EFFECTS OF LABORATORY PRACTICAL EXERCISE ON BIOLOGY ACHIEVEMENT AND RETENTION AMONG SECONDARY SCHOOL STUDENTS IN MINNA METROPOLIS.

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ABSTRACT

The study investigated the effects of laboratory practical exercise on biology achievement and retention among secondary school students in Minna metropolis. Four research questions and four null hypotheses guided the study. The review of literature in the study was organized under conceptual framework, theoretical framework and empirical studies. In the conceptual framework, concept of laboratory, practical exercise, biology, achievement, retention, osmosis and gender were reviewed. Piaget's cognitive constructivist learning theory and vygotsky's social constructivist learning theory were also reviewed under theoretical framework. The empirical studies examined related studies on the effect of laboratory practical exercise on biology students' achievement and retention of the concept of osmosis, and studies on gender and academic achievement and retention. A quasi- experimental design was adopted for the study. The study was carried out in Minna Metropolis of Niger State. The sample for the study comprised of one hundred and three (103) students drawn from the population of the study using simple random sampling technique. Two groups were used for this study; they are experimental and control groups. The instrument for data collection in this study was Osmosis Achievement Test (OAT). The items were questions from teacher- made test. Data collected from the questions were analysed using mean, standard deviation and ANOVA to test the hypotheses at 0.05 level of significance. The results revealed that students taught the concept of osmosis using laboratory practical exercise performed better than their counterparts taught using conventional method (lecture method). Male and female students of experimental group had higher mean achievement score than male and female of the control group. The mean retention of students in experimental group is higher than the control group. Retention score of male and female in experimental group is higher than the control group. In line with the findings of the study, the recommendations made which include among others that teachers should use laboratory practical exercise in teaching of osmosis and other practical topics in biology.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of study

For every developing nation to attain and sustain national development, a well-planned and implemented science and technology education remains the only essential tool for her national development (Tafi, 2016). This is because individuals who acquire scientific and technological literacy, think innovatively and rationally, thus enabling them to conduct themselves within the global acceptable standard. Science is a type of discipline with unusual characteristics, the prominent among which is the approach through which knowledge is sought. This approach is known as scientific method. Scientific method is a logical, rational and systematic process by which knowledge in science is acquired. The steps involved in scientific method are observation, hypotheses, predictions, experimentations, conclusion and host of others (Ezeh, 2013). Science is both a process (scientific method) and a product (knowledge, fact and principles) as asserted Ezeh (2013). Both the process and product of science are acquired through education and this is a specialized type of education such as science education. Science plays important roles in the society because it relates to our daily life and career. The importance of science in our society made the Federal Government of Nigeria, through the Federal Ministry of Education to introduce science subjects in the nation's secondary school curriculum. Biology is one of such subjects introduced. Biology is defined as the study of life and structure of living things. Biology is the study of living things and concerns itself with the study of the structural, behaviour, distribution, the origin of plants, and animals and their relationship with their

environment (American Heritage Dictionary of the English Language, 2009). Abugu (2007) stated that biology is natural science in which we study living organisms' (plants and animals). Also Biology is a branch of science that deals with the study of living things, which includes human-beings (Michael, 2012). Despite the importance of biology, students' achievement in the subject from West African Secondary School Certificate Examination (WASSCE) has been poor (Glasson, 2009). The available data on students' performance in biology in School Certificate revealed that on the average, the performance of student's are not encouraging. Looking at the fundamental characteristics and importance of biology, it is today viewed as a standard subject of instruction at all levels of our educational systems, from post-primary to tertiary. It is the only core science subject at Secondary School Certificate Examination (SSCE), whose study is very relevant to man's successful living (Akindele, 2009). Araoye (2009) opined that exposure to biology education offers the learners a wide range of relevance to all aspects of life. The idea behind biology as a course of study is to produce knowledgeable, highly motivated, professional and effective teachers of biology who will be able to develop in students, an appreciation and understanding of biological process and principles (NCCE, 2008). Biology as a subject is quite popular at all levels of Nigerian education. The poor achievement in Biology by the students in National Examination Council (NECO) and West African Senior School Certificate Examination (WASSCE) over the years has generated a great concern such that Federal Government of Nigeria in recent time organized for a probe of the results in WAEC and NECO (Umoh, 2010). Students' abysmal performance in Biology examination has been linked to so many factors like the unavailability of the needed teaching

and learning resources and facilities. This performance can also be linked to the method of teaching. According to Ada (2006), teaching method is a mode of organization of the instructional content, materials, the manner of presentation to the learner and the activities that learners and teachers carryout. There are a number of methods of teaching which are available for the teacher's use in teaching Biology. These methods are classified under two major groups; traditional and contemporary methods. The traditional method popularly called teacher- centred is where the teacher dominates in teaching and learning process. Examples are Lecture method, demonstration method, and descriptive method among others. Contemporary teaching method is also referred to as students-centred teaching approach. Here students are actively involved in knowledge generation. Examples are Laboratory method, computer based approach, concept mapping, and cooperative learning among others. Agwagah (2008) viewed that the traditional methods are guilty of imposing poor concept formation and reducing the interest and retention and thereby leading to poor achievement among science students. This then calls for the use of the laboratory teaching method which is one of the contemporary teaching methods that could help to increase students' achievement and promotes retention of psychomotor skills in Biology. Laboratory method of teaching according to Akuto, Aduloju and Odeh (2012) is a process where the students are in direct contact with the concept or processes they are learning. This includes; any activity involving students in real situations using genuine materials and properly working equipment. The authors added that the use of laboratory method of teaching aids the development of visual, perceptual and manipulative skills and also makes learning permanent (retention)

among students. According to Joshi (2008), Laboratory exercise method of teaching is a unique way of instruction and it forms an integral part of effective science teaching. In this method, the teacher does not take recourse to lecturing nor to demonstration of experiment. Rather, the students are encouraged to derive the laws and principles of science themselves by actually performing the experiments. The students are given all necessary materials and equipment in the laboratory along with their proper instructions for carrying out their experiments with their own initiative and effort. The observations are recorded and the results are inferred. It helps the students to understand complex abstract ideas and gives students an opportunity to participate in the process and have an appreciation for the methods of science. He viewed that the knowledge and skills gained through laboratory method is more lasting and permanent as they learn by their own experience, observation, testing and verification.

Osmosis is the movement of any solvent through a selectively permeable membrane into an area of higher solute concentration, the result of which will be an equalizing of solute concentration on either side of the membrane. The equilibrium is important for the efficient and optimized function of cells; as mentioned before, balance is the preferred state in a natural environment. While any solvent can undergo the process of osmosis, including supercritical liquids and some gases, the majority of discussion surrounding osmosis relates to the movement throughout our entire body is done through the manipulation of solute concentrations and osmosis. The absorption or diffusion of water helps to unconsciously provide stability and functionality to every cell, tissue and organ in our body.

There are three types of solutions – isotonic, hypertonic and hypotonic solutions in which osmosis plays a key role and occurs differently; understanding these basic examples is necessary before learning about the cool and more complex details of osmosis, as its importance on so many aspects of our survival.

Isotonic solution: if you place a cell in an isotonic solution (in relation to the cell), the concentration of solutes is even, meaning that water can move into and out of the cell at an equal rate. Osmosis will occur, but at a balanced pace, meaning that the cell won't swell or shrink. For example, if both your solvent and your cell's cytoplasm are composed of 75% water and 25% salt, the concentrations are equal and there is no net movement of water across the selectively permeable membrane.

Hypotonic: if you place a cell in a hypotonic solution (in relation to the cell), water will flow into the cell in order to equalize the solvent concentration. The best example of this situation is the way your fingers prune after you go swimming. The concentration of salts and other solvents in your skin cells is higher than the water of the lake or pool, so water moves into those cells, causing them to swell and wrinkle. Imagine placing a cell with 60% water and 40% salt into a solution with 80% water and 20% salt. Water would flow from the solution into the cell until a balance of 70% water and 30% salt was achieved. In extreme cases within a cell, when too much water is taken in, it can cause the cell to swell and lyse (burst), causing cell death.

Hypertonic: when a cell is placed in a hypertonic solution (in a relation to the cell), there will be a higher concentration of solute outside of the cell, so water will diffuse away from the cell, towards the hypertonic solution, in order to balance the solvent

concentrations. Essentially, the cell will be sucked dry, and made flaccid, to compensate for the excess solute outside the membrane. In extreme cases, the cell shrivels enough that the cell membrane detaches from the cell wall and becomes plasmolyzed. Without water to move the various molecules in the cell, it will die.

For plants, osmosis is responsible for the movement of water into the root system, which allows the plant to grow and survive. The root hairs of plants are the key point where minerals and water are taken into the organism. The concentration of water molecules are less in the root hairs than in the soil (hypertonic solution), so water moves into the cells of the root hairs; osmosis continues through numerous layers of cells (cell-to-cell movement) until that water reaches the xylem tubes equivalent to human veins. On a related noted note, when water is taken into the cells of plants, the pressure caused by that osmotic movement is called turgidity. When equilibrium is achieved, those plants cells should be full of water, as well as firm and turgid. This prevents leaves from wilting, allowing them to increase their surface area for sunlight capture. Osmosis also helps protect plants against drought and frost damage, as well as in regulating the opening and closing of stomata.

For animals (humans), some of the key osmotic functions relate to the balance of water content in the blood versus the surrounding tissues. Similarly, in the kidneys, osmosis controls the amount of waste build up by increasing fluid flow into that organ. When the solute concentration is higher in the kidney cells(hypertonic solution), water is pulled from the body's bloodstream into the kidney (nephrons), which will eventually stimulate the need to urinate in a person/animal, thus eliminating those unwanted waste products.

1.2 Statement of the Research problem

In any teaching and learning process, the objective is to see that the learner is able to perform tasks and if possible transfer the experience in solving problems in a new situation. This objective is hardly been achieved over the years. The rate of failure in local and external examination in Biology in recent times is a matter of concern. Many suggested that this ugly trend might have been the poor foundation of students in Biology. This may also be connected to the method of teaching used by the science teachers, because a good learning is a product of a good method of teaching. This persistent poor achievement in Biology process skills acquisition exhibited by science students in practical examination leaves no doubt about the in effectiveness of the teaching method used by science teachers for teaching this subject. Students may have seen Biology as abstract and meaningless concepts. Students neither understand the basic concepts nor the underlying process that gave rise to the Biology concepts. This may be because the teaching methods used by the teacher were teacher's centred and does not allow students' participation, therefore imposing poor concept formation and reducing interest of the students in Biology. This makes students resort to learning by memorization, which results in consistent mass failure. It is against this backdrop that this study is necessitated to investigate the effect of laboratory method of teaching on senior secondary school students' achievement and retention in Biology in Minna metropolis.

According to (Glasson, 2009), students' achievement in biology subject from West African Secondary School Certificate Examination (WASSCE) has not been encouraging. (WAEC Chief Examiner Report, 2011, 2012, 2013), report on how the performance of candidates in biology fell below expectation. The report discussed the

candidate's weakness under the following sub heading: Poor observation, Misinterpretation of question and Poor spelling.

The examiners lamented that many candidates who could not answer correctly a single question in section A, in most cases they have wild guesses and quite unrelated answer that were sometimes unbiological on the academic achievement, retention and performance. This study therefore intends to examine the effects of laboratory practical exercise on Biology achievement and retention of the concept of osmosis among secondary school students in Minna metropolis.

1.3 Aim and Objectives of the Study

The aim of this study is to determine the effects of laboratory practical exercise on Biology achievement and retention of the concept of osmosis among secondary school students in Minna metropolis. Specifically, this study intends to achieve the following objectives by determining:

1. The difference in students' achievement in Biology when taught the concept of osmosis using laboratory practical exercise and lecture method.
2. The difference in male and female students' achievement in Biology when taught the concept of osmosis through laboratory practical exercise and lecture method.
3. The difference in retention when taught the concept of osmosis through laboratory practical exercise and lecture method.
4. The difference in students' retention based on gender when taught the concept of osmosis through laboratory practical exercise and lecture method.

1.4 Research Questions

The following research questions were raised to guide the study:

1. What are the achievement scores of the students in Biology when taught the concept of osmosis by using Laboratory practical exercise and those taught using lecture method?
2. What are the achievement scores of male and female students in Biology when taught the concept of osmosis using laboratory practical exercise and those taught using lecture method?
3. What are the retention scores of students taught the concept of osmosis using laboratory practical exercise and those taught using lecture method?
4. What are the retention scores of students based on Gender when taught the concept of osmosis using laboratory practical exercise and those taught lecture method?

1.5 Statement of Hypotheses

The following null hypotheses will be tested at 0.05 level of significance:

HO_1: There is no significant difference between the mean achievement scores of students in Biology when taught the concept of osmosis using laboratory practical exercise and those taught using lecture method.

HO_2: There is no significant difference between the mean achievement scores of male and female students in Biology when taught the concept of osmosis using laboratory practical exercise and that using lecture method.

HO_3: There is no significant difference between the mean retention scores of student in Biology when taught the concept of osmosis using laboratory practical exercise and those taught using lecture method.

HO_4: There is no significant difference between the mean retention scores of students based on gender when taught the concept of osmosis using laboratory practical exercise and those taught using lecture method.

1.6 Scope of the Study

The study is targeted on the senior secondary schools in Minna Metropolis. The scope is also limited on SSII biology students and the concept of osmosis, the study covered two (2) schools in Minna metropolis within 6-10 weeks. The instrument for data collection was OAT (Osmosis Achievement Test).

1.7 Significance of the Study

This study will be of benefit to biology students, teachers, curriculum planners/ developers, and future researchers.

Biology students will benefit from the findings of this study as the use of laboratory practical exercise in the teaching of the concept of osmosis in Biology will boost their achievement and retention. This help to increase their retention of Biology concepts. It will also help them to develop more interest in Biology and acquire and develop scientific skills which will help them in their career choice particularly those careers geared towards Biological sciences.

The findings of this study will be of benefit to Biology teachers as it will help teachers in choosing appropriate instructional methods and materials capable of releasing students' tension toward the subject. It will motivate teachers to develop interest in utilizing modern instructional material like using experiments in teaching topics that are experimental in nature and selecting suitable teaching methods that will be a possible means towards reducing failure in the teaching and learning of Biology. The findings of this study will also sensitize Biology teachers on the benefits of the use of laboratory practical exercise and experimental techniques for teaching as it will have a great effect on the academic achievement and retention of the students. This findings study will enable curriculum planners to be aware of the importance of using laboratory practical exercise for teaching the concept of osmosis and also introducing it into the new curriculum for senior secondary school student's achievement and retention. For the future researchers, the findings of this study will make them to be aware of the effect of laboratory practical exercise on the achievement and retention of senior secondary school students of the concept of osmosis.

1.8 Operation definition of Terms

- **Achievement –**Is the students' score in pre-test, post-test and retention test.
- **Lecture Method-** This refers to an oral presentation of lesson given to a class by teacher. The teacher usually dispenses facts and opinions about contents, while students listen passively and sometimes make their own contributions when they are familiar with the topic(s).

- **Retention-** In this study retention is the ability of students to remember or recall Biology concepts they have been taught 2 weeks and 5 weeks after the study respectively.
- **Osmosis –** Is 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 permeable membrane.
- **Experiment-** This is a test under controlled conditions made to either demonstrate a known truth, examine the validity of a hypothesis or determine the efficacy of something previously untried.
- **Laboratory-** Is a room, building or institution equipped for scientific research, experimentation or analysis.
- **Practical-** Is part of an exam or series of exams in which the candidate has to demonstrate their practical ability or is based on practice or action rather than theory or hypothesis**.**
- **Abysmal-** Immeasurably
- **Sensitize-** To become increasingly aware of.
- **Plasmolyzed-** Is when the cell membrane has shrunken and detached from the plant cell wall.
- **Membrane-** Is the thin layer that forms the outer boundary of a living cell or an internal cell compartment.
- **Shrivels-** If something becomes smaller and its surface becomes covered in lines because it is very dry or cold.

CHAPTER TWO

2.0 LITERATURE REVIEW

The review of literature for this study is organized under the following sub sections: conceptual framework, Theoretical framework, empirical studies and summary of literature reviewed

2.1 Conceptual Framework

2.1.1 Concept of Laboratory

Laboratory is a room or a building or place where experimental study or research is carried out. In this place a person or group of persons are engaged in human enterprise of examining and explaining natural phenomena in a practical way. Laboratory is a place that gives the learner opportunity to investigate information via experimental procedures. These procedures need careful observations and interpretation of data. It has the characteristics of questioning, investigating and confronting the unknown. Fridler and Tamir (2009) opined that laboratory is the right place where students learn to do what scientists do, specifically where they use the skills and attitudes of science to go through the scientific process to seek knowledge. It is through laboratory teaching and learning processes that students put into practice those scientific skills and attitudes developed in them to make them self-dependent in the future, the goal for laboratory instruction in modern science courses focuses on the inquiry and discovery process or methodological phase of science and upon its intellectual constituents. Besides, laboratories are useful for teaching of science in schools and the success of science or any science-related course so much relies on the laboratory provision made for it. Students depend on the laboratory as

a place where they can watch the teachers demonstrate and as well carry out practical works themselves. Biology as a science subject is to some extent experimental. A laboratory- oriented approach is closer to the true nature of science since it helps students to know what experimental scientists do and how they develop a rational approach in generating and answering questions. Based on the foregoing, Hofstein and Lunetta (2013) reported that the advantages of the laboratory work which represent important goals in biology education and also demonstrate, how to teach biology in the laboratory is appropriate with advancement in science and technology.

2.1.2 Concept of practical Exercise

Practical exercise is a technique used during a training session that permits students to acquire and practice the knowledge, skills, and attitudes necessary to successfully perform one or more training objectives. Laboratory practical exercise include; experiments, and other activities which help the students in acquiring scientific skills. A laboratory is a room, or building or a special period of time equipped and set apart for practical or experiment studies to take place''. If science education aims to enhance the understanding of the natural world by students and how it functions, then the students have to experience and observe the relevant of science phenomena. Recent studies advocate for a change in teaching methods so that students participate fully and understand different science concepts (Miller, 2010). Students should understand processes and structure; develop skills in manipulation, processing of science information and conducting scientific investigations. (Capel, Least & Turner 2009), hence the teaching methods such as learner's design, reciprocal, inclusion, divergent and self-check could enhance the teaching of Biology practical lessons. Obiekwe and Chinwe (2015),

conducted a study in Nigeria on the teaching of biological concepts using the 5E (Engagement, Exploration, Explanation, Elaboration and Evaluation) model revealed that student who were exposed to the 5E method achieve better results than those whose teacher use the lecture method. Some teacher laid too much emphasis on content and the use of "chalk and talk approach which does not enhance the teaching and learning of biology. This slackness and shy-away attitude from activity based-approach of instructional delivery has led to abstraction, which makes the students passive and more inclined to role memorization (obiekwe & Chinwe, 2012). Such teacher-centered method put the students as passive recipients of knowledge and the teacher as the only source of knowledge might not improve achievement towards biology practical lessons.

2.1.3 Concept of Biology

Biology is one of the fields in the natural sciences that studies living things. The word 'Biology' is come from Greek words; Bios meaning life, and logy (logia) which means study (Ezemoka, 2011). Thus the concept of biology is concerned with the study of life. Biology in addition, is the study of life, structure, function, growth, origin, evolutions distributions, interrelationships, problems such as diseases, and adaptation of things and proposes solutions where possible, stated by Miller and Levine (2012). However, biology is the branch of science that studies life using inquiry methods and discoveries.

Inquiry process involves asking question that stimulates students to think critically which enables students to develop scientific knowledge and scientific habit such as curiosity, creativity, and open minded etc. that is needed for understanding biological concepts. Biology as science of life provides potentials for the use of many inquiry methods.

Biology is natural science in which we study living organism's plants and animals. The knowledge of biology helps in checking environmental degradation such as desertification, erosion, water hyacinth, land, air and water pollution.

The important objectives of biology education are to prepare students to acquire: adequate laboratory and field skills in biology; meaningful and relevant knowledge in biology, ability to apply scientific knowledge to everyday life in matter of personal and community health and agriculture and lastly reasonable and functional scientific attitudes (Federal Ministry of Education 2004). The study of biology in senior secondary school can equip students with useful concept principles and theories that will enable them face the challenges before and after graduation. Practical biology is the scientific study of the life and structure of plant and animals and their relative environment in real or experimental set-up rather than dwelling in the theory and ideas (Opuh, Eze, & Eze Magu, 2008).

2.1.4 Concept of Achievement

Achievement is regarded as a change in behaviour exhibited at the end of a given period of time or within a given time range. Anekwe (2006) sees achievement as a test for the measurement and comparison of skills in various fields of academic study. Hence achievement could be described as a task which has been accomplished successfully, especially by means of exertion, skill practice or perseverance. (Etuk, Koko & Eno, 2011), academic achievement enables us to obtain information on the extent to which a student has attained the criterion performance. It also enables us to determine the relative position of individual student with respect to their performance. Students, teachers, parents and the society are much concerned about the academic achievement of students.

The following are some of the purposes of academic achievement by Ekhasemomhe (2010):

- To determine the relative effectiveness of the programme in terms of students behavioural output.
- To identify students' growth or lack of growth in acquiring desirable knowledge, skills, attitudes and societal values.
- To help teachers determine the effectiveness of their teaching technique and learning materials.
- To help motivate students to learn more as they discover their progress or lack of progress in a given task.
- To encourage students to develop sense of discipline and systematic study habits
- To acquaint parents or guardians with their children's performance.
- To predict the general trend in the development of the teaching –learning process. To make reliable decision about educational planning.
- To provide educational administrators with adequate information about teachers' effectiveness and school needs.

In summary academic achievement measurement is used for instructional, administrative, guidance and counselling and research purposes. Many researchers have long investigated factors that affect the academic achievement of students in science. One of the factors that have been investigated for its effects on biology academic achievement is classroom environment. According to Talton and Simpson (2006) classroom environment is composed of six areas; the emotional climate of science classroom, science curriculum, physical environment of science classroom, science teacher, students in the science

classroom, friends' attitude toward science. Talton and Simpson stated that there exists a significant correlation between attitude towards science and all the classroom environmental variables and that these affect students' achievement in science particularly biology. If students experience an unpleasant punishment in science classroom the little science knowledge that they learn may disappear because the classroom environment is not suitable and will affect the students' academic achievement, emphasized by Simpson and Troost (2002). In the laboratory practical work the teacher should create good atmosphere by organizing the lesson that would be interactive and attractive to students either in group or individually. Teachings method is another factor in academic achievement especially cooperative learning approach which encourages students to work together in small groups and to use a variety of activities to improve their understanding of subject matter. Inquiry instructional approach encourages students to extend their thinking and express their ideas in a variety of ways through exploring and experiencing their environment through guided or unguided learning activities. inquiry approach which involves students gathering information, collecting and interpreting data, formulating hypotheses and drawing logical conclusions. It could be therefore possible for academic achievement to be attained if biology subject will be learned practically through the use of inquiry method in the laboratory for meaningful learning. It is generally believed that science is better learnt in an applied manner through laboratory activities. The students in doing experiments construct the bases for learning science because practical work involves the use of five senses which enable the students to understand and retain the knowledge they acquired through the process of teaching and learning; this makes them behave like scientists. Laboratory experiment could at

therefore enhance students' academic achievement through practical skills (Weinburgh &Englehard, 2009).

2.1.5 Concept of Retention

Retention is the continued possession of something (Hornby, 2006). Retention, in other words, is the continued existence of what has been. In education. Tere (2011) as cited in Eze (2015) defined retention as the 'remaining impressions of experience or learning'. Retention therefore involves the amount of learning experiences that is correctly remembered at a later time. For students to retain what they learnt for a long period of time aids their overall achievements in a subject. At times, terminal examination is administered to students and their achievements will depend on how much of what was done in the class lessons they were able to remember.

Eze (2015) posits that retention is higher when the degree of original learning is high. In other words, any teaching method that will lead to effective learning will also lead to higher retention. In pedagogical consideration, it is a rule of thumb that being a genius in one's field of study does not necessarily predict that one would be a good teacher. What makes a good teacher is the case with which one is able to impact knowledge to the learner or bring about a change in the behaviour of the learner. For a student to remember what was taught for a long period can be an assessment of how well he or she was taught.

2.1.6 Concept of osmosis

Is the spontaneous net movement of solvent molecules through a selectively permeable membrane into a region of higher solute concentration, in the direction that tends to equalize the solute concentration on the two sides. It may also be used to describe a

physical process in which any solvent moves across a selectively permeable membrane (permeable to the solvent, but not the solute) separating two solutions of different concentrations. Osmosis can be made to do work. Osmotic pressure is a colligative property, meaning that the osmotic pressure depends on the molar concentration of the solute but not on its identity.

Osmosis is a vital process in biological systems, as biological membranes are semipermeable. In general, these membranes are impermeable to large and polar molecules, such as ions, proteins, and polysaccharides, while being permeable to non-polar or hydrophobic molecules like oxygen, carbon dioxide, nitrogen, and nitric oxide. Permeability depends on solubility, charge, or chemistry, as well as solute size. Water molecules travel through the plasma membrane, tonoplast membrane (vacuole) or protoplast by diffusing across the phospholipid bilayer via aquaporins (small transmembrane) proteins similar to those responsible for facilitated diffusion and ion channels). Osmosis provides the primary means by which water is transported into and out of cells. The turgor pressure of a cell is largely maintained by osmosis across the cell membrane between the cell interior and its relatively hypotonic environment. Jean – Antoine Nollet (1748) first documented observation of ‘‘osmosis’’ descends from the words endosmose and ‘exosmose’, which were coined by French physician . in 1867, Moritz Traube invented highly selective precipitation membranes, advancing the art and techniques of measurement of osmotic flow.

2.1.7 Concept of Gender

Gender has been described as a cultural construct and social positions which members of the society attach to being male or female. Gender also means a dimension of social

organization which shapes how people interact with others and how people behave or act and think about themselves. It also includes hierarchy and ranking of men and women distinctly in terms of power, wealth, privilege and other resources. Okeke (2009) stated that gender is a social or cultural determinant that varies from place to place or culture to culture. It is not universal, unlike sex which is biologically determined and universal. Macionis and Genber (2015) observed that throughout life (birth and death), human feelings, thought and actions reflect the social definitions that people attach to gender which affects the way the individual's daily activities may either be positively or negatively influenced. As gender affects the way people think of themselves, it teaches them to act in normative ways, that is acting and feeling in the manner that the society ascribed to each sex. Connell (2013) maintained that as much as culture defines males as ambitious and competitive and females' differential and emotional, males are expected to aspire to leadership positions while females are expected to be good listeners and supportive observers. This gender role discrimination begin from the family and is later extended to other areas of one's life where a man sees himself as superior in every human endeavors and sees woman in a subordinate position in the educational setting, workplace or other parts of life. In other words gender is a fundamental category for ranking, and classifying social relations in the world (Evans, 2014).

In educational setting for instance, experience has shown that the curriculum, textbooks and the teaching materials tend to favour males and the females' intellectual potentials are ignored. This gender distinction manifests itself in the courses offered by males and females in the school, for example males are represented in mathematics, science and technology while females are grouped into humanities, education and social science

courses (Gaidzanwa, 2010; Cottes, 2013). In the new areas of study such as computer science with its grounding in engineering, logic and mathematics, males mostly enroll in it while female mostly enroll in gender studies (Macionis & Genber, 2015). The word gender does not mean that there are clear difference between female and male in term of preferences for arts, science and technology. If there are differences, they are based on hierarchical structures within the culture of what is suitable for males and females respectively (Walkerdine, 2009). According to Kembler (2010) science and information and communication technology (ICT) is in no manner separated from the cultural structures that treat women and girls unfairly or unequally compared to the men counterparts. Males and females are supposed to be allowed and encouraged to study science and technology, Arts, and humanities because there is no course that is made specifically for each sex. Science and technology courses are not for males alone; females are to be encouraged and motivated to offer science and technology because of its importance in this era of globalization and computer age Nwosu (2011). Recently gender related issues in science education have continued to receive serious attention judging by the number of studies done to that effect. For example Babajide (2010) reported that science subjects such as physics and chemistry are given masculine outlook by educational practitioners. In addition to this, the studies by Ogunleye (2012); Zirim (2009); Okwo and Otubar (2010) indicated that science achievement depends on gender. Also the studies by Nzewi (2010); Ogunleye and Babajide (2011); posited that gender is insignificant in science achievement. Oludipe (2012) also opined that promoting achievement in students' understanding of science does not depend on gender rather it is

through determination of the students. Agomuoh (2010); Ukozor (2011) found that gender influences students' conceptual shift in favour of the male.

Harlen (2012) attributed gender inequality in science teaching methods used by science teachers that creates wider gap in achievement. This statement has been supported by Agomouh (2010).

Some are of the opinion that males are superior to females, while others said is females and some are even neutral.

2.2 Theoretical Framework

2.2.1 Piaget's Cognitive Constructivist Learning Theory.

Piaget's cognitive constructivist theory was propounded in (1973) and proposed that children progress through a sequence of four stages, assumed to reflect qualitative differences in children's cognitive abilities. Limited by the logical structures in the different developmental stages, learners cannot be taught key cognitive tasks if they have not reached the particular stage of development. Piaget emphasized on the holistic approach to learning. To him a child constructs understanding through exploring and experiencing his or her environment. Later in (1985) Piaget expanded this theory to explain how new information is shaped to fit with the learner's existing knowledge, and existing knowledge is itself modified to accommodate the new information. The major concepts in this cognitive process include:

- Assimilation: it occurs when a learner perceives new objects or events in terms of existing schemes or operations. This information is compared with existing cognitive structures.

- Equilibration: it is the master developmental process, encompassing both assimilation and accommodation. Anomalies of experience create a state of disequilibrium which can be only resolved when a more adaptive, more sophisticated mode of thought is adopted.

Piagetian constructivist theory generally regards the purpose of education as educating the individual child in a fashion that supports the child's interests and needs; consequently, the child is the subject of study, and individual cognitive development is the emphasis. This is a child-centred approach that seeks to identify, through scientific study, and the natural part of cognitive development. It also assumes that learners come to classrooms with ideas, beliefs, and opinions that need to be altered or modified by a teacher who facilitates this alteration by devising tasks and questions that create dilemmas for the learners. Considering the educational reflections of this theory, Piaget sees the child as continually interacting with the world around the child, solving problems that are presented by the environment and learning occurs through taking action to solve these problems. The laboratory work in this study will also be based on these principles. Within Piaget's theory, the basis of learning is discovery: to understand is to discover, or reconstruct by rediscovery and such conditions must be complied with if in the future individuals are to be developed who are capable of production and creativity and not simply repetitive. According to Piaget, children go through stages in which they accept ideas they may later discard as wrong. Understanding, therefore, is built up step by step through active participation and involvement. Piaget further states that children begin to think logically between the age of 8 and 11 years, a stage he called the concrete operational stage of development. Laboratory practical activities require meaningful

learning, i.e. learning that involves critical and creative thinking. Piaget's ideology supports this with the idea of logical thinking. This implies that teachers should create situations that would help the learners to discover facts by themselves. In this case, the teacher should establish an explorative environment for the learners to explore facts or truth by themselves. Pre-packaged information can lead only to rote memorization of facts. Rote memorization is of no substantial benefit to the learner because it is not of much benefit in the exploration of the environment and the solution of problem. Individual acquires information through his interaction with the materials and the environment. Such information is retained and utilized for the solution of the environmental problem. Piaget's cognitive constructivist learning theory is related to the present study which is the effects of laboratory practical exercise on biology achievement and retention on the concept of osmosis among secondary school student ; because laboratory work encourages students' active participation, critical thinking, problem solving abilities and others.

2.2.2 Vygotsky's Social Constructivist Learning Theory

Vygotsky's theory states that knowledge is co-constructed and that individuals learn from one another. Vygotsky is one amongst those who believe that children actively construct their knowledge. Vygotsky (1962) viewed cognitive development as a result of logical process, where the child learns through shared problem solving experiences with someone else, such as teachers, parents, siblings and peers. As a social constructivist theorist, Vygotsky emphasizes the social contexts of learning and the fact that knowledge is mutually built and constructed. It also emphasizes the benefits of collaboration in group work and with a more skilled tutor; an individual will facilitate transition from learners' zone of proximal development to new levels of skills and competences. Zone of

proximal development (ZPD) is Vygotsky's term for the range of tasks that are too difficult for children to master alone, but can be learnt with the guidance and assistance from adults or more skilled children working independently. This implies that the science teacher should act as a facilitator by gradually withdrawing explanation, hints and demonstrations until the student is able to perform the skill alone. This will encourage the students to learn from previous knowledge they had before coming to school or the knowledge they already have to build the new knowledge. Vygotsky (1962) also emphasized that in the practical class the science teacher is expected to sensitize learners to their environment, develop critical thinking, encourage creative thinking and encourage exploration that will enhance self-directed and cooperate learning among the learners. Vygotsky theory is related to the present study which is effect of laboratory practical exercise on biology achievement and retention on the concept of osmosis among secondary school student because it supports the view that in laboratory, students interact with the materials or with one another in the course of practical work. This theory plays an important function in education to guide students in learning the skills. The teacher according to Vygotsky's view should also establish many opportunities for students to learn with the teacher and more skilful peers. In this respect it is evident from this theory that science should be taught in such a way that students will be able to apply the knowledge outside the classroom. Practical work in the laboratory can help achieve this. Looking at the constructivist theory as postulated by Vygotsky in the context of this study we find that achievement in biology largely depends on the learner and the environment itself and then the interactions that exist between the learners. The implication of this is that the science teacher must give the learners the opportunities to construct, produce and

use experience that is meaningful to their understanding of their environment. When this is done, then they can comfortably think, reason, perceive, talk and reflect about their environment. The expectation within this study may require that learners are given the opportunities to interact with their classmates and teachers in order to socially construct meaningful knowledge about their environment. Such knowledge construction will equally enhance the practical skills and subsequently better achievement in biology. The child's interaction with other people is important in the development of the child's view of the world. Through exchange of ideas with other people the learner becomes aware that self-criticism is possible only in the social interaction. Vygotsky's theory is related to the present study which is the effect of laboratory practical exercise on biology achievement and retention on the concept of osmosis among secondary school students because in laboratory, students interact with the materials or with one another in the course of practical work.

2.3 Empirical Studies

There are several related studies to the effects of laboratory practical exercise on biology students' achievement and retention of the concept of osmosis among secondary school students.

Chikelu (2009) conducted a research on effect of biology practical activities on student's process skill acquisition. A quasi experimental design was employed for the study. The sample consists of one hundred and eleven (111) senior secondary one biology students selected through simple random sampling techniques. The instrument for data collection in the study has 20 items Science Process Skill Acquisition Test (SPSAT). The data was analyzed using mean and standard deviation to answer the research questions and

analysis of covariance (ANCOVA) to test the hypothesis at 0.05 level of significance. The results revealed that practical activity method to foster the acquisition of science process skills than the lecture method. The interaction effect between teaching methods and gender of the subjects was not significant.

Based on the findings of this study, the use of practical activity method to foster the acquisition of science process skills in biology students was recommended to biology teachers.

The similarity between the reviewed study and the present study is that the studies are both conducted in the laboratory. They used the same experimental research design. Both studies used gender as their moderating variable. The differences between the two studies are that the present study is investigating the effect of laboratory practical exercise on biology achievement and retention of the concept of osmosis.

Cengiz (2010) carried out study on the effect of the virtual laboratory on student's achievement and attitudes in chemistry. The study employed a quasi-experimental research design, specifically the pre-test and post-test, experimental control group model. The study employed two scales which are 15-item knowledge scale (ks) questions. TheKuderRPichardson coefficient reliability was 0.86 for ks and 24 items for students attitudes scale (SAS), were selected with cronbach alpha-reliability coefficient of 0.92. The sample of the study was 341 high school students. The data collected were analyzed by using SPASS/PC version 120 statistical programs. Two different t-tests were performed. The results of the study showed that virtual laboratory applications made positive effects on student's achievement and retention when compared to traditional teaching methods. The study is related to the present study in the sense that they were

conducted within the context of laboratory work. However, the present study differs from the reviewed study because the previous study was in chemistry while the present study is biology. The present study intend to investigate the effect of laboratory practical exercise on biology achievement and retention of the concept of osmosis.

Ukozor (2011) carried out research on the effect of constructivist teaching strategy on senior secondary school students' achievement and self-efficacy in physics. The study employed one hundred and eight four (184) students from four (4) secondary schools. Non-equivalent control group design was adapted. Five research questions were posed and three null hypotheses guided the study. Means and standard deviation was used in answering the research questions and ANCOVA was used in testing the hypothesis. A significant effect of gender on student's physics academic achievement was found. In the light of the above result, therefore the present study intends to investigate the effect of laboratory practical exercise on biology achievement and retention of the concept of osmosis.

Okoh, Iwuozor and Obioma (2011) investigated gender differences in computational problems in chemistry among senior secondary school students. A total of multiple choice, pre and post achievement test items were constructed on three concepts treated in the experiment and administered to four hundred (400) SSII students drawn from twenty randomly selected secondary schools in four local government areas of Delta State. Two hypotheses were formulated and tested using the t-test at 0.05 level of significant. Analysis of the results revealed that the male students failed to achieve significantly higher in computational problems in chemistry than their female counterparts. The present study is aimed at investigating whether there is any difference due to gender by

using laboratory practical exercise on students' achievement and retention of the concept of osmosis in biology.

Nwosu, (2011) examined gender differences in the utilization of information and communication technology (ICT) among undergraduate students. One research question and one null hypothesis guided the study. Considering the findings of different people above, it is clear that there is not yet a consensus as to whether gender influences science achievement and retention or not. Some are of the opinion that males are superior to females, while others said is females and some are even neutral.

2.4 Summary of the Literature Reviewed

The review of literature was presented under conceptual framework, theoretical framework, empirical studies and summary of literature review. In the conceptual framework, the concept of laboratory in science teaching and learning was reviewed. Laboratory was seen as a room or a building or place where experimental study or research is carried out by scientists .From the review, it was seen that laboratory helps in the teaching and learning of science whereby students are able to observe and manipulate materials to demonstrate certain aspects of the subject matter which have been learned in the class through lecture, discussion and textbooks.The concept of biology was reviewed, biology knowledge is an essential element for national and human development. Over the years, use of ineffective teaching methods in teaching biology has contributed to the reduction in the number of students that could have opted for biological sciences and also in harnessing of the potentials in study of biology. Concept of academic achievement was also reviewed. Ifeakor (2012) regarded achievement as a change in behavior

exhibited at the end of a given period of time or within at the end of a given period of time or within a given time. Aronson (2010) explain academic achievement as the degree of attainment by student in schools, college, and universities or field work in which the student is sufficiently exposed to. Concept of retention, retention is an ability to recall or recognize what has been learned or experienced; memory. The way that a student grows, progresses, or increases his or her developmental capabilities as a result of enrolment in an institution of higher education. The more involved a student is with activities, the higher likelihood of student retention. Interaction between student characteristics and campus environment.

Concept of osmosis, osmosis is the spontaneous net movement of solvent molecules through a selectively permeable membrane into a region of higher solute concentration, in the direction that tends to equalize the solute concentration on the two sides. It may also be used to describe a physical process in which any solvent moves across a selectively permeable membrane (permeable to the solvent, but not the solute) separating two solutions of different concentrations.

According to Okeke (2009) gender is a social or cultural determinant that varies from place to place or culture to culture. It is not universal, unlike sex which is biologically determined and universal. Gender has been described as a cultural construct and social positions which members of the society attach to being male or female. Gender also means a dimension of social organization which shapes how people interact with others and how people behave or act and think about themselves. It also includes hierarchy and ranking of men and women distinctly in terms of power, wealth, privilege and other resources.

The review examines Piaget's cognitive constructivist learning theory and Vygotsky's social constructivist learning theory. These theories explain the importance of interactive learning with materials, environments or among students themselves which is what laboratory practical is all about. Learning theories of Piaget and Vygotsky emphasizes the need for active participation of the students during the learning process. So that they can find out fact for themselves, with the teacher serving as a facilitator. These theories relates to the present study because in laboratory activities, students are given the opportunity to construct knowledge by themselves by either working in groups or individually.

More so, some empirical studies were reviewed on the effect of different instructional approaches on students in different science subjects .This show that there is need for active instructional approach and strategies for effective conduct of practical which would enhance students' achievement and retention in sciences. Hence, this study investigates the effect of laboratory practical exercise on biology achievement and retention on the concept of osmosis in Minna metropolis, Niger State.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

This chapter is presented and discussed under the following sub-headings. Research design, population for the study, sample and sampling techniques, method of data collection, instrumentations, validity of instrument, reliability of the instruments, collections treatment of experimental group and method of data analysis.

3.1 Research Design

The study employed a quasi- experimental design. According to Offor (2000) and Sambo (2005) quasi- experimental research design permits the use of intact classes.

E $O_1X_1O_2O_3$

C $O_1X_2O_2O_3$

Where;

E - stands for experimental group

C - stands for control group

O_1 represent the pretest in the two groups

X_1 and X_2 represents treatment 1 (Experiment), treatment 2 (Lecture method)

respectively also O_2 represents post tests for two groups O_3 represents retention test.

3.2 Population

The population for the study comprised of 10,390 SS2 biology students in Minna Metropolis. There are twenty four (24) senior secondary schools of which (two) 2 are selected using targeted population.

Figure 3.1 Targeted Population of SSII Biology students' in Minna Metropolis

S/N	Name of schools	Populations of male students	Populations of female students	Total
1	Bosso secondary school	237	208	445
2	Zarumai model school	223	164	387

3.3 Sample and Sampling technique

Two senior secondary schools were sampled for the study. The school include Bosso secondary school (B.S.S) and Zarumai Model School (Z.M.S). The choice of the schools were because they shared similar characteristics like student type (Co-educational), and presence of experienced biology teachers. In each of the senior secondary schools SS2 students were used for the study. The SS2 class will be used for the study as the experimental group of Bosso Secondary School. The SS2 students of Zarumai Model School were used as the control group for the study.

Table 3.2 Sample size of streams of schools used for the study

Groups	Name of school	Class	Female population	Male population	Total
Experimental Group(taught using experiment)	Bosso Secondary School	SS2	208	237	445
Control Group (taught using lecture method)	Zarumai Model school	SS2	164	223	387

Eight hundred and thirty-two (832) SS2 students, four hundred and forty-five (445) SS2 constituted students in the experimental group and three hundred and eighty- seven (387) constituted the students in the control group. In each of the schools, the researcher used an intact class for the study. In the two schools sampled, the simple random technique was used to select intact SS2 class for the study and each class for the experimental and control groups comprised of 50 students. The view of Eboh (2009) who states that a common quasi- experimental design uses two or more groups which have not been randomly selected or allocated and the number in each group should be manageable.

3.4 Instrumentation

The Osmosis Achievement Test (OAT) was used in the study. Three tests were used to measure achievement and retention, one a pre-test which was used to test students'

prerequisite knowledge in topic related to the one that was covered during the study. Appendix A presents sample of the questions that was used in the pre-test and post-test, to measured students' achievement and retention at the conclusion of the study. Appendix B shows sample of the questions which was used in the retention test. A test, must be at the comprehension level and above in order to measure meaningful learning. The pre-test assessed students' Achievement on the concept of osmosis; the post test and the retention test also assessed students' achievement and retention on the concept of osmosis.

The Osmosis Achievement Test comprised of 20 test items of multiple choice questions. Each question had four options A-D, the questions used in the pre-test were re-numbered for the post test and retention test. The students' pre, post and retention test questions were scored. Each correct answered carried one mark and each wrong answer carried no mark.

The following instruments were used for data collection:

- Osmosis Achievement Test (OAT) for pre-test & post-test Appendix A
- Osmosis Achievement Test For Retention (OATR) Appendix B
- Lesson plan for experiment
- Lesson plan for control group(lecture method)

3.4.1 Validity of the Instrument

The OAT (osmosis achievement test) were questions from teacher made test. The lesson plans and the OAT were validated by experts from Department of Science Education of Federal University of Technology Minna.

3.4.2 Reliability of the instrument

The reliability co-efficient for both laboratory practical exercise and lecture method was determined using the kuder-Richardson formula 21 which determined the suitability of the instrument for the study and yielded a co-efficient value of 0.8. Brown (1983) has indicated the reliability co-efficient of 0.5 or more is considered reliable.

3.5 Method of data collection

The researcher and the trained biology teacher administered the pre-test to the experimental and control groups respectively. In the pre-test, the Osmosis Achievement Test (OAT) was administered to the groups. Objective question sheets (Appendix A) was provided for the students' to mark the correct answers for the OAT. The researcher marked the sheets of the OAT to obtain the students' scores on achievement before the treatment. The exercise provided data on students' performance in Osmosis before the treatment. The treatment commence with the use of laboratory practical exercise in giving instruction on osmosis to the experimental group. The researcher administered a post-test to the experimental group after the treatment, while the trained Biology teacher administered the retention test after two (2) weeks of teaching. The researcher administered the post-test to the control group. The sheets for the OAT were marked by the researcher to obtain the students' scores in achievement after treatment, and the same for the control group.

3.5.1Treatment of Experimental Group

The experimental group was treated for three weeks. The pre-test was administered to the students before the commencement of the treatment.

In the first week, the experimental class was taught the concept of osmosis using laboratory practical exercise. In the second week, the post-test was administered to the students. In the third week, the researcher administered the retention test.

3.6 Method of Data Analysis

The researcher questions were answered using mean and standard deviation while ANOVA was used to test the hypothesis at 0.05 level of significance.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presented the results of data analysed for the study based on the four research questions and four hypotheses that guided the study. The results were presented according to research questions and hypotheses that guided the study.

4.1 Results

Table 4.1 **control group**

	N	Mean	Std. Deviation
pre-test	50	5.5800	2.63485
post-test	50	6.2800	2.18567
retention score	50	8.1000	2.00255
Valid N (listwise)	50		

Interpretation of results

The table above shows the descriptive statistics results for control group in which we have mean for pre-test as 5.5800, mean for post-test as 6.2800 and mean for retention score given as 8.100

Table 4.2 **experimental group**

	N	Mean	Std. Deviation
pre-test(experimental group)	53	7.4906	2.41488
post-test(experimental group)	53	8.6604	3.57848
retention(experimental group)	53	10.6226	3.07738
Valid N (listwise)	53		

Interpretation of results

The table above shows the descriptive statistics results for experimental group in which

we have mean for pre-test as 7.4906, mean for post-test as 8.6604 and mean for retention score given as 10.6226

Summary of results

From the analyze carried out, the experimental group has the highest mean for the two groups.

4.2 Response to the Research Questions

Research question 1

What are the achievement scores of the students in biology when taught the concept of osmosis by using laboratory practical exercise and those taught using lecture method?

Table 4.3 shows the mean achievement score of experimental and control group

Group	Number	mean(x)	standard deviation	mean difference
experimental group	53	8.66	3.58	2.38
control group	50	6.28	2.19	

In table 4.3 shows the average scores of experimental and control results, the results shows that the experimental group has a mean score of 8.6 while the control group has 6.28, from the results, its explain that the students' scores in the experimental group has the higher mean.

Research question 2

What are the achievement scores of male and female students in biology when taught the concept of osmosis by using laboratory practical exercise and those taught using lecture method?

Table 4.4: The mean achievement of score of male and female students in experimental and control group.

Group	number	mean(x)	standard deviation	mean difference
experimental group(male)	23	9.08	3.08	2.69
control group(male)	33	6.39	2.001	
experimental group(female)	31	8	3.37	1.5
control group(female)	17	6.5	1.65	

Discussion of table

In table 4.4: The mean score male students in the experimental group is 9.08 and for control group for male 6.39 and also mean score female students in the experimental group is 8.00 and for control group for female 6.50, it shows the male student has the highest mean difference .

Research question 3

What are the retention of students taught the concept of osmosis by using laboratory practical exercise and those taught using lecture method?

Table 4.5: shows the mean retention scores of experimental and control group below

Group	Number	mean(x)	standard deviation	mean difference
experimental group	53	10.62	3.08	2.52
control group	50	8.1	2.001	

Discussion of table

The table above shows the mean retention score which shows that experimental group has the highest mean score of 10.62 while the control group has an average of 8.1.

Research question 4

What are the retention score of students based on gender when taught the concept of osmosis by using laboratory practical exercise and those taught using lecture method?

Table 4.6: shows the mean retention scores of students based on gender is shown below

Group	number	mean(x)	standard deviation	mean difference
experimental group(male)	23	10.7	3.08	2.98
control group(male)	32	7.72	2.001	
experimental group(female)	27	10.51	2.78	1.99
control group(female)	14	8.52	1.65	

Table 4.4 shows the mean retention scores of experimental group for male is 10.7 and control group for male is 7.72 and also for experimental group for female is 10.51 and control group for female is 8.52, therefore male has the highest mean difference of 2.98 while female has 1.99.

4.2 Testing hypothesis

HO_1: There is no significant difference between the mean achievement scores of students in biology when taught the concept of osmosis using laboratory practical exercise and those taught using lecture method.

Table 4.7; shows the anova results for the mean achievement scores of the experimental and control group.

Group	Number	mean(x)	standard deviation	df	F	sig	remark
experimental group	53	8.92	3.58	52	4.75	0.00000	significant
control group	50	6.65	2.1	49	0.575	0.823	not sig

Results discussion

From the analysis carried out and the data available, it was observed that there is significant difference in the experimental group and the control group is not significant at 0.05%

HO_2: There is no significant difference between the mean achievement scores of male and female students in biology when taught with the concept of osmosis using laboratory practical exercise and that using lecture method.

Table 4.8; shows the anova results for the mean achievement scores of gender in the experimental and control group.

Group	number	mean(x)	standard deviation	df	F	sig	remark
experimental group(Gender)	53	7.13	2.53	52	0.902	0.347	not significant
control group(Gender)	50	6.31	2.46	49	0.019	0.89	not sig

Results discussion

From the analysis carried out , it was observed that there is no significant difference in the experimental group and the control group for gender are not significant at 0.05%.

HO_3: There is no significant difference between the mean retention scores of students in biology when taught with the concept of osmosis using laboratory practical exercise and that using lecture method.

Table 4.9

Group	number	mean(x)	standard deviation	Df	F	sig	remark
experimental group	53	10.62	3.08	52	0.512	0.894	not significant
control group	50	8.1	2	49	0.817	0.592	not sig

Results discussion

From the analysis carried out, it was observed that there is no significant difference between the mean retention scores of students in biology when taught with the concept of osmosis using laboratory practical exercise and when using lecture method.

HO_4: There is no significant difference between the mean retention scores of students based on gender when taught with the concept of osmosis using laboratory practical exercise and that using lecture method.

Table 4.10

Group	Number	mean(x)	standard deviation	Df	F	sig	remark
experimental group	53	10.62	3.08	52	0.864	0.588	not significant
control group	50	8.1	3.07	49	0.101	0.101	not sig

Results discussion

From the analysis carried out, it was observed that there is no significant difference between the mean retention scores of students based on gender when taught with the concept of osmosis using laboratory practical exercise and that using lecture method.

4.3 Summary of major findings

The major findings from the data analysis and test of the hypotheses are summarised as follows:

1. The use of laboratory practical exercise in teaching the concept of osmosis improved the achievement of students in biology than the lecture method.
2. The use of laboratory practical exercise enhances the performance of students significantly better than lecture method.
3. The use of laboratory practical exercise makes better retention ability than the lecture method.
4. Students have a more positive attitude towards the use of laboratory practical exercise than lecture method.

4.4 Discussion of Results

From the analysis of the data from this experiment, the use of laboratory practical exercise on biology achievement and retention of the concept of osmosis was found to have better advantages over the lecture method.

In the test of HO_1, shows significant difference in the achievement scores of students exposed to experimental group, and the two control group is not significant at 0.05%. This finding is consistent with the report of Nwagbo and Chikelu(2011), Nwagbo(2008) and Nzewi(2008) who respectively found that experimental techniques as helping students to acquire basic scientific skills which helps to improve performance because students are involved in process skills and not only the theories behind them.

In the test of HO_2 of the study, the result revealed that no significant difference between the achievement of male and female students who were exposed to laboratory practical exercise and those exposed to the lecture method. The null hypothesis was rejected. Connell (2013) maintained that as much as culture defines male as ambitious and competitive and females' differential and emotional, males are expected to aspire to leadership positions while females are expected to be good listeners and supportive observers. This discrimination begin from the family and later extended to other areas of one's life where a man sees himself as superior in every human endeavours and sees woman in a subordinate position in the education setting workplace or other parts of life.

In the test for HO_3, it was observed that there is no significant difference between the mean retention scores of students in biology when taught the concept of osmosis using

laboratory practical exercise and that using lecture method.The null hypothesis was therefore rejected.

Lyop and Mangut (2011) pointed out that there are inherent setbacks of lecturing method,. They affirm that it does not promote meaningful learning, more effective learning goes on only when many senses are involved. From the result revealed, it was observed that students who were taught the concept of osmosis with laboratory practical exercise were significantly better in their retention ability than those taught with lecture method.

HO_4, the result of the test revealed no significant difference between the mean retention of students based on gender. The null hypothesis was rejected. Gender is a fundamental category for ranking and classifying social relations in the world. (Evans, 2014) pointed out that in educational setting for instance, experience has shown that the curriculum, textbooks and the teaching materials tend favour males and the females intellectual potentials are ignored.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

From the finding, laboratory practical exercise on the concept of osmosis as effect on student achievement and retention on biology among senior secondary school in Minna Metropolis. This in agreement with that of Kiladare and Okoro (2007) who established that student understands better when they involve in practical experiment, thus matching theory with practical.

To determine the effect of the investigation, a study was conducted where the achievement and retention of students exposed to laboratory practical exercise and lecture method.

Four research questions and four hypotheses guided the study. The review of literature in the study was organised under conceptual framework, theoretical framework, and review of empirical studies. In the conceptual framework, concept of laboratory, concept practical exercise, concept of biology, concept of achievement, concept of retention, concept of osmosis and concept of gender was reviewed. Piaget's cognitive constructivist learning theory and vygotsky's social constructivist learning theory were also reviewed under theoretical framework. The empirical studies examined related studies on the effect of laboratory practical exercise on biology students' achievement and retention of the concept of osmosis, and studies on gender and academic achievement and retention.

A quasi- experimental design was adopted for the study. The study was carried out in Minna Metropolis. The instrument for data collection in this study was an osmosis test question (OAT) which was administered to each of the group before and after the experiment. Data collected from the research questions were analysed using mean standard deviation and t-test was used to test the hypotheses at 0.05 level of significance. The result revealed that students taught the concept of osmosis in biology performed better than their counterparts taught using lecture method.

5.2 Conclusion

From the analysis of the data collected from the study and test of the study hypotheses, the following conclusions were drawn:

1. The use of laboratory practical exercise for teaching the concept of osmosis on biology students' enhance students' achievement significantly better than the use of lecture method.
2. The use of laboratory practical exercise significantly shows a difference between male and female achievement.
3. The use of laboratory practical exercise significantly improved students' performance on osmosis concept than the lecture method.
4. The use of laboratory practical exercise significantly improved student's retention ability based on gender than the lecture method.

5.3 Recommendations

1. Science teachers should lay more emphasis on the use of laboratory practical exercise in the teaching and learning of osmosis and other practical topics in biology for improving student performance
2. STAN (The Science Teachers' Association of Nigeria) in conjunction with Federal Ministry of Education and various secondary school boards should ensure the availability of standard laboratories in our senior secondary school.
3. The lecture method should still be used to teach very abstract topics to enable students acquire knowledge, new information and explanations of events and things.
4. The curriculum planners should ensure that they include laboratory practical exercise in biology curriculum, as it will help to promote students' achievement and retention in the subject.

5.4 Contribution to knowledge

1. This study has been able has been able to establish the fact that laboratory practical exercise can be used by biology teacher for instructions on the concept of osmosis and other biology topics in Minna Metropolis among senior secondary schools, this will aid in the change of students attitude to biology and their achievement.
2. The use of laboratory practical exercise in teaching and learning osmosis and other biology topics could be a way out to improving the teaching and learning of biology in our senior secondary school.

5.5 Suggestions

1. The effect of using laboratory practical exercise as study tools on achievement and retention in biology.
2. The study should be also replicated with other practical topics in biology.

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APPENDIX A

OSMOSIS ACHIEVEMENT TEST (OAT)

PRE TEST QUESTION

Name:…….

Sex:…….

Instruction: choose from option A-D

1. Osmosis can be define as

(a) The diffusion of mineral molecules through a selectively permeable membrane

(b) The diffusion of water molecules through a selectively permeable membrane

(c) The diffusion of water minerals through a selectively permeable membrane

(d) The diffusion of water molecules through a membrane

2. A selectively permeable membrane----------

(a) Allows all substances to enter and leave

(b) Prevents all substances from entering or leaving

(c) Allows certain size substances to enter and leave

(d) Allows only waste material to leave

3. All matter is composed of very small particles called----------

(a) Molecules

(b) Ions

(c) Solutes

(d) Isotopes

4. Hypotonic solution----------

(a) Has a higher concentration of solutes and a lower concentration of water than other solutions

(b) Has a higher concentration of water and a lower concentration of solutes than another solution

(c) Has an equal concentration of water and solutes as another solution

(d) Has more solutes than solvent another solution

5. The openings in selectively permeable membranes are called ---------

(a) Homeostatic openings

(b) Perforation

(c) Diffusion holes

(d) pores

6. A solution in which the concentration of solutes is the same inside and outside of a cell is a ---------- solution

(a) Hypertonic

(b) Hypotonic

(c) Isotonic

(d) Homeotonic

7. …… Is a force that draws in water into the cell

(a)Osmotic pressure

(b) Osmotic potential

(c) Osmoregulation

(d) Osmosis potential

8. Osmosis is sometimes referred to as

(a) Turgor pressure

(b) Homeostasis

(c) Active transport

(d) Specialised diffusion

9. The control of fluctuations in the concentration of substances in cell fluids is called……

(a) Diffusion

(b) Osmosis

(c) Active transport

(d) Osmoregulation

10. The movement of molecules from an area of high concentration to an area of low concentration

(a) Solution

(b) Osmosis

(c) Diffusion

(d) Isotonic

11. Which of these is not a condition necessary for osmosis

(a) Presence of a stronger solution

(b) Presence of a stronger weaker solution

(c) Presence of a weaker solution

(d) Presence of a selectively permeable membrane

12. When the concentration of solute molecules is higher outside the cell. Water will move out of the cell

(a) Homeostasis

(b) Hypertonic

(c) Hypotonic

(d) Isotonic

13. Concentration of solute molecules is lower outside the cell. Water will go into the cell.

(a) Isotonic

(b) Hypertonic

(c) Homeostasis

(d) Hypotonic

14. Concentration of solute molecules outside the cell is equal to that inside the cell

(a) Isotonic

(b) Hypotonic

(c) Homeostasis

(d) Hypertonic

15. Diffusion of water across a semi- permeable membrane from an area of high concentration to an area of low concentration

(a) Diffusion

(b) Hypotonic

(c) Osmosis

(d) Hypertonic

16. The substances being dissolved in a solution

(a) Solvent

(b) Diffusion

(c) Solute

(d) Solution

17. The substance in which a solute is being dissolved

(a) Solute

(b) Diffusion

(c) Solvent

(d) Solution

18. A mixture in which one or more substances are uniformly dissolved in another substance (a) Solution

(b) Solute

(c) Solvent

(d) Diffusion

19. As molecules diffuse, they create…… which is a difference in concentration across space (a) Concentration gradient

(b) Diffusion

(c) Osmosis

(d) Semi-permeable

20. The following materials can be used as living tissues EXCEPT ….

(a) Yam tubers

(b) Beans

(c) Potatoes

(d) Cocoyam

Answers

1.B 2.C 3.A 4.B 5.D 6.C 7.A 8.D 9.D 10.C

11.B 12.B 13.D 14.A 15.C 16.A 17.A 18.A 19.A 20.B

OSMOSIS ACHIEVEMENT TEST FOR (OAT)

POST TEST QUESTION

Name:…….

Sex:…….

Instruction: choose from option A-D

1. Osmosis is sometimes referred to as

(a) Turgor pressure

(b) Homeostasis

(c) Active transport

(d) Specialised diffusion

2. The control of fluctuations in the concentration of substances in cell fluids is called……

(a) Diffusion

(b) Osmosis

(c) Active transport

(d) Osmoregulation.

3. The movement of molecules from an area of high concentration to an area of low concentration

(a) Solution

(b) Osmosis

(c) Diffusion

(d) Isotonic

4. Which of these is not a condition necessary for osmosis

(a) Presence of a stronger solution

(b) Presence of a stronger weaker solution

(c) Presence of a weaker solution

(d) Presence of a selectively permeable membrane

5. When the concentration of solute molecules is higher outside the cell. Water will move out of the cell

(a) Homeostasis

(b) Hypertonic

(c) Hypotonic

(d) Isotonic

6. Concentration of solute molecules is lower outside the cell. Water will go into the cell.

(a) Isotonic

(b) Hypertonic

(c) Homeostasis

(d) Hypotonic

7. Concentration of solute molecules outside the cell is equal to that inside the cell

(a) Isotonic

(b) Hypotonic

(c) Homeostasis

(d) Hypertonic

8. Diffusion of water across a semi- permeable membrane from an area of high concentration to an area of low concentration

(a) Diffusion

(b) Hypotonic

(c) Osmosis

(d) Hypertonic

9. The substances being dissolved in a solution

(a) Solvent

(b) Diffusion

(c) Solute

(d) Solution

10. The substance in which a solute is being dissolved

(a) Solute

(b) Diffusion

(c) Solvent

(d) Solution

11. A mixture in which one or more substances are uniformly dissolved in another substance (a) Solution

(b) Solute

(c) Solvent

(d) Diffusion

12. As molecules diffuse, they create ….. which is a difference in concentration across space (a) Concentration gradient

(b) Diffusion

(c) Osmosis

(d) Semi-permeable

13. The following materials can be used as living tissues EXCEPT….

(a) Yam tubers

(b) Beans

(c) Potatoes

(d) Cocoyam

14. Osmosis can be define as

(a) The diffusion of mineral molecules through a selectively permeable membrane

(b) The diffusion of water molecules through a selectively permeable membrane

(c) The diffusion of water minerals through a selectively permeable membrane

(d) The diffusion of water molecules through a membrane

15. A selectively permeable membrane----------

(a) Allows all substances to enter and leave

(b) Prevents all substances from entering or leaving

(c) Allows certain size substances to enter and leave

(d) Allows only waste material to leave

16. All matter is composed of very small particles called----------

(a) Molecules

(b) Ions

(c) Solutes

(d) Isotopes

17. Hypotonic solution----------

(a) Has a higher concentration of solutes and a lower concentration of water than other solutions

(b) Has a higher concentration of water and a lower concentration of solutes than another solution

(c) Has an equal concentration of water and solutes as another solution

(d) Has more solutes than solvent than another solution

18. The openings in selectively permeable membranes are called ---------

(a) Homeostatic openings

(b) Perforation

(c) Diffusion holes

(d) Pores

19. A solution in which the concentration of solutes is the same inside and outside of a cell is a ---------- solution

(a) Hypertonic

(b) Hypotonic

(c) Isotonic

(d) Homeotonic

20...…… Is a force that draws in water into the cell

(a) Osmotic pressure

(b) Osmotic potential

(c) Osmoregulation

(d) Osmosis potential

Answers

1.D	2.D	3.C	4.B	5.B	6.D	7.A	8.C	9.A	10.A
11.A	12.A	13.B	14.B	15.C	16.A	17.B	18.D	19.C	20.A

APPENDIX B

OSMOSIS ACHIEVEMENT TEST FOR RETENTION (OATR)

Name:…….

Sex:…….

Instruction: choose from option A-D

1. Osmosis is sometimes referred to as

(a) Turgor pressure

(b) Homeostasis

(c) Active transport

(d) Specialised diffusion

2. The control of fluctuations in the concentration of substances in cell fluids is called……

(a) Diffusion

(b) Osmosis

(c) Active transport

(d) Osmoregulation

3. The movement of molecules from an area of high concentration to an area of low concentration

(a) Solution

(b) osmosis

(c) Diffusion

(d) Isotonic

4. Which of these is not a condition necessary for osmosis

(a) Presence of a stronger solution

(b) Presence of a stronger weaker solution

(c) Presence of a weaker solution

(d) Presence of a selectively permeable membrane

5. When the concentration of solute molecules is higher outside the cell. Water will move out of the cell

(a) Homeostasis

(b) Hypertonic

(c) Hypotonic

(d) Isotonic

6. Concentration of solute molecules is lower outside the cell. Water will go into the cell.

(a) Isotonic

(b) Hypertonic

(c) Homeostasis

(d) Hypotonic

7. Concentration of solute molecules outside the cell is equal to that inside the cell

(a) Isotonic

(b) Hypotonic

(c) Homeostasis

(d) Hypertonic

8. Diffusion of water across a semi- permeable membrane from an area of high concentration to an area of low concentration

(a) Diffusion

(b) Hypotonic

(c) Osmosis

(d) Hypertonic

9. The substances being dissolved in a solution

(a) Solvent

(b) Diffusion

(c) Solute

(d) Solution

10. The substance in which a solute is being dissolved

(a) Solute

(b) Diffusion

(c) Solvent

(d) Solution

11. A mixture in which one or more substances are uniformly dissolved in another substance (a) Solution

(b) Solute

(c) Solvent

(d) Diffusion

12. As molecules diffuse, they create….. which is a difference in concentration across space (a) Concentration gradient

(b) Diffusion

(c) Osmosis

(d) Semi-permeable

13. The following materials can be used as living tissues EXCEPT…

(a) Yam

(b) Beans

(c) Potatoes

(d) Cocoyam

14. Osmosis can be define as

(a) The diffusion of mineral molecules through a selectively permeable membrane

(b) The diffusion of water molecules through a selectively permeable membrane

(c) The diffusion of water minerals through a selectively permeable membrane

(d) The diffusion of water molecules through a membrane

15. A selectively permeable membrane----------

(a) Allows all substances to enter and leave

(b) Prevents all substances from entering or leaving

(c) Allows certain size substances to enter and leave

(d) Allows only waste material to leave

16. All matter is composed of very small particles called----------

(a) Molecules

(b) Ions

(c) Solutes

(d) Isotopes

17. Hypotonic solution----------

(a) Has a higher concentration of solutes and a lower concentration of water than other solutions

(b) Has a higher concentration of water and a lower concentration of solutes than another solution

(c) Has an equal concentration of water and solutes as another solution

(d) Has more solutes than solvent another solution

18. The openings in selectively permeable membranes are called ---------

(a) Homeostatic openings

(b) Perforation

(c) Diffusion holes

(d) Pores

19. A solution in which the concentration of solutes is the same inside and outside of a cell is a ---------- solution

(a) Hypertonic

(b) Hypotonic

(c) Isotonic

(d) Homeotonic

20...…… Is a force that draws in water into the cell

(a) Osmotic pressure

(b) Osmotic potential

(c) Osmoregulation

(d) Osmosis potential

Answers

1.D 2.D 3.C 4.B 5.B 6.D 7.A 8.C 9.A 10.A

11.A 12.A 13.B 14.B 15.C 16.A 17.B 18.D 19.C 20.A

Lesson plan for control Group (Lecture method)

Date – 2nd Sept; 2019

Class- SS2

Subject- Biology

Topic – The cell and its environment

Sub- Topic- Osmosis

Duration – 40 minutes

Reference- M.C Michael Essential biology for senior secondary schools (Pg 159)

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

1. Define Osmosis
2. List the conditions necessary for osmosis to take place
3. Explain living cells as osmometer

Entry behaviour- The teacher asks the students what they understand by diffusion.

Presentation- The teacher presents the lesson by using the following steps:

Step 1- The teacher explains the meaning of osmosis;

Osmosis is defined as the flow of water or solvent molecules from a region of dilute or 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 2- The teacher list and explains the conditions necessary for osmosis to take place.

There are three major conditions which are necessary for osmosis to take place, these are:

1. Presence of stronger solution e.g sugar solution

2. Presence of a weaker solution e.g distilled water

3. Presence of selectively or differentially permeable membrane

Step 3- The teacher explains the living cells as osmometer;

In osmosis, there are usually two solutions which are separated by a differentially permeable membrane. 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.

a. Hypotonic: when a cell of a living plant or animal is surrounded by pure water or solution whose solute concentration is lower, water passes into the cell by osmosis. The solution therefore is said to be hypotonic.

b. Isotonic : when the solute concentration of the cell and its surrounding medium are the same, the solution is said to be isotonic.

c. Hypertonic: when the cell is surrounded by a stronger solution, water will be lost by the cell. The shrinking of the cell is as a result of the surrounding solution being hypertonic.

Evaluation – The teacher evaluates the students by asking the following questions;

1. Define osmosis

2. List the conditions necessary for osmosis to take place

3. Explain living cells as osmometer

Conclusion- The teacher concludes the lesson by briefly summarising the topic and give the students assignment.

Assignment- write short note on the following; hypotonic, hypertonic and isotonic.

Lesson plan on Experimental Group

Date- 2nd Sept; 2019

Class- SS2

Subject- Biology

Topic- The cell and its environment

Sub- Topic- Osmosis

Duration- 40 minutes

Materials required-potatoes, sugar solution, water, knife, petri-dish

Aim- To demonstrate osmosis using a living tissue

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

1. Define osmosis and perform osmosis experiment in living cells

2. List conditions necessary for osmosis

3. Explain living cells as osmometer

Presentation:

Step 1 – peel the potatoes, make a cavity with the aid of the knife into the two cut potatoes. Pour water into the petri-dishes. Place each potatoes with base down into the petri-dishes containing water, add small quantity of sugar solution to potatoes tissue A and allow potatoes B to serve as control experiment. The set-up is allowed to stand for 4-6 hours. The teacher informs the students to carry out the experiment.

Step 2- The teacher list out to the student's conditions necessary for osmosis using the experiment, student's listens and jot down.

Step 3- The teacher explains the living cells as osmometer.

Conclusion- The teacher concludes the experiment by briefly summarising.