EFFECT OF INQUIRY-BASED INSTRUCTIONAL STRATEGY ON STUDENTS' ACADEMIC ACHIEVEMENT IN CELL STRUCTURE AND FUNCTIONS AMONG SECONDARY SCHOOLS IN GASHUA EDUCATION ZONE YOBE STATE.

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ABSTRACT

This study investigated the effects of inquiry-based instructional strategy on students' academic achievement in cell structure and function among secondary school students in Gashu'a Education Zone, Yobe State. The study employed quasi-experimental design involving pre-test post-test control group. The population of the study comprised of 2148 SSII biology students in Gashu'a Education Zone. A sample of 121 SS II Biology students from two government secondary schools in Gashu'a education zone was drawn using Purposive sampling technique. Biology Achievement Test (BAT) was used for data collection which was validated and computed for reliability coefficient. The BAT instrument was found to have r=0.806. Both experimental and control groups were pretested thereby establishing their equivalency in performance. The students' in the experimental group were taught cell structure and functions using inquiry-based instructional strategy while the control group were taught the same cell structure and functions through traditional method of teaching (Lecture method) for duration of six weeks. Thereafter, a posttest using BAT was administered on the two groups and the scores obtained were computed and analyzed effectively. Mean, Standard Deviation were used for answering the research questions, T--test and Mann-whitney U-test were used for testing hypotheses.at p < 0.05. The results showed that, experimental group students performed significantly better than the control

group. It was recommended among others that Biology teachers should adopt the use of inquiry-based instructional strategy in their lessons in order to enhance students' academic achievements in biology. .

Keywords: *Inquiry-based strategy, Academic achievement, Secondary school*

1.0 INTRODUCTION

1.1 Background of Study

Educational activities are geared towards ensuring that students achieve mastery of educational objectives. In school, the extent to which these objectives have been achieved is determined by instructional strategies and interest of students, which are reflected in their academic performance **(**Ekpenyongl, Edem & Martin; 2015). Science education is a veritable tool for scientific and technological advancement of any nation. It is in realization of this fact that the Federal Government of Nigeria stated in the National Policy on Education that science education should among other things equip students to live effectively in the modern age of science and technology (FRN 2014).

Effective teaching and meaningful learning of science subjects, biology inclusive at Secondary schools level depend to a large extent on the adequate and appropriate use of instructional strategies through a rich variety of stimulating experiences, progress from concrete to abstract and then a powerful conceptualization maybe achieved. Biology is a natural science that deals with the living world: How the world is structured, how it functions and what these functions are, how it develops, how living things came into existence, and how they react to one another and with their environment (Ajaja, 2013). It is a prerequisite subject for many fields of learning that contributes immensely to the technological growth of the nation (Cimer, 2012). This includes medicines, pharmacy, nursing, agriculture, forestry, biotechnology, nanotechnology and many other areas (Eziyi, Mumuni & Nwanekezi, 2016). Biological disciplines imply a significant responsibility for the protection and welfare of all living species. Any advances in medicine and dealing with environmental issues or biotechnology depend largely on understanding of living organisms (Ali, Torima & Gasim, 2014). This is best understood by having thorough understanding of cells and their functions in the field of biology.

Achievement in education could be related to academic success recorded by the learner in the teaching and learning process. It could be seen as the success students make in their academic pursuit (Gambari, Yaki, Gana,& Ughovwa, 2014). For example, if a student is able to pass West African School Certificate Examination (WASCE) at A, B and C levels, it can be said that the student has made success in the said examination. But if the student in question has made Ds, Es and Fs, it can be said that the student did not succeed in the said examination. This implies that the yardstick for measuring students' level of academic achievement is by assessing the academic performance of the individual through test (Ali, Toriman & Gasim, 2014). Despite the

importance of Biology as a secondary school subject, students' achievement in the subject has declined tremendously. The results of students WAEC performance in Biology SSCE 2013-2017 in Yobe state showed that students' achievement in Biology is below average. Though many factors have been attributed to the poor performance of students such as learning environment, population explosion, teacher factor, lack of incentive/staff welfare, poor attitude of students to work, quality of instruction as teachers still use the traditional pedagogical approach of 'stand and deliver' method where students would sit in their seats and passively receive information, to mention but a few (Opara, 2011).

Inquiry refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world (National science Teachers Association, 2009).. Inquiry-based instruction offers an opportunity to engage student interest in scientific investigation, sharpen critical-thinking skills, distinguish science from pseudoscience, increase awareness of the importance of basic research and humanize the image of scientists (Kauchak & Eggen, 2011). Ajuonuma, (2011) suggested that engaging in inquiry can help students develop a wide range of skills, such as psychomotor and academic or intellectual skills. In addition, students' attitudes and dispositions such as curiosity, inquisitiveness and independence of mind, freedom from external authority and a personal search for knowledge about the world can also improve their academic achievement (Ikitde & Bassey, 2013). Moreso, it would appear that inquiry-based can prepare students to be lifetime learners rather than classroom-only also arouse the interest of the students'

1.2 Statement of the Problem

Students' performance in Secondary School Certificate Examination (SSCE) is one of the criteria for measuring and establishing the effectiveness of Nigerian secondary schools. The poor performance of senior secondary students in sciences including Biology has been persistent over the years. West African Examination Council (WAEC) May/June result analysis for 2013 to 2017 gave the following percentage pass at credit level and above in Biology, also number of students' that failed as shown in the table 1.1.

Table 1.1 revealed percentage pass at credit level and above in Biology and students' that failed. The Table depicted that performance of students over the years was not satisfactory as consistent failure was obvious. This alarming poor performance was attributed to inability of students to properly interpret questions, failure to write or answer their questions logically, systematically and convincingly, poor drawing skills, shallow understanding of most concepts in Biology, poor power of expression, inability to relate features to functions and inability of the candidates to correctly spell many Biological terms (Ali, Torima & Gasim 2014). This may also be an indication that meaningful learning has not taken place through learner-centred environment such as inquiry-based strategy which has the required features for solving as well as improving the performance of the students. Ifeyinwa, (2009) showed that, ability levels of the learners,

gender, learning environment, teaching methods were among other variables that led to poor performance of students.

Table 1.1: Result of Students' WAEC performance in Biology (2013-2017) in Yobe State

Year	Total Number of Students Registered	Total Number of students Pass	% Pass	Total Number of students that Failed	% Failed
2013	5977	1664	27.84	4313	72.16
2014	6116	1511	24.70	4605	75.30
2015	7028	2305	32.80	4723	67.20
2016	13,346	7111	53.25	6235	46.72
2017	14,065	5845	41.56	8220	58.44

Source: Education Resource Centre Damaturu, Yobe State (2018)

1.3 Objectives of the Study

The objectives of the study are to;

1. Determine the effect of inquiry-based instructional strategy on the academic achievement of students in cell structure and functions;

1.4 Research Questions

1. What is the difference in the mean academic achievement scores of students taught cell structure and functions using inquiry-based instructional strategy and those taught using lecture method of teaching?

1.5 Research Hypotheses

Ho_1: There is no significant difference between the mean academic achievement scores of students taught cell structure and function using inquiry-based instructional strategy and those taught using lecture method.

1.6 Significance of the Study

Ministry of Education on whom the responsibility of ensuring that schools are teaching students relevant materials and monitoring the academic progress of students would benefit from the findings of this study on the effect of inquiry-based instructional strategy on the academic achievement and interest of biology students. The result of this study would also provide educational leaders with a blue-print which would guide them in their attempt to train biology teachers on how to teach and arouse students' interest and gender friendly.. This can be accomplished through organizing teachers' in-service training, workshops, seminars and

conferences for biology teachers specifically meant to enhance students' interest and gender friendly.

1.7 Scope of the Study

The study is delimited to the investigation of the effect of inquiry-based instructional strategy and interest on Senior Secondary Schools class II Biological Students. The investigation is restricting only to the topic Unit of life as found in the Senior Secondary School (SSS) Biology Curriculum. The Unit of Life which deals with forms in which cells exist, cell theory, cell structure and function and cell and its environment as found in the curriculum meant for SSS biology students. The choice of the topic is informed by researches which identified the topic as one of those that students find it difficult to understand effectively (Cimer, 2011; Iketde and Bassey, 2013; Ashiru and Sadiq 2016).

The study was carried out on SSS Biology students in Gashua Educational Zone of Yobe State.. In addition to that, this research was limited to two senior secondary schools (that is two co-educational secondary schools) in the zone specifically Government Science Secondary School Gwio-Kura to be experimental group and Government Secondary School Yusufari to be the control group.

2.0 REVIEW OF RELATED LITERATURE

2.2 Theoretical Framework

2.2.1 Constructivism Theory of learning by Jean Piaget (1896-1980).

This study is hinged on constructivism Theory of learning by Jean Piaget (1896-1980). The theory state that learners construct new knowledge by means of associating the knowledge they gain through their interaction with events and objects around with what they already know.(Woolfork, 2010). This theory makes learning a student-centeredness through providing suitable environment for them to construct their knowledge scientifically in accordance with the existing ones. Constructivism is the process in which learners compare new information with the old, within the context of their current conceptual framework and so reconstruct their knowledge (Mangal, 2011). This study emphasized much on the cognitive theory of learning developed by Jean Piaget (1896-1980) that individual learners construct mental models to understand the world around them (Nnachi, 2007). The main principle in Piaget's theory is that knowledge must be built by students as the active creator of that knowledge (Woolfork, 2010). This means that students must be active in all their learning activities; they should be able to pick up and dig new information and at the same time process it according to their needs. Piaget was of the opinion that a child must act on the objects in his environment for him to learn. This means that he should be actively involved and should not be passive. The active involvement of the child may be in form of direct manipulations, visual observations or through mental or internal transportation or change (Nnachi, 2007).

In addition to that, constructivist theory emphasizes that students learn when they construct their own meaning and deep learning takes place when students are engaged in active learning (Mangal, 2011). The theory has direct implication for the use of inquiry-based instructional strategy in teaching cell structure and function. In the first place, in the constructivist theory of learning individual perceives the total environment, stores the information and restructured/process. Secondly, the theory emphasized active participation of the learner which inquiry strategy encourages (Opara, 2011). This is because in teaching cell structure and function using inquiry-based strategy, learning materials were broken into small steps which are sequentially arranged from known to unknown and in an increasing order of difficulty. A child must master a step before proceeding to the next one and in doing so the learner was actively involved in the learning process. Moreover, there are a lot of activities such as sample collection and preparation which the learner carried out by him, making the learner very active in the learning process (Ikitde and Bassey, 2013).

2.3 Conceptual Framework

2.3.1 Concept of Biology

Biology is a natural science that deals with the living world. How the world is structured, how it functions and what these functions are, how it develops, how living things came into existence, and how they react to one another and with their environment (Ali, Toriman, & Gasim, 2014). . Biology as one of the science subjects, when properly taught, will help the students to solve personal and societal problems. The knowledge of Biology helps to question superstitions, know the function of the various parts of the body, enables one to understand oneself, maintain good health practices such as the use of clean water, good sanitation, balanced diet, the need to vaccinate, among others. It is a prerequisite subject for many fields of learning that contributes immensely to the technological growth of the nation. This includes Medicines, Pharmacy, Nursing, Agriculture, Forestry, Biotechnology, and many other areas (Umar, 2011).

Biology is seen as one of the core subjects in Nigerian secondary school curriculum. Because of its importance, more students enrolled for biology in the senior secondary school certificate examination (SSCE) than for physics and chemistry (West African Examination Council, 2011). Biology is introduced to students at senior secondary school level as a preparatory ground for human development, where career abilities are groomed, and potentials and talents discovered and energized (Federal Republic of Nigeria, 2009). The quality and quantity of science education received by secondary school students are geared toward developing future scientists, technologists, engineers, and related professionals (Ali, Toriman & Gasim, 2014).. Biology is the science of Living Things. That is why Biology is sometimes known as Life Science.

2.3.2 Inquiry-Based Instructional Strategy

Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as

well as an understanding of how scientists study the natural world (NSTA, 2009). Inquiry is the process of defining and investigating problems, formulating hypotheses, designing experiments, gathering data and drawing conclusions about problems. Inquiry-based instruction offers an opportunity to engage student interest in scientific investigation, sharpen critical-thinking skills, distinguish science from pseudoscience, increase awareness of the importance of basic research, and humanize the image of scientists (Kauchak & Eggen, 2011).

Ajuonuma, (2011) suggested that engaging in inquiry can help students develop a wide range of skills, such as psychomotor and academic or intellectual skills. In addition students' attitudes and dispositions such as curiosity, inquisitiveness and independence of mind, freedom from external authority and a personal search form learning about the world can also improve. Therefore, it would appear that inquiry-based can prepare students to be lifetime learners rather than classroom-only learners. Nayak and Rao (2011); Ikitde and Bassey (2013) stated that in non-threatening and trusting classroom environments, students can show their willingness to seek understanding and express their curiosity, while on the contrary in such classrooms where the conditions are not supportive and encouraging, students may not put forward questions. The teachers 'role in encouraging student inquiry is often dependent on the creation of a cooperative social environment, where students learn how best to negotiate and solve conflicts necessary for problem solving (Ajuonuma, 2011). Teachers should encourage inquiry-based learning among students and create opportunities for them to conduct inquiry about a particular problem or issue. Science is an activity-oriented, thought-provoking creative method in which students out of curiosity and on their own, under the guidance of the teacher probe, investigate, and interpret relevant issues and problems with a view to providing solution through reflective thinking and rational decision making which this method develops in the inquirer (Ibe 2013,and Enebechi 2021).. This inquiry method involves the scientific approach of identifying problems, formulating hypothesis, collecting relevant data to authenticate the data, drawing conclusion even if tentatively and developing generalization (Ekon and Edim, 2015). It is through exposing students to the more or less independent activities which the inquiry method entails that the students develop the intellectual skills essential for problem-solving. Some of the advantages of inquiry method of teaching are (Ugwu, 2014 and Ekon & Edim, 2015).;

i. It inculcates in the learner reflective thinking through exposure to inquiry oriented processes and skills as well as issues and problems requiring solution.
ii. The reflective thinking acquired through the inquiry method enables the beneficiary to independently, or in collaboration with knowledgeable ideas, solve personal societal problems thereby living and surviving successfully in a complex society
iii. It arouses the curiosity of the learners, stimulates their interest and makes them actively involved in the teaching-learning process
iv. Inquiry oriented teaching engenders real learning because it fosters self-reliance which is consistent with one of the laudable Nigerian National objectives- the building of "a self-reliant nation".

Nevertheless inquiry method of teaching has the following disadvantages (Ugwu, 2014 and Ekon & Edim, 2015).;

i. It is time-consuming and as a result the syllabus is rarely covered in depth.
ii. The planning of a good inquiry lesson is not easy
iii. In problematic situations, within only the reach of gifted
iv. Burden and frustration.

Despite the relevancy of inquiry method of teaching in fostering effective learning to the individuals, its time-consuming serve as a barrier to its effective utilization by professional/nonprofessional teachers coupled with difficulty in planning good inquiry-based lessons.

2.3.3 Lecture Method of Teaching

The current Nigerian classroom whether primary, secondary or tertiary institutions level, tends to resemble a one-person show with a captain but often comatose audience. Classes are usually driven by "teacher-talk "and depend heavily on textbooks for the structure of the course (Supasorn,Kamsai & Promarak, 2013). There is the idea that there is a fixed world of knowledge that the student must come to know. Information is divided into parts and built into a whole concept. Teachers serve as pipelines and seek to transfer their thoughts and meanings to the passive students. There is little room for student-initiated questions, independent thought or interaction between students. The Traditional Method according to Das, (2009) is defined as a teaching technique in which one person usually the teacher presents a spoken discourse on a particular subject. Ajuonuma, (2011) sees the method as a teacher dominated approach to teaching.

According to Nayak and Rao (2011), the science teacher comes to the class fully armed with a mass of facts, he presents ideas or concepts, develops and evaluates them and summarizes the main point at the end while the students listen and take down notes. They also observed that students merely "absorb and absorb" scientific facts and factual memorization of discrete facts. Traditional teaching is teacher-centred. In this teacher is authoritative person and students are the passive recipients of information (e.g. lecture, demonstration, Socratic etc). Some of the advantages of lecture method are (Das, 2009 and Ugwu, 2014);

i. It is not expensive as only the chalk is required .Good command of English and boldness saves the teacher a lot of challenge in the class.
ii It offers easy coverage of syllabus and faster dissemination of scientific information and facts.
ii. It allows easy handling of large classes without much stress. The students are given the same material content at the same time, which implies is uniformity in the facts the students is given.

iii. The students' efforts in searching for facts in books are saved as they are told the facts by the teachers.
iv. The teacher has the full control of what the students should learn or know.

2.3.4 Students' Academic Achievement in Biology

Academic Achievement according to Uche and Chima (2013) is accomplishments of students as a result of exertion of efforts, skills, perseverance and practice. It is the degree or level of success attained at the end of an academic endeavour (Eziyi, Mumuni & Nwanekezi, 2016). This includes the knowledge, skills and ideas acquired and/or gained through the course of the study within and outside the classroom situations. Academic achievement in education could be related to academic success recorded by the learner in the teaching and learning process (Ugwoke, 2014). It could be seen as the success students make in their academic pursuit. The importance of Biology as a secondary school subject can be illustrated by the fact that a candidate must obtain a credit pass in it, for admission into any Nigerian University to study such important science – based courses as Medicine, Pharmacy, Biochemistry, Microbiology, Food Technology, etc. (John & Ademola, 2014).

There are two dimensions to academic achievement: good academic achievement that leads to success and poor academic achievement that resulted to failure. Each of the achievement has been experienced by students in one form or another. In this study, any student that score between 20 and 40 out of the obtainable 40 marks will be considered to have good academic achievement while those who score between 0-19 will be considered to have poor academic achievement. .

2.4 Review of Related Empirical Studies

Opara (2011) examined Inquiry Method of teaching and Student Academic Achievement in Biology Lessons and Policy Implications in Ogba/Egbema/Ndoni Local Government Area of Rivers state. Pre-test, post-test, quasi-experimental research designed was used for the study. The populations of the study were all SSI biology students of fifteen schools secondary in Ogba/Egbema/Ndoni Local Government Area of River State. The sample of the study consisted of two hundred and forty (240) SS1 biology Students drawn from four secondary schools out of fifteen secondary using Stratified random sampling techniques considering the type of school (urban/rural) and gender in Ogba/Egbema/Ndoni Local Government Area of River State. These students were randomly assigned to two groups (treatment and control group). Treatment group were those taught biology using the inquiry teaching method while conventional method (lecture) was used for the control group. Biology Achievement Test (BAT) was developed on the following units in biology, flower pollination, muscle structure and function and seed germination was used as the instrument for data collection. The data collected were analyzed

using frequency counts, simple percentages, and t-test analysis. Results revealed that inquiry teaching method improve students' academic achievement in science. Based on the findings, it was recommended that: The use of inquiring based method should be given emphasis in the curriculum of Biology. Biology teachers should be trained and retrained on the use of inquiry based method in teaching. There should be proper provisions of facilities which are necessary for effective inquiring strategies. Inquiry based method should be employed in teaching Biology. This work shares a similarity with the present study since both of them deal with effect of inquiry-based instructional strategy on students' academic achievement in Biology, pre-test, post-test quasi- experimental research designed was used, Biology achievement Test (BAT) was used as instrument for data collection, t-test was used for testing the hypotheses and gender was considered during data collection. However, they differ in terms of: Opara carried out the research in Ogba/Egbema local government area of River state the current study was conducted in Gashu'a Education zone of Yobe state. Two hundred and forty (240) SS1 Biology students' were used as sample of the study obtained through stratified random sampling technique by Opara (2011) while the current study used one hundred and twenty one (121) SS11 Biology students' as sample of the study obtained through purposive sampling technique. BAT was the only instrument for data collection used by Opara, in addition to BAT Biology Interest Inventory (BII) was used as instruments for data collection by the current study. For answering research questions, Opara used frequency count and simple percentage the current study used mean and standard deviation. In addition to t-test, the current study used Mann-Whitney U-test for testing the hypotheses.

3.0 METHODOLOGY

3.2 Research Design

The research design used for this study was quasi-experimental design involving Pretest Posttest control group. Quasi-experimental design was considered appropriate for the study because intact classes were used to avoid disrupting the normal class lessons and participants cannot be randomly selected and assign in to experimental and control treatment groups.

The specific design is illustrated in the figure 3.1.

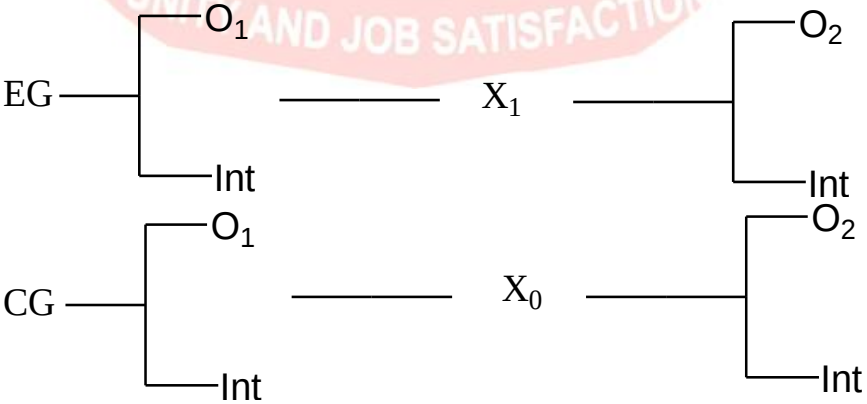

Figure 3.1: Research design

Where: **EG** = Experimental Group
CG = Control Group.
Int = Interest level
$\mathbf{O_1}$ = Pre-test administered to EG and CG respectively.
$\mathbf{O_2}$ = Post-test administered to EG and CG respectively.
X_1 = Treatment.
$\mathbf{X_0}$ = No treatment

The two groups were pre tested to ascertain equivalence in academic achievement. The reason for adopting the quasi-experimental design was that intact classes were used by the researcher.

3.3 Population of the Study

The population of the study comprised of two thousand six hundred and twenty nine (2629) students' consisting of 2,023 male and 606 female SSII biology students in Eight senior secondary schools in Gashu'a Education Zone. The detail of the students' population is presented in table 3.1.

Table 3.1: Population of Students in the Study Area

S/NO.	Schools	Male	Female	Total
1	Government Science Technical College Gahu'a	364	00	364
2	Government Girls Arabic Secondary School Dagona	00	280	280
3	Government Day Secondary School Gashu'a	876	00	876
4	Government Science Secondary School Gwio-Kura	168	104	272
5	Government Secondary School Jakusko	210	00	210
6	Government Secondary School Yusufari	107	79	186
7	Government Secondary School Amshi	156	87	243
8	Government High Islamic College Yusufari	142	96	238
Total		2023	606	2629

Source: Examination offices of the respective schools (2018)

3.4.1 Sample Size

The sample consisted of 121 biology students involving 75 male and 46 female from two senior secondary schools in the study zone. The senior secondary schools that were selected were Government Senior Science Secondary School Gwio-Kura (School A) and Government Secondary school Yusufari (School B). The schools were randomly assigned into the experimental group (EG) and control group (CG). Gender being one of the important variables in this study for finding the effect of inquiry-based instructional strategy on male and female biology students' academic achievement and interest was the reason for selecting this sample as they were the only co-educational secondary schools. The detail of the sample is presented in table 3.2.

Table 3.2: Sample Size

S/NO	Schools	Group	Male	Female	Total
1	School A	EG	41	27	68
2	School B	CG	34	19	53
			75		
Total				46	121

3.4.2 Sampling Technique

Purposive sampling technique was used in this study. Purposive sampling technique was a technique in which the researcher selects a number of subjects for the study with conviction that they represent the characteristics of the total population. This is because one of the study objectives involves gender and there were only two co-educational secondary schools in the zone. For this reason, the co-educational secondary schools which comprises of both male and female students were purposely used due to the nature of data required for the study. Furthermore, the Schools A & B selected have A, B and C streams of classes, and one intact class from each school was selected using random sampling technique and used for the study.

3.5 Selected Topics

The following topics were selected and taught in this study which consisted of these aspects of cell structure and its functions Cell as a unit of an organism, Forms in which living cells exist, Cell Theory, Cell structure and functions of cell components, Diffusion process and significance, Osmosis, haemolysis, and plasmolysis, and Biological significance of these processes (diffusion and osmosis) These topics were selected because they cut across the cell structure and its functions syllabus for senior secondary schools classes (National Educational Research and Development Council, 2008) that require proper demonstration, explanation and understanding of which inquiry-based instructional strategy is suited for.

3.6 Data Collection Instruments

The instrument used for data collection in this study was Biology Achievement Test (BAT).

The Biology Achievement Test (BAT) was adopted by the researcher from West African Examination Council (WAEC) and National Examination Council (NECO) Examination. Questions with respect to SSII Syllabus topics that were taught during the period of study were selected from past questions papers of WAEC and NECO of 2015, 2016, 2017 and 2018. The instrument was validated by Lecturers from Department of Biology, Federal University Gashu'a and Federal College of Education (Technical) Potiskum. Also Biology graduate Teachers in Secondary Schools with 10 years' experience was used for validating the instruments. To ensure the content validity, a table of specification on the BAT instrument which ensured appropriate distribution of the test item with respect to the relevant content area chosen as well as the cognitive objective levels desired was applied based on the Bloom's Taxonomy of educational objectives. A table of specification was developed and indicated in table 3.3, which was indicating the distribution of items across the content taught and entails fair distribution of the test items across the units covered as well as ensured content validity of the instrument.

Table 3.3: Table of Specification of Items Based on Bloom's Taxonomy

S/No.	Aspect	Questions	Number of Questions
1	Knowledge	2, 4, 11, 17, 19, & 27	7
2	Comprehension	1, 3, 8, 12, 18, 23,& 25	7
3	Application	10. 5, & 29	3
4	Analysis	6, 16, & 20	3
5	Synthesis	9, 13, 15, & 30	4
6	Evaluation	14, 21, 22, 24, 26, & 28	6
Total			30

3.7 Validity of the Instrument

The Biology Achievement Test (BAT) along with its marking scheme was validated by a senior lecturer from biology department Federal University, Gashu'a (FUGA), and Principal lecturer in test and measurement from Federal College of Education Potiskum, and two experienced Biology teachers from Secondary schools. The Validators determined:

1. BAT items coverage of the Cell structure and Function.;
2. Clarity of items in terms of its appropriateness;
3. Satisfactory to students' intellectual abilities.

3.8 Pilot Study

A trial test of Biology Achievement Test (BAT) was carried out using test-retest reliability technique. The instrument was administered on Fiftenn year two senior secondary students (SSS II) of Government Science and Technical College, Gashu'a Yobe State. The reliability coefficient of BAT was 0.806 using Pearson Product Moment Correlation Coefficient as shown

in table 3.4 below which shows that the instrument was reliable (Eziyi, Mumuni, & Nwanekezi, 2016) .

Table3.4; Correlation Analysis of BAT Test-Retest

		TEST	RETEST
TEST	Pearson Correlation	1	.069
	Sig. (2-tailed)		.806
	N	15	15
RETEST	Pearson Correlation	.069	1
	Sig. (2-tailed)	.806	
	N	15	15

3.9 Items Analysis of Biology Achievement Test (BAT)

Item analysis (difficulty index and discrimination index) was carried out for the thirty multiple choice items (using score obtained during pilot testing). This was to ensure the quality of the individual test items that make up the test, hence the standardization of the test items. Item difficulty index was basically known as *p*-value which refers to proportion of students answering each item correctly while item discrimination index discriminates between the more able and the less able students in the test. Item difficulty was calculated using the following formula:

$$P = \frac{H+L}{N}$$

Where:

P = Item difficulty index

H = Number of correct responses to the test item in up $^1/_3$

L = Number of correct responses to the test item in the lower $^1/_3$

N = Number of responses to the test item

Item discrimination index was calculated using formula D = $\frac{H-L}{N/2}$

Where,

D = Discrimination index

H = Number of students that got the items right in upper $^1/_3$ group

L = Number of students that got the items right in lower $^1/_3$ group

N = Number of student involved in the item analysis

It was recommended that, item difficulty index should be within the range of 0.25 – 0.75 and item discrimination index should be +0.10 and above for good test item's value (Sidhu, 2012), which was used in this study (See appendix III page 87).

3.10 Administration of Treatment to Experimental Group

The following procedures were used for administration of treatment to experimental group. Before the treatment, the research subjects were given a pretest. The test was administered by the researcher and the research assistant in the sampled schools. The scripts were marked by the researcher. The initial administration was aimed at establishing the same entry behaviour for the experimental and control groups. It also served as basis for equating the experimental and control groups by establishing them on the same level of their respective achievements from the onset (see appendix V, VI, VII and VIII page 91, 92, 93 and p4).

The main treatment to experimental group for the study was the teaching of the Cell structure and its functions to senior secondary II Biology students using Inquiry-based instructional strategy whereby the teacher asks students questions related to the learning unit of that time while the students answer best on their previous experiences. The teaching of experimental group commenced on 25th September, 2019 by the researcher one period per week for six weeks (see appendix IX page 95 for the lesson plan), the teaching was done during the normal school have. During the period of experiment, the researcher spends more time to ensure that the practical was conducted appropriately. At the end of the week six, the subjects were post-tested the researcher collected the scripts and marked, their scores were used for the analysis (see appendix XI and XIII page 121 and 123).

3.11 Teaching the Control Group

The lecture method was used in teaching the control group in sample school. In this method, the teacher verbalized the relevant concepts and principles during the lesson. The students watched and listened attentively, taking down relevant notes (see appendix X page 107 for the lesson plan). The teaching was done during the normal school biology periods using the lesson plan prepared by the researcher.

3.12 Data Collection Procedure

The Biology Achievement Test (BAT) and Biology Interest Inventory (BII) were administered to the subjects before the treatment which lasted for six weeks. At the end of the treatment, a post-Biology Achievement Test (BAT) and Biology Interest Inventory (BII) were administered. The scores for both the experimental and control group were recorded accordingly (see appendix I, II, IV, V, VI, VII, VIII, XI, XII, XIII and XIV).

3.13 Data Analysis Procedure;

The scores obtain from both the experimental group (School A) and the control group (School B) on Biology Achievement Test (BAT), were analyzed by using mean and standard deviation to answer the research questions and independent-samples t-test and Mann-Whitney U test at 0.05 level of significance to test the hypotheses.

3.14 Decision Rule;

For the purpose of interpreting the result, hypotheses were testing at alpha (ά) 0.05 level of significance in order to reject or accept the Null hypotheses. When the calculated P- value was less than the level of significance (P-value < ά) Null hypotheses (HO) is accepted, when the P-value was greater than level of significance P-value > ά) Null hypotheses was rejected.

4.0 DATA ANALYSIS AND RESULTS

4.2 Data Analysis and Results

The data collected at posttest from both experimental and control group on academic achievement and interest were analyzed using mean, standard deviation, independent-samples t-test and Mann-whitney U test. The results of the analyses were presented based on the research questions and corresponding hypotheses as follows.

Research Question One: What is the difference in mean academic achievement scores of students taught cell structure and function using inquiry-based instructional strategy and those taught using lecture method?

Table 4.1: Mean and Standard Deviation of Posttest Scores of Experimental and Control Groups

Group	N	Mean	Standard Deviation	Mean Difference
Experimental	68	29.44	4.621	7.93
Control	53	21.5	3.841	

Total	121

Table 4.1 shows that the experimental group has a mean of 29.44 and a standard deviation of 4.621. The control group has a mean of 21.51 and a standard deviation of 3.841. This indicates that there is a mean difference of 7.93. The difference indicated that the students in experimental group achieved higher than those in the control group. However, the difference in the mean scores was tested statistically to show significant difference in the difference as presented below in hypothesis testing.

Hypothesis One: There was no significant difference in the mean academic achievement scores of students taught to cell structure and function using inquiry-based instructional strategy and those taught using lecture method.

The hypothesis was tested using t-test statistics as presented in Table 4.2.

Table 4.2: T-test Results on Posttest Scores of Experimental and Control Groups

Group	N	Mean	Standard Deviation	df	t-value	P-Value	Decision
Experimental	68	29.44	4.621				
Control	53	21.51	3.841	119	10.072	.001	Ho Rejected
Total	**121**						

Significance difference P ≤ 0.05 alpha level.

Results in Table 4.2, shows that the t-value (199, 121) = 10.073 and p-value = .001. The p-value (.001) is less than the level of significance (0.05) and therefore the null hypothesis is rejected. This means that there is significant difference in the mean academic achievement scores of the students in experimental and control groups. The significant difference was in favour of the students in experimental group who were taught through inquiry-based instructional strategy and having the higher mean score (29.44 ± 4.621) compared to the students in control group who were taught through lecture method and having the lower mean score (21.51 ± 3.841).

4.3 Summary of Findings

The Summary of the finding are presented as follows;

1. Students taught cell structure and function through inquiry-based instructional strategy achieved significantly better than those taught through lecture method.

4.4 Discussions of the Results

The finding of hypothesis one shows that, inquiry-based teaching had a significant effect on the academic achievement of students taught cell structure and functions. The students in the

experimental group who were taught using inquiry-based strategy performed significantly better than those taught using lecture method. This affirms the effectiveness of inquiry-based strategy in promoting comprehension of Cell structure and functions with corresponding improved academic achievement. This was achieved because students participated actively during the teaching and learning process as it takes into cognizance their familiar knowledge and toward thorough understanding of the unfamiliar knowledge taught in lined with the sequential steps followed in inquiry-based strategy. Also students were given opportunity to contribute, discuss and observe most of the events that had taken place during teaching and learning sessions. This result agrees with the finding of Ibe (2013), who reported remarkable significant academic achievement of students who were taught biology using inquiry over those taught using conventional method of teaching. It is also in agreement with the finding of Eziyi, Mumuni and Nwanekezi (2016), who equally affirm high academic achievement of the experimental group taught Photosynthesis using inquiry over the control group. Likewise, Opara (2011) conducted a study on using inquiry method of teaching biology and reported that, student in the experimental group performed better than the control group. Furthermore, the result agrees with the findings of Adejo (2015), Abdi (2014), Njoroge, Changeiywo and Ndirangu (2014), and Ukoh, and Adejimi (2017), that inquiry-based approach significantly enhanced better comprehension and performance of students in science and biological concepts.

5.0 CONCLUSIONS

Based on the findings of the study, the research shows that, students taught cell structure and functions using inquiry-based instructional strategy academically achieved significantly better than those taught using lecture method as they have the higher mean score deviation compared to those in lecture group.This research established that inquiry-based instructional strategy was effective in improving students' academic achievement with higher mean score of 29.44 with standard deviation of 4.621 compared to those in lecture method with mean score of 21.51 with standard deviation of 3.841. The study also revealed that male students achieved significantly better with mean score of 30.98 than their female counterpart with a mean of 27.11 who were taught with inquiry-based instructional strategy. Therefore teachers should be train through workshops and seminars to be gender friendly during inquiry-based instructional strategy.

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