in the leaf or young stem which aids transpiration.

The teacher then introduces the topic, and the objectives of the lesson.

He gives the background information on the following; transpiration stream, transpiration pull, and root pressure. He states the significance of transpiration to the plant.

Phase II Team Study . Cooperative learning strategy with model.

The students assume their places in the different working teams. They collect their worksheets and other materials. The students all go into their different cooperative learning teams. They are to observe the following cooperative activity principles, which are permanently pasted on the classroom board

1. Students have the responsibility to make sure that their teammates have learned the material.
2. No one is finished studying until all *teammates* have mastered the subject.
3. Ask all teammates for help before asking the teacher.
4. Teammates may talk to each other *softly.*

Activity I : Which side of the leave transpires more water?

- With this activity, you are to investigate the side of the leaf that transpires more water vapour.
- You are provided with the following materials: Cobalt chloride, leaf of amaranthus, forcep and adhesive tape, take the amaranthus leaf, and with a forcep, put a piece of cobalt chloride paper on the upper surface and cover with piece of adhesive tape. Put the second piece of cobalt chloride paper on the lower surface, and cover with tape. Put a third piece of cobalt chloride paper on the bench surface, exposed to air.
- How long did it take the cobalt chloride paper on the upper surface to change from blue to pink color because of absorbing water? _____
- how long on the lower surface _____

Activity II

Take four amaranthus leaves and number them 1 – 4. Use the cotton wool to apply a thin, continuous layer of Vaseline over the surface of these leaves as follows:

1. Leaf 1. Untreated, Leaf 2, grease upper surface,
2. Leaf 3: grease lower surface, leaf 4 , grease both surfaces
3. Weigh each leaf as soon as Vaseline is applied and record the mass. Place the leaves on a dry warn place. At intervals of 15 mins, over a period of 45 mins, reweigh the leaves and record their masses. Tabulate your result. What is the total mass of water lost in 45 mins from:

- Leaf 1 _____
- Leaf 2 _____
- Leaf 3 _____
- Leaf 4 _____

1. Which side of a leaf transpires more water _____
2. Write 'true' or 'false' when one side of a leaf is covered with Vaseline, the side covered will transpire more water ----------
3. What chemical is used to detect the presence of water _____
4. In the presence of water, cobalt chloride paper changes from _____ to _____color.
5. Which of the papers changed color faster ? _____
6. Why did it change color faster than the other one? _____
7. What has caused the change in color? _____

Phase III Test/Evaluation

The students are given tests, which they do individually. They are not to discuss with anyone. The test is marked individually. The scores are awarded and the total for all members of each group become the group mark.

1. What is transpiration stream? ….....
   …….
2. Transpiration pull is…….
   ……
3. Root pressure is……
4. One significance of transpiration is…….
5. …….. is used in detecting the presence of water vapour.

Phase IV Reward/ Team Recognition

Team averages are reported in the weekly recognition chart. The teacher can use special words to describe the team's performance such as *science stars, science geniuses, or Einstein's.*

As the winning teams are praised, others are encouraged to do better.

Conclusion

The teacher concludes the lesson by summarizing the main points of the lesson. He asks the students questions. The response of the students forms the lesson summary.

Lesson Six

Class:	Pre National Diploma Biology
Time:	2 hrs
No. of students	25
Sex:	Mixed
Topic	Transpiration
Sub-Topic	Understanding the process and significance of transpiration in plants.

Instructional Objectives

By the end of the lesson, the students should be able to:

1. name the different conditions that affect the rate of transpiration.
2. examine the different conditions that affect the rate of transpiration.
3. state the use of potometer in the process of transpiration.

Instructional materials

A model of potometer

A leafy twig, a conical flask, a pipette ($1cm^3$), clamp, and a stand

A chart showing potometer

Previous knowledge

- The students know that water is lost from the leaf surface.
- Cobalt chloride glass is used in detecting the presence of water vapour.
- Transpiration has biological significance in the life of plant.

Phase I Presentation

The teacher asks questions from the previous lesson.

Name two importance of transpiration in the plant .

The teacher introduces the topic and the objectives of the lesson.

The teacher gives the background information.

Water is being constantly lost from the plant through the leaves. This loss depends on so many factors both internal and external. The number and distribution of the stomata in the leaves is an important internal factor. The external factors include light, wind, temperature, and humidity.

The potometer is an apparatus for measuring the rate of water uptake (i .e the rate at which water is absorbed by the plant) and the effect of the different conditions. The teacher used the **model** and the potometer in different parts of the classroom to illustrate his points.

Phase II Team Study Students' cooperative activities using model .

The class is shared into their learning teams. They are to observe the following cooperative activity principles, which are permanently pasted on the classroom board.

1. Students have the responsibility to make sure that their teammates have learned the material.
2. No one is finished studying until all *teammates* have mastered the subject.
3. Ask all teammates for help before asking the teacher.
4. Teammates may talk to each other *softly.*

Team Study

Observe the model of potometer provided for each team.

What is the use of the apparatus? _____

With the materials provided set up similar apparatus

Introduce air bubble into the apparatus

Take note of how long it takes the bubble to travel from point A to B

Return the bubble to point A or introduce another bubble and place the potometer under different conditions and note the time the bubble travels from point A to B, or take note of the distance travelled every 2 minutes under different conditions.

Condition	The distance water moves along the capillary take every 2 mins.[in cm]
Placing the plant by an electric fan	
humid environment covering the plant with polystyrene	
Raise the temperature by keeping near a radiator	
Blocking the stomata by smearing with Vaseline	
Still air in the light	
Still air in the dark	

What does this apparatus measure? _____

Give four conditions that would conditions that would affect the rate at which a plant loses water

_____

How would you measure the rate of water loss? _____

In which set of conditions did the plant lose water the most slowly _____

Why is it so? _____

1. Loss of water through small pores, called _____ in the leaves is a _____

2. Changes in turgor pressure in guard cells, which open and close pores in the leaves, are mainly the result of movements of _____ which cause an increase in turgor pressure when they move _____ a guard cell and a decrease in turgor pressure when they move _____ a guard cell

3. Transpiration is _____ by higher air temperatures, _____

   By higher air humidities, _____ by having stomata on the underside of leaves, _____ by acid metabolism _____ by hairs, _____ by wind, and _____ by having sunken stomata.

4. The stomata of most plants _____ in the evening.

Phase III Test/Evaluation

The students are given tests, which they do individually. They are not to discuss with anyone. The test is marked individually. The scores are awarded and the total for all members of each group become the group mark.

1. List the different conditions that affect the rate of transpiration in plant

……..……..

…….

…….

……

……

…….

2. The apparatus used in measuring the rate of water uptake is……

3. From your observation, where do you have a faster rate of transpiration on the ordinary bench or on the windowpane? .....

Phase IV Reward/ Team Recognition

Team averages are reported in the weekly recognition chart. The teacher can use special words to describe the team's performance such as *science stars, science geniuses, or Einstein's.*

As the winning teams are praised, others are encouraged to do better.

Conclusion

The teacher concludes the lesson by summarizing the main points of the lesson. He asks the students oral questions. The response of the students to the questions forms the lesson summary, which the students now write in their notes.

APPENDIX TEN

LESSON PLANS FOR THE COOPERATIVE LEARNING STRATEGY

Lesson one

Class:	Pre National Diploma Biology
Time:	2 hrs
No. of students	25
Sex:	Mixed
Topic	Osmosis
Sub-Topic	Understanding the mechanism of osmosis in plants

Instructional objectives

At the end of the lesson, students should be able to

1. define osmosis
2. identify sites where osmosis occur
3. differentiate between permeable and semi permeable membranes
4. list conditions necessary for osmosis to take place
5. differentiate between isotonic, hypertonic and hypotonic media.
6. define turgidity and describe turgor pressure
7. state the usefulness of turgidity to the plant

Instructional materials

Potato strips, sugar solution of different concentrations, and weighing balance.

Students' worksheets.

Previous knowledge: The students have studied the process of diffusion (movement of molecules from a place of higher concentration to a place of lower concentration).

Phase I Presentation

The teacher introduces the topic, states the objectives of the lesson as above.

He presents the background information on the topic such as the definition of osmosis, where it occurs, permeable and semi permeable membranes, conditions for osmosis to take place, and different media. Terms such as turgidity and turgor pressure are explained.

Phase II Team Study

The students are shared into cooperative learning groups. They are to observe the following cooperative activity principles, which are permanently pasted on the classroom board .

1. Students have the responsibility to make sure that their teammates have learned the material.
2. No one is finished studying until all *teammates* have mastered the subject.
3. Ask all teammates for help before asking the teacher.
4. Teammates may talk to each other *softly.*

Activity 1: Title Osmosis in living Tissue

The students are given worksheets and are given instructions as follows.

You are provided with following:

- 6 labeled cups with one cup containing 100 cm^3 of one of the following:

  1 distilled water, .2m glucose solution .4m glucose solution

  .6m glucose solution, .8m and 1m glucose solutions respectively.

- 6 solid rods of potato tissues (3cm each in length), weighing balance,
- Weigh each of the potatoes before investigation.
- Put one potato tissue in each of the cups containing the glucose solution and one in the distilled water.
- Allow the cups to stand for 1 hour
- Now measure the length and weight of each and record the length of the potatoes from each cup .Tabulate your result.

(a) Which potato is the longest?_____

(b) Which potato has the least weight?_____

(c) Which solution allowed water into the potato_____

(d) When the cells of the potatoes can no longer take in more water, they are described as being _____

The uptake of water through the roots occurs by _____

In osmosis, water passes from a region of _____ to _____

The tissue through which water moves is described as being _____ because it allows water to pass through and not the _____

What type of solution around a cell would allow movement of solvent from outside to inside the cell _____

Name the solution that would cause water from the cell sap to move outside the cell? _____

What is the effect of an isotonic solution on a cell? _____

Phase III Test / Evaluation

The students are given tests, which they do individually. They are not to discuss with anyone. The test is marked individually. The scores are awarded and the total for each group is added.

a. What is osmosis? .....
……

b. Name one importance of osmosis……

c. Which part of the plant does osmosis takes place? .....

d. What is a semi permeable membrane? .....
……

e. In osmosis, water moves from a place of ……concentration, to a place of …… concentration

f. Turgor pressure is ……
……

g. The pressure exerted on the cell sap by the cell wall is referred to as……

Phase IV: Reward / Team Recognition

Team averages are reported in the weekly recognition chart. The teacher can use special words to describe the team's performance such as *science stars, science geniuses, or Einstein's.*

As the winning teams are praised, others are encouraged to do better.

Conclusion

The lesson is concluded by the

Lesson Two

Class:	Pre National Diploma Biology
Time:	2 hrs
No. of students	25
Sex:	Mixed
Topic	Osmosis
Sub-Topic	Understanding the mechanism of osmosis in plants

Instructional Objectives

At the end of the lesson, the students should be able to

1. define osmotic pressure
2. describe suction pressure
3. list the forces that contribute to the upward movement of water from the root to the other parts of the plant.
4. demonstrate the process of osmosis using plant tissue

Instructional materials

A set up of osmosis process with yam tissue.

A piece of yam tuber, sugar solution, distilled water, and a trough for each team.

Previous knowledge

The students can define osmosis, list the sites of osmosis and conditions leading to the process of osmosis in plants.

Phase I - Presentation

The teacher introduces the lesson by asking questions on the previous lesson on osmosis – What is osmosis? Where does osmosis take place?

The teacher states the topic, and the objectives of the lesson as above.

He presents the background information on the topic. What is root pressure, suction pressure, mechanical pull, and the functions of each of these forces in the transportation of water in the plant.

Phase II Team Study

Cooperative Activities

The students are shared into their different cooperative learning teams.

They are to observe the following cooperative activity principles, which are permanently pasted on the classroom board.

1. Students have the responsibility to make sure that their teammates have learned the material.
2. No one is finished studying until all *teammates* have mastered the subject.
3. Ask all teammates for help before asking the teacher.
4. Teammates may talk to each other *softly.*

Activity I

The models of the root hair in the soil will be given to each group

You are provided with diagram of yam tuber being used to demonstrate osmosis, observe and compare it to the diagram of the osmosis in the root hair in the soil.

Record your observation…….....

…….

Observe the flow of water from the soil into the root hair (A) Movement, when much water is taken into the root hair, you describe the state of the cell as being _____

What is the name of the pressure exerted by the cell sap on the cell wall? _____

A cell in the above condition is said to be _____

When the cell wall is fully stretched, it exerts a pressure on the cell sap, this pressure is called _____

The water in the xylem vessels may be forced upwards by a pressure known as……

When plant cell loses water, their turgor pressure falls and they become ……

……

Phase III Test / Evaluation

The students are given tests, which they do individually. They are not to discuss with anyone. The test is marked individually. The scores are awarded and the total for each group is added.

1. What is osmotic pressure?.....

……..

2. What is suction pressure?.....

…….

3. In the process of osmosis, the yam tissue is the ……. membrane

4. When the solutions outside and inside and outside of the yam tissues are of equal strength the two solutions are said to be ……..

Phase IV: Reward / Team Recognition

Team averages are reported in the weekly recognition chart. The teacher can use special words to describe the team's performance such as *science stars, science geniuses, or Einstein's.*

As the winning teams are praised, others are encouraged to do better.

Conclusion

To conclude the lesson, the different groups are to carry out the activity that follows.

Activity II

You are provided with a piece of yam tuber, a knife, salt solution, distilled water, and a trough. Set up an experiment just like the one in the model. Leave this for about two hours and record your observations.

Report the experiment using the format:

Title

Aim/Objective,Materials, Drawing, Procedure, Observation/Results, Conclusion.

Lesson Three

Class:	Pre National Diploma Biology
Time:	2 hrs
No. of students	25
Sex:	Mixed
Topic:	Plasmolysis
Sub topic:	Understanding the mechanism of plasmolysis

Instructional Objectives

At the end of the lesson, the students should be able to

1. define plasmolysis.
2. explain the conditions for plasmolysis to take place.
3. state the practical application of plasmolysis.
4. demonstrate the process of plasmolysis in plants using spirogyra filaments and potato strips.
5. describe the effect of plasmolysis on the cell and on the plant.
6. describe how a cell and plant can be deplasmolysed.

Instructional Materials.

Filaments of spirogyra, microscope, plain slides, 30% sodium chloride solution, six pieces of equal lengths of potato strips, different concentrations of salt solution.

Previous knowledge

Students know that when cells are immersed in a solution of lower concentration than the cell sap, there is absorption of water into the cell (e.g. potato cells) and the cells become turgid. This is also what happens to the root hairs in the soil – osmosis.

Phase I - Presentation

The teacher asks the class to define osmosis,

State the condition for osmosis to occur.

The teacher then introduces the new topic and the objectives of the lesson.

The teacher gives background information on plasmolysis.

A phenomenon whereby plants lose water from the protoplasm with the contents pulling off the cell wall and collapsing is termed plasmolysis.

The teacher explains further that the cell has to be in a medium of higher concentration (hypertonic solution). Plasmolysis therefore is ex-osmosis.

For plasmolysis to take place the cell has to be in hypertonic solution; there should also be a semi permeable membrane.

When plasmolysed, water is lost from the protoplasm, the contents of the cell pull off the cell wall and the cell wall collapses.

Plasmolysis leads to wilting of plants cells.

However, the cell can be deplasmolysed if it is quickly returned into a hypotonic solution (i.e. lower concentration, such as distilled water.

Phase II Team Study Cooperative Activity with model

Students fall into their various cooperative learning groups, collect their worksheets III, and other working materials

They are to observe the following cooperative activity principles, which are permanently pasted on the classroom board.

Students have the responsibility to make sure that their teammates have learned the material.

1 No one is finished studying until all *teammates* have mastered the subject.
2 Ask all teammates for help before asking the teacher.
3 Teammates may talk to each other *softly*.

Activity I

Mount a few filaments of spirogyra in pond water and observe under the low power microscope

1. What do you observe _____

2. What is the state of the cells as observed?_____

3. With a piece of blotting paper, remove the pond water and replace it with concentrated salt solution.

What do you observe?

1. What caused the change in the spirogyra cell? _____

2. What would happen if the filament of the spirogyra is placed in distilled water _____

3. What would happen if this state continues for a long time _____

Activity II

You are given 2 sucrose solutions of different concentrations (1m & .8m) and 2 strips of potato of equal size and weight;

Weigh each potato strip; Record the weight.

Weight	1	2	3
Before			
After			

Immerse each strip in different concentration of sucrose solution for 1 hour.

Remove the potato strips from the solution and quickly blot and weigh them.

Record your observation as shown in the table.

Which of the potato strips increase in weight? _____

Which of the potato strips decrease in weight? _____

How do you describe the condition of the potato strip immersed in higher concentration of glucose _____

1. When water enters the cell vacuole, it increases the amount of cell sap. This creates a condition, which makes the cell wall rigid and stretched. This state of the cell is known as turgidity and the cell is described as being turgid. What is the importance of this state of the cell? _____
2 What name is given to a cell that has lost water and therefore has become weak, limp and soft? _____

3. Which of the above two phenomena is likely to happen to the plant naturally? _____

4. How does the plant avoid the adverse effect of this state? _____

Phase III Test / Evaluation

The students are given tests, which they do individually. They are not to discuss with anyone. The test is marked individually. The scores are awarded and the total for each group is added. The students are asked these questions

1. What is plasmolysis?
2. Under what condition does plasmolysis take place?
3. What did you observe when you place spirogyra in a NaCl solution?
4. What happens when a cell is plasmolysed?
5. How can we de-plasmolysed a cell?

Phase IV: Reward / Team Recognition

Team averages are reported in the weekly recognition chart. The teacher can use special words to describe the team's performance such as *science stars, science geniuses, or Einstein's.*
As the winning teams are praised, others are encouraged to do better.

Conclusion

The teacher concludes the lesson by summarizing the main points of the lesson.

Lesson Four

Class:	Pre National Diploma Biology
Time:	2 hrs
No. of students,,	25
Sex:	Mixed
Topic	Transpiration
Sub-Topic	Understanding the process of transpiration in plants

Instructional Objectives

By the end of the lesson, the students should be able to

1. define transpiration.
2. identify the types/ sites of transpiration in plant.
3. identify the leaf as a major organ of transpiration.
4. state the functions of stomata and guard cells in the process of transpiration.
5. observe, draw and label stomata and guard cells

Instructional materials

Worksheets for the students. Bell jars, two twigs, (one without leaves), oil, and two glass sheets.

Previous knowledge

The students know that in the process of osmosis, water is absorbed into the plant through the root.

Phase I Presentation

The teacher asks the class questions such as

iv. By what process does water enter into the roots of plant?

v. How does the water get to the upper parts of the plant?

vi. What happens to the water in the plant – specifically in the leaves?

The teacher tells the class the topic also states the objectives of the lesson – Transpiration

The teacher gives background information on the lesson, which includes the definition of transpiration, sites of transpiration, structure of stomata and guard cells, the distribution of stomata in the leaves. Others are functions of stomata in the process of transpiration, and the

process of transpiration in the plant. He explains that transpiration occurs mainly through the leaves.

Phase II Team Study Students Activities

The students all go into their different cooperative learning teams. They are to observe the following cooperative activity principles, which are permanently pasted on the classroom board

4. Students have the responsibility to make sure that their teammates have learned the material.
5. No one is finished studying until all *teammates* have mastered the subject.
6. Ask all teammates for help before asking the teacher.

4. Teammates may talk to each other *softly*.

Activity I Transpiration occurs through leaves.

You are provided with **drawing of a transpiring tree, use it for the following activities**

Water is lost from plants in form of …….

…….. is responsible for the opening and closing of stomata

In the diagram of stomata provided what is the difference between stoma A and B?

What is the role of guard cells in the process of transpiration?.....

……

Activity II

You are provided with two bell jars, two beakers, oil, two leafy shoots, and two glass sheets. With these, set up the experiment as shown in the diagram provided. Leave it in a bright room for a few hours and observe what has taken place.

Activity III

Make a labeled drawing of stomata and guard cells.

Phase III Test/Evaluation

The students are given tests, which they do individually. They are not to discuss with anyone. The test is marked individually. The scores are awarded and the total for all members of each group become the group mark.

The students are asked these questions in order to assess their understanding of the lesson.

1. What is transpiration?.....
2. Name the different types of transpiration.

   (i)…… (ii)…… and (iii)…… …

3. Where does transpiration occur in the plant?.....

4. When the guard cells are……., the stoma opens, but when the guard cells are ……., the stoma closes.

.

Phase IV: Reward / Team Recognition

Team averages are reported in the weekly recognition chart. The teacher can use special words to describe the team's performance such as *science stars, science geniuses, or Einstein's.*

As the winning teams are praised, others are encouraged to do better.

Conclusion

The teacher concludes the lesson by summarizing the main points of the lesson. He asks the students questions. The response of the students to the questions forms the lesson summary, which the students now write in their notes.

Lesson Five	**Cooperative Learning Strategy**
Class:	Pre National Diploma Biology
Time:	2hrs
No. of students	25
Sex:	Mixed
Topic	Transpiration
Sub-Topic	Understanding the process and significance of transpiration in plants

Instructional Objectives

At the end of the lesson, the students should be able to

1. differentiate between transpiration stream, transpiration pull and root pressure,
2. state the significance of transpiration,
3. identify the side of the leaf with more stomata,
4. use cobalt chloride paper in detecting the presence of water vapour,
5. describe an experiment to show which of the two leaf surfaces show more transpiration.

Instruction Materials

Chart of stomata and guard cells

Cobalt chloride paper, 5 amarathus leaves, cotton wool, adhesive tape, forceps, scissors, clock or watch, and glass marking pen.

Previous knowledge:

The students can define transpiration and name the sites of transpiration in the place – such as stomata, cuticle and lenticels. They know that transpiration takes place mainly from the leaves.

Phase I Presentation

The teacher starts the lesson by asking the following questions:

What is transpiration?

Name the different types of transpirations that occur in the plant

Name one important structure in the leaf or young stem which aids transpiration.

The teacher then introduces the topic, and the objectives of the lesson.

He gives the background information on the following; transpiration stream, transpiration pull, and root pressure. He states the significance of transpiration to the plant.

Phase II Team Study. Cooperative learning strategy

The students assume their places in the different working teams. They collect their worksheets and other materials. The students all go into their different cooperative learning teams. They are to observe the following cooperative activity principles, which are permanently pasted on the classroom board

1. Students have the responsibility to make sure that their teammates have learned the material.
2. No one is finished studying until all *teammates* have mastered the subject.
3. Ask all teammates for help before asking the teacher.
4. Teammates may talk to each other *softly*.

Activity I : Which side of the leaf transpires more water?

With this activity, you are to investigate the side of the leaf that transpires more water vapour.

You are provided with the following materials: Cobalt chloride, leaf of amaranthus, forcep and adhesive tape. Take the amaranthus leaf, and with a forcep, put a piece of cobalt chloride paper on the upper surface and cover with piece of adhesive tape. Put the second piece of cobalt chloride paper on the lower surface, and cover with tape. Put a third piece of cobalt chloride paper on the bench surface, exposed to air.

- How long did it take the cobalt chloride paper on the upper surface to change from blue to pink color because of absorbing water? _____
- How long on the lower surface _____

Activity II

Take four amaranthus leaves and number them 1 – 4. Use the cotton wool to apply a thin, continuous layer of Vaseline over the surface of these leaves as follows:

- Leaf 1. Untreated, Leaf 2, grease upper surface,

- Leaf 3: grease lower surface, leaf 4 , grease both surfaces
- Weigh each leaf as soon as Vaseline is applied and record the mass. Place the leaves on a dry warn place. At intervals of 15 mins, over a period of 45 mins, reweigh the leaves and record their masses. Tabulate your result. What is the total mass of water lost in 45 mins from:

1. Leaf 1 _____
2. Leaf 2 _____
3. Leaf 3 _____
4. Leaf 4 _____
5. Which side of a leaf transpires more water _____
6. Write 'true' or 'false' when one side of a leaf is covered with Vaseline, the side covered will transpire more water ----------
7. What chemical is used to detect the presence of water _____
8. In the presence of water, cobalt chloride paper changes from _____ to _____color.
9. Which of the papers changed color faster? _____
10. Why did it change color faster than the other one? _____
11. What has caused the change in color? _____

Phase III Test/Evaluation

The students are given tests, which they do individually. They are not to discuss with anyone. The test is marked individually. The scores are awarded and the total for all members of each group become the group mark.

1. What is transpiration stream?
   …….....…….……
2. Transpiration pull is……..
   ……
3. Root pressure is……
4. One significance of transpiration is……
5. …….. is used in detecting the presence of water vapour.

Phase IV Reward/ Team Recognition

Team averages are reported in the weekly recognition chart. The teacher can use special words to describe the team's performance such as *science stars, science geniuses, or Einstein's.*

As the winning teams are praised, others are encouraged to do better.

Conclusion

The teacher concludes the lesson by summarizing the main points of the lesson. He asks the students questions. The response of the students forms the lesson summary.

Lesson Six

Class:	Pre National Diploma Biology
Time:	2 hrs
No. of students	25
Sex:	Mixed
Topic	Transpiration
Sub-Topic	Understanding the process and significance of transpiration in plants.

Instructional Objectives

By the end of the lesson, the students should be able to:

1. name the different conditions that affect the rate of transpiration.
2. examine the different conditions that affect the rate of transpiration.
3. state the use of potometer in the process of transpiration.

Instructional materials

A leafy twig, a conical flask, a pipette ($1cm^3$), clamp, and a stand

A chart showing potometer

Previous knowledge

- The students know that water is lost from the leaf surface.
- Cobalt chloride glass is used in detecting the presence of water vapour.
- Transpiration has biological significance in the life of plant.

Phase I Presentation

The teacher asks questions from the previous lesson.

Name two importance of transpiration in the plant .

The teacher introduces the topic and the objectives of the lesson.

The teacher gives the background information.

Water is being constantly lost from the plant through the leaves. This loss depends on so many factors both internal and external. The number and distribution of the stomata in the leaves is an important internal factor. The external factors include light, wind, temperature, and humidity.

The potometer is an apparatus for measuring the rate of water uptake (i .e the rate at which water is absorbed by the plant) and the effect of the different conditions.

Phase II Team Study Students' cooperative activities

The class is shared into their learning teams. They are to observe the following cooperative activity principles, which are permanently pasted on the classroom board.

1. Students have the responsibility to make sure that their teammates have learned the material.
2. No one is finished studying until all *teammates* have mastered the subject.
3. Ask all teammates for help before asking the teacher.
4. Teammates may talk to each other *softly*.

Team Study

Observe the model of potometer provided for each team.

What is the use of the apparatus? _____

With the materials provided set up similar apparatus

Introduce air bubble into the apparatus

Take note of how long it takes the bubble to travel from point A to B

Return the bubble to point A or introduce another bubble and place the potometer under different conditions and note the time the bubble travels from point A to B, or take note of the distance travelled every 2 minutes under different conditions.

Condition	The distance water moves along the capillary take every 2 mins.[in cm]
Placing the plant by an electric fan	
humid environment covering the plant with polystyrene	
Raise the temperature by keeping near a radiator	
Blocking the stomata by smearing with Vaseline	
Still air in the light	
Still air in the dark	

What does this apparatus measure? _____

Give four conditions that would conditions that would affect the rate at which a plant loses water

_____

How would you measure the rate of water loss? _____

In which set of conditions did the plant lose water the most slowly _____

Why is it so _____

1. Loss of water through small pores, called _____ in the leaves is a _____

2. Changes in turgor pressure in guard cells, which open and close pores in the leaves, are mainly the result of movements of _____ which cause an increase in turgor pressure when they move _____ a guard cell and a decrease in turgor pressure when they move _____ a guard cell

3. Transpiration is _____ by higher air temperatures, _____

   By higher air humidities, _____ by having stomata on the underside of leaves, _____ by acid metabolism _____ by hairs, _____ by wind, and _____ by having sunken stomata.

4. The stomata of most plants _____ in the evening.

Phase III Test/Evaluation

The students are given tests, which they do individually. They are not to discuss with anyone. The test is marked individually. The scores are awarded and the total for all members of each group become the group mark.

1. List the different conditions that affect the rate of transpiration in plant

……..

……

……

……

……

……

2. The apparatus used in measuring the rate of water uptake is……

3. From your observation, where do you have a faster rate of transpiration on the ordinary bench or on the windowpane? …….....

Phase IV Reward/ Team Recognition

Team averages are reported in the weekly recognition chart. The teacher can use special words to describe the team's performance such as *science stars, science geniuses, or Einstein's.*

As the winning teams are praised, others are encouraged to do better.

Conclusion

The teacher concludes the lesson by summarizing the main points of the lesson . He asks the students oral questions. The response of the students to the questions forms the lesson summary, which the students now write in their notes.

APPENDIX ELEVEN

LESSON PLANS

THE LECTURE WITH MODEL LEARNING STRATEGY

Lesson one

Class:	Pre National Diploma Biology
Time:	2 hrs
No. of students	25
Sex:	Mixed
Topic	Osmosis
Sub-Topic	Understanding the mechanism of osmosis in plants

Instructional objectives

At the end of the lesson, students should be able to

1. define osmosis
2. identify sites where osmosis occur
3. differentiate between permeable and semi permeable membranes
4. list conditions necessary for osmosis to take place
5. differentiate between isotonic, hypertonic and hypotonic media.
6. define turgidity and describe turgor pressure
7. state the usefulness of turgidity to the plant.

Instructional materials

Models of root hairs in the soil, transparent plastic container, wire gauze, polystyrene balls (big & small,) and water.

Previous knowledge: The students have studied the process of diffusion (movement of molecules from a place of higher concentration to a place of lower concentration).

Presentation - Lecture with model

The teacher introduces the topic, states the objectives of the lesson as above.

He presents the background information on the topic such as the definition of osmosis, where it occurs, permeable and semi permeable membranes, conditions for osmosis to take place, and

different media. Terms such as turgidity and turgor pressure are explained. The students are shown the **model** of root hair in the soil and this is used to illustrate the process of osmosis. The teacher explains the use of model as a representative of the real system.

Students Activities

The students are allowed to ask questions from the teacher and respond to the teacher's questions.

Evaluation:

The teacher asks the class questions on what has been taught such as:

- What is osmosis?
- Where does osmosis occur?
- What type of membrane will allow osmosis to take place?

Conclusion: The class response together with the teacher's assistance form the summary of the lesson, the class then writes down the summary of the main points of the lesson.

Lesson Two **Lecture with model strategy.**

Class: Pre National Diploma Biology

Time: 2 hrs

No. of students 25

Sex: Mixed

Topic Osmosis

Sub-Topic Understanding the mechanism of osmosis in plants

Instructional Objectives

At the end of the lesson, the students should be able to

1. define osmotic pressure
2. describe suction pressure
3. list the forces that contribute to the upward movement of water from the root to the other parts of the plant.
4. demonstrate the process of osmosis using plant tissue

Instructional materials

Models of root hairs in the soil, and of a set up of osmosis process with yam tissue.

Previous knowledge

The students can define osmosis, list the sites of osmosis and conditions leading to the process of osmosis in plants.

Presentation

The teacher introduces the lesson by asking questions on the previous lesson on osmosis – What is osmosis? Where does osmosis take place?

The teacher states the topic, and the objectives of the lesson as above.

He uses the **model** of the root hair to illustrate his points as he presents the background information on the topic. The meaning of root pressure, suction pressure, mechanical pull, and the functions of each of these forces in the transportation of water in the plant.

You are given a **model** of osmosis process; observe and compare it to the diagram of the osmosis in the root hair in the soil.

Record your observation…….....

…….

Evaluation

The teacher asks the class questions:

- What is osmosis?
- Where does osmosis occur?
- What type of membrane will allow osmosis to take place?

Conclusion: The class response together with the teacher's assistance, form the summary of the lesson, the class then writes down the summary of the main points of the lesson.

Lesson Three

Class:	Pre National Diploma Biology
Time:	2 hrs
No. of students	25
Sex:	Mixed
Topic:	Plasmolysis
Sub topic:	Understanding the mechanism of plasmolysis

Instructional Objectives

At the end of the lesson, the students should be able to

1. define plasmolysis.
2. explain the conditions for plasmolysis to take place.
3. state the practical application of plasmolysis.
4. demonstrate the process of plasmolysis in plants using spirogyra filaments and potato strips.
5. describe the effect of plasmolysis on the cell and on the plant.
6. describe how a cell and plant can be deplasmolysed.

Instructional Materials

A large model showing the process of plasmolysis in spirogyra.

Previous knowledge

Students know that when cells are immersed in a solution of lower concentration than the cell sap, there is absorption of water into the cell (e.g. potato cells) and the cells become turgid. This is also what happens to the root hairs in the soil – osmosis.

Presentation

The teacher asks the class to define osmosis,

State the condition for osmosis to occur.

The teacher then introduces the new topic and the objectives of the lesson.

The teacher, using the **model of plasmolysis** to illustrate, gives background information on plasmolysis. The model comprised of a normal turgid cell and a plasmolysed cell.

A phenomenon whereby plants lose water from the protoplasm with the contents pulling off the cell wall and collapsing is termed plasmolysis.

The teacher explains further that the cell has to be in a medium of higher concentration (hypertonic solution). Plasmolysis therefore is ex-osmosis.

For plasmolysis to take place the cell has to be in hypertonic solution; there should also be a semi permeable membrane.

When plasmolysed, water is lost from the protoplasm, the contents of the cell pull off the cell wall and the cell wall collapses

Plasmolysis leads to wilting of plants cells.

However, the cell can be deplasmolysed if it is quickly returned into a hypotonic solution (i.e. lower concentration such as distilled water.

Evaluation

The students are asked questions.

What is plasmolysis?

Under what condition does plasmolysis take place?

What happens when you place spirogyra in a NaCl solution?

What happens when a cell is plasmolysed?

How can we de-plasmolysed a cell?

Conclusion

The teacher concludes the lesson by summarizing the main points of the lesson .

Lesson Four

Class:	Pre National Diploma Biology
Time:	2 hrs
No. of students,,	25
Sex:	Mixed
Topic	Transpiration
Sub-Topic	Understanding the process of transpiration in plants

Instructional Objectives

By the end of the lesson, the students should be able to

1. define transpiration.
2. identify the types/ sites of transpiration in plant.
3. identify the leaf as a major organ of transpiration.
4. state the functions of stomata and guard cells in the process of transpiration.
5. observe, draw and label stomata and guard cells

Instructional materials

Models of a transpiring tree and of stomata and guard cells.

Previous knowledge

The students know that in the process of osmosis, water is absorbed into the plant through the root.

Presentation

The teacher asks the class questions such as

By what process does water enter into the roots of plant?

How does the water get to the upper parts of the plant?

What happens to the water in the plant – specifically in the leaves?

The teacher tells the class the topic also states the objectives of the lesson – Transpiration.

With the aid of the **models,** the teacher gives background information on the lesson, which includes the definition of transpiration, sites of transpiration, structure of stomata and guard cells,

the distribution of stomata in the leaves. Others are, functions of stomata in the process of transpiration, and the process of transpiration in the plant. He explains that transpiration occurs mainly through the leaves.

Student's activities

The students make drawing of stomata and guard cells, label the drawing and answer questions from the teacher.

Evaluation

The teacher asks the class these questions on the lesson:

- What is transpiration?
- Where does transpiration occur in the plant?
- Which cells of the plant support the opening of the stomata?
- What is the function of the stomata in the process of transpiration?

Conclusion: The teacher recapitulates the main points of the lesson and allows the students to write the notes using the main objectives of the lesson.

Assignment:

Students are to read more about transpiration in preparation for the next lesson.

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Lesson Five	**Lecture with Model Learning Strategy**
Class:	Pre National Diploma Biology
Time:	2hrs
No. of students	25
Sex:	Mixed
Topic	Transpiration
Sub-Topic	Understanding the process and significance of transpiration in plants

Instructional Objectives

At the end of the lesson, the students should be able to

1. differentiate between transpiration stream, transpiration pull and root pressure
2. state the significance of transpiration
3. identify the side of the leaf with more stomata
4. use cobalt chloride paper in detecting the presence of water vapour
5. describe an experiment to show which of the two leaf surfaces show more transpiration.

Instruction Materials

Models of a transpiring tree and of stomata and guard cells.

Previous knowledge:

The students can define transpiration and name the sites of transpiration in the place – such as stomata, cuticle and lenticels. They know that transpiration takes place mainly from the leaves.

Lesson introduction:

The teacher asks the class what is transpiration. Where does transpiration take place in plant?

Presentation:

Step I: The teacher presents the lesson topics and the objectives

The teacher explains the meaning of the following: Transpiration stream, transpiration pull and root pressure.

Step II: The teacher lists and explains the significance/importance of transpiration such as:

-Loss of excess water.

-Continuous flow of water is encouraged.

-Supply of water to every cell of the plant.

-Encourages the entry of more inorganic salt.

-Has cooling effect on the plant.

Step III: The teacher explains that the liquid given out by a transpiring plant is water. The presence of water can be detected by the use of cobalt chloride paper.

Students Activities

The students are to observe the **model** of a transpiring tree to see how water is being absorbed and lost by plants.

Evaluation:

The teacher asks the students to:-

- list the importance of transpiration to the plant.

- name the material used in detecting the presence of water vapour on the leaves.

- define transpiration stream, transpiration pull and root pressure.

Conclusion:

The teacher summarizes the main points of the lesson and the students write out the lesson summary.

Assignment:

The students are to read more on experiments on transpiration in their textbooks.

Lesson Six

Class:	Pre National Diploma Biology
Time:	two hrs
No. of students	25
Sex:	Mixed
Topic	Transpiration
Sub-Topic	Understanding the process and significance of transpiration in plants

Instructional Objectives

By the end of the lesson, the students should be able to:

1. name the different conditions that affect the rate of transpiration.
2. describe the different conditions that affect the rate of transpiration.
3. state the use of potometer in the process of transpiration.

Instructional materials

A model of potometer

Previous knowledge

- The students know that water is lost from the leaf surface.
- Cobalt chloride glass is used in detecting the presence of water vapour.
- Transpiration has biological significance in the life of plant.

Introduction

The teacher asks questions from the previous lesson

- Name two importance of transpiration in the plant

Presentation

The teacher introduces the topic and the objectives of the lesson

The teacher gives the background information.

Water is being constantly lost from the plant through the leaves. This loss depends on so many factors both internal and external. The number and distribution of the stomata in the leaves is an important internal factor. The external factors include light, wind, temperature, and humidity.

The potometer is an apparatus for measuring the rate of water uptake (i .e the rate at which water is absorbed by the plant) and the effect of the different conditions. The teacher uses the **model** of the potometer in the classroom to illustrate his points.

Evaluation

-What are the different conditions that affect the rate of transpiration in plant?
-Name the apparatus used in measuring the rate of water uptake, which amounts to the rate of water loss during transpiration?
-from your observation, where do you have a faster rate of transpiration on the ordinary bench or on the windowpane?

Conclusion

The teacher concludes the lesson by summarizing the main points of the lesson. He asks the students oral questions. The response of the students to the questions forms the lesson summary, which the students now write in their notes.

APPENDIX TWELVE

LESSON NOTES FOR THE CONTROL GROUP

LECTURE METHOD

Lesson one

Class:	Pre National Diploma Biology
Time:	2 hr
No. of students	25
Sex:	Mixed
Topic	Osmosis
Sub-Topic	Understanding the mechanism of osmosis in plants

Instructional objectives

At the end of the lesson, students should be able to

1. define osmosis
2. identify sites where osmosis occur
3. differentiate between permeable and semi permeable membranes
4. list conditions necessary for osmosis to take place
5. differentiate between isotonic, hypertonic and hypotonic media
6. describe the mechanism of osmosis in plant cell
7. define turgidity and describe turgor pressure
8. state the usefulness of turgidity to the plant

Instructional materials

Chalk and Board

Previous knowledge: The students already understand the concept of diffusion

Introduction: The teacher asks the students to define diffusion.

Presentation

Step I: The teacher present the topic (Osmosis) and the objectives of the lesson as stated above

Step II: The teacher then lectures the class as he presents the background information (knowledge) on the definition of osmosis, where osmosis occurs; permeable and semi permeable membrane, conditions necessary for osmosis to take place; differences in the isotonic, hypertonic and hypotonic media, mechanism of osmosis, Turgor pressure and Turgidity, usefulness of turgidity to the plant .

The teacher asks the class questions and responds to the students questions.

Students Activities

The students are allowed to ask questions from the teacher and respond to the teacher's questions.

Evaluation:

The teacher asks the class questions on what has been taught such as:

What is osmosis?

Where does osmosis occur?

What type of membrane will allow osmosis to take place?

Conclusion: The class response together with the teacher's assistance form the summary of the lesson, the class then writes down the summary of the main points of the lesson.

Lesson Two **LECTURE METHOD**

Class: Pre National Diploma Biology

Time: 2hrs

No. of students 25

Sex: Mixed

Topic Osmosis

Sub-Topic Understanding the mechanism of osmosis in plants

Instructional Objectives

At the end of the lesson, the students should be able to

1. define osmotic pressure
2. describe suction pressure
3. state the biological importance of osmosis
4. describe the process of osmosis

Previous knowledge

The students can define osmosis, the sites of osmosis and conditions leading to the process of osmosis in plants.

Introduction

The teacher asks questions on the previous lesson on osmosis – what is osmosis? Where does osmosis take place?

Presentation

Step I: The teacher presents the topic and the objectives of the lesson as stated above

Step II: The teacher describes to the class the meaning of suction pressure, osmotic pressure; the importance of osmosis to the plant.

Step III: The teacher further explains the process of osmosis in a living plant tissue.

Evaluation

The teacher asks the class questions on what has been taught such as:

- What is osmosis?
- Where does osmosis occur?
- What type of membrane will allow osmosis to take place?

Conclusion: The class response together with the teacher's assistance form the summary of the lesson, the class then writes down the summary of the main points of the lesson.

Lesson Three **LECTURE METHOD**

Class: Pre National Diploma Biology

Time: 2hr

No. of students 25

Sex: Mixed

Topic Plasmolysis

Sub-Topic Understanding the mechanism of Plasmolysis in plants

Instructional Objectives

By the end of the lesson, the students should be able to:

1. define plasmolysis
2. state the site of plasmolysis
3. explain the conditions for plasmolysis to take place
4. state the practical application of plasmolysis
5. describe how a cell can be deplasmolysed
6. describe the effect of plasmolysis on the cell and on the plant

Previous knowledge

Most students have witnessed plants witting and dying because of applying fertilizer to plants without adding enough water or no water at all.

Introduction

The teacher asks the class to define osmosis, and state the condition for osmosis to occur.

The teacher then introduces the new topic and the objectives of the lesson.

Presentation:

Step I: The teacher gives background information about plasmolysis such as the definition of plasmolysis.

A phenomenon whereby plants lose water from the protoplasm with the contents pulling off the cell wall and collapsing.

The teacher explains further that the cell has to be in a medium of higher concentration (hypertonic solution). Plasmolysis therefore is ex-osmosis.

For plasmolysis to take place the cell has to be in hypertonic solution; there should also be a semi permeable membrane.

Plasmolysis leads to the wilting of plant cell.

Plasmolysis leads to wilting of plants cells. However, the cell can be deplasmolysed if it is quickly returned into a hypotonic solution (i.e. lower concentration such as distilled water.

Step II: The teacher describes and demonstrates how plasmolysis takes place in living plants. Immersing spirogyra filaments in a solution of NaCl for a while and observing the contents of the cell under the microscope.

Students Activities

The students ask questions. The teacher and members of the class answer the questions in general.

Evaluation: The students are asked questions such as-

What is plasmolysis?

Under what condition does plasmolysis take place?

What happens when you place spirogyra in a NaCl solution?

What happens when a cell is plasmolysed?

How can we de-plasmolysed a cell?

Conclusion:

The students are to write the summary of the lesson.

Assignment:-

Students are to study a plant whereby fertilizer or manure has been applied without enough water and report their observation to the class.

Lesson 4 LECTURE METHOD

Class: Pre National Diploma Biology

Time: 2hr

No. of students 25

Sex: Mixed

Topic Transpiration

Sub-Topic: Understanding the process of transpiration in plants

Instructional Objectives

By the end of the lesson, the students should be able to

1. define transpiration
2. identify the types of transpiration in plant
3. state the functions of stomata and guard cells in the process of transpiration
4. explain the process of transpiration

Previous knowledge:

The students know the fact that water enters into the plant through the process of osmosis; water is also produced in the plant as a by-product of tissue respiration.

Introduction

The teacher asks the class what happens to the water taken in by the plant during the process of osmosis.

Presentation

Step I: The teacher introduces the topic and the objectives of the lesson

Step II: The teacher define what transpiration is

Step III: The teacher explains to the class the different sites of transpiration and that can be referred as the types of the particular transpiration stomatal, cuticular and lenticular.

Step IV: The teacher mentions that stomata transpiration is more recognized than the other two.

Step V: The teacher then defines the stomata, their distribution, structure of guard cells and the functions they perform in the process of gas exchange.

Step VI: The teacher explains the process of transpiration.

- Transpiration is a continuous process
- The internal calls, the parenchymatous cells lose water to the spaces between them especially what these spaces are humid. Through these, the water vapour finds its way to the atmosphere via the stomata, or article or the lenticels. As water continually leaves the content of the cells, it is replaced by water, which comes from the root setting up a kid of water current known as transpiration stream.

Student's activities

The students make drawing of stomata and guard cells, label the drawing and answer questions from the teacher.

Evaluation

The teacher asks the class these questions on the lesson:

- What is transpiration?
- Where does transpiration occur in the plant?
- Which cells of the plant support the opening of the stomata?
- What is the function of the stomata in the process of transpiration?

Conclusion: The teacher recapitulates the main points of the lesson and allows the students to write the notes using the main objectives of the lesson.

Assignment:

Students are to read more about transpiration in preparation for the next lesson.

Lesson Five	**LECTURE METHOD**
Class:	Pre National Diploma Biology
Time:	2hr
No. of students	25
Sex:	Mixed
Topic	Transpiration
Sub-Topic	Understanding the process and significance of transpiration in plants

Instructional Objectives

At the end of the lesson, the students should be able to

1. differentiate between transpiration stream, transpiration pull and root pressure
2. state the significance of transpiration
3. name cobalt chloride paper in detecting the presence of water vapour
4. describe an experiment to show that water is given off during transpiration.

Previous knowledge:

Students can define transpiration; list sites of transpiration can describe the process of transpiration.

Lesson introduction:

The teacher asks the class what is transpiration. Where does transpiration take place in plant?

Presentation:

Step I: The teacher presents the lesson topics and the objectives

The teacher explains the meaning of the following: Transpiration stream, transpiration pull and root pressure.

Step II: The teacher lists and explains the significance/importance of transpiration such as:

-Loss of excess water.

-Continuous flow of water is encouraged.

-Supply of water to every cell of the plant.

-Encourages the entry of more inorganic salt.

-Has cooling effect on the plant.

Step III: The teacher explains that the liquid given out by a transpiring plant is water. The presence of water can be detected by the use of cobalt chloride paper.

Evaluation:

- The teacher asks the students to
- list the importance of transpiration to the plant.
- name the material used in detecting the presence of water vapour on the leaves.
- define transpiration stream, transpiration pull and root pressure.

Conclusion:

The teacher summarizes the main points of the lesson and the students write out the lesson summary.

Assignment:

The students are to read more on experiments on transpiration in their textbooks.

Lesson Six	**LECTURE METHOD**
Class:	Pre National Diploma Biology
Time:	2hr
No. of students	25
Sex:	Mixed
Topic	Transpiration
Sub-Topic	Understanding the process and significance of transpiration in plants

Instructional Objectives

By the end of the lesson, the students should be able to:

1. name the different conditions that affect the rate of transpiration
2. describe the different conditions affecting the rate of transpiration
3. describe the use of photometer in the process of water uptake during transpiration.

Previous knowledge

The students know that water is given out of the leaf during the process of transpiration.

Introduction

The teacher asks the class what liquid lost into the atmosphere during transpiration. What instrument is used in detecting the presence of water?

Presentation:

Step I: The teacher tells the class the topic and the objectives of lesson.

Step II: The teacher tells the class that the rate at which transpiration (water loss) occurs depends on a number of factors and names such factors or conditions such as Light, Wind, Temperature and Humidity. The teacher explains the effect of each of these on the rate of transpiration.

Step III: The teacher describes the potometer as an apparatus for measuring the rate of water uptake (i .e the rate at which water is absorbed by the plant).

Evaluation:

The teacher asks the class

- What are the different conditions that affect the rate of transpiration in plant?
- Name the apparatus used in measuring the rate of water uptake, which amounts to the rate of water loss during transpiration?

Conclusion:

The teacher writes the lesson summary on different factors and their effects the rate of transpiration and specifically name potometer as an instrument used in the rate of water uptake during transpiration. The students copy the notes.

APPENDIX THIRTEEN

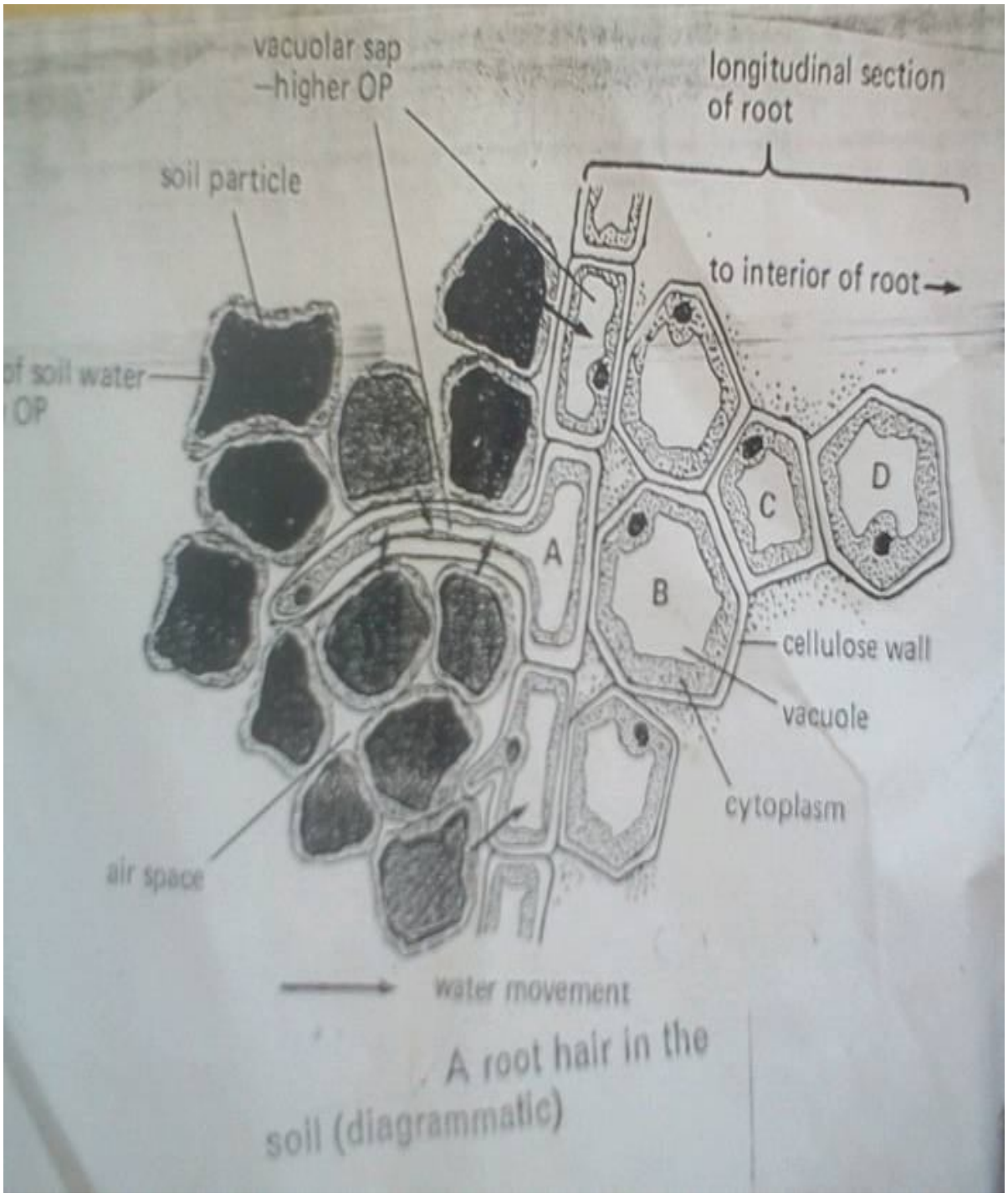


PLATE I: DIAGRAMATIC REPRESENTATION OF ROOT HAIR IN THE SOIL.

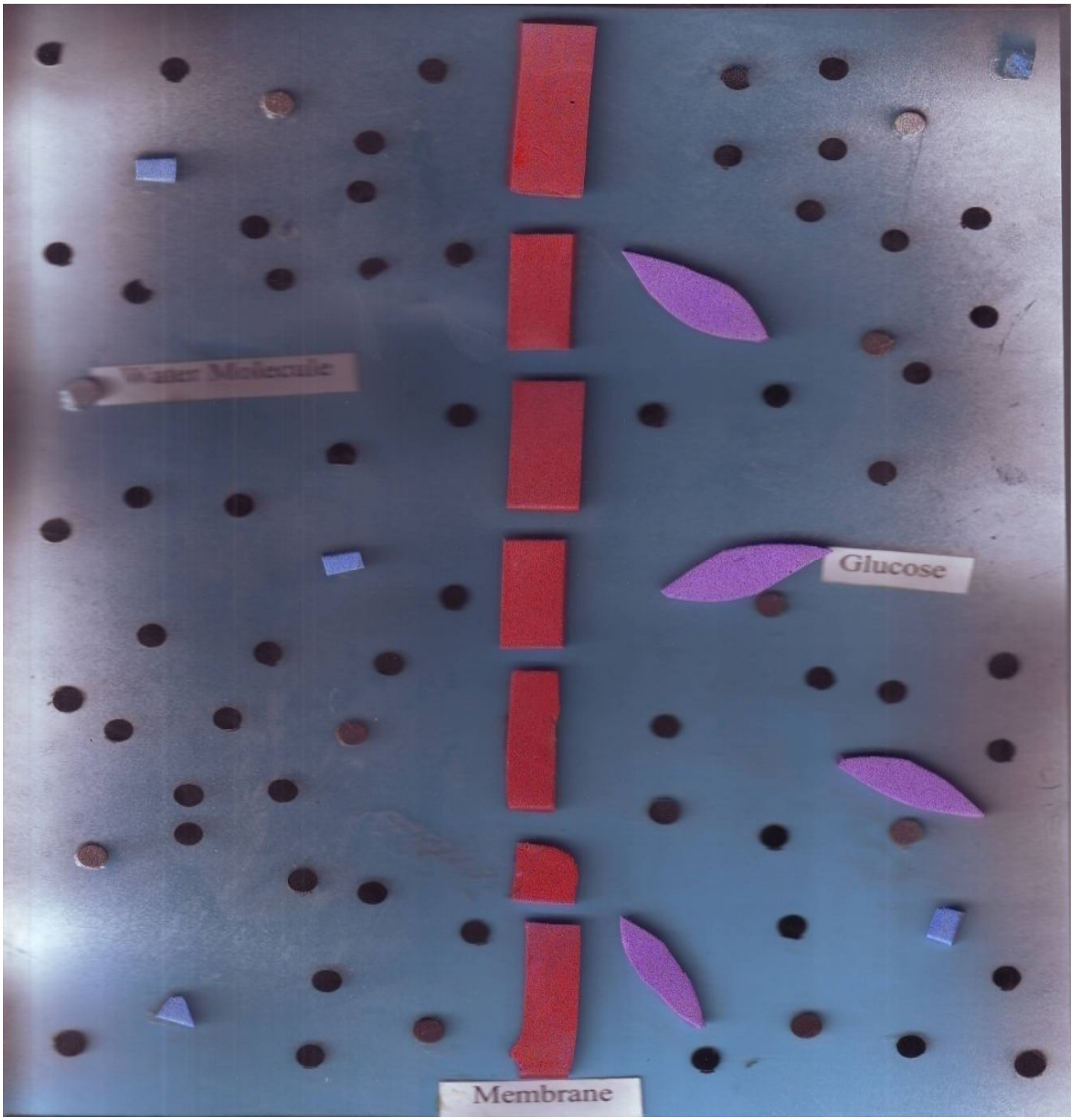


PLATE II: MODEL OF OSMOSIS PROCESS



PLATE III MODEL SHOWING OSMOTIC PROCESS



PLATE IV MODEL OF A TRANSPIRING TREE

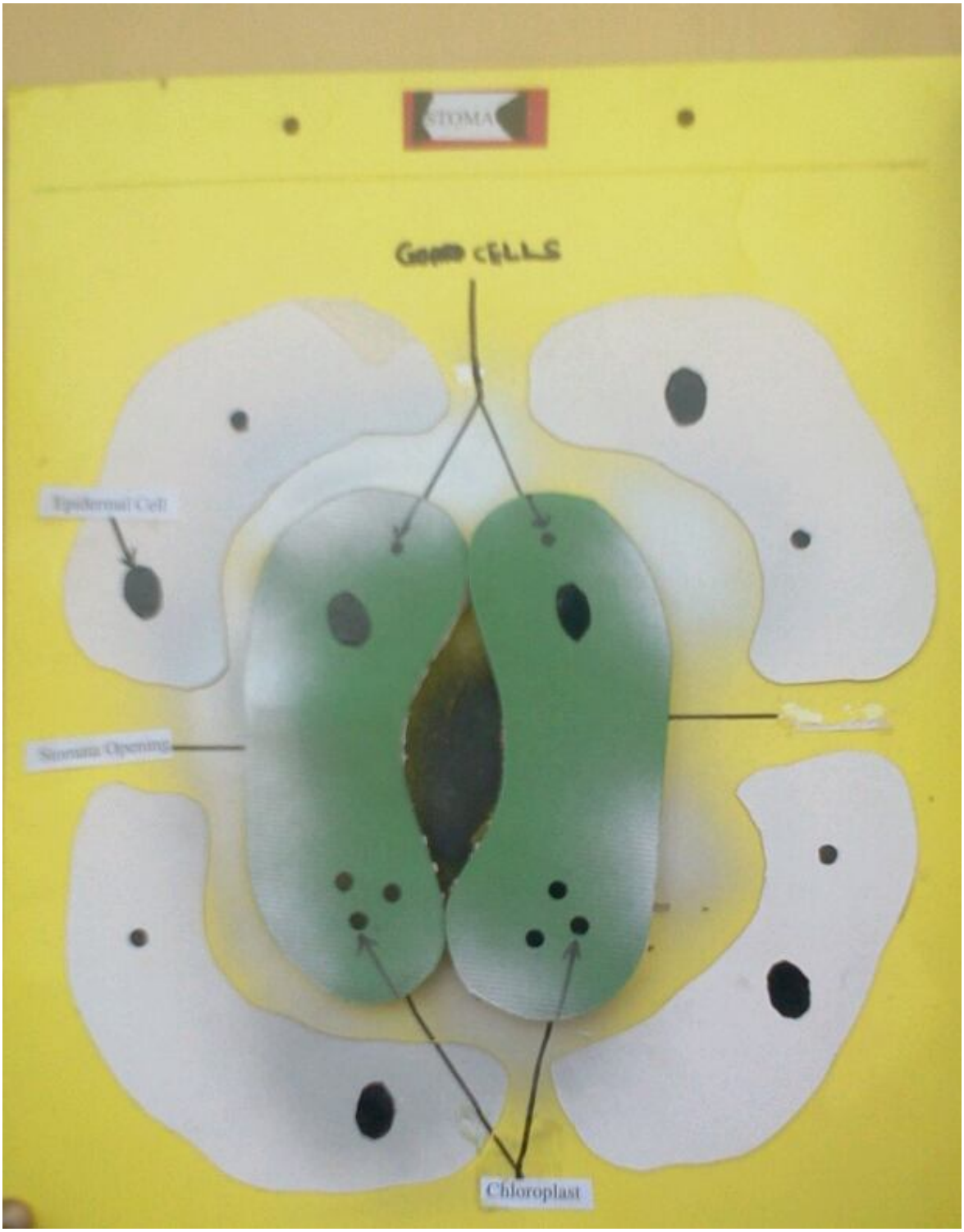


PLATE (V): MODEL OF GUARD CELLS WITH STOMA



PLATE (VI): MODEL OF POTOMETER