EFFECT OF LABORATORY INSTRUCTION ON BIOLOGY STUDENTS' ACADEMIC ACHIEVEMENT AND RETENTION IN SENIOR SECONDARY SCHOOLS IN JIGAWA STATE

BY

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APPROVAL PAGE

This research on "Effect Laboratory Instruction on Biology Students Academic Achievement and Retention in Senior Secondary Schools in Jigawa State" has been read and approved as meeting the requirement for the award of Master Degree in Science Education (M.Sc Ed Biology).

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CERTIFICATION

I certify that this research work was conducted, written and compiled by me. I also certify to the best of my knowledge this work has not been presented wholly or partially for the award of any degree or for publication elsewhere.

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DEDICATION

This research work is dedicated to my late father Alhaji IbrahimYandutse may his soul rest in perfect peace Ameen, and mother Hajiya Zainab Umar May Almighty reward her abundantly Ameen.

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LIST OF ABBREVIATIONS

BAT	Biology Achievement Test
CG	Control Group
EG	Experimental Group
FME	Federal Ministry of Education
GDSS	Government Day Secondary School
GDASS	Government Day Arabic Secondary School

DEFINITION OF OPERATIONAL TERMS

Academic Achievement: This is the assessment of how much students have learned, the extent to which a student has acquired certain information or mastered skill usually because of planned information or training.

Laboratory Instruction: Is a student centred, activity-oriented teaching strategy in which the teacher directs students through problem-solving approach to find out the truth of ideas, fact and assumption for confirmation or rejection.

Conventional Teaching Method: Is a teacher centred approach involving largely one way form of communication from the teacher to the student, in which the teacher delivers a lesson to the students with little or no active participation by the students.

Retention: refers to ability to store things experienced or learned. It also refers to ability of keeping and recalling past experienced, is an act of storing information and later recall when in need.

ABSTRACT

This study was carried out to determine the Effect of Laboratory Instruction on Biology students' Academic Achievement and Retention in Senior Secondary Schools in Jigawa state, Nigeria. Four research questions were formulated with their corresponding null hypotheses. The main objective of the study is to find out the effect of laboratory instruction on biology students academic achievement and retention in senior secondary school. The research design used for the study was the quasi-experimental design. The study population consisted of one thousand two hundred and twenty five (1225) SS ll Biology students drawn from the eleven senior secondary schools in Jahun Educational zone of Jigawa state. The sample of the study was made up of one hundred and thirty seven (137) SS ll intact class students chosen from two schools in the population as each school is having only single SS ll class. The two schools were chosen using purposive and simple random sampling techniques. One school was randomly assigned as experimental group who were taught using laboratory instruction while the other school as control group who were taught using conventional method. The two schools were both post test and post posttest to determine students' achievement and retention of Biology concept. The instrument used was adopted from West African Examination Council past question papers and validated for data collection was Biology Achievement Test (BAT). The reliability of the instrument was found to be 0.89. Data were collected and analyzed using mean and standard deviation to answer the research questions and t-test to test the hypotheses at 0.05 levels of significance. Finding from the hypotheses testing revealed a significance difference between the students exposed to laboratory instruction (experimental group) and those exposed to conventional method (control group) in favor of the experimental group academic achievement and retention of Biology concepts. There was however no significance difference in academic achievement and retention between male and female students exposed to laboratory instruction. Based on these results it was concluded that the laboratory instruction enhances better academic achievement and retention as well as gender friendly among Biology students than the conventional method at senior secondary schools. It was also recommended that teachers should use the laboratory instruction to teach biology in senior secondary schools as against the conventional method and ministry of Education should organize training and retraining workshops for Biology teachers in senior secondary schools on the use of laboratory instruction among others.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Biology is an integral part of science that focuses on living things (plants and animals). Biology is defined as the study of life and its evolution, of organisms and their structures, functions, processes, and interactions with each other and with their environments. Biology as a branch of science and prerequisite subject for many fields of learning, contributes immensely to the technological growth of the nation. This includes; medicine, forestry, nursing, agriculture, biotechnology and so on. The study of Biology in Senior Secondary School can equip Students with useful concepts, principles and theories that will enable them to face challenges (Abiodum and Victoria, 2013). By studying Biology, the students understand themselves and other organism as living things, the interaction between them and the non living things. Such knowledge is used to better the life of the individual. Biology is a vast and eclectic field, composed of many branches and sub-disciplines, these include; Evolutionary, Genetic, Molecular biology, Ecology Physiology and Anatomy (Yadav and Mishra, 2013).

The importance accorded Biology in the School curriculum from senior high level to tertiary level reflects accurately the vital role played by the subject in contemporary society. The importance of the subject is not restricted to the development of the individual alone, but for the advancement of the social, economic and political goals of countries all over the world. The general goals of Biology teaching is to equip the learner with the basic knowledge, skills and attitude that will enable one to lead an independent and useful life, both to himself/herself and the larger community in which he/she lives. Furthermore, one primary function of Biology teaching is to help the students understand biology concepts, principles, theories and laws.

Hence, the Federal Ministry of Education (FME, 2009), spell out the major objectives of the biology curriculum as:

1. Understanding of the structure and function of living organisms as well as appreciation of nature.
2. Acquisition of adequate laboratory and field skills in order to carry out and evaluate experiments and projects in Biology.
3. Acquisition of necessary scientific skills, for example observing, classifying and interpreting biological data.
4. Relevant knowledge in Biology needed for future advanced studies in biological science; acquisition of scientific attitude for problem solving.
5. Ability to apply biological principles in matters that affect personal, social environmental, community health and economic problems.

Laboratory has been defined and explained by different educationist. Oludipe (2006), stated that a place where practical activities take place is known as the laboratory.Ardo (2004) described the School Science laboratory as an instructional facility for helping students learn what Science is and how scientist work. Laboratory work is an indispensable part of science instruction, and no effective science education can exist without practical work (Udo, 2010). In support of the above statement, Nzewi (2008) asserted that practical activities can be regarded as a strategy that could be adopted to make teaching more real to the students as opposed to abstract or theoretical presentation of facts, principles and concepts of subject matters which characterize conventional teaching method. He also maintained that, practical activities should engage the students in hand-on, mind-on activities, using varieties of instructional materials to drive the lesson home. Nwagbo (2008) pointed out that, the use of practical activities (approach) to the

teaching of biological concepts should therefore be a rule rather than an option to the Biology teachers, if we hope to produce students that would be able to acquire necessary knowledge, skills and competence needed to meet the scientific and technological demand of nation.

Omiko (2015) observed that, laboratory instruction as an activity involving a two-way approach carried out by one or more persons through the exercise and experimental approaches both of which are usuful in science teaching. The experimental approach provides an opportunity for students to seek information using experimental procedures. These procedures call for careful observations and interpretation of data. It has the qualities of questioning, investigating and confronting the unknown. Laboratory instruction is describes as the process of guiding the student to find out truth of ideas, facts and assumptions for confirmation or rejection (Okoli, 2010). The rational in using laboratory instruction for teaching science is centred on the fact that if student are fully involved in activities and are challenge to produce results themselves they are more likely to learn more effectively than if they were simply told or presented with outcomes of experiments. The current trend in science curricular emphasis implies that science laboratory instruction should be taught as an integral part of classroom instruction in science with pre-and-post laboratory discussion (Udu, 2010). Okoli (2006) indicated that many Science teacher's prefer the traditional expository/lecture method of teaching that is, a teaching technique where one person, the teacher, presents a spoken discourse on a particular subject and do away from activity oriented teaching methods which are student centered (such as inquiry method, the discovery method, laboratory strategy). The persistent use of conventional method make students passive rather than active learners. It does not promote insightful learning and long term retention of any abstract concepts in biology, and emphasizes learning through the teacher's guidance at all times (Gambari, Yaki, Gana and Ughovwa, 2014). The use of conventional

method may be one of the factors that lead to poor academic performance of Senior Secondary School Students in Biology.

The performance of students in senior secondary Biology in Nigeria has remained consistently poor. In recent times, observations on student's academic performance in Biology, over the years in results of the Senior Secondary Certificate Examination (SSCE) conducted by West African Examination (WAEC) and National Examination Council (NECO) revealed that a very few number of students performed better in Biology Examination compared with other subjects, and as a result affected the academic aspirations of many candidate (Ogundiwin,Asaaju, Adegoke and Ojo 2015). In support of this,Statistical evidence reveals that the percentage of students that passed Biology at credit level and above (A1-C6) was consistently less 50% for the past 10 years between 2002 to 2012 in Nigeria (WAEC Chief Examiners Report cited in Ogundiwin,Asaaju, Adegoke and Ojo 2015). Also, according to the WAEC Chief Examiners Report (WAEC 2010, 2011 and 2012), the Senior Secondary School Biology candidates' have a number of problems associated with both cognitive and motor skills which have culminated in the poor performance of students in the secondary certificate Examinations (Umoke and Nwafor, 2014).

Table 1.1 Statistics of Result for may/June WASSCE Biology

Year	No. of Candidates sat	No. of Credit passes A1-C6	Percentage passes (%)
2009	1,340,206	453,928	33.84
2010	1,300,418	427,644	33.90
2011	1,505,199	579,432	38.50
2012	1,672,224	649,156	38.82
2013	1646741	850706	51.66

Source: Statistics Section, West African Examination Council (WAEC)

Retention is the ability to retain things experienced or learned. Olarewaju (2012), defined retention as the ability to store learned concepts which can be easily be recalled from the short and long term memory. Appropriate coding of information provides the index that may be consulted so that retention takes place without an elaborate search in the memory lane (Saidou, 2013). Laboratory instruction approach de-emphasizes rote-learning or memorization of scientific concepts and principles while emphasized acquisition of knowledge and skills through active participation under the guidance of a teacher (Nwagbo, 2008). In this approach students are availed the opportunity to interact with materials within the environment by observing, classifying, measuring, questioning, hypothesizing, collecting and interpreting data; accurate reporting, predicting and inferring. Laboratory instruction may help in the retention of learned concepts by providing anchorage between what the students already know and the intending learning task to be presented the learned.

Bichi (2002) defines gender as the amount of masculity and feminity found in person and obviously while there are mixtures of both in most human beings, the normal male has a preponderance of masculinity and normal female has a preponderance of feminity. Striving after academic achievement in science conflicts with the traditional female role in many societies. Right from childhood, a boy traditionally receives more training and encouragement for achievement than girls (Bichi, 2002). He maintained that, there is sex difference in subject choice and academic performance within subjects and that school subjects are sex- stereotype such that mathematics, physical science, computing and engineering for example are regarded as masculine subjects while humanities, languages, domestic subjects are regarded as feminine. Some findings indicated male superiority in science achievement (Ekeh, 2004, Ncharam, 2004,

Jacinta 2011) while others indicated female superiority in science achievement (shu'aibu and mari 1997, Galadima, 2003). Also other studies such as Ariyibi, (2004) and Udo, (2006) indicated zero effect of gender in student academic achievement in science. This group maintained that, if given the right conditions of teaching and learning both male and female would perform equally well in science Katcha and Wushishi, (2015). As such this, study was hopefully set to determine the effect of laboratory instruction in relation to gender on students' academic achievement and retention in Senior Secondary Schools in Jigawa state.

1.2 Statement of the Problem

The dwindling student's performance in Science especially biology has been a source of concern to all stakeholders – the parents, teachers, students, science educators, researcher, government and the general public. Despite the efforts by science educators such as biology teachers, Science Teachers Association of Nigeria (STAN), Researchers, In recent times, observations on student's academic performance in Biology, over the years in results of the senior secondary certificate Examination (SSCE) conducted by West African Examination (WAEC) and National Examination Council (NECO) revealed that, the percentage of students that passed Biology at credit level was consistently less than 50% for the past 10 years and as a result affected the academic aspirations of many candidate (WAEC Chief Examiners Report 2013 cited in Ogundiwin,Asaaju, Adegoke and Ojo 2015).Several studies have been conducted in and outside the shores of this country to investigate the causes of students' poor academic achievement in science particularly Biology and the most recurring factors in all the reports were; inefficient teaching strategy employed by the teachers, which is the conventional teaching strategy (Umar, 2011).In the same vein, other factors enumerated for failure in Biology

according to chief Examiners Report (2007) on Biology include drawing of poor diagrams with loss of details, non conformity to size specification in diagrams, wrong spellings of levels, omission of titles to diagrams, poor handwriting making their work illegible, poor numbering of questions, inability to relate structure to function, not writing magnification to diagrams, guidelines drawn with free hand and crossing each other (May/June 2007 WASSCE Report). Researchers such as Duniya (2016), Ezenduka (2014), Ibe (2002), Agommuoh and Ndirika (2014) have reported, with high degree of consistency, the effectiveness of laboratory instruction in achieving positive learning outcomes in several domains. The problem is can laboratory instruction improve students' academic achievement and retention in senior secondary school biology?

Consequently, this study was set to determine the effect of laboratory instruction on biology students' academic achievement and retention in Senior Secondary Schools in Jigawa State.

1.3 Objectives of the Study

The Objectives of this research work are as follows:

1. To find out the effect of laboratory instruction on Academic Achievement of students in Senior Secondary Schools of Jigawa State.
2. To find out gender differences (if any) on Academic Achievement between students taught using laboratory instruction.
3. To determine if the use of laboratory instruction can enhance the retention level of students when exposed to laboratory instruction or not.
4. To find out gender differences in retention scores between students taught using laboratory instruction.

1.4 Research Questions

The following research questions were put forward for answering:

1. What is the effect of laboratory instruction on academic achievement of students in Senior Secondary School Students of Jigawa State?
2. Is there any difference in academic achievement between male and female students taught using laboratory instruction?
3. Is there any difference in mean retention scores between students taught with laboratory instruction and those taught using conventional teaching method?
4. Is there any difference on mean retention scores between male and female students taught using laboratory instruction?

1.5 Research Hypotheses

The following null hypotheses were formulated for testing at $p< 0.05$

$H0_1$: There is no significance difference in academic achievement between students taught using laboratory instruction and those taught using conventional teaching method.

$H0_2$: There is no significance difference in academic achievement between male and female students taught using laboratory instruction.

$H0_3$: There is no significance difference in the mean retention scores of students taught with laboratory instruction and those taught using conventional teaching method.

H04: There is no significance difference in mean retention scores between male and female students taught using laboratory instruction.

1.6 Significance of the Study

The study will be of immense importance to the government in the sense that, it will serve as an observable situation which reflects the relevance of Biology laboratory instruction on student's academic performance. It is also hope that, the work will encourage government to provide laboratory materials, equipment and facilities in Senior Secondary Laboratories. The result of this study will hopefully be useful to the School Authority for identifying, vital tools or facilities for enhancement of achievement and retention of concept learnt in Biology.

The study could motivate teachers to use instructional strategy that has potential to enhance learning, achievement retention and self- regulation in learner. The study will hopefully sensitize the Biology teachers to adopt strategies that will enhance the academic achievement and learning retention of students. The study will also be valuable to the parents when the academic achievement of their children's were improved.

The Curriculum and Educational planners will hopefully find the result valuable for curriculum review in Science Education particularly Biology. The findings of the research work will also provide empirical support for use of laboratory instruction and empirical data for future reference by researchers. It can also be useful to professional organizations and bodies such as Science Teachers Association of Nigeria (STAN), West African Examination Council (WAEC), National Examination Council (NECO), Federal Education Resources Centers as well as Federal and State Ministries of Education for curriculum review in senior secondary schools. The textbook publishers will also find the study useful in addressing current needs of biology teachers through the inclusion of laboratory instructional activities in next book materials. Finally, it will serve as reference point for other researcher who may wish to embark on similar study in another area.

1.7 Scope of the Study

The study was limited to one thousand two hundred and twenty five (1,225) SS II Biology students of the public Senior Secondary Schools in Jahun Educational zone of Jigawa state. The SS II students were considered because they are more stable class then SS III who are busy preparing for final examination while SS I are newcomers as well as newly introduce to biology. The topics taught include the cell, Osmosis and Diffusion as contained in the SS II Syllabus.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This study will review related literature based on the following sub-heading

- Theoretical Framework of the Study
- Secondary School Education in Nigeria
- Purpose of Secondary School Education
- Aims of Teaching Science in Secondary Schools in Nigeria
- Biology as a Teaching Subject in Senior Secondary Schools
- Students Academic Achievement in Biology Subject in Senior Secondary Schools
- Meaning and Types of Science Laboratory
- Roles of Laboratory in Science Teaching
- Science Teaching Methods
- Gender and Academic Achievement in Biology
- Retention and Academic Achievement in Science
- Review of Empirical studies
- Implication of Literature Reviewed

2.2 Theoretical Framework of the Study

The theoretical basis of this research work is centred on the Philosophy of pragmatism as propounded by Dewey (1916) and maintained by Okafor (2002). They maintained that learning is actualized in the domain of experience and that children learn more by doing. The laboratory instruction strategy draws a cue from the pragmatist theories of Dewey, which laid emphasis on practical experience between the children and the laboratory facilities through practical work.

Bruner (1967) in his intrinsic motivation theories upholds that there is no behavior of any individual that can be held to be an isolated activity and that curiosity emanating from the child's exposure to practical activities satisfies the novelty for academic performance and process skills acquisition in the child. Therefore the activities the child engages in must give him the satisfaction that he continuously seeks for. The laboratory instruction strategy which involves exposing the child to practical activities, serve as the intrinsic motivation that Bruner refers to.

Another theoretical basis for this research work is based on Piaget's theories. In Piaget's (1976) theories of cognitive development, motor activity is regarded as the basis for mental operation. Interaction of an individual with the environment is a necessary factor for the emergence of ideas or strategies by which mental operation are manifested. The features of the different stages identified by Piaget's (1976) and his associates clearly coincides with the senior secondary school biology students developmental age range that can accommodate concrete operations of classification, understanding concepts of number, quantity, weight, volume, time e.t.e. and also carryout formal operations like generalization, abstraction, hypothesis, e.t.c., from his different sorts of experiences. These are concrete operations in the child cognitive development that enhance academic achievement and retention. The laboratory instruction which involves learning by doing through practical's work could afford the student with opportunity to develop these cognitive potentials and attitude for better achievement in biology. Therefore in this study, a careful selection of laboratory practical activities to march the student's cognitive development potentials were made to enhance better academic achievement and retention in the students.

2.3Secondary School Education in Nigeria

The Federal Republic of Nigeria (2004) refers to the secondary school education as the education received after primary and before the tertiary stage. It further stresses that since the tertiary education system is built upon it, the secondary level is the key to the success or failure of the whole national educational system. Secondary education is the type of education which is exposed to children in secondary institution, where the students acquire fundamental knowledge, skills, thought feelings and actions, which are considered necessary for all citizens, regardless of sex, age, locality or social status and should be made available to all citizens as stated in the national policy on Education.

As from 1960, the country witnessed a considerable expansion in secondary education and major reorganization. In the northern Nigeria, middle schools were dissolved and sixth forms were introduced. Schools of basic and preliminary studies were also introduced. Since before then, the study of science had become popular worldwide and laboratory instruction was introduced in different parts of the world. In fact, as early as 1859, the principle of CMS Grammar School Lagos, Nigeria claimed the availability of some mechanical instructions to illustrate the sciences (Daramola, 1985). Ever since then, a laboratory instruction has been recognized as an indispensible aspect of science teaching. Today, no reputable school in Nigeria will not make efforts to run well established laboratory for effective teaching of science. As the year 1980/81, the first graduates of UPE scheme were turned out but these increased the number of candidates for secondary school. Thus facilities and teaching aids were heavenly expanded to cater for the population. Immediately after independence, the various regional governments addressed the issue of establishing more secondary schools (Osokoya, 1989 cited in Rabiu 2014).

2.3.1 Purpose of Secondary School Education

The secondary education in Nigeria, which is more significance of the entire educational system in the fast loosing relevance as it is not fulfilling the national objectives set down in the National Policy on Education. The National Policy on Education (NPE, 2004) spells out the broad goals of secondary school education on being prepared to the individual for;

(a) Useful living within the society, and

(b) Higher education.

In order to achieve these goals, the documents further states secondary education shall:

(i) Provide all primary school leavers with the opportunity for education of a high level, irrespective of sex, social status, religious or ethnic background;

(ii) Offer diversified curriculum to cater for the differences in talents, opportunities and future roles;

(iii) Provide trained manpower in the applied science, technology and commerce at sub-professional grades;

(iv) Develop and promote Nigerian languages, art and culture in the context of world cultural heritage;

(v) Inspire students with a desire for self improvement and achievement of excellence;

(vi) Foster National unity with an emphasis on the common ties that unite us in our diversity;

(vii) Rise a generation of peoples who can think for themselves, respect the views and feeling of others, respect the dignity of labor, appreciate those values specified under our broad national goals and live as good citizens;

(viii) Provide technical knowledge and vocational skills necessary for agricultural, industrial, commercial and economic development.

The above aims and objectives are more mirages today. The products of today secondary system can neither usefully live in the society nor move into higher institution without their portal aids or forgery. They cannot think for themselves or respect the views and feelings of others. They love no iota of dignity for labor except for things that will give them quick money (Rabiu, Toriman and Barzani, 2014). The astronomical increase in the population of these non-useful secondary school products is causing a great moral and social threat to the society.

2.4 Aim of Teaching Science in Secondary Schools in Nigeria

The Secondary School Education in the Nigerian system fall within the second tier in the educational process. At this stage in the educational process, a solid scientific foundation should be laid to prepare the students for their chosen career in Tertiary Institution. The goals of science Education as stipulated by the National Policy of Education (2004) are as follows:

- To cultivate inquiry, knowing and rational mind for the conduct of good life and democracy
- To produce scientists for national development
- Service studies in technology and the cause of technological development, and
- To provide knowledge and understanding of the complexity of the physical world, to forms and the conduct of life.

Looking critically in the stipulated goals of Science Education in Secondary schools in Nigeria, these goals cannot be actualized without the teacher performing the role of teaching as well as the method adopt. Therefore, one can deduce that, no meaningful teaching and learning can take place without the teacher. The role of the teacher in acquiring scientific knowledge for

technological advancement of the nation cannot be underestimated. National Policy on Education document (2004) has emphasized among the other; the laying of sound basis for scientific and reflective thinking, developing in the child ability to adopt to his changing environment, equip students to live effectively in the modern age of science and technology and giving the child opportunity for developing manipulative skills to enable him function effectively in the society. To achieve these objectives of teaching science in the secondary schools, the methods of teaching adopted by the teachers are important consideration for the actualization of the goals of National Policy on Education.

2.5 Biology as a Teaching Subject in Senior Secondary Schools

Biology is a life science that deals with the natural environment and the living organisms living in the environment; how they interact with the living and non-living (biotic and abiotic) components of the environment (Okoli, 2010). In the secondary school educational programmed, biology occupies a unique position. It is most favoured by most students considering the number of candidates that offer it in public examinations in line with federal government policy that all students most compulsorily offer one of chemistry, physics or biology. The high numbers of students is probably because of their belief that biology is ‘’cheap’’ (Soyibo, 2004).

Adejoh (2014) observed poor teaching as one of the major causes of students’ dismal performance in biology. Soyibo (2004) observed that the use of didactic method of teaching which is teacher-centred is the commonest form of classroom instruction in biolology. Unless there is re-orientation and the use of methods that will involve student’s active participation, the present trend of poor performance in biology may continue (Nzewi, 2008). Although Danmola and Adeoye (2004) submitted that no single method is best for the teaching of science especially biology, they unanimously agreed that the method that involves active students participation

such as outdoor or indoor laboratory work, group work, concept mapping e.t.c would ensure higher performance.

Biology curriculum is designed to produce individuals some of whom may or may not specialize in the biological sciences in their professional pursuits. It is however expected that in whatever profession they may finally find themselves, the biology education they acquired in schools would be of value to the totality of their education. Biology education exposes learner's to biological nature (facts, principles and concepts), processes and attitude as well as equips them with the professional skills of the biology teacher. A biology teacher should therefore possess both biological knowledge as well as skills for imparting such knowledge to the students (Adamu, 2014).

The biology curriculum as a teaching syllabus has four main objectives derived from the National Policy on Education, (FME, 2010). The objectives include:

- Adequate laboratory and field skills in biology
- Meaningful and relevance knowledge
- Ability to apply scientific knowledge in everyday life on matters of personal and community health and agriculture
- Reasonable and functional scientific attitudes.

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In accordance with the above objectives, the content and context of the biology syllabus place emphases on field studies, investigative laboratory-based instructions and conceptual thinking. The syllabus is intended to provide medium biology course as well as meet the needs of the society through relevant and functional content, method, process and application as stipulated in the National Policy in Education, (FME, 2010). To achieve these needs a spiral (or concentric) approach to sequencing of biology was adopted.

According to Nzewi (2008), due to knowledge explosion globally, via the internet biology as a subject has also expanded to include recent advances recorded in the fields of biochemistry, physiology, ecology, molecular biology, biotechnology, biodiversity and economic botany. Today the central focus of the subject biology is geared towards curbing human problems like food security, population, environmental degradation, health, biotechnology and ethics. The relevance of biology is judged in terms of the above and other related issues.

The problems associated with the teaching of biology at the senior secondary school are numerous and varied ranging from lack of enough qualified teachers, use of poor teaching strategies, and lack of adequate teaching materials among others. The use of biology instruction in this study is aimed at providing biology teacher with a pedagogy that will help to improve the academic achievement of their students in biology.

2.6 Students Academic Achievement in Biology Subject in Secondary Schools

Science educators have given various definitions of academic achievement. Usman (2000) defined academic achievement as the assessment of how much students have learned, the extent to which a student has acquired certain information or mastered skill usually because of planned information or training. Academic achievement according to Collia (2002) is what students are able to grain in the senior secondary school certificate Examination (SSCE) after completion of senior secondary instruction. Amuset (1994) defined academic achievement as the knowledge attained or skill developed in school subject, usually designed by means assigned by teacher.

The performance of students in Senior Secondary Biology in Nigeria has remained consistently poor. In recent times, observations on student's academic performance in Biology, over the years in results of the senior secondary certificate Examination (SSCE) conducted by

West African Examination (WAEC) and National Examination Council (NECO) revealed that a very few number of students performed better in Biology examination compared with other subjects, and as a result affected the academic aspirations of many candidate (Ogundiwin, Asaaju, Adegoke and Ojo, 2015). In support of this, Statistical evidence reveals that the percentage of students that passed Biology at credit level and above (A1-C6) was consistently less 50% for the past 10 years between 2002 to 2012 in Nigeria (WAEC Chief Examiners Report cited in Ogundiwin, Asaaju, Adegoke and Ojo, 2015). Also, according to the WAEC Chief Examiners Report (WAEC 2010, 2011 and 2012), the Senior Secondary School Biology candidates' have a number of problems associated with both cognitive and motor skills which have culminated in the poor performance of students in the secondary certificate Examinations (Umoke and Nwafor, 2014). Biology is very importance subject; it has to be given more priority. It enables one to understand himself and his intermediate environment. Nevertheless, the knowledge acquired in Biology subject is applied in many fields such as Medicine, Biochemistry, Pharmacy, and Agriculture among others.

Students' academic achievement in Biology subject in Senior Secondary Certificate Examination (SSCE) has been unsatisfactory over many years. The desire to know the causes of the poor performance in Biology has been the focus of many other researchers. Various reasons have been attached to this problem by scholars. Dinah (2013) concluded that, availability of text books, laboratory apparatus and other learning resources contribute significantly to the performance of students in Biology Examination. He added that, students with positive attitude towards the subject register better performance than those who had a negative attitude. Those with positive attitude are motivates to work hard and this is reflected in the good marks scored in the Examination. Suman (2011) conducted a research on the influence of parents' education and

parental occupation on academic achievement of students. He concluded that, education and occupation of parents positively influences the academic achievement of the children. In support of this, Femi and Adewale (2012) concluded that, educational qualification of the parents and health status of students are significant factors that affect the academic performance of students. This is also supported by Akinsanya, Ajayi and Salomi (2014) who also stated that parent education has the highest significant influence on the academic achievement of students. This is because the child from educated family has a lot of opportunities to study hard due to his/her access to internet, newspaper, television. They can also taught extra lessons at home. Students raised from an illiterate family have limited access to that.

It has been observed that falling academic standard and the influencing factors include the economic status of the parents. Just having a look at the present economic situation of the country, many poor parents do send their children's to go and do pity house hold work before going to school. These children were confused on that they can help their family through that. However, poverty of parents has elastic effects on their children academic works as they lack enough resources and funds to sponsor their education and good school, good housing facilities, medical care and social welfare services. Femi and Adewale (2012) pointed out that, socio-economic and education background of parents is not significant factors in students' performance. In support of this, Osuafor (2013) revealed that, family structure; parents' occupation and education level of parents did not have significant influence on students' achievement in biology.

Gambari, Isiaka, Emmanuel and Ikusanu (2014), observed that poor performances in sciences are caused by the poor quality of science teachers, overcrowded classroom and lack of suitable and adequate science equipment, among other. A recent study has revealed that many

aspects of school science (Biology included) pose problems of understanding of students, because of the teaching strategies employed including lack of adequate instructional resources (Kolawole, 2007). In addition, the laboratories are ill-equipped and the Biology syllabus is overloaded, it is therefore pertinent to look for variables that could be manipulated to rectify this situation and subsequently find their effects on learning outcomes. In the same vein, other factors enumerated as responsible for failure in Biology according to chief Examiners Report (2007) on Biology include drawing of poor diagrams with loss of details, non conformity to size specification in diagrams, wrong spellings of levels, omission of titles to diagrams, poor handwriting making their work illegible, poor numbering of questions, inability to relate structure to function, not writing magnification to diagrams, guidelines drawn with free hand and crossing each other (May/June 2007 WASSCE Report).

Some of the remedies suggested to overcome the factors responsible for failure by the same WASSCE Chief Examiners Reports (2007) over the years include the following; Candidate should prepare adequately for examinations, teachers should teach candidates to draw biological diagrams according to rules and regulations, Biology teachers should also make lessons lively with use of pictorial charts and models in teaching. Students should also be exposed to practical classes. Teachers should Endeavour to complete the syllabus before the Examination (May/June, 2012). Insufficient resources for the teaching and learning of science constitute a major cause of student under achievement. These insufficient resources include laboratories, science equipment and specimens to be used as teaching aids (Akinbobola and Ado 2007).Gbaje(2007) enumerated some of the factors that cause mass failure of students in senior secondary school Biology Examination to include, structuring of the curriculum, the concentration of Examination questions on a few topics and inability of students to perform enough practical before their

Examination. He also added that, many secondary school students are unfamiliar with more than half of laboratory apparatus and are unable to know in what experiment they are used.

Several studies have been conducted in and outside the shores of this country to investigate the causes of students' poor academic achievement in science particularly Biology and the most recurring factors in all the reports were; inefficient teaching strategy employed by the teachers, which is the conventional teaching strategy (Umar, 2011). Researchers such as Duniya (2016), Ezenduka (2014), Ibe (2004), Agommuoh and Ndirika (2014) have reported, with high degree of consistency, the effectiveness of Biology laboratory instruction (such as inquiry strategy) in achieving positive learning outcomes in several domains. It allows students to learn and experience biology firsthand, by taking on the roles of science. The students use the inquiry process to develop explanations from their observations (evidence) by integrating what they already know with what they have learned. They learned discrete biology concepts and skills on how to solve problems using practical approaches.

The persistent use of conventional method make students passive rather than active learners. It does not promote insightful learning and long term retention of any abstract concepts in biology, and emphasizes learning through the teacher's guidance at all times (Gambari, Yaki, Gana and Ughovwa, 2014). Okoli (2006) indicated that many Science teacher's prefer the traditional expository/lecture method of teaching that is, a teaching technique where one person, the teacher, presents a spoken discourse on a particular subject and do away from activity oriented teaching methods which are student centered (such as inquiry method, the discovery method, investigative laboratory approach). Nwagbo (2006) also observed that such teacher-centered approach which places the teacher as the sole processor of knowledge and the students as passive recipients of knowledge may not enhance achievement or promote positive attitude to

biology. The search for more effective approach for the teaching and learning of biology that will enhance the achievement has persisted over the years. This is because; the achievement is the basis for scientific inquiry and the development of intellectual skills that needed to learn concepts (Nwagbo, 2011). But there is little empirical evidence so far, on effects of laboratory instruction on Biology students' academic achievement and retention.

2.7 Concept of Science Laboratory

Laboratory has been defined and explained by different educationist. Achimugu, (2012) defined laboratory as a school building equipped with facilities, materials and apparatus which students use in carrying out investigation. Oludipe, (2006) defined laboratory as a place where practical activities take place. Ardo (2004) described the school laboratory as an instruction facility for helping students learn what science is and how the scientist work. Ezeliora (2001) defined science education as a workshop where science is done or where scientific activities are carried out under conducive environment. She also sees the laboratory as a place where science equipment, materials or instruments are housed for security safety. Laboratory work is an indispensable part of science instruction, and no effective science education can exist without practical work (Udo, 2010). In support of this, Nzewi (2008) asserted that practical activities can be regarded as a strategy that could be adopted to make teaching more to the students as opposed to abstract or theoretical presentation of facts, principles and concepts of subject matter. He also maintained that, practical activities should engage the students hand-on mind-on activities, using varieties of instructional materials to drive the lesson home.

Laboratory can either be indoor or outdoor laboratory. Mercy (2010) explained that an indoor laboratory is the school building set aside for scientific discovery and enquiry in which students are brought in direct contact with materials, manipulating them though procedures that

reflect scientific thinking. Outdoor laboratory is sited outside the school building, For example the school gardens, the river side, the mechanic workshop. Outdoor laboratory is also defines as any place outside that are conducive or designed for scientific observation and inquiry were student are brought in direct contact with natural environment (Mercy, 2010). Igwe (2003) as in Omiko (2015) observed that a laboratory can be indoor such as the sufficiently designed and equipped room found in most schools or outdoor involving such place as riverside, workshop, field and even market for carrying out scientific studies. He further stated that whatever the type of laboratory employed in science teaching, the same laboratory experience should be attained, that is participation on the series of experimental, observational and demonstrating activities which provide opportunity for students to develop understanding of practical and theoretical concepts through solutions of problems. In support of this statement, Adamu (2014) explained that laboratory work can be regarded as practical work performed in the laboratory (indoor laboratory approach), while practical work could also performed outside laboratory (outdoor laboratory approach), in other wards biology practical activities are not confined to the laboratory only. Therefore, indoor laboratory approach will be used in this research. It influences on students' academic achievement and were hopefully examined.

2.8 Role of the Laboratory in Science Teaching

The laboratory has always been the most distinctive feature of science instruction. It has continued to occupy a central role in the new science curriculum, which emphasizes student's involvement in science teaching through practical work. Laboratory work is an indispensable of teaching and learning in Science because students are able to observe and manipulate materials to demonstrate certain aspect of the subject matter which has been learnt in class through lecture, discussion and textbook. Mercy, (2010) stated that, because of the complexity and abstract nature

of science subjects some students find it difficult to understand and grasp the concepts without manipulations in the laboratories. Ufondu (2009) and Omiko (2015) observed that, the use of the laboratory in science teaching has following benefits:

- Laboratory teaching makes the students/learners to learn about the nature of science and technology in order to faster the knowledge of human enterprise of science and thus enhance the aesthetic and intellectual understanding of the child.
- Skills acquired are transferred to other spheres of problem solving (that is acquisition of problem solving skills). One of the basic goals of science education is to help students learn skills that can be applied to other life situations in future. It thus follows that the exercise of transfer of such learning condition must have something in common in with situation to which it will be applied.
- Students learning to appreciate and infact, emulate scientist through acquisition of manipulative skills. The students should be allowed to investigate by:
  (a) Indirect observation of objects and materials for the acquisition of mental as well as manipulative skills, example measuring substances, using weighing balance pictures, cylinder e.t.c
  (b) Through multiple trials, students can in the process of fiddling with materials and activities without stated theories arrive at useful conclusions.
  (c) Given a known theory, students can guided to observe some phenomena selected by the teacher and from such observation make prediction that are likely occur.
- Developing interests, attitudes and values by considering what science entails, it is clear that a field experience has the best potentials for stimulating a life time interest in science in the students when accorded the chance for personal experience by handling the real things.

Students interest in science increases as they yearn to investigate and explore more about their environment.

Queensu (2008) pointed out that, in the nineteenth century the study of science had become popular worldwide and laboratory instruction was introduced in different parts of the world. According to them instruction is considered essential because it provides training in observation, supplies detail information, and aroused pupils interest. It also goes further to say that developing and teaching in an effective laboratory requires as much skill, creativity and hard work as proposing and executing a first-rate research project. They also listed the following number of possible goals that can be achieve through a developed laboratory programmed:

- Develop intuition and deepen understanding of concept
- Apply concept learned in a new situations
- Experience basic phenomena
- Develop experimental and data analysis skills
- Learn to use scientific apparatus
- Learn to estimate statistical error and recognize systematic errors and
- Developing reporting skills (written and oral)

Omiko (2015) and Ufondu (2009) were on the same opinion that laboratory teaching is sometime used in conjunction with large lecture courses so that students may acquire technical skills and apply concepts and theories presented in the lecture. Omiko (2015) stated that, hands-on experience encourages students to develop a spirit of inquiry and allows them to acquire scientific skills and the right attitude to handle scientific tools and materials. Shulman and Tamir

in Omiko (2015), listed five groups of educational objectives that may be achieved through the use of the laboratory in science teaching.

1) Skills: manipulative skills, inquiry skills, investigative skills, organization skills and communicative skills.
2) Concept of mastery: For example, hypothesis, theoretical model, taxonomic category.
3) Development of cognitive abilities: Critical thinking, problem solving, application, analysis, synthesis.
4) Understanding the nature of science: scientific enterprises, scientists and how they work, existence of a multiplicity of science methods, inter-relationships between science and technology and among the various disciplines of science.
5) Development of scientific attitudes: For example, curiosity, interest, risk taking, objectivity, precision, confidence, perseverance, satisfaction, responsibility, consensus, collaboration, and liking science.

Based on the role of the science laboratory teaching and learning, it implies that schools without laboratories, where students can carry out biology, chemistry and physics practical's would end up producing or graduating students who will have no knowledge of science practical's required by the West African Examination Council (WAEC) and the National Examination Council (NECO) to pass the Senior School certificate examination. Consequently, these students will lack the requisite requirement qualification for courses like medicine, engineering, agricultural science and any of the science related careers.

The chief examiners reports of WAEC and NECO, 2013, 2014 and 2015 indicate poor performance of students in the sciences particularly biology. This calls for urgent attention if we are to meet up with the challenging and rapidly growing wealth of scientific knowledge.

2.9 Science Teaching Methods

A method can simply be described as the way in which one does something. The method a teacher use to bring the desired outcome in the teaching and learning process cannot be over-looked. There are various methods available for achieving effectiveness and the teacher has full responsibility for selecting the most appropriate method for the prevailing circumstances in order to achieve the aims of teaching science in secondary schools. Some of the methods of teaching science in secondary schools are as follows:

2.9.1 Guided Discovery

Guided discovery is the method of teaching science in the secondary schools. Inomiesa (2010) recommended the use of guided discovery approach in teaching science in secondary schools. This recommendation is in line with the suggestion from the Federal Government as enshrined in the Nation Policy on Education (2004), that guided discovery approach should be adopted for teaching science. It is the hope of the Federal Government that though this method, students will learn science better. Activity based science teaching allow students to explore their environment and discover nature. To successfully adopt the guided discovery approach, students must perform certain metal process, such as; observing, classifying, measuring, predicting, inferring and hypothesizing. This a lot of inquiry goes in the classroom where the teacher mainly serves as moderator, moving from point to point to guide the learning of student and help them to overcome difficulties. The teacher is the resource person who guides students' sources of information (Arubayi, 2015). The students may work in a variety of locations while the classroom is filled with a variety of instructional materials, these could be real objects or models, pictures or diagrams. This could help students to concretize the information gathered from the learning situation.

2.9.2 Demonstration Method

Another method of teaching science is the demonstration method. Enemali (2006) described this method of instruction as a showing procedure, to explain, teach and inform students while Arubayi (2015) described demonstration method as a visible presentation of ideas, skills, attitudes, processes and other intangibles. Demonstration lessons include facts and principles used along with materials for showing or teaching someone else. For demonstration method to be effective, the lesson should be planned ahead of time, have all necessary materials and equipments needed for the demonstration lesson. Participants should be given clear and simple instruction. The setting arrangement for the demonstration should be organized so that participants can see and hear clearly. After demonstrating generally, the students should be given opportunity to practice individually or in groups. The teacher should provide assistance and guidance to students who have not gasped the basic concept yet. Demonstration method of teaching science has many merits and demerits, one very important merit of using demonstration method is that it aids learning as students see, hear and do.

2.9.3 Inquiry Teaching Method

Inquiry is defined as the diverse ways in which students study the natural world and propose explanations on the evidence derived from their work (NRC, 1996 cited in Stella 2008). It involves getting students to carry out investigation of natural phenomena through which meaningful problems are answered and new knowledge obtained. Inquiry-based teaching approach provides useful platform for engaging students in practical, hands-on service science investigations that can bring them in interaction with living and non living aspects of the environment. Students are able to explore materials, design investigation for testing hypothesis, and work with data (with the teachers support) to identify and interpret patterns.

The importance of inquiry in the science process cannot be overemphasized; the National Research Council (NRC) created the standards around a central theme 'science standards for all students'. This theme emphasizes the importance of inquiring in science process, allowing students to describe objects and events, ask questions, construct explanation test those explanations against current scientific knowledge and communicate their ideas to others. In teaching science with an inquiry emphasis, the assumptions of the diverse populace are considered and critical and logical thinking skills are fostered (Jacinta 2011). According to the NSES inquiry-based classrooms should include: A multifaceted activity that involves making observation; posing questions; examining books and other sources of information to see what is already know; planning investigations; reviewing what is already know in light of experimental evidence; using tools to gather, analyze and interpret data; proposing answers, explanations and predictions; and communicating results. Stella (2008), explained that inquiry teaching method is a three-phase learning cycle that includes:

- Exploration: is the starting point of inquiry, it involves giving students the opportunity to acquaint with environment, get hands-on experience, and work with learning material. As students interact with the things around them, they begin to pose interesting questions that can lead to making predictions or creating conceptual models. Questions are asked on what, how and why of events. Teacher could direct questions for the students to provide answers, or students could ask questions on aspects of the topic about which they are curious to learn.
- Concept introduction and development: Students produce results of their investigation. The teacher then uses the students' experiences from their exploration to induce, interpret and explain the concepts or principles to be learned. It is essential to make students appreciate the values of honest and accurate reporting of their observation.

- Application and generalization: students are challenge to generalize the finding and learned concepts to situations. Inductive and deductive reasoning are used to draw meanings from the observations and findings or to provide generalizations.

Research findings indicate that inquiry-oriented instructions are effective to enhance students' performance, foster scientific literacy and understanding of scientific process, develop critical thinking and skills, and promote positive attitude toward science (Jacinta, 2011; Anderson and Kranthwohl, 2001; Suits, 2004). Inquiry allows students use the inquiry process to develop explanations from their observations (evidence) by integrating what they already know with what they have learned. They learned discrete biology concepts and skills on how to solve problems using practical approaches. Incorporating inquiry into biology classrooms empowers students. They play an active role in their learning rather than passive role commonly seen in traditional classrooms. Teachers can foster better experiences with inquiry in various ways and ultimately positively affect students' biology, whether the inquiry activity is structured, guided, or open.

2.9.4 Laboratory Instruction

The laboratory is an indispensable tool in the teaching of science which provides students with a place or setting, to attack and solve problems, collect data provides ideas and carry out an investigation which emphasizes learning by doing. Arubayi, (2009) opined that, the laboratory method of teaching science comprised variety of activities ranging from the experimental investigations to confirmatory exercise and skills learning. Arubayi, (2015) summarized the objectives sought in laboratory work, as the development of skills, concepts, cognitive abilities and understanding the nature of science skills such as manipulative, inquiry, investigation,

organization and communication can be developed from laboratory exercise. Also concepts such as hypothesis, theoretical models and taxonomic category are developed. Cognitive abilities such as critical thinking, problem solving, application, analysis, synthesis, evaluation, decision making and creativity are developed though laboratory exercises. Though well planned and carefully executed laboratory work participant is able to gain a better understanding of the nature of science. The laboratory method of teaching science assists learning and it is the true nature of science which teaches practical skills, help some desired traits such as appreciation which are necessary for problem solving and skill acquisition. Unfortunately, Operation Reach all Secondary Schools (ORASS) 2006, findings revealed that less than 10% of secondary schools in Nigeria have well equipped laboratories. In support of this, Inomiesa (2010) stated that most of the laboratories are seldonly brought and it is not uncommon for secondary schools students to migrate from one school to the other for external examination such as West African Examination Council (WAEC) and National Examination Council (NECO), in search for equipment and chemicals for laboratory work.

Studies have shown that one of the factors that influence the teaching/learning enterprise is the instructional medium used. Some methods that have been adjudged suitable for teaching and learning of science are inquiry, problem-solving and laboratory instruction (Bichi, 2002). In laboratory instruction, the students are guided to find out the truth of ideas, fact and assumption for confirmation or rejection (Okoli, 2010). The rational in using this approach for teaching science is centred on the fact that if student are fully involved in activities and are challenge to produce results themselves they are more likely to learn more effectively than if they were simply told or presented with outcomes of experiments. Laboratory instruction approach de-emphasizes rote-learning or memorization of scientific concepts and principles while emphasized

acquisition of knowledge and skills through active participation under the guidance of a teacher (Nwagbo, 2008). In this approach students are availed the opportunity to interact with materials within the environment by observing, classifying, measuring, questioning, hypothesizing, collecting and interpreting data; accurate reporting, predicting and inferring. Practical activities in biology provide opportunities for students to actually do science as opposed to learning about science. Nzewi, (2008) asserted that practical activities can be regarded as a strategy that could be adopted to make the task of a teacher (teaching) more real to the students as opposed to abstract or theoretical presentation of facts, principles and concepts of subject matters.

Omiko (2015) observed that, laboratory instruction as an activity involving a two-way approach carried out by one or more persons through the exercise and experimental approaches both of which are useful in science teaching. The experimental approach provides an opportunity for students to seek information using experimental procedures. These procedures call for careful observations and interpretation of data. It has the qualities of questioning, investigating and confronting the unknown. The rational in using laboratory instruction for teaching science is centred on the fact that if student are fully involved in activities and are challenge to produce results themselves they are more likely to learn more effectively than if they were simply told or presented with outcomes of experiments. The current trend in science curricular emphasis implies that science laboratory instruction should be taught as an integral part of classroom instruction in science with pre-and-post laboratory discussion (Udu, 2010).

In this frame work, students were taught how to do science rather than learn science through guided practical activities. The strategy consisted of a normal lesson with planned practical activities aimed at achieving certain stated behavioral objectives. The lesson started by introducing the topic drawing experience from previous knowledge of the students. The teacher

then progressed with the lesson through planned practical activities that the students did themselves making and recording observations and drawing conclusions as contained in the figure 2.1

Step I: Introduction: Each lesson was preceded by an introduction that linked the students' previous knowledge to the new topic that was taught.

Step II: Laboratory activities

For example: observing the structure of a typical plant cell.

Step III: Reporting the result

Step IV: Discussion of results

Step V: Evaluating. At the end teacher evaluated the students by asking questions. (see Appendix)

The steps involved in a typical Laboratory Instruction lesson plan can be summarized in a flow chart as shown in figure 2.1

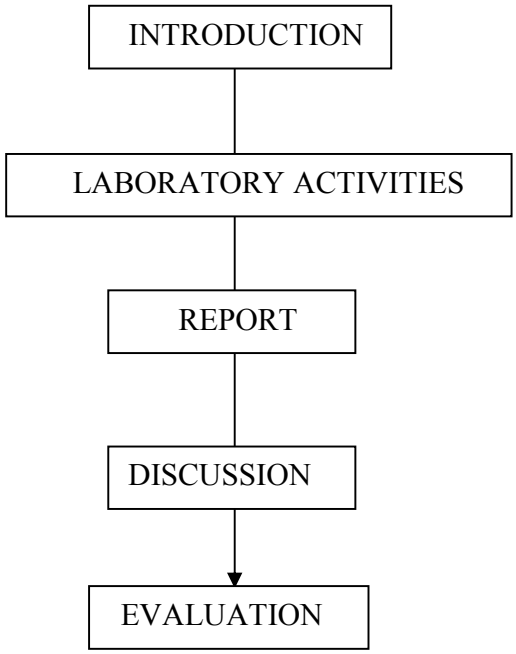

Figure 2.1 Flow-chart of laboratory instruction

The above laboratory instruction model was adopted from Duniya (2016)

2.10 Gender and Academic Achievement in Biology

Gender is defined as the amount of masculity and feminity found in person and obviously while there are mixtures of both in most human beings, the normal male has a preponderance of masculinity and normal female has a preponderance of feminity (Bichi, 2002). Achor, Wude and Duguryil (2013) stated that gender stereotypes seem to be a major impediment to the achievement. Oludipe, (2012) agreed that gender bias is very prevalent in Africa particularly Nigeria. He argued that in Nigeria, harder tasks are assigned to male while females are given the relatively easy and less demanding tasks. This problem also exist in our schools where Gbaje, 2007 cited in Ogundiwin, Asaaju, Adegoke and Ojo (2015) says teachers maintain gender stereotypical view of their students and thereby perceives science as being difficult for the female students.

The research reports on the effect of gender on students' academic achievement in Senior Secondary Biology are conflicting. Some findings indicated male superiority in science achievement (Ekeh, 2004, Ncharam, 2010, Jacinta 2011) while others indicated female superiority in science achievement (shu'aibu and mari 1997, Galadima, 2003). Also other studies such as Ariyibi, (2004) and Udo, (2006) indicated zero effect of gender in student academic achievement in science. This group maintained that, if given the right conditions of teaching and learning both male and female would perform equally well in science Katcha and Wushishi, (2015). In support of this, Katch (2005) observed that, the use of activity-based strategies of teaching such as Vee maps showed that students' achievement in biology is not sex dependent.

The issue of gender and gender stereotyping permeate every aspect of human endeavour. Okeke, (2007) observed that the consequences of gender stereotyping cut across social,

economic, political and educational development, especially in the areas of Science and technology. Several studies have been conducted with diverse strategies and approaches suggested, but yet no remarkable improvement in students' performance was found. As such this, study was hopefully set to determine the effect of laboratory instruction in relation to gender on students' academic achievement and retention in Senior Secondary Schools in Jigawa state.

2.11Retention and Academic Achievement in Science

Retention is defined by Kundu and Tutoo (2002) as a preservative factor of the mind. The mind acquires the material of knowledge through sensation and perception. These acquired materials in the mind need to be preserved inform and images for knowledge to develop. Whenever a simulating situation occurs retained images are received or reproduced to make memorization possible. Agbyeku (2011) explained that Retention of concept learnt would help in reflective thinking and the use of the retained concepts be used in creative way to solve day to day problem. Goldstain (2010) associated Retention with long term memory according to him retention focus not only on its functionality but on its duration as well because long term memory is involved with the long storage of manipulation and efficient processing of information. Martinez, Perez and Suero (2013) conceived retention as a process in which information is encoded, saved and retrieved. Encoding or registration allow information that is from outside world to reach our senses on the form of chemical and physical stimuli, it involves receiving, processing and containing of received information.

Retention was seen by Beer (2010) as tools employed by learners to assist them perform effectively in all aspect of life and particularly in the school. This essential tool is needed by learners to maintain and manipulate information in the mine for a brief and long period of time. Rabia (2008) posited that Retention is the ability to actively hold information in the mind needed

to the complete task such as active thinking comprehension and learning. He also explained that the in depth retention and achievement in science, technology and mathematics is an important need that is becoming highly felt by the Nigerian populace. Baddeley (2000) suggested that retention is related to academic performance on the domain of physical sciences and used academic achievement in enhanced by a number of abilities, storage, capacities, processing efficiency, the ability to combine storage and processing the ability to inhibit irrelevant information, the quality of knowledge representation and the ability to use efficient strategies in the face of interfering processes and distraction.

The level of retention is determined by the nature of material coded (Agbyeku, 2011; Bichi, 2002). This appropriate coding of incoming information provides the index that may be consulted so that retention takes place without an elaborate search in the memory (Bichi, 2002). The Retention according takes place when learning is coded into memory and that understanding and retention are produced of meaningful learning. So when teaching is effective and meaningful to the student, it inclines to build and maintain memory for a task. This memory according to him is characterized by a large capacity; it can hold and accept a large amount of new information at one time the capacity of the memory makes it convenient to assimilate a large chunk of information simultaneously (Martinez, Perez and Suero 2013). Learners at school need this memory on a daily basis for Variety of task and may assist in remembering task, irrelevant information and improve performance on cognitive task. Novak (2010) observed that teaching students to use memory strategies by employing appropriate teaching strategy will not only improve student thinking skill on complex task of production, modeling, experimentation and evaluation, but will also assist learners to attain deep understanding of conceptual knowledge and

will result in developing cognitive facilities domain.Agbyeku (2011) outlined the following factors affecting student's retention in relation to their academic achievements in sciences as:

- Thinking style of the individual learners
- The age of the learners
- Nature of materials to be learn
- Teacher's method of teaching.

Various research works including Oloyade (2011),and Wachanga, Mugiira and Mbugua(2013) revealed that laboratory activities enhances student's retention and achievement. Hence, this study therefore, intends to employ laboratory instruction to determine its effects on student's academic achievement and retention.

2.12 Review of Empirical Studies on the Effect of Biology Laboratory Instruction

Several studies have been carried out on the effect Laboratory Instruction. Nwagbo and Uzomaka (2006) in a study of the effects of laboratory activities on students academic achievement and process skills acquisition involving a sample of one hundred and one (101) SS 1 biology students, data was analyzed using mean, standard deviation and ANCOVA statistics at 0.05 level of significance, the result revealed that laboratory activity method was more effective then lecture method in fostering students academic achievement and science processes skills acquisition. The results of this study were in line with the views of other researchers like (Ibe, 2004, Agommuoh and Ndirika, 2014) who indicated that active participation of the students through laboratory practical activity gave rise to more meaningful and effective learning.

Duniya (2016) carried out the impact of laboratory instruction on attitude; science processes skills and performance in biology among convergent and divergent secondary school

students, in Kaduna state. The study population consisted of one thousand one hundred and thirty seven (1137) SS II biology students drawn from the twenty eight state government owned schools in Zankwa Educational division of Kaduna state. His sample of the study was made up of sixty two (62) SS II students randomly chosen from the two schools in the population. One school each was allocated to the experimental and control group who were taught using laboratory instruction and lecture method respectively. The data was allocated and analyzed using mean and standard deviation statistic as well as ANCOVA. His finding showed that, a significant difference between the convergent and divergent students exposed to laboratory instruction (experimental group) and those exposed to lecture method (control group) with respect to performance, processes skills acquisition and attitude change in favour of the convergent and divergent experimental groups. He concluded that, laboratory instruction enhances better performance and science processes skill acquisition and develops more positive attitude change in convergent and divergent biology students then the lecture method at secondary schools. It was recommended that teachers should use the laboratory instruction to teach biology in secondary schools.

A similar study designed to investigate the effectiveness of laboratory instruction in enhancing creativity and process skills acquisition in SS 2 biology students, was conducted at the the department of biology, College of Education, Nsugbe, Anambra State (N=150), by Ezenduka and Achufusi (2014). A test of Creativity instrument in biology was used to collect data and Analysis of Covariance (ANCOVA) statistic used to test the hypothesis at 0.05 of significance. The result showed that students taught with the laboratory instruction exhibited more creative skills and process skills acquisition than those taught using lecture method. The study therefore recommended the use of the laboratory instruction as against the lecture method. In this study the

laboratory instruction will be employed in order to find out its effect on academic performance and retention toward biology among Senior Secondary Students in Jigawa State.

2.13 Implications of Literature Reviewed

The literature reviewed clearly explained the concept of laboratory instruction teaching method. The scope of description of academic achievement as it relates to teaching and learning of Biology is shown. In the same vein, related studies covering gender and performance mainly in science subject such as Biology, Chemistry and Physics were review. Also attitude as a factor in teaching/learning of Biology was highlighted. The related literatures reviewed for the purpose of this study showed that the used of laboratory instruction in biology enhanced students' performance as well as improved students to biology. However, the use of conventional teaching method has been shown to be of little help for learners in enhancing learners' performance. And reports in the literature showed that the studies were carried out on students' process skills acquisition. In the light of these reports the researcher deems it necessary to employ the use of laboratory instruction method on students learning retention among senior secondary schools in Jigawa state.

In addition the laboratory instruction has found by science educators like Duniya (2016), Ezenduka and Achufusi (2014), to have effect on such variable attitude and attitude and creativity. These variables have been shown to have effect on learning. Most of the studies were carried out in either boys or girls schools secondary schools (single sex). The present study is carried out in co-educational schools. The presences study is unique in that, it is aimed at heterogeneous secondary schools. That is, co-educational school rather than homogenous secondary school (boys or girls secondary school). Specifically, the study seeks the effect of

laboratory instruction on biology students academic achievement and retention among senior secondary schools in Jigawa state.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter discusses the methodology of the entire study. It is presented under the following sub-headings; Research design, Population of the study, Sample size of the study, sampling technique, Data collection instrument, Validity of the instrument, Reliability of the instrument, Data collection procedure and Data analysis procedure.

3.2 Research Design

The research design employed for the purpose of this study was pre-test post test quasi – experiment design, since intact biology classes was used. Quasi-experiment is an empirical study used to estimate the causal impact of an intervention on its target population without random assignment. It is used when randomization is impossible or impractical (Badmus, 2012). The pretest was administered to the subjects in the two groups (experimental and control groups) in order to determine their equivalence in ability before treatment.

The experimental group was taught using laboratory instruction while the control group was taught using conventional teaching method. At the end of the six weeks treatment, a posttest was administered to both the experimental and control groups in order to assess the effect of the treatment on academic achievement among experimental and control group. The pretest and posttest administered were the same but test items were reshuffled at the posttest stage to limit the effects of "test- wiseness" (Mari, 2001). Three weeks duration after post test, the same test was also administered as post posttest to find out the retention level of the students. The design of the study is represented below:

$$EG \rightarrow O_1 \rightarrow X_1 \rightarrow O_2 \rightarrow O_3$$

$$CG \rightarrow O_1 \rightarrow X_2 \rightarrow O_2 \rightarrow O_3$$

EG = Experimental Group

CG = Control Group

O1 = Pre-test using BAT

O2 = Post Test using BAT

O3 = Post-post Test using BAT

X1 = Treatment using laboratory instruction

X2 = Treatment using conventional teaching Method

3.3 Population and Sample Size of the Study

A population is a set of all elements and subjects or events that are of interest in a particular study (Sambo 2008). While sample size is the number of entire (subjects, elements e.t.c) in a subset of a population selected for analysis.

3.3.1 Population of the Study

The population of this study consists of entire Government Senior Secondary School students II (SS2) of Jahun Educational Zone who offered Biology as a subject. There are eleven (11) senior secondary schools in the Jahun Educational zone, seven (7) of the schools were all boys schools, one (1) all girls schools and three co-educational schools totaling of One thousand two hundred and twenty five (1225) students out of which 334students were girls and 891 were boys. The average age of the students ranged from ages 15-17years. The population of the study is as represented in Table 3.1 below

Table 3.1 Population of the Study

Schools	Boys	Girls	Total
GSS, Aujara	423	-	423
GDSS,Kale	62	-	62
GSSS, Jahun	-	278	278
GDSS, Gunka	32	-	32
GDSS, Miga	36	13	49
GDSS, Harbo	78	-	78
GDSS, Tsakuwawa	46	-	46
GDASS, Jahun	50	23	73
GDSS, Jahun	44	20	64
GDSS, Zareku	55	-	55
GDSS, Dangyatin	65	-	65
Total	**891**	**334**	**1225**

Source: Jahun Educational Zone, (2015)

3.3.2 Sample Size of the Study

Since this study involved experimental and control group, in order to obtain accurate results and minimize error that could be introduced by some extraneous variable, the sample size of the research were restricted to two senior secondary schools. There are eleven (11) senior secondary schools in Jahun Educational zone, seven (7) of the schools were all boys schools, one (1) girls schools and three co-educational schools. The sample of this study were made up of two senior secondary year two (SS2) biology students purposively drawn out of the eleven (11) senior secondary schools in Jahun Educational zone. The sample subject of each school was

intact class of 73 for experimental group in which 50 are boys while 23 were girls and 64 for control group in which 44 are boys while 20 were girls respectively. Hence the sample size of the study is 137 consisted of 93 boys and 44 girls. This sample size is viable for this type of research. Tukman, (1975), recommended a minimum of 30 sample size for experimental study.

Table 3.2 Sample size of the study

S/N	Group	Schools	Male	Female	Total
1	Experimental Group	GDASS Jahun	50	23	73
2	Control Group	GDSS Jahun	44	20	64
TOTAL			**94**	**44**	**137**

3.3.3 Sampling Technique

Purposive sampling was used to select three (3) coeducational schools out of the eleven senior secondary schools in Jahun Educational zone. Purposive sampling technique is one of the non-probability sampling techniques based on the judgment of the researcher, as gender is part of this research work.

Two schools out of these three were selected randomly using simple random sampling technique involving yes and no as both school is having only single class for S II. The two schools chosen were GDSS Jahun, and GDASS Jahun, pre-test was also given to the schools and found do not differ significantly in their performance. The status of the schools was also determined using simple random sampling technique involving balloting. The names of the two schools were written on a difference piece of paper, folded and placed in a container, the papers were shake thoroughly and placed in two different containers labeled as experimental and control

groups. As results of this exercise GADSS Jahun was assigned experimental group while GDSS Jahun was assigned the as control group respectively.

4.4 Selection of the Topics Taught

The main topic were selected is cell biology as contained in the SSII curriculum. The contents of the topic are; the cell, diffusion and osmosis. The choice of the topics was informed by a number of reasons among which are: The topics form part of the SSII biology syllabus, the topic lend themselves to laboratory instruction and the topic like osmosis and diffusion are perceived as abstract concepts (Nwagbo, 2008) and both involve inductive reasoning.

Weighting was assigned to each content primarily based on area of coverage, work load and time involved.

3.5 Data Collection Instrument

The instrument that was used for data collection is Biology Achievement Test (BAT) adopted from West African Examination Council (WAEC) past objective questions. The Biology Achievement Test consists of two sections; section A: which deal with personal information of the students while section B: consists of thirty items objective test involving multiple choice of A-D to determine the student's academic achievement in biology. The items in the test covered the concept of the cell biology taught by the researcher.

3.6 Validity and Reliability of the Instrument

3.6.1 Validity of the Instrument

Despite using standardized questions from WAEC, the Biology Achievement Test and their marking scheme was validated by two senior lecturers with the rank of Ph.D in science and technology Department of Bayero University Kano and three graduate biology teachers with

rank of E.O from senior secondary schools in Jigawa state. They were asked to study the items based on the following:

- Clarification of the statement
- Clarification of content in relation to the objective of the study
- Language used based on the ability level of participant is ambiguous or not.

Concepts or items match the ability of the students

Table 3.3 Table of specification for BAT Based on Bloom's Cognitive Taxonomy

Concept	Weight %	Knowledge %	Compr. %	Application %	Analysis %	Synthesis %	Evaluation %	Total %
Cell	54	1	3	3	4	3	4	18
Osmosis	23	-	2	3	-	1	1	7
Diffusion	23	2	1	1	-	1	-	5
Total	**100**	**3**	**6**	**7**	**5**	**5**	**5**	**30**

Source: Researcher data, 2016

3.6.2 Reliability of the Instrument

The reliability of the instrument used for the purpose of data collection was pilot-tested using an intact class made up of thirty nine (39) SS II students of GDSS Yandutse outside the study area. To determine the reliability of the Biology Achievement Test (BAT) instrument, the test-retest method of establishing reliability at two weeks intervals was employed. The test was administered to SS II biology students of GDSS Yandutse outside the sampled population. The data from the trail testing was correlated using the Pearson Product Correlation Co-efficient (PPMCC) statistic to establish the reliability coefficient (r) of the instrument which was established to be r= 0.89

3.7 Data Collection Procedure

The sample population was grouped into two; the experimental group which was taught using biology laboratory instruction and control group which was taught using conventional method. Before treatment the test were administered to the sample as pre-test, to determine their equivalence in ability and the scores from the pre-test were used to place the students in the same prior knowledge level. After six weeks period of instruction by the researcher, biology achievement test (BAT) was then administered to the two groups as post-test to determine academic achievement. Three weeks duration after post test, the same biology achievement test was also administered by the researcher as post posttest to find out the retention level of the students in biology.

The experimental group students were taught how to do science rather than learn science through guided practical activities. The strategy consisted of a normal lesson with planned practical activities aimed at achieving certain stated behavioral objectives. The lesson started by introducing the topic drawing experience from previous knowledge of the students. The teacher then progressed with the lesson through planned practical activities that the students did themselves making and recording observations and drawing conclusions as follow;

Step I: Introduction: Each lesson was preceded by an introduction that linked the students' previous knowledge to the new topic that was taught.

Step II: Laboratory activities

For example: observing the structure of a typical plant cell.

Step III: Reporting the result

Step IV: Discussion of results

Step V: Evaluating. At the end teacher evaluated the students by asking questions. (see Appendix)

While the control group were taught the same concept using conventional teaching method.

3.8 Data Analysis Procedure

Mean and standard deviation were used to answer the research questions. Each of the hypotheses was tested along with the appropriate statistical tool for testing at significance level of $P \leq 0.05$ as follows;

H_{01} There is no significant difference in academic achievement between students taught using laboratory instruction and those taught using conventional teaching method.

The above stated hypothesis was analyzed using t-test (since there are two groups and it's an interval scale).

H_{02} There is no significant difference in academic achievement between male and female students taught using laboratory instruction.

The above stated hypothesis was analyzed using t-test (since there are two groups and it's an interval scale).

H_{03} There is no significant difference in the mean retention scores of students taught with laboratory instruction and those taught using conventional teaching method.

The above stated hypothesis was analyzed using t-test (since there are two groups and it's an interval scale).

H_{04} There is no significant difference in mean retention scores between male and female students taught using laboratory instruction.

The above stated hypothesis was analyzed using t-test (since there are two groups and it's an interval scale).

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSIONS

4.1 Introduction

This research examines the effects of laboratory instruction on biology students' academic achievement and retention in senior secondary schools in Jigawa state. In this chapter the results obtained from the analysis of data collected were presented and discussed. The data collected were analyzed using mean and standard deviation to answer the research questions while t-test for independent sample was used to test the null hypotheses. The chapter is presented in the following subheading:

4.2 Data Presentation and Analysis

4.3 Summary of the Findings

4.4 Discussions of the Result

4.2 Data Presentation and Analysis

The data collected from the study using the instrument (BAT) were used to answer the research questions and hypotheses testing as follows:

4.2.1 Answering the Research Questions and their Corresponding Null Hypotheses

Research Question 1: what is the effect of laboratory instruction on academic achievement of students in senior secondary school of Jigawa state?

To answer this research question means and standard deviations are required. The post test mean scores of experimental and control groups were subjected to descriptive statistics. Mean and standard deviation were computed and used to draw Table 4.1

Table 4.1: mean and standard deviation of post test scores for experimental and control Groups

VARIABLE	N	Mean	Std. Deviation
EXPERIMENTAL	73	20.27	5.912
CONTROL	64	15.53	5.155

The result in Table 4.1 shows that the experimental group with mean score of 20.27 performed higher than the control group with mean score of 15.53. This mean, difference exist between the post test mean scores of experimental group and post test mean scores of control group. To test whether the difference is significant or not, null hypothesis one was formulated and tested using t-test statistic.

Hypothesis one HO_1: There is no significant difference in academic achievement between students taught using laboratory instruction and those taught using conventional teaching method.

To test this hypothesis, the mean academic achievement scores of students in experimental and control groups were subjected to t- test statistic and summary of analysis are shown on Table 4.2.

Table 4.2: Result of t-test Analysis of Academic Achievement Mean Scores of Experimental and Control Groups

Variable	N	Mean	Std Dev	D.f	t-Value	P-Value	Decision
Experimental	73	20.27	5.91				
				135	4.97	0.000	Rejected
Control	64	15.53					

Table 4.2 results shows t-test between the academic achievements mean scores of experimental group and that of control counter parts. The result shows that p- value of 0.000 is less than 0.05 level of significant, which indicated significant difference. Therefore, the difference between the experimental group taught using laboratory instruction and that of control group taught using conventional teaching method is significant. Hence the stated null hypothesis one $H0_1$ is thereby rejected, which shows that, there is significant difference in academic achievement between students taught using laboratory instruction and those taught using conventional teaching method.

Research Question 2: is there any difference in academic achievement between male and female students taught using laboratory instruction?

To answer this research question means and standard deviations are required. The post tests mean scores of male and female experimental group were subjected to descriptive statistics. Mean and standard deviation were computed and used to draw Table 4.3

Table 4.3: mean and standard deviation of post test scores of male and female Experimental group

VARIABLE	N	Mean	Std. Deviation
MALE	50	20.32	5.930
FEMALE	23	20.17	6.005

The result in Table 4.3 shows that the female in the experimental group with mean score of 20.17 and standard deviation of 6.005 is lower than the male counterparts with mean score of 20.32 and standard deviation of 5.930. From this two mean, there is difference but the differences appear to

be negligible. To find out if the difference is significant or not, null hypothesis two was formulated and tested using t- test statistic.

Hypothesis two HO_2: There is no significant difference in academic achievement between male and female students taught using laboratory instruction.

To test this hypothesis, the mean academic achievement scores of male and female students in experimental group were subjected to t- test statistic and summary of analysis are shown on Table 4.4.

Table 4.4: Result of t- test Analysis of Academic Achievement Posttest Means Scores of Male and Female Students taught using laboratory instruction

VARIABLE	N	Mean	Std. Deviation	Df	t-value	p-value	Decision
MALE	50	20.32	5.930	71	0.097	0.923	Retain Ho2
FEMALE	23	20.17	6.005				

From Table 4.4, the result show that the p- value 0.923 obtained is higher than 0.05 level of significance, which indicated no significant difference. Consequently the null hypotheses two which state that there is no significant different in academic achievement between male and female students taught using laboratory instruction is thereby retained. This shows that, laboratory instruction is gender friendly.

Research Question 3: is there any difference between mean retention scores of students taught with laboratory instruction and those taught using Conventional teaching method?

To answer this research question means and standard deviations are required. The post posttest mean scores of experimental and control groups were subjected to descriptive statistics. Mean and standard deviation were computed and used to draw Table 4.5.

Table 4.5: mean and standard deviation of post posttest scores for experimental and Control group

VARIABLE	N	Mean	Std. Deviation
EXPERIMENTAL	73	17.16	5.580
CONTROL	64	12.11	4.755

The result in Table 4.5 shows the mean score of experimental group is 17.16 which are higher than control group with mean score of 12.11. This shows that experimental group has performed better than control group counterparts, which indicated that laboratory instruction enhanced better learning retention in biology among senior secondary school students than the conventional teaching method.

Hypothesis three HO_3: There is no significant difference in the mean retention scores of students taught with laboratory instruction and those taught using conventional teaching method

To test this hypothesis, the post posttest mean retention scores of students in experimental and control groups were subjected to t- test statistic and summary of analysis are shown on Table 4.6.

Table 4.6: Result of t-test Analysis of Academic Achievement post- posttest Mean Retention Scores of Experimental and Control Groups

VARIABLE	N	Mean	Std. Deviation	Df	t-valu e	p-value	Decision
EXPERIMENTAL	73	17.16	5.580	135	5.665	0.000	Reject HO3
CONTROL	64	12.11	4.755				

Table 4.6 results shows t-test between the academic achievements mean retention scores of experimental group and that of control group counter parts. The result shows that p- value of

0.000 is less than 0.05 level of significant, which indicated significance difference. Therefore, difference in learning retention between the experimental group taught using laboratory instruction and control group taught using conventional teaching method is significant. Hence the stated null hypothesis three HO_3 is thereby rejected.

Research Question 4: is there any difference in the mean retention scores between male and female students taught using laboratory instruction?

To answer this research question means and standard deviations are required. The post post test mean scores of male and female experimental group were subjected to descriptive statistics. Mean and standard deviation were computed and used to draw Table 4.7

Table 4.7 mean experimental group and standard deviation of post posttest scores for Male and female experimental group

VARIABLE	N	Mean	Std. Deviation
MALE	50	17.24	5.652
FEMALE	23	17.00	5.543

The result in Table 4.7 shows that the female in the experimental group with mean score of 17.00 and standard deviation of 5.543 is lower than the male counterparts with mean score 17.24 and standard deviation of 5.652. From this two mean, there is difference but the differences appear to be negligible. To find out if the difference is significant or not, null hypothesis four was formulated and tested using t- test statistic.

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Hypothesis fourHO_4: There is no significant difference in the mean retention scores between male and female students taught using laboratory instruction.

To test this hypothesis, the post posttest mean retention scores of male and female students in experimental group were subjected to t- test statistic and summary of analysis are shown on Table 4.8.

Table 4.8: Result of t- test Analysis of post- Posttest Mean Retention Scores of Male and Female Students taught using laboratory instruction

VARIABLE	N	Mean	Std. Deviation	Df	t-value	p-value	Decision
MALE	50	17.24	5.652	71	0.170	0.866	Retain Ho4
FEMALE	23	17.00	5.543				

From Table 4.8, the result show that the p- value 0.866 obtained is higher than 0.05 level of significance, which indicated no significant difference. Consequently the null hypotheses four which state that there is no significant different in mean retention scores between male and female students taught using laboratory instruction is thereby retained. This shows that, laboratory instruction is gender friend.

4.3 Summary of the Findings

In summary the research revealed as follows:

a) There is a significant difference in academic achievement between students taught using biology laboratory instruction and those taught using conventional class teaching method.
b) There is no significant difference in academic achievement between male and female students taught using biology laboratory instruction

c) There is a significant difference in the mean retention scores of students taught with biology laboratory instruction and those taught using conventional class teaching method.

d) There is no significant difference in the mean retention scores between male and female students taught using biology laboratory instruction.

The analysis therefore indicated that biology laboratory instruction were found to be positively affect academic achievement of senior secondary school students with no significant difference in male and female

4.4 Discussion of the Results

The study sought to find out the effect of the laboratory instruction on biology students academic achievement in and retention senior secondary schools in Jigawa state. To achieve this aim, students in experimental group were taught using laboratory instruction while students in control group were taught using convectional lecture method. Four research questions were asked and four null hypotheses were tested. Before the commencement of the treatment, it was established that the subject had equivalent knowledge in biology through the pre-test. Therefore, the observed difference in the results was due to treatment. The result of the analysis of the data on the research questions and null hypotheses are hereby discussed.

The results of analysis presented in table 4.1 and 4.2 showed significant difference in the academic achievement of the experimental group when compared with the control group. The difference is in favour of the experimental groups with mean scores of 20.27 who perform better than their control counter parts with a mean score of 15.53. This means student taught with laboratory instruction performed significantly better than those taught with lecture method in their academic achievement. This finding tends to imply that laboratory instruction is a more effective instructional strategy when compared with lecture method. This finding is in agreement

with Duniya (2016) who applied laboratory instruction to finding out it impact on academic performance, science process skills and attitude among convergent and divergent secondary school student, his finding indicated that significant difference exist between the posttest academic performance mean scores of convergent experimental and convergent control SSCE biology students taught using laboratory instruction and those taught using lecture method. The significant difference is in favour of convergent experimental students taught with the laboratory method of instruction. It also in agreement with Abiodun and Victoria (2013) who investigate the effect of practical assisted instructional strategy on students' academic achievement in biology. The result in their study showed that, the students in the experimental group had higher mean in the post test score compared to their control group counterparts. This shows that instructional strategy helped the students to learn the biology topic better. The active involvement of students in practical activities had given rise to improved learning. This result is also in line with finding of Lee (2003) who used laboratory instruction to enhance science process skills acquisition in biology students taught selected topics. He concluded that the two variables correlate highly with science process skill acquisition. Norman (2007) also reported in his findings that the development of science through the use of appropriate laboratory activities promotes students general performance in biology. The findings of Padilla, Okey and Dickshaw (2003) established a high relationship between science process skills acquisition and laboratory instruction and went further to postulate that exposure to laboratory activities may have positive influence on academic performance which is in line with results on Table 4.1 and 4.5 of this study. Okoli (2006) established that laboratory instruction strategy de-emphasizes rote-learning or memorization of scientific concepts and principles while emphasizing acquisition of knowledge and skills through active participation under the guidance of the science teacher. This according

to Nwagbo (2008) avail students the opportunity to interact with materials within the environment by observing, classifying, measuring, interpreting data and accurate reporting attributes which subjects in the control group were not exposed to.

The analysis of the mean achievement scores in table 4.3 and 4.4 between male and female students were not statistically significant. The finding from this study indicates that gender has no effect on laboratory instruction. This means that laboratory instruction is gender friendly. The result of this finding concur with that of Ariyibi, (2004) and Udo, (2006) who indicated zero effect of gender in student academic achievement in science. Their results indicated that, if given the right conditions of teaching and learning both male and female would perform equally well in science. The finding of this study is also supported by Abdu-raheem (2012) who found hat gender has no significant contribution to the achievement of student in social studies. Therefore male and female students when exposed to the same treatments have nearly the same achievement scores. This findings disagree with Ekeh (2004), Ncharam (2010) and Jacinta (2011) who reported male superiority in science academic achievement. The present finding also disagrees with the findings by Shuaibu and Mari (1997) and Galadima (2003) who reported female superiority in academic achievement in science.

The results of the analysis presented on tables 4.5 and 4.6. Indicate that students taught using laboratory instruction have higher learning retention scores than the students taught using lecture method. The observable difference in retention level of experiment and control group could be due to the fact that laboratory instruction provides a stable cognitive structure that enhances anchorage of new materials which lead to meaning learning as opposed to rote learning.

The analysis of the mean retention scores in table 4.7 and 4.8 between male and female students in experimental group were not statistically significant. The finding from this study indicates that gender has no effect on learning retention taught using laboratory instruction. This means that learning retention through laboratory instruction is gender friendly. Hence there is no significance difference in the mean retention scores between male and female students taught using biology laboratory instruction. This finding is in line with that of Katcha and Wushishi (2015) who maintained that, if given the right conditions of teaching and learning both male and female would perform equally well in science particularly biology. This finding is also in agreement with Abdu-raheem (2012) who confirmed that the main effect of gender on students' retention in Social Studies is not significant. The male and female students exposed to the same treatment do not differ significantly in their retention means scores. This is contrary to Adeosun (2002) who found that girls have better retention than boys in his research carried out on effect of multi-media packages on students' achievement and retention in social studies. However, it was believed that girls achieved and retained equally with boys because of the facts that education of the girl-child is now given better attention by the government and the society in general. This opportunity gives room for girls to use their untapped intellectual potentials effectively and erase the old stereotype that places boy above girls on academic issues.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction`

This study investigated the "Effect laboratory instruction on Biology students' academic achievement and Retention among Senior Secondary Schools in Jigawa state". The chapter was discussed under the following sub-headings: Summary of the study, Conclusion of the study, Contribution to the knowledge, Limitation of the study and Recommendation from the study as well as for further study.

5.2 Summary

This study investigated the effect of biology laboratory instruction on students' academic achievement and retention among senior secondary schools in Jigawa state, Nigeria. It also investigated the effects of gender related differences on students' academic achievement and retention using laboratory instruction. Four research questions were formulated with their corresponding null hypotheses. Available literatures related to the study were reviewed.

The design of the study was quasi experimental in nature. It was pretest, posttest control and experimental design. A total of seventy three (73) intact class students made up the experimental group while a total of sixty four (64) intact class students made up the control group. The experimental and control groups were chosen by purposive sampling technique and were exposed to the treatment for six (6) weeks. Before the commencement of the treatment, it was established that the subject had equivalent knowledge in biology through the pre-test. Students in experimental group were taught using laboratory instruction while students in control group were taught using conventional teaching method.

The instrument used for data collection was The Biology Achievement Test (BAT). These were used to collate data for both posttest and post posttest which were used for answering research questions and testing the stated null hypotheses. BAT is a thirty (30) item multiple choice questions instrument with reliability coefficient (r) of 0.89 were used to collect the relevant data which were then analyzed using t-test analysis for dependent and independent sample at $P \leq 0.05$ which was then used for testing the hypotheses by either retaining or rejecting it. The SPSS analytical package was used to analyze the data obtained.

The distribution of the scores showed that the academic achievement for the experimental group taught using the laboratory instruction performed significantly better than the control group taught using the lecture method.

Finally chapter five focused at a summary of the major findings of the study from where conclusions were drawn, recommendations proffered and suggestion for further studies made. Areas where the study contributed to knowledge were also highlighting and limitations to the study identified.

5.3 Conclusion

Based on the results obtained from this study the following conclusions were drawn:

1) Students taught using laboratory instruction method, performed better than those taught using conventional teaching method in both academic achievement and learning retention.
2) Laboratory instruction is gender friendly in relation to academic achievement and learning retention among senior secondary school biology. As both students performed well.

3) Laboratory instruction has potentiality of enhancing students' academic achievement due to its inbuilt features such as hand-on activities where students will manipulate experiments and carry out analysis on their own in the teaching and learning of biology.

5.4 Contribution to Knowledge

The research was initiated to investigate the effect of laboratory instruction on Biology students' academic achievement in and Retention senior secondary schools in Jigawa state. It was then observed that the study had contributed to knowledge in the following ways:

1) The study established that laboratory instruction strategy enhances better academic achievement among senior secondary school biology students.
2) The study also established that laboratory instruction strategy lead to better retention of learned biology concept among senior secondary school biology students.
3) The study also established that laboratory instruction strategy is gender friendly as both male and female benefit during teaching and learning process.

5.5 Limitation of the Study

The limitations of this study are:

a) The study was restricted to only SSII students in Jahun educational zone, jigawa Nigeria. This makes the generalization of the result fairly narrow.
b) A sample size of 137 students was used for this study. It may be possible to obtained different result if a larger sample size is used

5.6 Recommendations

5.6.1 Recommendations from the Study

Based on the findings and conclusions reached in this study, the following recommendations were made:

1) The ministry of education should encourage the use of laboratory instruction strategy for biology teachers in senior secondary schools.
2) Professional associations like the Science Teacher Association of Nigeria (STAN), Biology Society of Nigeria (BSN) and research centers such as Nigeria Educational and Research Development Council (NERDC) should incorporate laboratory instruction in their science curricular at secondary school level to encourage the use of the strategy among teachers. They should also organize workshops and seminars on how to use laboratory instruction to teach specific biology topics.
3) Authors and publishers of text books materials for secondary school biology should expand the curriculum content to include the methodology used in this study on the use of laboratory instruction so that both teachers and students can be exposed to the use of the strategy.
4) Co-educational schools should encourage the use of laboratory instruction, as it is gender friendly. Both male and female could benefit from the use of laboratory instruction during teaching and learning process.

5.6.2 Suggestion for Further Study

The followings suggestions are put forward for further studies:

a) Studies of this kind could be extended to other subjects in junior secondary schools, poly technics and Universities as the result obtained here is restricted to senior secondary schools.

b) This type of study could be extended to other subjects in science and art discipline

c) It could also be extended to other educational zones in jigawa state, and other state of the federation for wider more generalized result.

d) The study could be replicated to include other variables such as interest, attitude, and self-efficacy of student toward biology using laboratory instruction strategy.

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APPENDIX A

LESSON PLAN FOR EXPERIMENTAL GROUP (Laboratory instruction)

LESSON ONE

Date: 16 May, 2016

School: GASS Jahun

Class: SS II

Age range: 14-16 years

Subject: Biology

Topic: The cell

Time: 45 minutes

Number of students in class: 73

Instructional method: Laboratory instruction

Instructional Materials/Apparatus: Microscope, microscope slides, cover slips, lugol solution, iodine solution, paper towel, tooth pick and Pasteur pipette, unripe banana, onion

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

a) Define the term cell
b) Classification of living organisms based on the number of the cell
c) History of the cell
d) Enumerate two type of cell
e) Experiment to observed the structure of typical plants cell

Previous knowledge: The students have already learned on the characteristics of living things and differences between plant and animal.

Introduction: The lesson will be introduced by asking the students some questions:

a) What are the characteristics of living things?
b) What are the difference between plants and animals?
c) What is the basic unit of life?

Presentation:

Step I: Teacher defines the concept of cell as "the structural and functional unit of living organism. In other words, the cell is the simplest, the smallest and basic unit of life. All living things either plants or animals are made of cells.

Step II: Classification of living organisms based on the number of the cells.

Teacher explains that based on the number of the cell, living organisms are classified into unicellular and multicellular. Unicellular are the organisms that have single cell examples Amoeba, Euglena, Paramecium while multicellular are the organisms that have two or more cells examples Hydra, Spirogyra, Flowering plants, fish, bird, man.

Step III: History of the cell

Teacher describe fully on how cell come into been and some of the scientist that contributed to the history of the cell. Among the scientists are Robert hooke, Felix dujardin, Mathias schleiden and Theodor Schwann.Robert Hooke was the first human being to discover the honey-comb structure of the cell in (1665). In his book, micrographia, he described his observations of a magnified thin slice of an oak tree. He established that the cork is made up of thin components or rooms. He then named the components as cells.

Step IV: Enumerate two type of cell

Teacher enumerates two types of cell that is plant cell and animal cell.The structure of plant and animal cell can be fully understood through the use of microscope. The cell is composed of protoplasm which can be divided into two main parts: the cytoplasm and nucleus. Each cell (plant and animal) is bounded by a thin membrane. The cytoplasm is a fluid material that consists of cytoplasmic organelles such as lysosome, golgi bodies, endoplasmic recticulum, mitochondria, vacuoles etc. the nucleus is bounded by a nuclear membrane and it consist of chromosomes (chromatin granules) and nucleolus.

Step V: Experiment to observe the structures of a typical plant cell.

Teacher divide the students into difference group and provide each groups with microscope, microscope slide, lugol solution, iodine solution, onion, unripe banana, cover slip . The teacher instruct each work bench to smear a little of an unripe green banana on a slide microscope, place

a drop of iodine solution on top of the banana smear and cover with cover slip on top. Place the slide on the microscope, with 4+ or 10+ objectives in position and find a field of view containing the cell. Then view at higher magnifications.Teacher instructs to repeat another experiment with onion using iodine solution

Conclusion

The teacher concludes the lesson by summarizing the important point of lesson

Evaluation

The teacher evaluates the students understanding of the lesson by asking them the following questions:

1. Who can define the term cell?
2. Give three example each of unicellular and multicellular organisms
3. Who can describes the structures of a typical plant cell

LESSON TWO

Date: 23 May, 2016

School: GADSS Jahun

Class: SS II

Age range: 14-16

Subject: Biology

Topic: The cell

Time: 45 minutes

Number of students in class: 73

Instructional method: Laboratory instruction

Instructional Materials/Apparatus: microscope, microscope slide, cover slips, iodine solution, cheek

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

a) Experiment to observe some of the structure of animal cell
b) Describe the structures of plant and animal cells
c) Identified some of the cell organelles and their functions
d) List the similarities between plant and animal cells
e) Mention some difference between plant and animal cells

Previous knowledge: The students have already learned on the definition of cell, type of cell, classification of cell and structure of a typical plant cell.

Introduction: The lesson will be introduced by asking the students some questions:

a) What is cell?
b) Give two type of cell?
c) Describe the structure of plant cell?

Presentation:

Step I: Experiment to observe the structures of a typical animal cell.

Teachers divide the students into difference group and provide each group with microscope, microscope slide, iodine solution, human cheek, cover slip. The teacher instruct each group to smear a little human cheek on a microscope slide, place a drop of iodine solution on top of the human cheek smear and cover with

cover slip on top. Place the slide on the microscope, with 4+ and 10+ objectives in position and find a field of view containing cells. Then view at higher magnifications.

Step II: Describe the structures plant and animal cells.

Teachers ask the students to describe the structure of a typical plant and animal cell based on their observation from microscope. In addition to the answers from the students, teacher describe fully on the structures of the cell. The cell is composed of protoplasm which can be divided into two main parts: the cytoplasm and nucleus. Each cell (plant or animal) is bounded by a thin membrane. The cytoplasm is fluid material that consists of cytoplasm organelles such as lysosome, golgi bodies, endoplasmic reticulum, mitochondria, vacuoles etc. the nucleus is bounded by a nuclear membrane, and it consists of chromosomes (chromatin granules) and nucleolus.

Step III: Identified some of the cell organelles and their functions

Teacher list some the cell organelles or components and explain fully on their function. Nucleus (controls the activities of the cell and stores hereditary information as it contains DNA inside chromosomes which take part in cell division), mitochondria (is described as the power-house of the cell. They are sites of respiration or where energy is released from simple sugar), cell membrane (serves a great role in selective absorption of materials and also protects the cell) etc.

Step IV: Similarities between plant and animal cell.

Teachers ask students to identify some of the similarities between plant and animal cell based on their observation from the microscope. In addition, both plant and animal cell have: nucleus, golgi bodies, mitochondria, cytoplasm, chromosome, endoplasmic reticulum, nucleolus, ribosome, lysosomes and cell membrane.

Step V: Difference between plant and animal cell.

Teachers also ask students to mention some of the difference between typical plant and animal cell based on their observations from the microscope. In addition the teacher explains some of the differences between plant and animal cell as:

Plant cell	Animal cell
Plant cell has chloroplasts.	Animal cell has no chloroplast.
It has rigid cell wall.	It has no cell wall.
It has large vacuoles.	It has small vacuoles.
It stores lipid as oil.	It stores lipid as fat.
Rectangular and definite in shape.	Usually spherical or has no shape.
It has no flexible cell membrane.	It has flexible cell membrane.
It has nucleus at the edge of cytoplasm.	It has nucleus at the centre of cytoplasm.

Conclusion

The lesson will be concludes by summarizing the important point of the lesson.

Evaluation

The teacher evaluates the students understanding of the lesson by asking them the following questions:

1. Who can describe the structure of a typical animal cell?
2. Who can mention five differences between plant and animal?
3. List four similarities between plant and animal cell?
4. What is the organelle responsible for respiration?
5. Where does DNA is found in the cell and the function play?

LESSON THREE

Date: 30 May, 2016

School: GADSS Jahun

Class: SSS II

Age range: 14-16 years

Subject: Biology

Topic: Diffusion

Time: 45 minutes

Number of students in class: 73

Instructional method: Laboratory instruction

Instructional Materials/Apparatus: Perfume, black ink solution, conical flask, beakers, bottles, ammonia solution, hydragensulphide

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

a) Define the term diffusion
b) Demonstrate the diffusion of gases using ammonia solution
c) Demonstrate the diffusion of gases using hydrogen sulphide
d) Demonstrate the diffusion of a liquid

Previous knowledge: The students have previously learnt how to mix different types of substances in water, that substance move in both gaseous and aqueous media.

Introduction: Class have you noticed that when a rat dies in a hidden corner of a room, the smell gradually spreads all over?

Have you also noticed that when a gas that smells is introduced at one point in a room, it is felt by all occupants after some few minutes or seconds? Have you also noticed that when a coloured liquid is poured in water, the colour spreads over the entire water gradually? What do you think is responsible for that?

Presentation:

Step I: Teacher defines the concept of diffusion as the movement of gaseous or liquid substances from a region of high concentration to a region of lower concentration through the air or liquid medium. Such movement starts and continues until the

molecules of the gas or liquid are spread uniformly across the media. The molecules movements can be made faster by stirring or heat.

Step II: Demonstration of diffusion in gases using ammonium solution

Teacher instruct the students to take a bottle of ammonia solution, open the bottle and move some distance away from the bottle and wait for some time. Then smell the air to perceive the odour. The smell of the ammonia gas shows that diffusion of ammonia gas has taken place.

Step III: Demonstration of diffusion in gases using hydrogen sulphide.

The teacher introduces a pungent smelling gas of hydrogen sulphide at one corner of the laboratory. He ask the students to take note of the odour of the air in the laboratory before introducing the gas and five (5) minutes after the introduction. Before the introduction the odour in the laboratory was odorless and after few minutes the odour of the gas was felt by the whole class starting with those nearer the point of introduction and ending with those farer away. The movement of the gas can be explained as diffusion.

Step IV: Experiment to show the diffusion of a liquid.

Students grouped in pairs. Stock solution of black ink is provided on each work bench. Each group is asked to pipette out some iwnk and add 2 drops in a small portion of water in a conical flask (A) and allowed to stay for five 5 minutes, add another 2 drops of ink in conical flask (B) contain water and shake gradually.

Result:

(i) Conical flask (A) + 2 drops of ink (no shaking) = the ink spreads gradually until water colour turned light blue/black.

(ii) Conical flask (B) + 2 drops of ink (with shaking) = water colour turned light blue/black immediately at the end of the shaking.

Conclusion: Diffusion took place gradually in flask A while flask B diffusion took place faster with the shaking increasing the rate of diffusion.

Evaluation

The teacher evaluates the lesson by asking the students some of the questions about lesson as follows:

1. Who can define the term diffusion?
2. What factors are likely to increase or speed up the rate of diffusion?

Conclusion

The teacher concludes the lesson by writing a summary of the test carried out, the observation and conclusion/inference on the maker board.

LESSON FOUR

Date: 6 June, 2016

School: GADSS Jahun

Class: SSS II

Age range: 14-16 years

Subject: Biology

Topic: Diffusion

Time: 45 minutes

Number of students in class: 73

Instructional method: Laboratory instruction

Instructional Materials/Apparatus: Conical flask, beakers, bottles, crystals of potassium permanganate

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

a) Demonstrate the diffusion of solid in water
b) Name the areas where diffusion is applicable in plants
c) Name the areas where diffusion is applicable in animals

Previous knowledge: The students have previously learnt on the definition of diffusion and how to demonstrate diffusion in gases and liquid state.

Introduction: The lesson will be introduced by asking the students some question:

a) What is diffusion?
b) Explain the diffusion of gases
c) Explain the diffusion of liquid

Presentation:

Step I: Demonstration of diffusion of solid in water.

Each group is provided with a 250ml beaker ¾ filled with water. Crystals of potassium permanganate are also provided on each work bench. At the same time, the teacher instructs the students in each group to drop a few crystals of the potassium permanganate into the water at the centre of the beaker gradually taking note of observation/ colour changes at 5 minutes intervals up to the end of 15 minutes (Viz 0 minute, 5 minutes, 10 minutes and 15 minutes).

Results: 0 minute= a trail of purple colour seen as the crystals sink to the bottom

After 5 minutes= crystals dissolve forming a dense layer at the bottom and light purple layer above.

After 10 minutes= the distinct layers are formed: deep purple bottom, light purple middle and a lighter purple at the top.

After 15 minutes= the whole water turns purple.

Step II: Teacher explain some the areas where diffusion is take place in plants examples movement of carbon dioxide through the stomata of the leaves during respiration, movement of carbon dioxide through the stomata into the leaves during photosynthesis, water vapour leaving the leaves during respiration.

Step III: Teacher also explain on the importance of diffusion to animals' examples intake of oxygen or nutrients from the mother to the foetus through placenta, gaseous exchange in mammals that take place in the lungs during respiration, gaseous exchange in many cells and organisms' e.gAmeoba takes in oxygen and gets rid of carbon dioxide by diffusion

Evaluation

The teacher evaluates the students understanding of the lesson by asking them the following questions:

1. What are the importances's of diffusion in plants?
2. List the important areas where diffusion is applicable in animals?

Conclusion:

The teacher concludes the lesson by writing a summary of the test carried out, the observations and conclusion/inference on the maker board. A summary of the areas of application or importance of diffusion is also written down on the board for the students.

LESSON FIVE

Date: 13 June, 2016

School: GADSS Jahun

Class: SSS II

Age range: 14-16 years

Subject: Biology

Topic: Osmosis

Time: 45 minutes

Number of students in class: 73

Instructional method: Laboratory instruction

Instructional Materials/Apparatus: thistle funnels, beakers, sugar solution, water, cellophane.

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

a) Define the term osmosis
b) Explain osmosis using non living tissues
c) Demonstrate osmosis using non living system
d) Mention condition necessary for osmosis to take place
e) List some of the importance of osmosis in living organisms

Previous knowledge: The students have already learned on the concepts of solute and solvent. Students have also learned on diffusion

Introduction: the lesson will be introduce by asking the students some questions

a) Who can differentiate between solute and solvent with examples?
b) What is diffusion

Presentation:

Step I: Teacher defines the concept of osmosis as the flow of water or solvent molecules from a region of dilute or a weaker solution to a region of concentrated or stronger solution through a selectively or differentially permeable membrane. It should be noted that osmosis is a special form of diffusion.

Step II: Demonstration of osmosis using non living tissues:

Students are given the following activities to carry out in the laboratory class in a group

- Pour equal quantity of water into the beakers, cover the bottom of the thistle funnels with cellophane paper (selectively permeable membrane).
- Then pour sugar solution into thistle funnel A and water into thistle funnel B (control experiment) and mark their levels.
- Immerse the two funnels into beaker containing water
- Allow the experiment to remain for 2-3 hours.

  It was observed that at the end of the experiment, the volume sugar solution will rise in the thistle funnel A while the water level in the beaker will reduce. At the same time, the volume of water in funnel B and beaker remain at the same level.

  Conclusion: The rise of sugar solution in thistle funnel A and decrease in the water level in the beaker show that osmosis has taken place.

Step III: Condition necessary for osmosis to take place

Teacher explains that, there are three major conditions which are necessary for osmosis to take place. These are presence of stronger solution, presence of a weaker solution and presence of a selectively or differentially permeable membrane.

Step IV: Importance of osmosis in living organisms

Teacher list and explain some importance of osmosis in living organisms.

Student's activity: Students carry out the instructions given by the teacher in step II above and record their observations.

Conclusion

The teacher concludes the lesson by writing a summary of the test, results/observations and conclusion/inference of the experiment set to demonstrating osmosis in non living systems on the marker board for the students to copy, including the diagrammatic representation of the experiment.

Evaluation

The teacher evaluates the lesson by asking the students the follows questions:

1. Who can define the term osmosis?
2. How can explain the rise in the liquid level in the thistle funnel and the decrease in water level in the beaker
3. Why did the rise and fall of the liquid levels in both the thistle funnel and beaker eventually stooped?
4. What are the importances of osmosis in living organism?

LESSON SIX

Date: 20 June, 2016

School: GADSS Jahun

Class: SSS II

Age range: 14-16 years

Subject: Biology

Topic: Osmosis

Time: 45 minutes

Number of students in class: 73

Instructional method: Laboratory instruction

Instructional Materials/Apparatus: Yam tuber, sugar solution, water, knife, Petri-dishes.

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

a) Explain osmosis using a living tissue
b) Demonstrate osmosis using a living system/membrane
c) Identify living cells as osmometer
d) Enumerate some of the differences between osmosis and diffusion

Previous knowledge: The students have already learned on the concept of osmosis and demonstration of osmosis using non living tissue.

Introduction: the lesson will be introduced by asking the students some questions as follows:

a) Who can define the term osmosis?
b) What are the importance of osmosis

Presentation:

Step l: Experiment to demonstrate osmosis using a living system/ yam tuber

Students are guided to carry out the following instructions

- Peel the yam tuber, cut it into two parts and make a cavity with the aid of the knife into the two cut yam tubers.
- Pour water into the the two petri-dishes.
- Place each half of the yam tubers with base down into the petri-dishes containing water.
- Add small quantity of sugar solution to yam tissue A and allow yam tissue B to serve as control experiment.

- The set up is allowed to stand for 4-6 hours

Observation: At the end of the experiment, it is observed that the level of sugar solution in A has risen resulting in a decrease in water level in the petri-dish while the water level in B remains the same both in the tuber and the petri-dish.

Conclusion: Since the sugar solution has risen in yam tissue A, it shows that osmosis has taken place.

Step II: Living cells as osmometer

Teacher explains that in osmosis, there are usually two solutions which are separated by a differentially permeable. The weaker solution is said to be **hypotonic** while the stronger solution is said to be **hypertonic**. When both solutions have the same concentration, they are said to be **isotonic.**

Step III: Difference between osmosis and diffusion

Teacher will ask students from their observations in the experiments on diffusion and osmosis to differentiate between osmosis and diffusion

Diffusion	**Osmosis**
Involves movements of molecules of gases, liquid and solid	Involves the movement of water only
A semi-permeable membrane is not involved	A semi-permeable membrane is involved
Molecules move to any space available to them	Water movement is only between 2 solutions of different osmotic pressures.

Conclusion

The teacher concludes the lesson by writing a summary of the test carried out, the observation and conclusion/inference on the maker board

Evaluation

The teacher evaluates the lesson by asking the students some of the questions about lesson as follows:

1. Who can define the term diffusion?
2. What factors are likely to increase or speed up the rate of diffusion?

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APPENDIX B

LESSON PLAN FOR CONTROL GROUP (Conventional teaching method)

LESSON ONE

Date: 16 May, 2016

School: GDSS Jahun

Class: SS II

Age range: 14-16 years

Subject: Biology

Topic: The cell

Time: 45 minutes

Number of students in class: 64

Instructional method: Conventional teaching method

Instructional Materials/Apparatus: White board and maker

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

a) Define the term cell
b) Classification of living organisms based on the number of the cell
c) History of the cell
d) Enumerate two type of cell
e) Demonstrates how to observed the structure of typical plants cell

Previous knowledge: The students have already learned on the characteristics of living things and differences between plant and animal.

Introduction: The lesson will be introduced by asking the students some questions:

a) What are the characteristics of living things?
b) What are the difference between plants and animals?
c) What is the basic unit of life?

Presentation:

Step I: Teacher defines the concept of cell as "the structural and functional unit of living organism. In other words, the cell is the simplest, the smallest and basic unit of life. All living things either plants or animals are made of cells.

Step II: Classification of living organisms based on the number of the cells.

Teacher explains that based on the number of the cell, living organisms are classified into unicellular and multicellular. Unicellular are the organisms that have single cell examples Amoeba, Euglena, Paramecium while multicellular are the organisms that have two or more cells examples Hydra, Spirogyra, Flowering plants, fish, bird, man.

Step III: History of the cell

Teacher describe fully on how cell come into being and some of the scientists that contributed to the history of the cell. Among the scientists are Robert hooke, Felix dujardin, Mathias schleiden and Theodor Schwann. Robert Hooke was the first human being to discover the honey-comb structure of the cell in (1665). In his book, micrographia, he described his observations of a magnified thin slice of an oak tree. He established that the cork is made up of thin components or rooms. He then named the components as cells.

Step IV: Enumerate two type of cell

Teacher enumerates two types of cell that is plant cell and animal cell. The structure of plant and animal cell can be fully understood through the use of microscope. The cell is composed of protoplasm which can be divided into two main parts: the cytoplasm and nucleus. Each cell (plant and animal) is bounded by a thin membrane. The cytoplasm is a fluid material that consists of cytoplasmic organelles such as lysosome, golgi bodies, endoplasmic recticulum, mitochondria, vacuoles etc. the nucleus is bounded by a nuclear membrane and it consist of chromosomes (chromatin granules) and nucleolus.

Step V: Demonstrates how to observe the structures of a typical plant cell.

The teacher describes steps to go through in identifying the structures of a typical plant cell. Smear a little of an unripe green banana on a slide microscope, place a drop of iodine solution on top of he banana smear and cover with cover slip on top. Place the slide on the microscope, with 4+ or 10+ objectives in position and find a field of view containing the cell. Then view at higher magnifications.Teacher describes another experiment with onion using iodine solution.

Conclusion

The teacher concludes the lesson by summarizing the important point of lesson and writing a steps involve on how to observe a typical plant cell on the maker board for the student to copy.

Evaluation

The teacher evaluates the students understanding of the lesson by asking them the following questions:

1. Who can define the term cell?
2. Give three example each of unicellular and multicellular organisms
3. Who can describes the structures of a typical plant cell

LESSON TWO

Date: 23 May, 2016

School: GDSS Jahun

Class: SS II

Age range: 14-16

Subject: Biology

Topic: The cell

Time: 45 minutes

Number of students in class: 64

Instructional method: Conventional teaching Method

Instructional Materials/Apparatus: Maker board and maker

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

a) Describes how to observe some of the structure of animal cell
b) Describe the structures of plant and animal cells
c) Identified some of the cell organelles and their functions
d) List the similarities between plant and animal cells
e) Mention some difference between plant and animal cells

Previous knowledge: the students have already learned on the definition of cell, type of cell, classification of cell and structure of a typical plant cell.

Introduction: the lesson will be introduced by asking the students some questions:

a) What is cell?
b) Give two type of cell?
c) Describe the structure of plant cell?

Presentation:

Step I: Describe how to observe the structures of a typical animal cell.

Teachers describes to the students the steps involve to observe the structures of a typical plant cell. Firstly smear a little human cheek on a microscope slide, place a drop of iodine solution on top of the human cheek smear and cover with cover slip on top. Place the slide on the microscope, with 4+ and 10+ objectives in

position and find a field of view containing cells. Then view at higher magnifications.

Step II: Describe the structures plant and animal cells.

Teachers describes to the students on the structures of plant and animal cell. The cell is composed of protoplasm which can be divided into two main parts: the cytoplasm and nucleus. Each cell (plant or animal) is bounded by a thin membrane. The cytoplasm is fluid material that consists of cytoplasm organelles such as lysosome, golgi bodies, endoplasmic reticulum, mitochondria, vacuoles etc. the nucleus is bounded by a nuclear membrane, and it consists of chromosomes (chromatin granules) and nucleolus.

Step III: Identified some of the cell organelles and their functions

Teacher list some the cell organelles or components and explain fully on their function. Nucleus (controls the activities of the cell and stores hereditary information as it contains DNA inside chromosomes which take part in cell division), mitochondria (is described as the power-house of the cell. They are sites of respiration or where energy is released from simple sugar), cell membrane (serves a great role in selective absorption of materials and also protects the cell) etc.

Step IV: Similarities between plant and animal cell.

Teachers explain on the similarities between plant and animal cell. Both plant and animal cell have: nucleus, golgi bodies, mitochondria, cytoplasm, chromosome, endoplasmic reticulum, nucleolus, ribosome, lysosomes and cell membrane.

Step V: Difference between plant and animal cell.

Teacher writes and explains fully on the difference between plant and animal cell as follow:

Plant cell	Animal cell
Plant cell has chloroplasts.	Animal cell has no chloroplast.
It has rigid cell wall.	It has no cell wall.
It has large vacuoles.	It has small vacuoles.
It stores lipid as oil.	It stores lipid as fat.
Rectangular and definite in shape.	Usually spherical or has no shape.
It has no flexible cell membrane.	It has flexible cell membrane.
It has nucleus at the edge of cytoplasm.	It has nucleus at the centre of cytoplasm.

Conclusion

The lesson will be concludes by summarizing the important point of the lesson.

Evaluation

The teacher evaluates the students understanding of the lesson by asking them the following questions:

1. Who can describe the structure of a typical animal cell?
2. Who can mention five differences between plant and animal?
3. List four similarities between plant and animal cell?
4. What is the organelle responsible for respiration?
5. Where does DNA is found in the cell and the function play?

LESSON THREE

Date: 30 May, 2016

School: GDSS Jahun

Class: SSS II

Age range: 14-16 years

Subject: Biology

Topic: Diffusion

Time: 45 minutes

Number of students in class: 64

Instructional method: Conventional teaching method

Instructional Materials/Apparatus: Maker board, maker

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

a) Define the term diffusion
b) Demonstrate the diffusion of gases using ammonia solution
c) Demonstrate the diffusion of gases using hydrogen sulphide
d) Demonstrate the diffusion of a liquid

Previous knowledge: The students have previously learnt how to mix different types of substances in water, that substance move in both gaseous and aqueous media.

Introduction: Class have you noticed that when a rat dies in a hidden corner of a room, the smell gradually spreads all over?

Have you also noticed that when a gas that smells is introduced at one point in a room, it is felt by all occupants after some few minutes or seconds? Have you also noticed that when a coloured liquid is poured in water, the colour spreads over the entire water gradually? What do you think is responsible for that?

Presentation:

Step I: Teacher defines the concept of diffusion as the movement of gaseous or liquid substances from a region of high concentration to a region of lower concentration through the air or liquid medium. Such movement starts and continues until the

molecules of the gas or liquid are spread uniformly across the media. The molecules movements can be made faster by stirring or heat.

Step II: Demonstration of diffusion in gases using ammonium solution

Teacher describe to the students on the steps involve in the diffusion of gases using ammonium solution. Firstly take a bottle of ammonia solution, open the bottle and move some distance away from the bottle and wait for some time. Then smell the air to perceive the odour. The smell of the ammonia gas shows that diffusion of ammonia gas has taken place.

Step III: Demonstration of diffusion in gases using hydrogen sulphide.

The teacher also describes the diffusion of gasses using hydrogen sulphite. Firstly introduces a pungent smelling gas of hydrogen sulphide at one corner of the class. He ask the students to take note of the odour of the air in the class before introducing the gas and five (5) minutes after the introduction. Before the introduction the odour in the class was odorless and after few minutes the odour of the gas was felt by the whole class starting with those nearer the point of introduction and ending with that farer away. The movement of the gas can be explained as diffusion.

Step IV: Experiment to show the diffusion of a liquid

Teacher descries the steps involve on the experiment to show diffusion of liquid. Firstly pipette out some ink and add 2 drops in a small portion of water in a conical flask (A) and allowed to stay for five 5 minutes, add another 2 drops of ink in conical flask (B) contain water and shake gradually.

Result:

(i) Conical flask (A) + 2 drops of ink (no shaking) = the ink spreads gradually until water colour turned light blue/black.

(ii) Conical flask (B) + 2 drops of ink (with shaking) = water colour turned light blue/black immediately at the end of the shaking.

Conclusion: Diffusion took place gradually in flask A while flask B diffusion took place faster with the shaking increasing the rate of diffusion.

Evaluation

The teacher evaluates the lesson by asking the students some of the questions about lesson as follows:

1. Who can define the term diffusion?
2. What factors are likely to increase or speed up the rate of diffusion?

Conclusion

The teacher concludes the lesson by writing a summary of the describes test, the observation and conclusion/inference on the maker board.

LESSON FOUR

Date: 6 June, 2016

School: GDSS Jahun

Class: SSS II

Age range: 14-16 years

Subject: Biology

Topic: Diffusion

Time: 45 minutes

Number of students in class: 64

Instructional method: Conventional teaching method

Instructional Materials/Apparatus: maker board, maker

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

a) Demonstrate the diffusion of solid in water

b) Name the areas where diffusion is applicable in plants

d) Name the areas where diffusion is applicable in animals

Previous knowledge: The students have previously learnt on the definition of diffusion and how to demonstrate diffusion in gases and liquid state.

Introduction: The lesson will be introduced by asking the students some question:

a) What is diffusion?

b) Explain the diffusion of gases

c) Explain the diffusion of liquid

Presentation:

Step I: Demonstration of diffusion of solid in water.

The teacher describes the process to involve in the demonstration of diffusion in water. Firstly, drop a feww crystals of the potassium permanganate into the water at the centre of the beaker gradually taking note of observation/ colour changes at 5 minutes intervals up to the end of 15 minutes (Viz 0 minute, 5 minutes, 10 minutes and 15 minutes).

Results: 0 minute= a trail of purple colour seen as the crystals sink to the bottom

After 5 minutes= crystals dissolve forming a dense layer at the bottom and light purple layer above.

After 10 minutes= the distinct layers are formed: deep purple bottom, light purple middle and a lighter purple at the top.

After 15 minutes= the whole water turns purple.

Step II: Teacher explain some the areas where diffusion is take place in plants examples movement of carbon dioxide through the stomata of the leaves during respiration, movement of carbon dioxide through the stomata into the leaves during photosynthesis, water vapour leaving the leaves during respiration.

Step III: Teacher also explain on the importance of diffusion to animals' examples intake of oxygen or nutrients from the mother to the foetus through placenta, gaseous exchange in mammals that take place in the lungs during respiration, gaseous exchange in many cells and organisms' e.gAmeoba takes in oxygen and gets rid of carbon dioxide by diffusion

Conclusion:

The teacher concludes the lesson by writing a summary of the test described by the teacher, based on observations and conclusion/inference on the maker board. A summary of the areas of application or importance of diffusion is also written down on the board for the students to copy.

Evaluation

The teacher evaluates the students understanding of the lesson by asking them the following questions:

1. What are the importances of diffusion in plants?
2. List the important areas where diffusion is applicable in animals?

LESSON FIVE

Date: 13 June, 2016

School: GDSS Jahun

Class: SSS II

Age range: 14-16 years

Subject: Biology

Topic: Osmosis

Time: 45 minutes

Number of students in class: 64

Instructional method: Conventional teaching method

Instructional Materials/Apparatus: White board, maker

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

a) Define the term osmosis
b) Explain osmosis using non living tissues
c) Demonstrate osmosis using non living system
d) Mention condition necessary for osmosis to take place
e) List some of the importance of osmosis in living organisms

Previous knowledge: The students have already learned on the concepts of solute and solvent. Students have also learned on diffusion

Introduction: The lesson will be introduce by asking the students some questions

a) Who can differentiate between solute and solvent with examples?
b) What is diffusion

Presentation:

Step I: Teacher defines the concept of osmosis as the flow of water or solvent molecules from a region of dilute or a weaker solution to a region of concentrated or stronger solution through a selectively or differentially permeable membrane. It should be noted that osmosis is a special form of diffusion.

Step II: Demonstration of osmosis using non living tissues:

Teacher describes steps involve in demonstrating osmosis using non living tissues as follows:

- Pour equal quantity of water into the beakers, cover the bottom of the thistle funnels with cellophane paper (selectively permeable membrane).
- Then pour sugar solution into thistle funnel A and water into thistle funnel B (control experiment) and mark their levels.
- Immerse the two funnels into beaker containing water
- Allow the experiment to remain for 2-3 hours.

  It was observed that at the end of the experiment, the volume sugar solution will rise in the thistle funnel A while the water level in the beaker will reduce. At the same time, the volume of water in funnel B and beaker remain at the same level.

Conclusion: The rise of sugar solution in thistle funnel A and decrease in the water level in the beaker show that osmosis has taken place.

Step III: Condition necessary for osmosis to take place

Teacher explains that, there are three major conditions which are necessary for osmosis to take place. These are presence of stronger solution, presence of a weaker solution and presence of a selectively or differentially permeable membrane.

Step IV: Importance of osmosis in living organisms

Teacher list and explain some importance of osmosis in living organisms.

Conclusion

The teacher concludes the lesson by writing a summary of the test describe by the teacher based on, results/observations and conclusion/inference of the experiment set to describe osmosis in non living systems on the marker board for the students to copy, including the diagrammatic representation of the experiment

Evaluation

The teacher evaluates the lesson by asking the students the follows questions:

1. Who can define the term osmosis?
2. How can explain the rise in the liquid level in the thistle funnel and the decrease in water level in the beaker
3. Why did the rise and fall of the liquid levels in both the thistle funnel and beaker eventually stooped?
4. What are the importances of osmosis in living organism?

LESSON SIX

Date: 20 June, 2016

School: GDSS Jahun

Class: SSS II

Age range: 14-16 years

Subject: Biology

Topic: Osmosis

Time: 45 minutes

Number of students in class: 73

Instructional method: Conventional teaching method

Instructional Materials/Apparatus: white board, maker

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

a) Explain osmosis using a living tissue
b) Demonstrate osmosis using a living system/membrane
c) Identify living cells as osmometer
d) Enumerate some of the differences between osmosis and diffusion

Previous knowledge: The students have already learned on the concept of osmosis and demonstration of osmosis using non living tissue.

Introduction: The lesson will be introduced by asking the students some questions as follows:

a) Who can define the term osmosis?
b) What are the importance of osmosis

Presentation:

Step I: Experiment to demonstrate osmosis using a living system/ yam tuber

Teacher describes the steps involves in demonstrating osmosis using living system as follows:

- Peel the yam tuber, cut it into two parts and make a cavity with the aid of the knife into the two cut yam tubers.
- Pour water into the two Petri-dishes.
- Place each half of the yam tubers with base down into the Petri-dishes containing water.

- Add small quantity of sugar solution to yam tissue A and allow yam tissue B to serve as control experiment.
- The set up is allowed to stand for 4-6 hours

Observation: At the end of the experiment, it is observed that the level of sugar solution in A has risen resulting in a decrease in water level in the Petri-dish while the water level in B remains the same both in the tuber and the Petri-dish.

Conclusion: Since the sugar solution has risen in yam tissue A, it shows that osmosis has taken place.

Step II: Living cells as osmometer

Teacher explains that in osmosis, there are usually two solutions which are separated by a differentially permeable. The weaker solution is said to be **hypotonic** while the stronger solution is said to be **hypertonic**. When both solutions have the same concentration, they are said to be **isotonic.**

Step III: Difference between osmosis and diffusion

Teacher will write and explain on the difference between osmosis and diffusion

Diffusion	**Osmosis**
Involves movements of molecules of gases, liquid and solid	Involves the movement of water only
A semi-permeable membrane is not involved	A semi-permeable membrane is involved
Molecules move to any space available to them	Water movement is only between 2 solutions of different osmotic pressures.

Conclusion

The teacher concludes the lesson by summarizing the importance point of the lesson

Evaluation

The teacher evaluates the lesson by asking the students some of the questions about lesson as follows:

3. Who can define the term diffusion?
4. What factors are likely to increase or speed up the rate of diffusion?

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APPENDIX C

BIOLOGY ACHIEVEMENT TEST (BAT)

SECTION A: Personal data of respondent

School……

Class……...

Gender……

Age ……..

SECTION B: Test

Instructions: This test consists of thirty (30) multiple-choice objective equations with options lettered A-D choose the correct answer by ticking the correct option.

1. Which of the following statements is **correct** about diffusion?
   A. It involves the movement of water molecule.
   B. Molecules move from a region of higher concentration to a region of lower concentration.
   C. Differentially permeable membrane must present for diffusion to occur.
   D. It involves the movement of only solute molecules.
2. Osmosis can be defined as diffusion of :
   A. Atoms and molecules through a membrane to an area of higher concentration
   B. Water molecules from a dilute solution to a concentrated solution across a permeable membrane.
   C. Water molecules from an area of high concentration to an area of low concentration.
   D. Water molecules from a dilute solution to a concentrated solution through a semi-permeable membrane.
3. Cells that utilize a lot of energy are characterized by the presence of a large number of
   A. Vacuole B. Mitochondria C. Endoplasmic reticulum D. Ribosome
4. A typical plant cell is mainly distinguished from an animal cell by the possession of
   A. Chloroplast and nucleus B. Cell wall and cytoplasm C. Chloroplast and cell wall D. Cell wall and mitochondria.

5. Which of the following process involves diffusion?
   A. Opening and closing of stomatal pores. B. Turgidity of herbaceous plants C. Absorption of water through the root hair D. Obsorption of digested food into the villi.
6. Which of the following statement is **not** true of osmotic process?
   A. There must be selectively permeable membrane
   B. The two solutions are of equal concentration at the beginning of the experiment.
   C. It involves only the movement of water molecules.
   D. Equilibrium is reached when there is equal distribution of water molecules
7. The two important physical processes involved in the absorption and transport of materials in plants are:
   A. Diffusion and plasmolysis B. Cohesion and diffusion C. Flaccidity and turgidity D. Osmosis and diffusion.
8. The cell membrane of a cell is said to be semi-permeable because
   A. It allows only large molecular substances to pass through it into the cell.
   B. It actively allows substances to pass through it by diffusion.
   C. It actively selective in allowing substances to pass through it.
   D. Fatty acids are the only building blocks of the membrane.
9. Movement of water across a semi-permeable membrane from a weaker to a stronger solution is known as:
   A. Osmosis B. Diffusion C. Active Transport D. Plasmolysis
10. Which of the following processes occurs by diffusion?
    A. Reabsorption of water in the kidney tubules
    B. Entry of water into the cytoplasm of unicellular animals
    C. Absorption of water in the large intestine
    D. Exchange of nutrients between mother and foetus
11. One major difference between osmosis and diffusion is that diffusion:
    A. Does not need a semi- permeable membrane
    B. Does not take place in living tissue
    C. The cytoplasm is less dense
    D. The cell lacks a wall

12. The organelle involved in the transport of substances within a cell is

    A. Golgi body B. Endoplasmic recticulum C. Ribosome D. Mitochondria

13. The nucleus controls the activities of the cell because it

    A. Synthesis hormones B. is like a brain in the cell C. Uses DNA to synthesize enzymes which are used in cell metabolism D. sends out nervous impulses to ensure the functioning of the cytoplasm.

14. Which of the following statements define plasmolysis?

    A. Shrinking of a plant cell in a solution
    B. Shrinking away of cytoplasm from an animal cell
    C. Shrinking away of cytoplasm from an animal plant cell wall
    D. Shrinking of the vacuaole and leaving the cytoplasm attached to the cell wall

15. Which of the following substances pass through the root cell membrane by osmosis?

    A. Cell sap B. Carbon dioxide C. Oxygen D. Water

16. Which of the following organism has both plant and animal like features?

    A. Paramecium B. Euglena C. Ameoba D. Spirogyra

17. All the following organelles have membranes **except**

    A. Nucleus B. Vacuole C. Cell membrane D. Cell wall

18. The unit contained in a cell structures responsible for change in form and shape of organisms is called

    A. Mitochondria B. Gene C. Ribosome D. Lysosome

19. The plant cell mostly store food as

    A. Glycogen B. Auxins C. Hormones D. Starch

20. Turgor pressure occurs in a cell when the

    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

21. Which of the follow statement is **incorrect** about diffusion?

    A. Molecules move from region of higher concentration to that of lower concentration

B. It occurs mainly in gaseous and liquid media. C. No D. molecules move from region of lower concentration to that of higher concentration

22. In plant cell the role of membrane is played by

A. Nucleolus B. Cell wall C. Cytoplasm D. Ribosomes

23. If amoeba is placed in a salt solution contractile vacuole will

A. Burst B. Be more numerous C. Shrink D. Become bigger and burst.

24. Diffusion takes place in all the following surfaces **except**:

A. Semi-permeable membrane B. Aveoli C. Skin of earthworm D. Cell membrane of Amoeba

25. Which of the following is a similarity between a typical animal cell and typical plant cell?

A. Cellulose cell wall B. Chlorophyll C. Centrally-placed nucleus D. Cell membrane.

26. The scientist to describe the cell was

A. Theodor Schwann B. Felix Dujardin C. Robert Hooke D. Mathias Schleiden.

27. In which of the following parts of a cell is the chromosome found?

A. Nucleus B. Golgi body C. Cytoplasm D. Cell membrane

28. Which of the following structure control the activities of the living cell?

A. Nucleus B. Centrosome C. Chloroplast D. Mitochondria

29. Most of the energy in the cell is produced in the

A. Mitochondria B. Lysosome C. Plastid D. Cytoplasm

30. Which of the following structures differentiates an animal cell from a plant cell?

A. Ribosome B. Cell membrane C. Chloroplast D. Mitochondria.

APPENDIX D

MARKING SCHEME FOR BIOLOGY ACHIEVEMENT TEST (BAT)

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

APPENDIX E

ANSWER SHEET FOR BIOLOGY ACHIEVEMENT TEST

SECTION A: BIODATA

Name of School _____

Class _____

Gender _____

SECTION B:

Please shade the correct answer appropriately

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

APPENDICES

Hypothesis 1

Group Statistics

Post test	N	Mean	Std. Deviation	Std. Error Mean
Experimental Group	73	20.27	5.912	.692
Control Group	64	15.53	5.155	.644

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Si	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Post Test	Equal variances assumed	1.1	.28	4.9	13	.000	4.743	.954	2.856	6.630

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Si	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Post Test	Equal variances assumed	1.1	.28	4.9	13	.000	4.743	.954	2.856	6.630
	Equal variances not assumed			5.0	13	.000	4.743	.945	2.873	6.613

Hypothesis 2

Group Statistics

Experimental Group	N	Mean	Std. Deviation	Std. Error Mean
Male	50	20.32	5.930	.839
Female	23	20.17	6.005	1.252

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
								Std. Error Difference	95% Confidence Interval of the Difference	
		F	Si	T	df	Sig. (2-tailed)	Mean Difference		Lower	Upper
Experimental	Equal variances assumed	.00	.93	.09	7	.923	.146	1.500	-2.845	3.137
	Equal variances not assumed			.09	4	.923	.146	1.507	-2.894	3.187

Hypothesis 3

Group Statistics

Post Posttest	N	Mean	Std. Deviation	Std. Error Mean
Experimental Group	73	17.16	5.580	.653
Control Group	64	12.11	4.755	.594

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means					
	F	Sig.	T	df	Sig	Mean Dif fe	Std. E rr or	95% Confiden Interval o the Differenc

							re n c e	D if fe re n c e	Low e r	Upp
Post - Post Test	Equal variances assumed	3.779	.05 4	5.665	135	.00	5.055	.892	3.290	6.8
	Equal variances not assumed			5.724	134	.00	5.055	.883	3.309	6.8

Hypothesis 4

Group Statistics

Post Test Experimental Group	N	Mean	Std. Deviation	Std. Error Mean
Male	50	17.24	5.652	.799
Female	23	17.00	5.543	1.156

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confid Interval o Differe	
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	U
Post- Post Test	Equal variances assumed	.021	.885	.17	7	.866	.240	1.416	-2.582	
	Equal variances not assumed			.17	4	.865	.240	1.405	-2.593	