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Effect of Field-Based Instructions on Students' Understanding of Ecological Concepts in Public Secondary Schools, Benin City, Nigeria: An Experimental Study

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Abstract*: The focus of this study was to examine the effects of field-based experiences on students' understanding of ecological concepts and biology achievement. The study employed the quasi-experimental (pre-test and post-test) and control group design. The reason for the adoption of this design is hinged on the fact that intact students were randomly assigned to experimental and control groups respectively. The major findings of this study included: students' understanding of ecological concepts was below standard (mean= 38.14, t= -12.38, p<0.001); students' understanding of ecological concepts with field-based was higher at end line test when compared to baseline measurement (t= -9.41, p<0.001); The achievement of students in field-based group was higher than the traditional(control) group (mean-experimental= 54.71, mean-control= 45.07 t= 4.30, p<0.001). It was concluded that field-based experiences improved students' understanding of ecological concepts, enhanced students' understanding of ecology and significantly influenced their achievement.*

Keywords: *Field-based, Ecology, Quasi-experimental, Misconceptions, Biology. Environment*

I. Introduction

Biology is a core subject offered in the senior secondary school. Its curriculum was adapted and reversed from the 1985 edition developed by the comparative Education Study and Adaptation Centre (CESAC), the objective of this curriculum as derived from NPE (2004) includes the preparation of students to acquire adequate laboratory and field skills in biology. In pursuance of the stated objectives, the content and context of the curriculum place emphasis on field studies, guided discovery Laboratory techniques among others Biology Curriculum for Senior Secondary Schools (2009). Today, the Nigerian teachers have deviated from the stated objectives, rather than teaching ecological concepts in the natural settings, the talk and chalk approach to teaching have become a natural phenomenon in most schools in Nigeria, an approach to teaching where the teacher does the talking while the students are passive in the learning process . Their duties only include listening and answering questions from the teacher. Kristina *et al.* [2] stated that science education has been removed from its natural environment (nature) to an artificial environment (a school class). According to them, this affects students' performance in biology. National Research Council [3] stated that the key to success in science is not just providing students with a science immersion experience, but also enabling them to conceptualize science as a creative process and of thinking other than a defined body of knowledge. According to Kristina *et al* [2], the most natural learning is realized through personal experience. Piaget, also posited that getting students involve in their work will make them learn and enjoy it. He stressed the importance of engaging students in learning involving doing as well as thinking. Smith [4] stressed the need to engage students with learning materials by having them interact and experience it.

Ajaja [5] defined Field trip as an outdoor or field work or learning exercise undertaken by teachers and students in certain aspects of subjects particularly, biology so as to give the students the opportunity to acquire knowledge. Kprepel *et al* [6] defined field trip as a trip arranged by the school and undertaken for educational purpose in which the students go to places where materials for instruction may be observed and studied directly in their functional setting. In field work, students assume active investigative roles, thinking like a scientist and doing real science. According to Novak [7], "direct experience with real objects and processes can give form and meaning to primary concepts". According to him, "nature" plays an active role in effective learning. Environmental learning creates close association between the learner and the environment thereby granting the students (learner) the opportunity to involve the complete senses in the learning process.

Field-based approach to learning will create a platform for social learning amongst students. Simmons [8] posited that learning takes place through the interaction students have with their peers, teachers and the social environment. In this approach, the natural environment serves as a social environment which will

maximize the learners' ability to interact with each other through discussion, collaboration and feedback. Hence, the duty of the researcher is to facilitate the learning process, to create the environment where directed and guided interaction can occur in collaboration amongst students. Science education in the field centers primarily on observational and experimental activities the natural environment is the main source of information for learning activities. Pupils learn how to use the scientific methods for solving problem. They take and analyze samples, create hypothesis and plan experiments. Small co-operative learning groups are highly motivating. Dialogues, discussions and presenting their own findings in these groups are more interactive methods of learning than individual work in the class room [2].

Several researchers have shown that students have misconceptions in ecology which affect their performance in biology and that this misconceptions can be corrected by instruction [9]. This is the major focus of this research. That is to determine how field-based instruction can be used to promote conceptual understanding of ecological concepts.

II. Statement of the Problem

The traditional teaching method which is the talk and chalk approach to teaching has become an inherent attribute to the Nigerian teacher. To them, they are master 'know-it-all'; as a result they tend to impart their knowledge to the learner as though the learner's brain is a machine which is capable of absorbing everything presented unto it. The duty of the learner is to sit, grasp and assimilate all information. This has not augured well with the Nigerian school-child as there has been a large report of student poor performance in internal and external examination [10].

In this 21st century, effort is being placed on paradigm shift in the students from being a passive learner into a learner who actively involve in the learning process and discovers knowledge for them. The issue therefore is how can the Nigerian students be effectively taught to ensure proper conceptual understanding of ecological concepts?

1. Do all students have a good understanding of ecological concepts?
2. What effect has field-based instruction on students' conceptual understanding of ecological concepts?
3. Does field-based instruction significantly improve students' understandings of ecological concepts?

Hypotheses

The hypotheses tested were stated in the null form:

1. The understanding of ecological concepts among students is up to standard
2. Field-based instruction does not have a significant effect on students' understanding of ecological concepts.
3. Field-based instruction does not significantly improve students' understanding of ecological concepts compared to the traditional teaching method

Significance of the Study

This research is useful in improving the understanding and educational performance of the students. It is important to the teachers as it will enlighten them on the use of field-base instruction in the teaching of concepts in biology. It will bring to their awareness that nature cannot be removed from teaching and learning.
It will also be very important to the curriculum planners as this study will make them see the need to include in the curriculum the need for teachers to teach biological concepts in the natural environment (field-based). On the part of stakeholders, this work will create in them the need to conserve nature for knowledge and intellectual development.

Purpose of the Study

The aim of the study was to find out, if all the students had good knowledge of ecological concepts and to find out the effect of field-based instruction on students conceptual understanding of ecological concepts.

Scope/Delimitation of the Study

The study was design to cover the secondary schools in Egor and Ovia Local Government Area of Edo State for the year 2015-2016.

III. Leterature Review

Conceptual Framework of Teaching Methodology

The basic reason of teaching is to bring an essential change to the student [11]. To expedite the process of knowledge transfer, tutors should apply the right teaching strategy that best fit specific objectives and outcomes. In the conventional method, many tutors widely applied teacher-centered strategy to impart knowledge to students compared to student-centered approach. Until today, questions about the efficacy of teaching methods on student learning have constantly raised significant interest in the field of educational

research [12]. In addition, research on teaching and learning consistently endeavor to determine the extent to which various teaching methods support growth in student learning.

The conceptual framework which described the inter-play between impact of interventional teaching methods and students' performance was formulated. The method of teaching is said to affect the level of achievement, which in this research are students' academic performance in the understanding of ecological concepts.

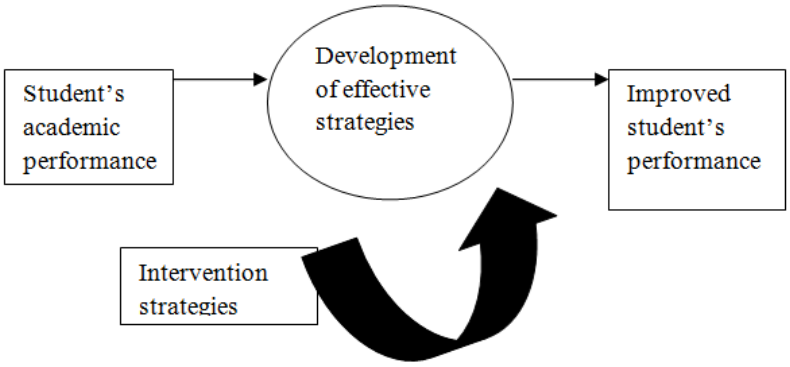

Fig. 1: Framework of students' academic learning trend [13].

Fig.1 shows the inter-play of students' academic performance with teaching intervention strategies. The factors revealed in the figure above are students' academic achievement which is their grade point average in the subject. The intervening variables are the intervention methods that are improved and recommended. Those variables are processed so as to have improved students' academic performance and enhance the quality of education in the area of ecological concepts. Remarkably, regular poor academic achievement by the majority of students is originally linked to application of unproductive teaching methods by teachers to impact knowledge to students [14]. Extensive research on the effectiveness of teaching methods reveals that the quality of teaching is often reflected by the achievements of students. Ayeni [15] stated that teaching is a process that involves creating desirable changes in students to achieve specific results. In order for the method used for teaching to be effectual, Adunola [14] maintains that teachers should be acquainted with numerous teaching methods that take recognition of the size or complexity of the concepts to be covered.

Ayeni [15] reported that teaching is a continuous activity that consists of bringing about desirable changes in students through use of useful methods. Adunola [14] maintained that in order to obtain desirable changes in students, teaching methods used by tutors should be best for the subject matter. Teaching methods work excellently only if they suit students' desires because every student interprets and responds to questions in a unique manner [16]. Hence, the position of teaching methods with students' needs influence students' academic achievement.

Teaching Methods and Retention Levels

This study is committed to determine the effects of field-based learning on the academic achievement and retention (remembrance) level in teaching of ecological concepts. Critics of public education have argued that many Nigerian students do not possess the depth of knowledge or skills to assure either personal life success or national economic competitiveness [17]. A specific concern of the critics has been the apparent failure of many students to engage in complex problem-solving activities and to apply school knowledge and skills to real-life problems in workplace settings [17]. What teachers and schools encounter is a basic redefinition of what it means to be a student or a teacher and what it means to learn or to teach. Educators are faced with a model shift in learning and teaching which is driven by the increasing anomalies of the current educational system. High drop-out rates, low skill and knowledge levels among many students, low levels of student engagement in school work and poor international comparisons suggest that the current educational teaching model is weak or inappropriate.

Teachers must understand that changes in students' attainment must be supported by corresponding changes in curriculum and instruction. However, it is clear that many of today's teachers are caught in the hub of a change for which they may not have been professionally prepared [18]. Many teachers were educated in areas where the role of the student was to conduct well-regulated experiments, memorize facts, perform numerical calculations using a particular algorithm and were then examined on their ability to perform these tasks or remember particular facts. The ideas which are core to an education which defines skills as the ability of the student to apply knowledge and skills to unfamiliar problems are not new. These ideas were got in traditional training programs, where children learned life sustaining skills from parents and they were fundamental to the successes of all traditional peoples. Theorists in cognition, curriculum and instruction are

now presenting the fundamental rationale and language for discussing this basic change in teaching and learning which is at the heart of the current school improvement agenda. Constructivist theory provides a framework through which the developing ideas about teaching, learning and assessment can be integrated [19]. The challenges confronting classroom professionals is that the reform methods in curriculum, instruction and assessment organized within the theory of constructivism are informed by various assumptions and beliefs about the nature of knowledge and about the human capacity to learn than are traditional classroom experiences.

More so, the traditional teaching method of teacher as sole information-giver to passive students appears obsolete. Colburn [20] reported from his work on undergraduates in a large lecture hall setting, he said only 20% of the students retained what the instructor taught after the lecture. They were too busy taking notes to internalize the information. Also, after a lecture has passed eight (8) minutes, only about 15% of the students are paying attention. Furthermore, the curricula in the subjects are overstuffed and undernourished [21]. The subjects' curricula emphasize the learning of solutions more than the exploration of questions, memory at the expense of critical thought, bits and pieces of information instead of knowing in context, recitation over argument, reading in lieu of doing. The curricula also fail to encourage students to work together, to share ideas and information freely with each other, or to use modern instruments to extend their intellectual capabilities [21]. One proposed solution to the aforementioned problem is to prepare students to become good adaptive learners. That is, students should be able to apply what they learn in school to the various and unpredictable situations that they might encounter in the course of their work lives. Obviously, the conventional teacher as information giver and textbook-guided classroom has failed to bring about the desired result of producing thinking students [19]. A much heralded alternative is to change the focus of the classroom from teacher dominated to student-centered using a constructivist approach.

In terms of traditional teaching governed by teachers, verbal or oral methods, students' learning by heart, future tutors of biology must prepare and become practically enabled for quite different teaching technique, gone are the days when the progressive and scholastic tasks could be pursued by tutors "craftsmen" reproducing the work models they experienced in their study. Now, teachers should create new and innovative situations to discuss a concept with students

To make students be familiar with the complex system of knowledge about nature and understand the full difficulty of social relations in which they will find themselves, it is paramount that they are directed towards the ways and means of discerning the scientific truth as early as in the earliest grades of secondary school. In biology classes, methods of learning which principally contribute to the advancement of students' cognitive ability and involve them during lessons; raise interest and curiosity in further study of phenomena, activities and relationships that surround them must be mastered and used continually. The prominence should be on students becoming independent, preparing them for applying various sources of knowledge, for connecting the acquired knowledge from different areas, for direct application of knowledge in solving problems in students' routines, and for designing situations for such diverse and creative participation of students in the teaching process. Modern education insists on the active role of students in the teaching-learning process, and the teacher is expected to be qualified academically, and to determine the most appropriate teaching method from the series of teaching methods.

In addition, teachers who use more theoretical approach are insufficiently trained for the practical application of contemporary, active teaching methods and innovative models in teaching students. Research shows that the education of teachers significantly places greater importance on academic content, while their practical and applicable skills and abilities are undermined. Teaching approaches in schools is an equal and important segment of the overall preparation of students for their future careers. This is consequent upon the mistaken assumption that the knowledge acquired in the academic field is sufficient to effectively perform the teaching profession, which asserts that mastering academic disciplines in combination with a talent for teaching is a satisfactory requirement for the qualitative input of the teaching profession

Teachers in the secondary schools should have general guidelines for the innovation of teaching, learning should not be conceived as memorizing facts and concepts, definitions and phenomena, individual differences among students should be respected, student should be brought into a situation to develop their knowledge. The introduction of innovation will be facilitated by providing complete materials which will help teachers to apply these innovations in practice more easily. The use of modern instructional technology does not mean only modernization of the school with new and modern teaching aids, but providing clear guidelines for implementation of the active forms and methods in the context of current educational learning. The teacher must know how to combine modern methods, forms and methods of teaching, or what the advantages and disadvantages of such models and frameworks are, and in what frames they can be successfully applied in our teaching.

Constructivist-Based Teaching Method on Academic Performance

Constructivism is a mental theory of knowledge which claims that humans build knowledge and meaning from their practices. Constructivism implies a set of principles about knowledge that starts with the notions that reality exists but cannot be known as a set of truth [22]. Constructivism does not accept what is being described to you, but your prior knowledge about what you are taught and your observations about it. Active participation of students is emphasized in constructivism, hence knowledge obtained remain in their memory. This technique is an age-long concept, which has its roots in philosophy and has been applied to anthropology and sociology as well as cognitive psychology and education. Perhaps the first constructivist philosopher, Giambatista Vico, noted in a treatise in 1710 that "one only knows something if one can explain it. In addition, Immanuel Kant elaborated this idea by claiming that human beings are not passive recipients of information. Students actively take knowledge and link it to previously assimilated knowledge and make it theirs by constructing their own interpretation [23]. There are five basic premises that pervade the multiplicities of theories expressing constructivism; which are (i) active agency, (ii) order, (iii) self, (iv) social-symbolic relatedness, and (v) lifespan development.

With various language and terminological preferences, constructivists have proposed, first, that human experiencing comprises continuous active agency. This distinguishes constructivism from other forms of determinism that cast humans as passive stake in the play of larger factors. Second is the contention that much of human activity is applied to ordering process – the organizational patterning of experience by means of unspoken, emotional meaning-making methods. In a third common contention, constructivists assert that the organization of personal activity is fundamental self-referent or recursive. This makes the body a fulcrum of experiencing and it honors a deep sense of personal identity. However, the personality is not an inaccessible island of Cartesian mentation since people associate in living webs of relationships. The fourth common premise of constructivism is that individuals cannot be understood besides their biological inheritance in symbolic and social systems. Lastly, all of this meaningful, active and socially-embedded self-organization reflects an ongoing developmental flow in which dynamic dialectical tensions are essential. Order and disorder co-exist in lifelong pursuits for a dynamic balance that is never quite achieved. The existential manner here is unmistakable. Together, then, these five premises communicate a constructive view of human experience as one that emphasizes important action by a developing self in complex and unfolding relationships. Focusing on a more educational description of constructivism, meaning is intimately connected with practice or experience [24].

According to Mahoney [24], students come into a classroom with their own experiences and a cognitive structure based on their practices. These preconceived structures are valid, invalid or incomplete and they will recreate his existing structures only if new experiences or information are linked to knowledge already in memory. Inferences, elaborations and relationships between old perceptions and new ideas must be personally drawn by the student in order for the new idea to become an integrated, useful part of his/her memory.

Memorized facts or information that has not been linked with the student's prior experiences will be quickly forgotten. In short, the learner must actively construct new information onto his/her existing mental framework for meaningful learning to occur. Conventional method of teaching is the process of transfer of knowledge from teacher to student. The current Nigerian classroom especially secondary school level tends to resemble a one-person show with a captive but often bored audience. Classes are regularly driven by "teacher-talk" and rely heavily on textbooks for the pattern of the subject. There is the plan that a fixed world of knowledge that the learner must come to know. Information is broken into parts and built into a complete concept. Teachers serve as channels and seek to communicate their thoughts and meanings to the passive learners. There is little chance for student-initiated questions, independent thought or interaction among students.

The goal of the student is to repeat the accepted explanation or pattern expostulated by the teacher [25]. This teaching approach can prevent the development of individual student's active and creative abilities, and students who practice only this model of education may no longer be regarded sufficient for the desires of a future educated citizenry. In a constructivist situation, knowledge is not objective; calculations and science are viewed as systems with models that reveal how the world might be rather than how it is. These models derive their validity not from their accuracy in explaining the real world, but from the accuracy of any predictions which might be based on them [26]. The duty of the teacher is to organize information within conceptual clusters of problems, questions and discrepant situations in order to engage the student's interest. Teachers help the students in developing new insights and linking them with their previous knowledge. Ideas are presented holistically as wide concepts and then separated into parts. The practices are student-centered and students are encouraged to ask their own questions, conduct their own experiments, make their own comparisons and come to their own conclusions.

Cognitive theorists accept that the role of the teacher is to provide students with opportunities and motivation to learn, holding that among other things: (i) All learning, except for simple role memorization, requires the learners to actively construct meaning. (ii) Students' prior understandings and thoughts about a

topic or concept before instruction exert a tremendous influence on what they learn during instruction. (iii) The teacher's primary goal is to generate a change in the learner's cognitive structure or way of viewing and organizing the world and (iv) Learning in co-operation with others is a vital source of motivation, modeling, support and coaching.The constructivist theory of learning supports cognitive teaching, for opposing that humans have a distinctive sense of the world and this field allows them to move from passive observers to active learners. It become important to identify, building upon and modify the previous knowledge students bring to the classroom, rather than assuming they will automatically absorb and believe what they read from academic materials and are taught in the class. Caprico [25] reported that higher tests or exams grades were obtained by students taught using constructivist methodology.

White & Gunstone [27] reported that the constructivist model has been known to affect students' achievement in a favourable manner. The constructivist model is efficient in getting students more involved in learning. Kurt & Becker [28] stated that students who participated more in the classroom activities and gained in content knowledge when a constructivist approach was used. Brad [29] reported that students in the constructivist instruction showed higher degree of academic attainment than students in the conventional instruction in all situations. Makanong [30] stated that students in constructivist and conventional classes had similar performances. Kurt & Becker [28] reported that there was no difference in performance between Thailand students exposed to traditional teaching method and constructivist teaching approach in vocational programmes. However, they concluded that the constructivist-instructed students had higher scores on the post-test compared to those of the traditional method. This infers that students in the constructivist's group retain the concepts taught better than their colleagues in the traditionalist's lecture class.

Field-Based Instruction

Field-based instruction is an outdoor or field work or learning exercise undertaken by teachers and students in certain subjects particularly, biology this is done to give the students the opportunity to acquire knowledge from the real material under study. Field-based instruction is also commonly known as Field-trip. According to Kprepel & Duvall [6], field trip is a trip arranged by the school and undertaken for educational purpose in it, the students go to places where materials for instruction may be observed and studied directly in their functional and natural settings. The term 'field trip' emphasizes some of the formal exercises, which are carried out outside the classroom usually in biology and geography at secondary and tertiary levels. Posner *et al.* [31] revealed the following as the reasons why biology teachers conduct field trips:

1. It providing firsthand experience for students;
2. It stimulating interest and motivation to learn science;
3. It gives meaning to learning and interrelationship;
4. Promotes observation and perception skills; and
5. Enhances personal social development.

All these culminate in influencing student's attitude in the following ways:

(a.) interest in hands-on real world experiences

(b.) positive attitude towards the subject;

(c.) improvement of the socialization between students, and development of rapport between teachers and students; and

(d.) urging teachers to utilize other teaching strategies such as cooperative learning.

Nature study creates a concrete bridge in learning abstract concepts. To achieve this, students are taken to the field to observe materials in their natural and functional settings. This approach help promotes concretization necessary for higher levels of cognitive learning. It also involve the summary unit, this includes bringing to light complex and abstract concepts learnt in the field into discussion in class. This is aimed towards the application and transfer of field trip learning. This will bring a significant improvement in the understanding of the concepts.

This study, which grew out of the observation of less frequency in the use of natural settings as an extension of the biology laboratory for student initiated, independent and cooperative investigation and the feeling that since it is a hands-on activity, is tailored to find out how field trip affects biology students' learning of methodology of science and biology.

Biology curriculum in use emphasized empirical processes in science; it becomes appropriate to determine the effects of field exposure on secondary school students' conceptual understanding of ecological concepts

Importance of field-based based instruction to learning.

One approach which help learner develop the needed skills is direct field experience with opportunities for active, authentic scientific investigation and for gaining skills in inquiry pedagogy. Researches have maintained that field work is "critical to the development of spatial reasoning, to the ability to create integrated mental visualizations of nature and it processes, and to developing facility with analyzing the quality and

certainty of observational data supporting science theories" [32]. A well planned and delivered fieldwork provides experiences that cannot be duplicated in the classroom; it also positively impacts attitudes, leading to reinforcement between affective and cognitive domains of learning and higher level learning. Field experiences do not only permit but actually encourage perception of the integrated whole, not just the individual parts. The opportunity for direct hands-on experience provided by a field trip can be useful for transition from a concrete to abstract level of cognition as described by [33]. It can lead to conceptual change and refinement of student pre-conceptions [34].

According to Gwen *et al.* [35] postulated that in field-based instruction learners become active part of the experience rather than mere observers, generate information rather than receiving it, and constructing their own records of the scene rather than accepting the teacher's version."Authentic science," a central strategy of science teaching, occurs through fieldwork. It requires that students assume active, investigative roles, thinking like a scientist and "doing" real science. Key to the success is not just providing students with a science immersion experience, but also helping them conceptualize science as a creative process and way of thinking rather than a defined body of content [36].

IV. Methodology

Here, we describe the method that was employed for this study and it is discussed under the following sub-headings:

Research Design

The study employed the quasi-experimental setting of non-equivalent (pre-test and post-test) and control group design. The reason for the adoption of this design was hinged on the fact that intact students were randomly assigned to experimental and control groups respectively, since it is difficult to have complete randomization of subjects.

Table 1: The Research Design Employing the Pre-test and Post-test Group Design

Groups	Pre-test	Treatment	Post-test
Experimental group	Y_1	X_1	Y_3
Control group	Y_2	X_2	Y_4

Notes:

Pre-test - Students in experimental group and control group were given a test on all materials to know students' initial baseline

Treatment stage - Students in experimental group were thought using the field-based approach, while the control group were taught using the conventional teaching method

Post-test - Students in experimental group and control group were given a test on all materials to know students' learning achievement after treatment.

Y_1 - the learning achievement of students in experimental group before treatment

Y_2- the learning achievement of students in control group before treatment

Y_3 - the learning achievement of students in experimental group after treatment

Y_4 - the learning achievement of students in control group after treatment

X_2 - treatment in form of field-based

X_3 - treatment in form of conventional learning method.

The main independent variable is the field-based study, while the dependent variables were achievement scores in ecological concepts.

Study Population

This study population was senior secondary school students in Benin metropolis. In Edo State, there are a total of 341 public and 596 approved private secondary schools are in Edo State. The population of public secondary school students is 105,922 students and the population of students in the approved private secondary school is 82,362 students. Therefore, the total population of students in Edo State as at October, 2013 is 188,284. This statistics of schools and students was from the Ministry of Education, Benin.

Study Area

This study involved Egor and Ovia North EastLocal Government Areas (LGA). In Edo State, there are 18 Local Government areas. The State lies between latitudes 6^o 10^1N and 6^o 20^1N and longitudes 6^o 10^1E and 6^o 15^1E with a population of over 2.5 million and a population density of 168 persons per square kilometer. It is located in the south southern region of Nigeria. She shares boundaries with Ondo State (West), Delta State (South), and Kogi State to the North (Cleen Foundation, 2014).

Sample Size Estimation

The sample size of this study was calculated using the formula;

$$n = \frac{2*(z_{1-\alpha/2} + z_{1-\beta})^2 * s^2}{(\mu_0 - \mu_1)^2}$$

Where, $z_{1-\alpha/2}$ = 1.96 (standard normal deviate at 95% confidence level); $Z_{1-\beta}$ = 0.84 (power of the test at 80%); s = standard deviation of the academic achievement of students in field-based group (5.7348), μ_0 = formal classroom group (50.08); μ_1 = field-based group (53.36)

Source: Summary of t-test analysis comparing the post-test biology achievement score of field trip group and formal classroom teaching method group (Ajaja, 2010).

$$n = \frac{2*(1.96+0.84)^2 * 5.7348^2}{(50.08-53.36)^2}$$

n = 48; design effect = 2
Therefore, minimum sample size = 96

Sample and Sampling Procedures

A sample is defined as a subject of a population, while sampling refers to the selection of a subject or cases from a population of interest. Simple random sampling technique was used in selecting the school and the classes used as experimental and control groups. This was to capture the experiences of students in the school. This procedure assessed students with a wide range of socio-economic backgrounds and mixed academic ability. In any chosen school, every consenting student in a randomly selected senior class who agreed to sign the consent form after reading through it participated in the study. It means that any class which was selected for study, by simple random sampling, all students in the class are also eligible to participate in the study.

Research Instruments

There were two instruments employed in the study; the first instrument was the lesson plan which was used to apply the treatment, and the second instrument was used to measure students' learning achievement. The lesson plan was validated by the supervisor while the achievement test was a standardized test adopted from Senior Secondary School Certificate Examination (S.S.S.C.E.) past questions. These instruments were then used in data collection stage. The two instruments were elaborated in the following sub-sections.

- **Treatment Instrument**

The treatment instrument in this study was the Lesson Plans used in the two classes which were; (i) experimental group (ii) conventional teaching-learning method for control group.

- **Learning Achievement Measurement Instrument**

The instrument was in a form of a test, which was a multiple choice test consisting of 33 test items, each having five alternatives. This test was used for measuring students' learning achievement. The test was in form of objective written test. The learning achievement in this study referred to cognitive domain.

Validity and Reliability of the Instrument

This is a measure of how well a test measures what it is supposed to measure. This is the accuracy and meaningfulness of inferences which are based on the research. Assessment of content and construct validity will be achieved by the use of non-statistical approaches including peer and/or expert review will be involved.
Reliability is defined as a measure of how consistent the results from the test are. It is a measure of the degree to which a research instrument yields consistent results or data after repeated trials. A reliable instrument is one that produces consistent results when used more than once in the process of data collection.
The test items were selected from the Senior Secondary School Certificate Examination (S.S.S.C.E.) past questions. The SSSCE questions were assumed to be standardized in nature because the Questions are written by the experienced test and measurement experts in the ministry of education using an approved table of specification. Moderating Committee is believed to edit selected items. Therefore the test items are believed to be valid and reliable.

Ethical Considerations and Approval

Ethical approval for this study was obtained from authorities of the school that participated in the study with the school principals.

Data Collection Procedure

Data collected in the study is a quantitative data. Data was collected by giving a pre-test to know students' initial conceptual baseline. The test was given to the experimental group as well as to the control group this was done in the first week. After the pre-test, the treatment was given to the students for a period of four (4) weeks. Post-test was administered during the sixth week. The post-test was done to determine the effect of treatment on students' achievement.

Two classes were randomly selected for this study. One of which served as control group while the second served as experimental group. The test instruments covered topics in ecology which were taught during the period of study. The subject teacher who was taught by the researcher on applying field-based approach to teaching carried out the teaching of the students on each topic for four weeks respectively. The materials used were as follows:

1. A scheme of work consisting of selected ecological topics in biology which were taught for a period of four weeks. The students were exposed to these topics before the study.
2. An instructional package with the use of conventional (lecture) instruction.
3. An instructional package with the use of field-based instruction.
4. A set of thirty-three multiple-choice ecological test items.

The instrument in (4) above was used as pre-test and post-test in order to evaluate students' performance. The test items were selected from the Senior Secondary School Certificate Examination (S.S.S.C.E.) past questions. The SSSCE questions were assumed to be standardized in nature because the Questions were written by the experienced test and measurement experts in the ministry of education using an approved table of specification. Moderating Committee was believed to have edited selected items.

Data Management and Analysis Plan

Paired t-test and independent group t-test were used to analyze the data collected (in order to examine the statistical difference between groups). The paired t-test was used to analyze the pretest post-test scores of the two groups; the independent t-test was used to compare performance of the two groups. Computation for the aforementioned methods of data analysis was done using STATA version 12 which was employed for both descriptive and analytical techniques. Data screening and preliminary analyses, such as data cleaning, missing values/no-response, and systematic endorsement (e.g. endorsing the same response for the entire survey), the normality test (using the rule of thumb) were performed so as to allow the results to be meaningfully interpreted.

V. Results

A total of 109 senior secondary school students were involved in the study. In this chapter the data collected and analyzed are presented in tables and results of this study are explained.

Hypothesis 1: The understanding of ecological concepts among students is up to standard

Table 2: One sample t-test analysis comparing the baseline and standard score (50) of total participants on conceptual understanding of ecological concepts

	N	Mean	Std.dev	t-value	P
Baseline	109	38.14	10.01	-12.38	<0.001***
Difference		-11.86			

***p-value significant at 0.05

Table 2 shows that there is a significant difference between baseline and standard scores of the total students' understanding of ecological concepts (t= -12.38, p<0.001). Hence, H_0^1 is rejected. The result showed that the understanding of ecological concepts among students is below standard.

Hypothesis 2: Field-based instruction does not have a significant effect on students' understanding of ecological concepts.

Table 3: Summary of paired t-test analysis comparing the baseline and end line scores of field-based method on conceptual understanding of ecological concepts

	N	Mean	Std.dev	t-value	P
Baseline	55	37.58	10.16	-9.41	<0.001***
End line	55	54.71	12.53		
Difference		-17.13			

***p-value significant at 0.05

Table 3 shows that there is a significant difference between students exposed to field-based experiences for pre-test and post-test scores for students' understanding of ecological concepts (t= -9.41, p<0.001). Hence,

H_0^2 is rejected. This shows that field-based instruction has a significant effect on students' understanding of ecological concepts.

Hypothesis 3: Field-based instruction does not significantly improve students' understanding of ecological concepts compared to the traditional teaching method

Table 4: Summary of independent t-test analysis comparing the end line scores of traditional (control) and field-based teaching methods on conceptual understanding of ecological concepts

	N	Mean	Std.dev	t-value	P
Traditional (control)	54	45.07	10.77	-4.30	<0.001***
Field-based	55	54.71	12.53		
Difference		-9.64			

***p-value significant at 0.05

Table 4 shows that there is a significant difference between the post-test scores of traditional (control) and field-based teaching methods on conceptual understanding of ecological concepts (t= -4.30, p<0.001). Therefore, H_0^3 is rejected. Hence, the result showed that field-based instruction significantly improved students' understanding of ecological concepts compared to the traditional teaching method.

Table 5: Summary of paired t-test analysis comparing the baseline and end line scores of traditional teaching method on conceptual understanding of ecological concepts

	N	Mean	Std.dev	t-value	P
Baseline	54	38.70	9.91	-3.50	0.001***
End line	54	45.07	10.77		
Difference		-6.37			

***p-value significant at 0.05

Table 5 shows that there is a significant difference in the pre-test and post-test scores between students exposed to traditional teaching method experiences of students' understanding of ecological concepts (t= -3.50, p = 0.001).

Table 6: Summary of independent t-test analysis comparing the baseline scores of traditional (control) and field-based teaching methods on conceptual understanding of ecological concepts

	N	Mean	Std.dev	t-value	P
Traditional (control)	54	38.70	9.91	0.58	0.561
Field-based	55	37.58	10.16		
Difference		1.12			

***p-value significant at 0.05

Table 6 shows that there is no significant difference in the pre-test scores between students exposed to field-based and traditional (control) methods (t= 0.58, p = 0.561).

Table 7: Summary of paired t-test analysis comparing the baseline and end line scores of the total participants on conceptual understanding of ecological concepts

	N	Mean	Std.dev	t-value	P
Baseline	109	38.14	10.01	-8.54	<0.001***
End line	109	49.94	12.60		
Difference		-11.80			

***p-value significant at 0.05

Table 7 shows that there is a significant difference between baseline and end line scores of the total students' understanding of ecological concepts (t= -8.54, p<0.001). The result showed that the understanding of ecological concepts among students was significantly improved by the intervention.

VI. Discussion

This study demonstrates the effect of a teaching method consisting of interactive engagement elements to student understanding of ecological concepts. The conceptual comprehension of students in the field-based is better than that in the control classes, as was shown by the average gain in scores. In light of the fact that learning is a process that involves reasoning, formulating, investigating and using appropriate strategies to solve problems, teachers should realize that it becomes more effective if the students are tasked to perform rather than just asked to remember some information. A typical learning environment with a presentation from the subject teacher accompanied by a lecture neither promotes students' participation nor build the required level of

reasoning among students. Students build a better understanding of the main concepts more effectively when they are engaged to interact with nature [15], [5]. Without new approaches to instruction that connect to the learning needs of secondary school students, many will perform poorly and are likely to drop out of studies.
Findings of this research showed that field-based teaching method increased the academic achievement of students significantly when compared to the traditional teaching method as research evidence from previous studies indicates that a student-centered learning environment seems to produce higher-level learning outcomes more efficiently than a traditional teacher-centered environment [5], [2], [4], [7], [37]

VII. Conclusion

Based on the research findings, bias inherent in the traditional teaching methods by teachers in which they possess exclusive monopoly knowledge should be avoided to improve students' academic performance.
More so, from the findings of this research, the outcomes of field-based teaching approach compared with traditional teaching were found to be significantly different in three areas. Firstly, the new teaching approach was found to successfully promote interaction and learning engagement, including concentration, thinking, and discussion. Secondly, the program developed the learners' perspectives of their own learning. The students in the intervention group seemed to shift their focus from teaching performance to their own learning when assessing the subject. They became more aware of the learning barriers and took more responsibility for their own learning.

This research also has implications in the following two areas: Firstly, the findings from this study reveal the critical role of field-based teaching method in promoting learning engagement as well as broadening the students' perspectives of learning. These two learning outcomes are also emphasized by many other education researchers. Secondly, in spite of many of the teachers' hesitations about modifying the traditional lecturing under the restrictions of the existing teaching environment, this study showed that the implementation of field-based approach is feasible under the same teaching resources and students' situations. Although the intervention program was as short as four weeks, the outcomes were found to be promising, in developing students' understanding as well as affective outcomes without sacrificing their academic performance in traditional group assessment.

VIII. Recommendations

1. Teachers should create an atmosphere conducive to learning in order to enhance the development of students' learning experiences.
2. Moreover, teachers should also increase their knowledge of various instructional strategies in order to keep students engaged and motivated throughout the learning process.
3. Stakeholders in Education should encourage capacity building to enhance the teachers acquire the skills to help students interact with their immediate surroundings.
4. As this investigation reveals a number of problems in implementing field-based teaching approach, it is advisable for instructors to consider the following suggestions if they think about adopting the approach in the future:

1. Instructors should explain the rationales and purposes of the interactive engagement activities. This should be done at the beginning of and throughout the term.
2. As the class schedule is occupied with various activities, there should be additional hours to deal with the problem solving and unanswered questions. Tutorial classes supervised by teaching assistants may be the best solution to this problem.
3. The interactive engagement activities should be reflected in the test or exam. It will encourage the students to participate in the learning process seriously.
4. Grading the test or exam should also reflect how much understanding students are expected to achieve. Process-oriented is certainly preferable than result-oriented.

The subject teacher should not overrule the importance of the school environment in the effective teaching of ecological concepts as there are lives there that can enhance the proper understanding of ecological concepts.

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