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On Misconceptions of Ecological Concepts among Public Senior Secondary Schools Students in Benin City, Nigeria

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ABSTRACT: This study was motivated by the poor performance of students in science (biology) in WAEC and NECO examinations. Research showed that conflicts exist between science and students perceptions of science which results in students developing misconceptions in science, eventually leading to low performance of students in external examinations. As a result, the need to study ecological misconceptions as a major topic in biology syllabus became paramount. The focus of this was to find out the misconceptions held by students in ecology, to determine if sex, cultural background and school type have influence on students conception on ecological concepts. Based on this, four schools were chosen from urban centre and two schools were chosen from the rural location. A total of 246 students participated and two-tier diagnostic questionnaire with 20 items was used as the research instrument. Hypotheses were tested using t-test with 0.05 level of significance. Analysis was done using SPSS and the results showed that students holt much much misconceptions in the tested concepts, and that these misconceptions were not different by sex, but are significantly different by cultural backgrounds and school types with a higher misconceptions existing amongst students in rural and public secondary schools. In sum, improving teaching techniques could ameliorate the challenges inherent with understanding of scientific phenomenon.

KEYWORDS: Misconception, Ecology, Biology, Science.

BACKGROUND

Society and culture are the primary agents of socialization of a child that pass information or ideas into the child even before the child's formal education. This information or idea may conform to what is generally accepted or held by experts in the field or it may be at variance with the acceptable meaning (misconception). Today, it is said that students brings to the classroom, alternative conceptions which can be different from the acceptable views. These views influence what students learn during science lessons. [1], in her study in 1983, posited that more than 50 percent of the respondents to a questionnaires on the cultural implication on science education, were found to adhere to or share in certain superstitious beliefs, and these interferes with their understanding of science concepts. [2], also stressed that no child comes to classroom completely blank, they emphasized that students make meaning of what you teach by comparing it to what they already know or believe. According to them, what the students know may be misconceptions about the topic the teacher is teaching. These misconceptions interfere with learning and that these misconceptions are held strongly and hence are resistant to change.

[3] said that in Africa, various conception of knowledge are strongly tied to the culture and traditions of the people. Explanations of natural phenomena (scientific knowledge), often conflict with the accepted knowledge in science. Much of these preconceived or erroneous explanation and views, have their roots in family's held believes of the African world".

[4], stated that the African child is practically operating in a three ways of life (scientific, native, and religion). As a result, an African child embarking upon the acquisition of scientific concepts in his tricontextual setting (native, religious and scientific), has always been under constant confusion. [1] described misconception as one of the major factors which leads to poor performance of students in ecology. According to her, more than 50 percent of students who sat for ecology, failed in the year 1995, 1997, and 2000. Same also apply to the performance of students at the National Examination Council (NECO) 2011 such that of 97,595 students who sat for ecology, only 29.52 percent passed and 70.48 percent failed.

The West Africa Examination Certificates chief examiners reports (2004), also reveals misconception as one of the major weakness manifested by candidates in ecology. In a position paper reported by the Science Teachers Association of Nigeria (STAN), [4] further confirmed that cultural beliefs are actually among some of the major causes of poor performance in science, technology and mathematics education in Nigeria. Similarly, [5], stated that the kinds of conceptions students brings to school were largely invisible to pedagogies and even more unknown to those who set educational policy. Only a pre – established harmony between the students mind and the school curriculum, would justify the prediction that the school as constitute could succeed in their ambitious and over expanding mission.

SOME BASIC CLAIMS ABOUT MISCONCEPTIONS

[6] stated that:

1. Students come to school instruction with diverse misconceptions concerning natural object and events.
2. The misconception that students bring to school instruction goes beyond age, ability, gender and cultural boundaries.
3. Misconceptions are tenacious and resistance to extinction by conventional teaching strategies.
4. Misconception often parallel explanation of natural phenomena offered by previous generation of scientists and philosophers.
5. Misconceptions have their origin in diverse set of personal experiences including direct observation and perception, peer, culture and language as well as in teachers' explanation and instructional materials.
6 Students prior knowledge interact with the knowledge presented in the formal instruction resulting in a diverse set of unintended learning outcome.
7. Instructional approaches that facilitate conceptual change can be effective classroom tools.

STATEMENT OF THE PROBLEM

The perception of science by an average Nigerian student is that of seeing science as something foreign to him or her and therefore difficult. This is as a result of the conflicts between science and the students' preconception. This results in low performance of students in science. Efforts have been made to improve science education in Nigeria, despite this; the performance of science students in external examinations is on the decline and alarming. The problem of the study therefore is: what are the misconceptions held by students in ecology? What is the influence of misconceptions held by students on academic performance in ecology?

1) Does the sex of the students have a role to play in acquiring misconception in ecology?
2) How has cultural location (urban and rural) promoted misconception of concepts in ecology?
3) Does the type of school attended by the students promote or eliminate misconceptions in students?

HYPOTHESES OF THE STUDY

This problem was tested with the following hypotheses. They are stated in null form and was tested at a significance level of 0.05.

NULL HYPOTHESES

1) The misconceptions held by students in ecology are not significantly different by se
2) The misconceptions held by students in ecology are not significantly different by culture.
3) Students who hold the wrong and right conceptions in ecology is not significantly different by school type

SIGNIFICANCE OF THE STUDY

The significance of this study in the Nigerian society where science enrolment and achievement are on the decline cannot be over emphasized. If Nigeria has to accomplish the aim and objectives of education, issues which hinder the effective learning of science cannot be ignored. The factors underlying the differential participation and achievement of boys and girls in school ecology are needed to be examined. The results and conclusions will provide information to help teachers take students understanding of ecological concepts thereby improving ecology instruction in Nigeria. It is also expected that the results of this of this study will give textbook authors information about the misconception existing amongst student into consideration thereby enhancing the quality of Nigerian ecology textbooks. This will help in developing meaningful conceptual knowledge about ecology and its real world application. The result of this study enables the teachers and curriculum developers to identify factors which may have influenced on male and female students negative attitude towards ecology. The study will have important implications for treating understanding of ecological concepts and giving more attention to improve education equity for both boys and girls.

REVIEW OF RELATED LITERATURES

MISCONCEPTIONS IN ECOLOGY

There are many science education research that emphasized the importance of understanding students' misconceptions on ecological terms, such as food chain, food web, energy pyramid and decomposers [7]. [8] listed 50 most important ecological concepts by surveying the members of the British Ecological Society. Twenty important concepts from the Cherrett's list would be recognized and endorsed as essential to environmental literacy by some of the environmental educators [9]. Munson listed these 20 most important concepts: the ecosystem, succession, energy flow, conservation of resources, competition, niche, materials cycling, the community, life history strategies, ecosystem fragility, food web, ecological adaptation, environmental heterogeneity, species diversity, density dependent regulation, limiting factors, carrying capacity, maximum sustainable yield, population cycles, and predator-prey interaction. As seen in the list, ecosystem, energy flow, food chain, food web and prey-predator interaction are among the most important 20 concepts.

Ecological concepts are prominent aspect of science syllabuses. While science teachers identified ecological concepts as important and believed them easy for students to understand. There are many studies that revealed certain misconceptions particularly about environment, population, community, habitat and decomposers [10]. For example, working with junior high students. [11] developed a unit that they hoped would change preexisting misconceptions and prevent the formation of new ones by ignoring details and avoiding information overload. They focused on the role of plants in moving materials (like carbon, hydrogen, and oxygen) cyclically through the ecosystem. They found that students have misconception that plants are dependent on people, not vice versa. Other misconception about producer is that green plants are only producers of carbohydrates in ecosystems. In addition, some students believed that plants take food from the outside environment, or plants get their food from the soil via roots [12], [13]. [14] found several misconceptions about consumers; for example, the number of producers is high to satisfy consumers and there are more herbivores because people keep and breed them and humans provide food for other organism.

[3] studied Nigerian students' misconceptions about ecology. After instruction, 26 students aged from 13 to 15 at elementary school were assessed by the essay test and clinical interview. Results of the essay test and interview revealed that students failed to define ecosystem, habitat, community, population, and many students confused ecosystem with habitat and population. They also stated community is the same as population. He found that students remembered the everyday language meaning when population was asked. Thus, students thought population as human population. Also, he reported that there are more herbivores than carnivores because plants eaters produce more young ones at one time and people breed more plant eaters than meat eaters. he stated students described carnivores as big or ferocious and herbivores as passive or smaller. Students also thought that bacteria are the source of energy in ecosystem because heat and gases are produced by decomposing dead plants and animals. Student ordered food chain in aquatic environment as small fish was eaten by large fish that was eaten by crocodile and lastly it was decomposed by bacteria. Students thought that plants do not live in water so they could not understand food relationship in aquatic environment. [3] found that students believed that the base (producer level) of the energy pyramid is wider than apex (consumer level) since the number of producers is higher than the herbivores to provide enough food for herbivores. Also, he indicated that students thought that energy decreases from producer level to consumer level since herbivores use some energy for digesting or herbivores may be hungry at time of eating or energy evaporates into the atmosphere during respiration so carnivores get little energy from herbivores. On the other hand, some students in his study considered that available energy increases from the base to the apex of the energy

pyramid so carnivores are the most powerful because energy accumulates up; thus, carnivores get their energy from both producers and herbivores. Moreover, students assumed that decomposers located at the top of the energy pyramid and they said that bacteria are the source of energy. Moreover,

[15] reported that decomposers release some energy that is cycled back to plants. The study conducted by [9] related to ecology indicated that some students do not perceive organism exist within a system of interacting biotic and abiotic factors. Students also believed that varying the population of an organism might not affect an ecosystem because some organisms in the ecosystem are not important. Furthermore, he found that students do not have clear explanation about species, population and community in their minds and students do not understand that each species has unique needs, and therefore each species has a unique effect on an ecosystem. On the other hand, some students believed that the needs of a species are general and typical of similar species that carry out the same role within the ecosystem. Munson reported that students interpreted food webs as simple food chains. He stated that populations higher on a food web increase in number because they deplete those lower in the web. Similarly, [16] revealed that students described ecosystem that are not an organized whole, but a collection of organisms. In another study, [14] investigated students' ideas about ecology and found that most pupils aged 5 and 16 are inconsistent in the form of explanation used in different contexts; for example, they may explain relative population size in different communities in different ways.

[17] studied seventh grade Turkish students' misconceptions related to ecological concepts. They conducted an interview and by using results of the interview and literature, they developed two-tier diagnostic test. Eighteen misconceptions were identified by means of this test related to the concepts of environment, ecosystem, decomposer, and population, energy resources in ecosystem and food chain and food web. They reported that students defined food chain as a kind of feeding relation including different food materials such as proteins and vitamins. Also, students had difficulty in identification of first consumer, second consumer or producer; for example, they maintained carnivores are the first consumer as they are wild and strong. On the other hand, several students claimed that humans are the first consumer because they consume everything. Moreover, they found that ecosystem is the interaction among living things and population is the number of people in a certain area; such as, population of city. Furthermore, they reported three misconceptions about decomposers such as decomposers eat dead plants and animals to keep environment, decomposers are not important because they are found on dead animals and they have no effect on ecosystems because they are too small to be seen by naked eye. They found several misconceptions about energy flow and energy pyramid. They reported that the strongest one has more energy; for example, when asked to which one has the greatest energy among grass, sheep and man, students believed that man has the greatest amount of energy since he is stronger so he has more energy. However, other students responded the reason of this question as man gets his energy from both grass and ship. On the other hand, students believed that energy flows from the stronger one to weaker one; for example, student stated in a food chain including plant, chicken and man, energy flows through man to plant because man has the greatest energy while some students thought that energy does not pass from one organism to other organism. Also, other students in her study believed that there is no relationship between plants and animals since plants and animals have own energy. Moreover, students claimed that plants get their energy from soil because they grow in soil and their food of mineral and water are present in soil.

[18] investigated tenth grade students' misconceptions related to food web that a hierarchy leading to the ability to determine how a change in the size of one population can affect another population in the same web but not on the same chain, and identification of specific misconceptions held by subjects concerning food web. Data were collected from 200 students. In their study, they found five misconceptions about food web. These are:

1. Interpretation of food web dynamics in terms of a food chain.
2. In a food web, a change in one population will only affect another population if two populations are directly related as predator and prey.
3. A population located higher on a given food chain within a food web is a predator of all populations located below it in the chain.
4. A change in the size of a prey population has no effect on its predator population
5. If the size of one population in a food web is altered, all other populations in the web will be altered in the same way.

[19] studied changes in students' ideas of a food chain and they looked for underlying ontological belief that may explain students' ideas. Data were collected by observing 28 ninth grade students during 24 instructional sessions on ecology in Israel. Results of the study showed that there are several factors that affect students' consideration in identifying a food chain such as eating event, size hierarchy and total elimination; for instance, students thought that a big fish fed on smaller fish fed on a smaller one. Furthermore, they reported that students considered if the organism is eliminated when consumed, it is assumed as an element in a food chain otherwise, it could not constitute food chain. The study conducted by [7] indicated that students considered bacteria as the microscopic-sized bacteria to diseases when asked whether bacteria in

the human body constitute a food chain. Some of the student defined food chain as cyclic that white blood cell swallows the bacteria that feed on the human body. On the other hand, most of students thought bacteria as decomposers but they stated that decomposers feed only on the last element of the chain. Furthermore, he reported that most of the students did not consider nectar as the first link of the feeding relations because it is not contained the green parts of plants. They thought that only a green component of plants is the part of a food chain since it contains photosynthesis products to pass on the subsequent consumers. In addition, students in this study believed that humans in feeding relations are always at the top of the pyramid and that larger organisms always feed on smaller ones.

[10] investigated common misconceptions about photosynthesis, respiration, food webs, evolution and ecosystems to help improve college ecology instruction, ecology faculty and researchers who study learning should collaborate to design research about ecology teaching and ecological thinking. He reported that students believed that energy is not lost in trophic transfer since diagrams of energy pyramids that indicate decreases in energy, without indicating that energy is given off as heat, can reinforce students' misconception that energy is not conserved.

METHODOLOGY

STUDY DESIGN AND POPULATION

The study design adopted was the cross-sectional study. The target population of this study consists of S.S 2 and S.S 3 students in Egor local government area of Edo state. Since it is not feasible to cover the entire population, it becomes important to define an accessible/representative sample from the population from which the result of this study was generalized. The desired sample size is 246 students. Simple random sampling was used to obtain the representative sample. The schools in this district were obtained from the catalogue of public and private secondary schools. Average of 40- 60 students per school participated in this study.

RESEARCH INSTRUMENT

Questionnaire was the major data instrument in this research. In it two-tier diagnostic instruments for assessing students' conceptions was used for data collection. The instrument consisted of multiple choice items with the diagnostic part which is the reason part. If a student gave the correct answer and correct reason a student is said to have right conception. Correct answer but wrong reason or wrong answer but correct reason for any of the items is said to be a misconception or alternative conception on that item. Section A of the test item sought for piece of information like class of participants, age, and sex type of school and settlement which was rural or urban. The second part contains the questions which the students responded to.

TEST ADMINISTRATION

A total of 250 questionnaires were administered to students of the selected secondary schools in Edo state. The questionnaires were self-administered. The administration were done after due permission by the principal and class teachers of the various schools. In the course of administration, the items not understood by the respondents in the questionnaires explained by the researcher. The questionnaires were filled and collected instantly.

METHOD OF DATA ANALYSIS

The statistical analysis was done by using the SPSS version 22. The significance level was set at 0.05. To test the hypothesis, frequency table, descriptive and cross tabulations which include person product correlation coefficient and the t-test were used to see the effect of sex, school type and school location (urban and rural) on students' misconceptions in ecology.

ASSUMPTIONS

1. Test was administered under standard conditions.
2. Students answer test questions seriously and time was assumed sufficient for answering all questions in each instrument
3. Students did not interact during the test.

RESULT

Summary statistics of students with respect age, gender, school type and school location. The descriptive statistics of participants like minimum age, maximum age, range, mean, standard error of the mean, standard deviation and variance of students. The results obtained from the participants who were of the senior secondary schools SSS II and SSSIII respectively gave a minimum age of the students to be 10 years old and a maximum age of the students (participants) to be 21 years old. The mean age was obtained to be 16. 39, std. Error = 0.1std. Deviation = 1.535, variance = 2. 357. Using the mean and std. deviation for the interval of the age of SSSII and SSSIII students; 16. 39 ± 1.535 = 14.855 years $\leq$ x $\leq$ 17. 925 year. This is approximately 15 years $\leq$ x $\leq$18 years old, as the age interval of students in the classes surveyed.

Table 1: Misconceptions held by students in the selected ecological concepts

S/N	Question	Frequency of misconception	Percentage (%) of misconception
1	Plants are found on land but absent in water? True/False	190	77.2
2	In the energy pyramid, which of the following trophic level is the widest?	143	58.1
3	As you move across the trophic levels in a food chain, energy ……	137	55.7
4	……. is the source of energy in a food chain?	190	77.2
5	In the pyramid of number, organisms at the higher trophic levels are …. in number.	227	92.3
6	The following is the first link of feeding relation in a food chain except?	139	56.5
7	In feeding relation, which of trophic level is occupied by man?	175	71.1
8	Ecosystem can be defined as ……..	113	45.9
9	One of these is not a biotic component of an environment	225	91.5
10	One of these does not influence population density.	85	34.6
11	Which of the following groups of organisms feed directly on green plants	182	74
12	All of these can be used in the measurement of common ecological factors except ?	108	43.9
13	One of these is not a major terrestrial biome of the world	192	78
14	Breathing roots are characteristic structures of plants growing on?	239	97.2
15	Puddles, ponds, rivers, lakes, seas, and oceans are grouped together as?	157	63.8
16	Fewer number of trees is characteristic of the savannah zones of Nigeria True/False	204	83
17	The adaptation for water conservation in organisms include the following except?	137	55.7
18	The relationship between a herbivore and the bacteria which live in the caecum is known as commensalism. True/False?	97	39.4
19	When large numbers of organisms share limited space and resources the result is :	178	72.4
20	Succession can best be defined as?	180	73.2

Table 2 presents descriptive statistics of participants according to gender, school type and school location in ecological concepts: Male (urban school); Mean score = 19.80, std. deviation = 14.683. Female (urban schools); mean = 23.49, std. deviation = 11.048. Male (private schools); mean score = 55.39, std. deviation = 14.537, Female (Private schools); mean score = 52.00, std deviation = 11.536. Male (rural schools); mean score = 27.73, std. deviation = 18.712. Female (rural schools); mean score = 28.33, std deviation = 16.061. From the results above, the male (private schools) had the highest mean score of 55.39 which means this group had the lowest misconceptions from the selected concepts on ecological terms. This group was closely followed by their female counter part still from private schools with the mean score of 52.00 which had no significant difference from that of their male group. The results showed that the male of the public urban schools had a mean score of 19.80, which means that they had the highest misconceptions of ecological terms. They were also followed by their female counter part which had 23. 49, similarly, no significant difference was observed between them. The male and female of the rural schools was observed to also held a high level of misconceptions from the results obtained.

Table 2: Descriptive statistics for the scores according to students' gender, school type and school location.

Variable	Mean	Std. Deviation	N
Male (urban schools)	19.80	14.683	49
Female (urban schools)	23.49	11.048	43
Male (private schools)	55.39	14.537	38
Female (private schools)	52.00	11.536	40
Male (rural schools)	27.73	18.712	33
Female (rural schools)	28.33	16.061	45

From table 3, we have that the students of urban public schools had a mean score = 21. 52, the urban private schools had a mean score = 53.65 and the rurals schools had a mean score = 28.08. The students of the urban public schools and rural schools are observed to hold a high level of misconceptions in ecological terms whereas the private schools have a lower level of misconceptions.

Table 3: Descriptive Statistics of the urban public schools, private schools and Rural schools

Variable	Mean	Std. Deviation	N
Urban Public Schools	21.52	13.171	92
Urban Private Schools	53.65	13.110	78
Rural Schools	28.08	17.117	78

From table 4, the t-test table above shows the comparison between the male and female of each school type. The rural schools had a mean score of 27.73 for male and 28.33 for female. The p-value = 0.878 which indicates that there is no significant difference between the performance of males and females in the schools. Urban private schools had 55.39 for males and 52.00 for females, p-value = 0.256 which shows no significant difference between the males and females. The urban public schools had a means of 19. 80 for males and 23.49 for females, P-value = 0.181. This outcome did not give sufficient evidence that there is significant difference between the means of the males and females.

Table 4: Inferential statistics t – test result

School type	Gender	Means	Std dev.	P-Volue	Decision
Rural Schools	Male	27.73	3.257	0.878	Not Significant
	Female	28.33	2.394		
Urban Private School	Male	55.39	2.358	0.256	Not Significant
	Female	52.00	1.824		
Urban Public School	Male	19.80	2.098	0.181	Not Significant
	Female	23.49	1.685		

INFERENTIAL STATISTICS

HYPOTHESIS I:

H_o: The misconception held by students in ecology is not significantly different by sex.

From table 5, the male students have a mean score of 33. 25, n = 120 standard error = 2,013 while the female students have a mean score of 34.10 n = 128 and standard error = 1.585. The p – value = 0.738 which shows that there is no significant difference between the means.

H_o is therefore not rejected. This may be because both the male and female student are made to use the same curriculum, taught by the same quality teachers and learn under the same environment with the same instructional materials and so possess the same misconception in ecology.

Table 5: t- test for comparison by sex

Sex	n	Mean	Std.dev	P-value	Inference
Male	120	33.25	2.013	0.738	Not significant
Female	180	34.10	1.585		

Hypothesis 2: The misconception held by students in ecology is not significantly different by culture (urban and rural).

From table 6 above, the urban schools have mean score = 36.26, n=17 std dev. = 1.590 while the rural schools have mean score = 28.08, n=78, std dev. = 1.938. The P-value of the means between urban schools and rural schools, P-value = 0.003, which shows that there is a significant difference between the means. From the results, we have that misconceptions is higher in rural schools with the lower mean = 28.08. The urban schools have less misconception when compared to the rural schools. From this result, H_o is therefore rejected and H_1 is accepted which says that the misconceptions held by students in ecology is significantly different by culture (urban and rural).

Table 6: t-test statistics for culture (urban & rural)

Variable	N	Mean	Std.dev	P-value	Inference
Urban schools	170	36.26	1.590	0.003	Significant
Rural schools	78	28.08	1.938		

Hypothesis 3: Students who hold the wrong and right conceptions in ecology is not significantly different by school type.

Comparing public schools with private schools, we have mean score = 24.53, std.dev = 1.182 n= 170 for the public schools. The private schools have mean score = 53.65, std.dev = 1.484, n = 78; when the means were compared, we have $p<0.001$. This shows a significant difference between the schools. The misconception is higher in public schools and less in private schools. From this result, H_o is therefore rejected; H_1 is accepted which says that: "Students who hold the wrong and right conceptions in ecology is significantly different by school type.

Table 7: t-test statistics for location (urban & rural)

Variable	N	Mean	Std.dev	P-value	Inference
Public schools	170	24.53	1.182	<0.001	Significant
Private schools	78	53.65	1.484		

OVERVIEW OF THE STUDY

The main purpose of the study was to investigate students' understandings of ecological concepts and the effect of gender and reasoning ability on senior secondary schools students' understanding ecological terms. In this study, Test of Ecology Concepts (TEC), was used to measure misconceptions related to ecological concepts two-tier tests, was developed based on the previous studies and administered in order to asses students' misconceptions related to ecological concepts. Statistical analyses were presented in chapter 4.

DISCUSSION AND CONCLUSIONS

The results of this study indicated that students have many misconceptions about basic ecological terms, food chain, food web, energy flow and source of energy according to results of TEC and interviews. Most of the students have misconception about food web since students thought food web as a simple food chain. [6] reported that students aged 15-17 have difficulty in progressing from food chain to food web and had many misconception about food web than first year university students since food chain is thought as a simple set of isolated organisms so students have difficulty to understand food web. Another most common misconception about food web in this study is that a change in one population will only affect another population if the two populations are directly related as predator and prey. [3], [18] revealed the similar result and

claimed that students overcome this difficulty in food web concept if food chains are thought as interactive population embedded in an ecological context. Moreover, students could not differentiate first consumer from second or third consumer. Results of TEC and interview also showed that students have many misconceptions about food chain; for instance, during interview students stated ''strong animals eat weak animals'', ''food chain is a kind of germination of seed'' and they drew food chain as a cyclic or linear. They considered part of plant like flower, leaves is not producer and producer must be green.

Moreover, a bacterium inside the herbivore is a part of food chain because a bacterium eats other organisms but other students said that a bacterium inside the herbivore is not a part of food chain since it decomposes organic materials into inorganic materials in the ecosystem. Students considered bacteria as the microscopic-sized bacteria to diseases when asked whether bacteria in the herbivore constitute a food chain as indicated by [7]. He concluded that students' prior knowledge affects further learning as seen in the function of bacteria.

Findings of this study showed that students have difficulty to understand energy pyramid and energy source; for instance, most of the students believed that the source of energy for plants is soil since plant grow in soil. [3], [13] were reported the similar findings.

More so, students thought that the number of plants is very high so the base of the energy pyramid is larger than the top of the energy pyramid. Moreover, they believed that number of producers is higher than the consumers. On the other hand, [14] found that the number of producers is high to satisfy consumers and there are more herbivores because people keep and breed them and humans provide food for other organisms.

These results suggest that students brought their misconceptions to the class and most of the students only memorize scientific facts. They do not try to understand facts with reasons. Therefore, teachers ought to realize and identify students' misconceptions. Also, they should design their lesson to remediate these misconceptions. Result of this study showed that there was not statistically significant gender difference with respect to understanding ecological concepts

IMPLICATIONS OF THE STUDY

There are several important implications according to results of this study and findings of the previous studies:

1. Results of the previous studies and this study showed that students have misconceptions and these misconceptions are obstacles for students to learn new concepts. Teacher should pay attention to students' misconceptions that was found in this study or previous studies while planning their learning activities and learning materials.
2. By means of two-tier diagnostic test, complete understanding and lack of knowledge can be differentiated from misconception so two-tier diagnostic test ought to be used to identify misconception.
3. Students' reasoning ability is important for understanding of ecological concepts that are abstract. It is very difficult for students to understand abstract ecological concepts like energy flow or notion of energy. In order to increase understanding, teachers should use more concrete materials like models, diagrams, simulations to make abstract concepts understandable to students.
4. Teachers should determine whether they introduce gender bias during instruction or interaction with their students. In addition, textbooks and curriculum materials ought to be examined to identify whether they reflect gender difference or not.

RECOMMENDATIONS FOR FURTHER RESEARCH

There are several recommendations for the further studies. They can be listed as the followings:

1. The other ecology topics can be investigated by using a three-tier test to identify students' misconceptions.
2. The sample can be chosen from different city and sample size can be increased to get more accurate results for further studies.
3. Senior secondary school students' misconception concerning some ecological concept was investigated in this study. Similar research studies can be conducted for different classes.
4. The effect of reasoning ability and gender on students' understanding and attitude regarding other ecology topics or other subject areas such as physics, chemistry can be investigated.

REFERENCES

[1] Omoifo C.N. (2012) Dance of the Limits Reversing the Trend in Science Education in Nigeria. Inaugural Lecture Series 124, University of Benin, Pg 13-36.

[2] National Teachers' Institute Kaduna (2007), Manual for Retraining of Primary School Teachers, 11-14

[3] Adeniyi, E.O. (1985). Misconceptions of selected ecological concepts held by some Nigerian students. *Journal of Ecological Education* 19 (4), 311-316.

[4] Wasagu M.A. (1999), The Relationship between Science Students' Cultural Beliefs and their Academic Achievement at the Secondary School Level in Sokoto State. Journal of the Science Teachers' Association in Nigeria, 34,1$2, 27-32

[5] Howard G. (2011), The Unschooled Mind , Misconceptions in the Sciences, 155-180

[6] Wandersee, J.H. (1994). *Making high-tech micrographs meaningful to the ecology student*. The content of science. London: The Falmer Press, 161-176.

[7] Eilam, R., (2002). Strata comprehending ecology: Looking through the prism of feeding relations. *Science Education*, 86(5), 645-671.

[8] Cherrett, J. M., (1989). *Key concepts: The results of a survey of our members' opinions.* Oxford: Blackwell Scientific Publications.

[9] Munson, B. H., (1994). Ecological misconceptions. *Journal of Environmental Education*, 25(4), 30-34.

[10] D'Avanzo, C. (2003). Application of research on learning to college teaching: ecological examples. *Bioscience*, 53, 1121-1128.

[11] Eisen, Y., Stavy, R. (1992). Material cycles in nature: a new approach to teaching photosynthesis in junior high school. *The American Ecology Teacher*, 54, 339-342.

[12] Bell, B., (1985). Students' ideas about plant nutrition: what are they? *Journal of Ecological Education,* 19, 213-218.

[13] Smith, E.L., Anderson, C.W. (1984). Plants as producers: A case study of elementary science teaching. *Journal of Research in Science Teaching*, 21(7), 685-698.

[14] Leach, J., Driver, R., Scott, P., Wood-Robinson, C., (1996). Children's ideas about ecology 3: ideas found in children aged 5-16 about the interdependency of organisms. *International Journal of Science Education*, 18, 129-141.

[15] Lavoie, D.R. (1997). *Using a modified concept mapping strategy to identify students' alternative scientific understandings of ecology*. Paper presentation at National Association for Research in Science Teaching, Annual meeting at Chicago, IL, March 21-24.

[16] Brehm, S., Anderson, C. W., & DuBay, J., (1986). Ecology: A teaching module. Occasional Paper No. 94. East Lansing, MI: Institute for Research on Teaching, Michigan State University.

[17] Özkan, Ö., (2001). *Remediation of seventh grade students' misconception related to the ecological concepts through conceptual change approach*. Unpublished Master Thesis, The Middle East Technical University, Ankara.

[18] Griffiths, A.K., & Grant B. A. C., (1985). High school students' understanding of food webs: Identification of a learning hierarchy and related misconceptions. *Journal of Research in Science Teaching*, 22(5), 421-436.

[19] Reiner, M., & Eilam, B., (2001). Conceptual classroom environment—a system view of learning. *International Journal of Science Education*, 23(6), 551- 568.