Effect of Argumentation Based Science Learning on Students Conceptual Understanding of Ecology in Senior Secondary Schools

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***Abstract*: While educators emphasize that the conceptual understanding of ecology is important, researchers have noted that the learning of ecology related concepts is relatively difficult. As part of the contribution to arrest the situation, this study was designed to determine the effects of Argumentation Based Science learning (ABSL) on student conceptual understanding of Ecology. The study used a quasi-experimental non- equivalent control group's pre-test and post-test design. The study was carried out in two randomly selected co-educational secondary schools in Uvwie local government area of Delta State. The sample for the study consisted of 94 (SSI) students from two randomly selected intact classes in the sampled schools. Data for the study were collected with a Two-Tier Multiple Choice Diagnostic instrument. The instrument was subjected to face and content validity. The two intact classes of 44 and 50 students each were assigned to experimental group and control group respectively. Research questions were answered using mean and percentage. Hypotheses were tested using inferential statistics t-test and Analysis of Covariance (ANCOVA) at 0.05 level of significance. Findings from the study revealed that Argumentation Based Science learning enhanced student's conceptual understanding of Ecology more than the traditional method of teaching. Recommendation and suggestion for further study were made based on the findings of the study.**

***Keywords*: Argumentation Based Science learning, Misconception, sex, Traditional Method of Teaching and Ecology**

I. INTRODUCTION

Science education's primary goal is to help science students improve their capacity to solve a wide variety of complicated issues and to instil scientific habits in them. Biology is a discipline in Life Science. It is a branch of natural science concerned with how the living world is generated, how it functions, how living things come into existence, and how they interact with one another and their environment. The importance of biology in everyday life cannot be emphasized.

Ecology is one of the important concept in the biology curriculum. This is because it studies the interactions among living things and their environment. Unlike some other concepts in biology, Ecology deals with real everyday life issues. Ecology deals with some of the pressing challenges faced by humans. From increasing population, food shortages, environmental pollutions, global warming and climate change. Climate change related events such as floods, thunderstorms, and extreme weathers have adverse effects on humans health directly or indirectly (McMichael et.al, 2006).

The knowledge of ecology provides interdependence between people and nature that is vital for food production, maintaining clean air and water and sustaining biodiversity in a changing climate. For these reasons the conceptual understanding of ecology is very important.

While educators emphasize that the conceptual understanding of ecology is important, researchers have noted that the learning of ecology related concepts is relatively difficult. (Ozkan et.al, 2004). Researchers noted that there are misconceptions students have about the concept of ecology that make the conceptual understanding of ecology difficult (Adeneyi; 1985, Muson; 1996, Ozkan et.al, 2004, Sander et.; 2006, Jordan et.al; 2009). Ecological concepts such as Food webs, Food pyramids, Food chains, nutrient cycles, ecosystems need to be taught in a manner that leads students to think deeply and critically in order to face the challenges they encounter in their daily life (Ozkan et.al, 2004).

One of the methods recommended by Science educators to help develop the ability of learners on aspects of critical thinking is the argumentation based science learning. Argumentation based Science learning is a student centered approach which allows students to make arguments through scientific inquires. (Choi.et.al, 2010). Argument based Science learning enhances critical thinking, reasoning, writing and high order cognitive skills and also develops students understanding of the nature of science. (Keys, 2000, Yore, 2000).

According to Tippert (2009), the language of science is argumentation, which is the act of persuading others of the validity of one's thesis. Scientific argumentation is an attempt to validate or reject a claim using reasons that represent the scientific communities' ideas when forming claims, weighing evidence, constructing justifications and discussing alternative explanations (Osborne et.al 2004). Argumentation based Science learning is an effective approach for students learning scientific. Concepts and developing skills. (Ural and Gencoglan, 2020)

The argumentation model developed by Toulmin (1958), consists of six components; data, claim, warrant, backup, qualifier and rebuttals. The model specifies a model of debating ideas (claims) by analyzing the evidence (data) that supports or refutes them, as well as the principles (warrants) and assumptions (backing) that underpin them. The link between the claim and the facts should be made the basis of

logic. Argumentation should not be limited to scientists, but should be used in the classroom as well. Argumentation in Science Education necessitates a shift from the traditional lecture method where learners are passive instead of being active in their learning process. The instructor pilots the typical scientific classroom, and the teacher leads the classroom in a discussion that is more teacher oriented. Argumentation in the classroom is not the same as argumentation in everyday life. It is a logical and reasonable debate aimed at discovering the link between ideas and evidence, rather than a passionate exchange of thoughts and emotions between two opponents focused at beating each other (Faize, Hussain, & Nisar 2017). As a result, the idea of presenting an argument is to establish a claim, refine it, and then back it up with scientific evidence.

From research, it has been found that courses in which argumentation practices were implemented fosters the development of epistemic beliefs, critical thinking, problem solving skills, scientific process skills and conceptual learning. (Pina, 2018).

There is a compelling argument that sex affects students' performance and understanding toward biology in particular as well as other science topics in general (Odagboyi; 2015, Ajaja; 2012, Ani et.al 2021). Due to the coeducational nature of the majority of Delta State institutions, it is crucial to ascertain how using Argumentations as an instructional strategy affects the conceptual understanding of male and female students, which was one of the justification for the study. The impacts of Argumentative technique on students' success and understanding are the subject of conflicting findings in evaluated empirical investigations. The results of this investigation will therefore contribute more actual data to support this claim. Another major goal for this study was to determine whether argumentation based science learning can improve student's conceptual understanding of ecology.

II. STATEMENT OF THE PROBLEM

Despite the importance of Biology in science and allied subjects, Aderogba (2012) and Orenaiya (2014) state in their research that students in Biology (of which Ecology is a branch) have persistently low academic performance at the Senior Secondary School Certificate Examinations (SSCE). This is evident in the steady decline of Biology performance of candidates in the West Africa Examination over the last 13 years. The West Africa Examination Council chief examiners report of 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018 and 2019 reveals that 33.37%, 33.94%, 33.87%, 32.88%, 38.50%, 35.66%, 51.66%, 56.17%, 53.28%, 61.68%, 33.90%, 33%, and 32.4% passed at credit level in Biology respectively. Only a significant increase in 2016 with 61.68% which is then followed by a sporadic decrease in credit pass.

Ecology is not just any topic in Biology but an important concept in the biology curriculum because unlike some other concepts in biology, Ecology deals with real everyday life issues. Ecology deals with some of the pressing challenges faced by humans. From increasing population, food shortages, environmental pollutions, global warming and climate change. Climate change related events such as floods, thunderstorms, and extreme weathers have adverse effects on humans health directly or indirectly (McMichael et.al, 2006).

A student-centered teaching technique is needed to increase students' conceptual knowledge of all concepts in Biology, based on the recommendation made by Science educators to help develop the ability of learners on aspects of critical thinking.one of such technique is the argumentation based science learning. Argumentation based Science learning is a student centered approach which allows students to make arguments through scientific inquires. (Choi.et.al, 2010). As a result, this research addresses a knowledge gap about the impact of Argumentation Based Science learning on students' conceptual understanding of ecology.

Research Questions

To guide this study the following research question were raised:

1. What is the difference in the percentage of students with correct conception before and after Treatment?
2. Do Male and Female students differ in the conceptual Understanding after being taught with Argumentation based learning?

Research Hypotheses

Research question 3-5 were hypothesized and tested at 0.05 level of significance

$H0_1$ There is no significant difference in the conceptual understanding of students taught with Argumentation Based Science learning and those who are taught with the traditional lecture method.

$H0_2$ There is no significant difference in the pre-test and post-test scores of the experimental group and the control group.

$H0_3$ There is no significant difference in the conceptual understanding of Ecological concepts between male and female student taught with Argumentation Based Science learning

III. METHODOLOGY

The research design that was adopted for this study was the quasi-experimental pre-test, post-test non-randomized non-equivalent control group design. The study consists of experimental and control groups of intact classes with no random assignment of subjects into groups. The population of the study consisted of all public senior secondary school I Biology students in Delta State, which is made up of 1433 males and 1581 female students from 16 public senior secondary school in Uvwie local government area of Delta state with a population of 3014 students both male and female. Two schools were randomly selected from the population. The sample size comprises of 94 SSI Biology students in two public co-educational secondary school in Uvwie Local Government area. The samples were selected using simple random

technique. (Balloting without Replacement after excluding single sex schools). The main reason is to ensure that all co-educational school in Uvwie local government has equal chances of being selected for this study. The two schools (Class A and Class B) were randomly assigned into experimental and control groups. Class A was used as the experimental group and Class B as the control group. An Intact classes of SS I Biology students in the sampled schools who already has a foundation on ecology at the beginning of the term was used for the study in order not to disrupt classroom teaching. A total of 94 students which consists of 19 male and 25 female students of Class A and 26 male and 24 female students of Class B formed two intact classes for the study. Class A was the experimental group taught with Argumentation Based Science learning while Class B was the control group who were taught with the traditional lecture method which was the conventional method used in the school.

Design over variable (variable Matrix)

	Pre-test	Treatment	Post-test
Group A (Experimental)	O_1	X_1	O_2
Group B (control)	O_1	X_2	O_2

Where O_1 = pre-test

O_2 = post-test

X_1 = Treatment (Argumentation Based Science learning approach) for experimental

X_2 = Traditional lecture method for the control group

The independent variable for this study is the instructional method (Argumentation Based Science learning and the traditional lecture method). While the dependent variable for this study is conceptual understanding. The two groups were pre-tested to determine their equivalence. Then the experimental group was exposed to the treatment which is Argumentation Based Science learning by the researcher while the control group was exposed to the traditional lecture method by the Biology teacher in the school for a period of four weeks after which both groups were post-tested to ascertain the effect of the treatment. During the treatment the learners were taught Autotrophy/heterotrophy, habitat, trophic levels and energy flow.

A two-tier multiple choice diagnostic instrument was used for data collection to assess student's Conceptual Understanding of Ecological Concepts in Biology (SCUEB). The instrument consists of two sections "A" and "B". Section A contains student's bio data involving Gender (male and female). While section B is made up of items designed to determine student's conceptual understanding of Ecological concepts in Biology which contains 20 questions drawn from Biology syllabus and SSCE questions on ecosystem and ecological interaction and association. The first part of each question in section B consists of 20 multiple choice questions on Autotrophy/heterotrophy, habitat, trophic levels and energy flow having four options (A,B,C, and D). The second part of each item contains a set of four possible reasons (option A, B, C and D) for the answers to the first part. Ticking the right answer alongside the right reason signifies a correct conception and a misconception is identified when the student picks the right option but the wrong reason. A correct conception with 50% scores was considered as pass mark. Content validity of the instrument was carried out using a table of specification to ensure identification of right conception or misconceptions in limited but clearly defined content area. The instrument was also given to two experienced Biology teachers for face validation. In other to ascertain the reliability of the instrument, pilot testing was carried out on 20 SS1 students from a mixed public senior secondary school in Delta state that was not part of the main study. The Kuder-Richardson formula 20 (KR- 20) was used to obtain the reliability coefficient. A reliability value of 0.86 was obtained.

The research took place over the course of six (6) weeks. The instrument was given to both the experimental and control groups as a pre-test during the first week of the investigation. Following that, appropriate instruction began utilizing the planned lesson plans. The experimental group was taught Ecology by the researcher via Argumentation Based Science learning during the second to fifth weeks, whereas the control group was taught the same topic for four weeks by the school's Biology instructor using the traditional lecture method which is the conventional method used in the school. A posttest was given to both the experimental and control groups at the end of the treatment, in the sixth week, using the same instrument. The completed instrument from each group was collected, marked and stored separately.

For the purpose of this study, data collected were analyzed using descriptive statistics and inferential statistics. Research question one and two was answered using descriptive statistics. Hypothesis 2 was tested using inferential statistics t-test at 0.05 level of significance because two independent groups were involved. Hypotheses 1 & 3 were tested using Analysis of Covariance (ANCOVA) because the two groups were unmatched at the beginning of the study. ANCOVA was used to partial out the initial difference. All hypotheses were tested at 0.05 level of significance

IV. FINDINGS

A total of 95 students were used for this study which is made up of 44 students of both sexes for the experimental group and 50 students of both sexes for the control group. To obtain the conceptual understanding of the students, the scores in their test were map with their reasons for choosing the scores. If the reason given for a correct answer is wrong, the student is deemed not to have a conceptual understanding of that particular question. The results obtained from the conceptual understanding of the students were used to answer the research questions and hypotheses. Research question 1 and 2 were answered while research question 3-5 were hypothesized. The research questions were answered using percentage, while hypotheses were tested using inferential statistics t-test at 0.05 level of significance. The pre-test and the post-test scores were analyzed to determine if there is any significant difference

between each group. Where there are differences, Analysis of Covariance (ANCOVA) was used to assess the effects of each treatment on student's conceptual understanding of Ecology. The results are presented in tables and charts as indicated.

*Research question 1***:** What is the difference in the percentage of students with correct conception before and after Treatment?

Cross tabulation, using frequencies and percentages were conducted. The result is presented in Table 1

Table 1: Percentage of Students with Correct and Incorrect Conception of Ecological Concepts

			Groups		Total
			Control group	Experimental group	
Conception before Treatment	1.00 Incorrect	N	43_a	36_a	79
		% of Total	45.7%	38.3%	84.0%
	2.00 Correct	N	7_a	8_a	15
		% of Total	7.5%	8.5%	16.0%
Post Conception	1.00 Incorrect	N	42_a	13_b	55
		% of Total	44.7%	13.8%	58.5%
	2.00 Correct	N	8_a	31_b	39
		% of Total	8.5%	33.0%	41.5%

*(a, b) each subscript letter denotes a subset of groups' categories whose column proportions do not differ significantly from each other at the .05 level

Table 1 shows the number and percentages of students with correct and incorrect conceptual understanding of ecology. The result shows that before treatment, the percentage of students with incorrect conceptual understanding did not differ as denoted by the subscript letter 'a' (i.e. 45.7% of the students in the control had an incorrect conception before the treatment, while 38.3% of students in the experimental group also had incorrect before the treatment. Only 7.5% and 8.5% in the control and experimental group respectively had the correct conceptual understanding before the treatment.

After the treatment, the result obtained showed that while students with incorrect conceptual understanding reduced by just 1%, the students with incorrect conceptual understanding in the experimental group reduced by 24.5%, thereby increasing the students with correct conception in experimental group to 33% from just 8%.

*Research question 2***:** Do Male and Female students differ in the conceptual Understanding after being taught with Argumentation based learning?

In answering the research question 3, a descriptive statistic using mean and standard deviation was conducted. The result is presented in Table 2

Table 2: Mean and Standard Deviation of student's conceptual understanding taught using the Argumentation based learning

groups	Gender		Pretest score for conceptual Understanding		Posttest scores Conceptual Understanding	
		N	Mean	SD	Mean	SD
Control group	Male		1.8462	0.73170	10.3077	2.14978
	Female	24	1.9583	0.85867	9.7500	1.42188
Experimental group	**Male**	**19**	**2.2105**	**0.97633**	**17.2632**	**1.48482**
	Female	**25**	**1.9600**	**0.78951**	**17.0800**	**1.38203**

The result shows that before the treatment, male (2.21±0.98) and female (1.96±0.78) did not differ in their conceptual understanding. Although both group of student improved in their conceptual understanding of ecological, the mean scores indicate that the male (17.26±1.49) and female (17.08±1.38) did not also differ in their performance.

Testing Hypotheses

To test the hypotheses, ANCOVA and Paired sampled t-test was conducted. The hypotheses were test at 0.05 level of significance (95% confidence Interval).

*Hypothesis 1***:** There is no significant difference in the conceptual understanding of students taught with Argumentation Based Science learning and those who are taught with the traditional lecture method

Table 3: Descriptive Statistics and ANCOVA between the experimental and control group

Groups		Mean (post conceptual understanding)		Std. Deviation		N
Control group		10.0400		1.84014		50
Experimental group		17.1591		1.41328		44
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	1189.586[a]	2	594.793	217.915	0.000	0.827
Intercept	2368.514	1	2368.514	867.756	0.000	0.905
Pre conceptual Understanding	3.425	1	3.425	1.255	0.266	0.014
Groups	**1161.019**	**1**	**1161.019**	**425.364**	**0.000**	**0.824**
Error	248.382	91	2.729			
Total	18247.000	94				
Corrected Total	1437.968	93				

Dependent Variable: Post Conceptual Understanding

Table 3 shows the descriptive statistic of the control (10.04±1.84) and the experimental (17.16±1.41) groups. The ANCOVA Result (test for between subject effect) shows that while controlling for the influence of the pretest scores (as seen in table 4, the pretest did not significantly influence the posttest scores (partial eta squared= 0.014), the result obtained shows that there is a significant difference in the post conceptual understanding scores between the control and experimental group (F (1, 91) = 425.36; ρ = 0.000; Partial eta squared = 0.824). The partial eta squared indicates the influence size of the treatment on the students' performance. The result indicates that argumentation based science learning improved students conceptual understanding of ecology by 82.4%. The null hypothesis one is therefore rejected. The result implies that there is a significant difference in the conceptual understanding of students taught with Argumentation Based Science learning and those who are taught with the traditional lecture method

*Hypothesis 2***:** There is no significant difference in the mean score with correct conception before and after Treatment in the experimental group?

Table 4: Paired sample t-test between the conceptual understanding scores before and after treatment

	Mean	SD	Mean Difference	t	df	ρ
Pre Conceptual Score	2.07	0.87	-15.09	65.11	43	0.00
Post Conceptual Score	17.16	1.41				

The result presented in Table 4 shows that there is a significant difference in the mean conceptual understanding of students before (2.07±0.87) and after (17.16±1.41) treatment using the argumentation based science learning [t (43) = 65.11; ρ = 0.00]. The null hypothesis 2 is rejected and the alternative which states that there is a significant difference in the mean score with correct conception before and after Treatment in the experimental group is accepted

*Hypothesis 3***:** There is no significant difference in the conceptual understanding of Ecological concepts between male and female student taught with Argumentation Based Science learning

Table 5: Descriptive Statistics and Analysis of Covariance (ANCOVA) on the conceptual understanding of Ecological concepts between male and female student taught with Argumentation Based Science learning

groups		Mean (post conceptual understanding)		Std. Deviation		N
Male		17.2632		1.48482		19
Female		17.0800		1.38203		25
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	2.368[b]	2	1.184	0.581	0.564	0.028
Intercept	1748.634	1	1748.634	858.427	0.000	0.954
Pre conceptual Understanding	2.006	1	2.006	0.985	0.327	0.023
Gender	**.154**	**1**	**.154**	**0.075**	**0.785**	**0.002**
Error	83.518	41	2.037			
Total	13041.000	44				
Corrected Total	85.886	43				

Dependent Variable: Post Conceptual Understanding

The ANCOVA Result in table 5 (test for between subject effect) shows that while controlling for the influence of the pretest scores (as seen in table 4, the pretest did not significantly influence the posttest scores (partial eta squared= 0.023), the result obtained shows that there is no significant difference in the post conceptual understanding scores between the male (17.26±1.49) and female (17.08±1.38) students (F(1, 41) = 0.075; ρ = 0.785; Partial eta squared = 0.002). The result indicates that being a male or female did not influence the effect of argumentation based science learning in improving students' conceptual understanding of ecology. The null hypothesis three is therefore accepted. The result maintains that there is no significant difference in the conceptual understanding of Ecological concepts between male and female student taught with Argumentation Based Science learning

IV. DISCUSSION OF FINDINGS

This study investigated the effect of Argumentation Based Science learning on student's conceptual understanding of Ecology. Two (2) research questions were raised and three (3) hypotheses were formulated to guide the study. Hypothesis one and hypothesis three were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance while hypothesis two was tested using independent sample t-test at 0.05 level of significance. The result of this study reveals that student understanding were the same at pre-test, both for the control group and the experimental group. This may be because the students were exposed to the same curriculum before treatment. The data analyzed above were interpreted and discussed based on thematic issues from the research questions and null hypotheses.

From Table 1 it shows that before treatment, the percentage of students with incorrect conceptual understanding did not differ as denoted by the subscript letter 'a' (i.e. 45.7% of the students in the control had an incorrect conception before the treatment, while 38.3% of students in the experimental group also had incorrect before the treatment. Only 7.5% and 8.5% in the control and experimental group respectively had the correct conceptual understanding before the treatment. After the treatment, the result obtained showed that while students with incorrect conceptual understanding reduced by just 1%, the students with incorrect conceptual understanding in the experimental group reduced by 24.5%, thereby increasing the students with correct conception in experimental group to 33% from just 8%. These findings conform to the findings of Turkoguz.S. (2014), Faize F.A, Husan W. & Nisar. F (2017) on the effect of Argumentation on student's achievements and conceptual understanding respectively

From Table 2 it is shown that students have correct conception of Ecology before treatment in the experimental group and the control group. Before the treatment, both male (2.21±0.98) and female (1.96±0.78) students did not differ in their conceptual understanding. After the treatment was administered, it was seen that both groups of students improved in their conceptual understanding of ecology. The mean scores of 17.26±1.49 indicates that the males and females of mean score of 17.08±1.38 did not also differ in their performance. Therefore sex was not a limiting factor and had no influence in the control and experimental groups.

The first hypothesis which states that there is no significant difference in the conceptual understanding of students taught with Argumentation Based Science learning and those who are taught with the traditional lecture method was rejected. From Table 3 it was seen that the ANCOVA Result (test for between subject effect) shows that while controlling for the influence of the pretest scores (as seen in table 4, the pretest did not significantly influence the posttest scores (partial eta squared= 0.014), the result obtained shows that there is a significant difference in the post conceptual understanding scores between the control and experimental group (F (1, 91) = 425.36; ρ = 0.000; Partial eta squared = 0.824). The partial eta squared indicates the influence size of the treatment on the students' performance. The result indicates that argumentation based science learning improved students conceptual understanding of ecology by 82.4%. The null hypothesis one was therefore rejected. The result implies that there is a significant difference in the conceptual understanding of students taught with Argumentation Based Science learning and those who are taught with the traditional lecture method. This result indicates that Argumentation Based Science learning approach is superior to the traditional lecture method in enhancing student's conceptual understanding of Ecological concepts. The better performance of those in the experimental group could be due to the active participation of students in their learning process. In the control group, the teacher writes on the chalk board and explains the content while the student's sits and listened passively. Pupils are not active in the learning process.

This study also reveals that there is a significant difference in the mean score with correct conception before and after Treatment in the experimental group. From table 4, it can be seen that the t-value is 65.11 with a degree of freedom (df) of 43 and level of significance of 0.00 which is less than the set alpha level of 0.05. Hypothesis two was then rejected. The null hypothesis 2 is rejected and the alternative which states that there is a significant difference in the mean score with correct conception before and after Treatment in the experimental group was therefore accepted. This shows that students taught with Argumentation Based Science learning approach improved tremendously.

ANCOVA was used to determine if there was a significant difference between conceptual understanding of Ecological concepts between male and female student taught with Argumentation Based Science learning in hypothesis 3. From table 5 it can be seen that that while controlling for the influence of the pretest scores (as seen in table 4, the pretest did not significantly influence the posttest scores (partial eta squared= 0.023), the result obtained shows that there is no significant difference in the post conceptual understanding scores between the male (17.26±1.49) and female (17.08±1.38) students (F (1, 41) = 0.075; ρ = 0.785; Partial eta squared =

0.002). This result indicates that being a male or female did not influence the effect of argumentation based science learning in improving students' conceptual understanding of ecology. The null hypothesis three is therefore accepted. This shows that there is no significant difference in the conceptual understanding of Ecological concepts between male and female student taught with Argumentation Based Science learning and there is no significant interaction effect between sex and method of instruction on student's conceptual understanding of Ecology.

V. CONCLUSION

The utilitarian nature of Ecology and Biology as a whole in human endeavors makes it highly essential. This study highlights the effect of Argumentation Based Science learning in promoting students conceptual understanding of Ecology in senior secondary school in Delta state.

The findings from this study indicated Argumentation Based Science learning approach is more superior and effective to the traditional method of teaching in improving student's conceptual understanding in Ecology. It can be said that one very good method of teaching Biology is the Argumentation Based Science learning teaching strategy, since students taught with this method performed better than students taught with the traditional method of teaching.

Secondly there was no significant difference in the conceptual understanding of Ecological concepts between male and female student taught with Argumentation Based Science learning and there is no significant interaction effect between sex and method of instruction on student's conceptual understanding of Ecology.

Thirdly since there was a significant interaction effect between instructional strategy and student conceptual understanding, it can be concluded that if the right instructional strategy is combined in the teaching and learning of Biology, students will perform better in Ecology.

Educational implication of the study

The findings of this study have some educational implications for students, Biology teachers, and curriculum planners among others.

1. All concepts in Biology are learnable if the right teaching approach is used.
2. The study has showed that Argumentation Based Science learning approach is an appropriate teaching method in developing meaningful conceptual knowledge about ecology and its real world application.
3. By means of active learning teaching strategy, concepts that are termed difficult by students can become very easy to learn.
4. The use of Argumentation Based Science learning approach in teaching and learning of biology will help to achieve the national curriculum objectives which are designed to promote students inquiry spirit and construction of a life-long knowledge needed for national development.

VI. RECOMMENDATIONS

Based on the findings and conclusions of the study, the following were recommended.

1. Biology teachers are to review their methods of teaching and adopt the ones that yield higher conceptual understanding.
2. More time should be allocated to Biology in the time table in other to encourage the use of active learning approaches.
3. Biology teachers should be motivated to teach Ecology well and also learners would be motivated to learn better as they interact with materials, if Argumentation Based Science learning is adopted as medium of instructions.
4. The Government should make provision for learning materials to all secondary schools.

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