

Effects of Cartoon-Incorporated Instructional Strategy on Students' Achievement on Ecology in Delta State

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ABSTRACT

While educators emphasize that the knowledge of ecology is important to man's progress, 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 cartoon-incorporated instructional strategy on students' achievement on ecology in Delta State. The designed employed for this study is a quasi-experimental non- equivalent control group's pre-test and post-test design. The study was carried out in four randomly selected co-educational secondary schools in the three senatorial district of Delta State. The sample for the study consisted of 235 (SSII) students from four randomly selected intact classes in the sampled schools. Data for the study were collected using the Biology Achievement test (BAT). The instrument was subjected to face and content validity. The four intact classes were assigned to experimental group and control group respectively. Research questions were answered using mean and standard deviation. 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 cartoon-incorporated instructional strategy enhanced student's achievement of Ecology more than the lecture method of teaching. Recommendation and suggestion for further study were made based on the findings of the study.

Keywords: Cartoon-incorporated instructional strategy, Achievement, sex, lecture Method and Ecology

INTRODUCTION

Nigeria as a nation sees education as a vital instrument for improving the capacity of its people to lead fulfilling lives and to make positive contributions to the national and local economies. Nigerians possess sufficient knowledge, skills, and attitudes if they receive the appropriate kind of instruction. In order to properly educate Nigerians, the Nigerian government, according to Norfarah, Mohd, and Chong (2019), arranged this knowledge, skills, and attitudes into subject topics to be acquired at different stages of school through the National Policy on Education. Biology is one of these subjects that are taught in senior secondary schools and post-secondary institutions (Eneh, 2015).

Science is the effort of man to investigate, examine, comprehend, and work with the substances and energies that surround him. Science originated at the beginning of time, when the first humans were inspired by what they saw in the natural world. Early people discovered which seeds to eat and how plants develop. Because of this, since the beginning of time, man has been fascinated by the study and interpretation of Earth. Science education should foster scientific concepts such as accepting truth, appreciating evidence, seeking clarity, being open-minded, and being objective in interpretation. The teacher must provide opportunities for all students to engage in learning, let them build their own concepts, and let them work at their own pace in order to meet these learning objectives. The study of biology is a branch of life science that focuses on how the living world forms and how it functions. Other branches of science include Earth sciences, Life sciences,

and Physical sciences. The main objective of biology education is to help students become more adept at solving a variety of challenging biological issues. One of the key ideas in biology is ecology since, in contrast to all other biological notions, it addresses issues that arise in everyday life, such food shortages, overpopulation, and ecosystems, among other things.

Given that ecology and other biological ideas are crucial to the advancement of humanity, students still do poorly in these subjects. According to Omoifo (2012) and Akinlade (2019), student performance in biology and other science subjects has declined over time. Additionally, ecological subjects appear to be difficult for Nigerian secondary school instructors and pupils to understand (Anderson and Helm 2010). A teaching strategy has to be relevant to the traits of the students and the type of learning it hopes to support in order to be both effective and appropriate.

The instructional strategies used by teachers can be classified into the Teacher-centered approach and student-centered approach. Teachers are the major authority figure in the teacher-centered approach. The primary duty of students is to passively receive material (through lectures and direct instruction) with the purpose of testing and assessment as the final result. Does Passivity on the part of students during the teaching and learning process help them understand ecological concepts? One method that encourages students' active participation and critical thinking in the classroom is the use of cartoon characters in presenting scientific topics.

A cartoon concept is a poster that presents several viewpoints on a scientific subject while being designed in a comic manner. Students are required to engage in class discussions as these cartoon characters present their beliefs through argumentation (Kabapnar, 2005). Cartoons, according to Naylor and Keogh, who are credited with its use, are "any large sketch or design on paper that reflects scenes either with or without sounds and may be humorous." These are illustrations that show several viewpoints on commonplace occurrences. Students are encouraged to share their opinions about the humorous images because of the images' compelling appeal. They serve as tools for instruction and testing.

It has been demonstrated that the capacity to convey information visually is very helpful when it comes to teaching (Dalacosta et al., 2009). The value of visual communication in teaching has been stressed by numerous writers (Arnheim, 1969; Barlex & Carré, 1985; Fisher, 1990). Graphical representations have a clear advantage over words because words are only meaningful within the context of the speakers' culture. Conversely, in a number of contexts, the adage "a picture is worth a thousand words" has been employed to deliver crucial instructional ideas (Srikwan & Jacobsson, 2007). Scholars continue to debate the effectiveness of empirical studies on cartoons as a teaching tool. Different studies have evaluated the Cartoons technique of training. Cartoons increased students' interest in and performance in environmental education (EE) in basic science and technology, according to Eneh (2015). Therefore, the purpose of this study is to compare the impact of a lecture and an instructional technique that incorporates cartoons on student achievement toward ecology.

The attainment of academic objectives, the outcomes of students' education, or, more precisely, the extent to which a learner, teacher, or instructor has fulfilled the stated educational objectives, is referred to as achievement. Research indicates that the achievement of biology students is influenced by the methods of instruction. Numerous research on the impact of instructional tactics on students' academic progress have been published in literatures.

Reviewing empirical studies on the impact of cartoon-incorporated educational strategies on students' achievement yielded a mixed bag of findings. Consequently, the results of this investigation offer more empirical support for this theory. It should be mentioned that this study's moderating variable is sex. In light of this, the purpose of this study is to determine how Delta State students' achievement in ecology is influenced with the use of cartoons instructional strategy in teaching and learning in the classroom.

Statement of the Problem

Understanding biological principles is essential for the growth of the nation and the individual. Despite biology's critical role in human development, a concerning number of students do poorly on external examinations in the subject. This is especially true of learners poor performance on the Senior School Certificate Examination in the biological component of the subject. This is also demonstrated by the student's sporadic fall in Biology scores over the previous 13 years on the West Africa Examination. The West Africa Examination Council only reported a notable gain in credit pass of 61.68% in 2016, which was followed by an intermittent fall. According to the WAEC Chief Examiners, one factor contributing to the students' subpar performance is their complete reliance on their teacher.

One of the variables contributing to students' low performance in the Senior School Certificate Examination (both internal and external) was found to be the teacher's incapacity to teach in a meaningful way. Some teachers are forced to employ the chalk-and-talk approach because they lack the necessary teaching resources, have an excessively long curriculum, and lack access to well-equipped laboratories, among other issues. The lecture style of training places more of an emphasis on knowledge transfer, which is actually a worse way to learn things because it emphasizes memorizing. Biology teachers are encouraged to use several approaches, such the cartoon-incorporated instructional style, which promotes student participation and interaction throughout the learning process.

Cartoons not only draw in learners, but also keep them interested throughout the entire learning process, allowing them to solve problems using critical thinking. This necessitates the use of student-centered teaching strategies, such as cartoon-incorporated instruction, which provide students the chance to create learning objectives, complete learning tasks, and make an effort to keep an eye on and manage their cognitive processes. Therefore, the comparative impacts of the lecture technique and the instructional strategy incorporating cartoons on the academic achievement of male and female students toward ecology constitute the study's focus.

Research Questions

To guide this study the following research questions were raised:

1. What is the effect of Cartoon-incorporated instructional strategy and the lecture method on Biology students' achievement of Ecological concepts?
2. What is the difference in mean achievement scores between students taught with cartoon-incorporated instructional strategy and those in the control group?
3. What is the difference in the mean achievement scores on Ecological concepts between male and female student taught with Cartoon-incorporated instructional strategy and those in the control group?
4. What is the effect of interaction of method and sex on achievement?

Hypotheses

The following hypotheses were formulated and were tested at 0.05 level of significance.

H₀₁ There is no significant effect of Cartoon-incorporated instructional strategy, and Lecture method on Biology students' achievement of Ecological concepts.

H₀₂ There is no significant difference in mean achievement scores between students taught with cartoon-incorporated instructional strategy and those in the control group.

H₀₃ There is no significant difference in the mean achievement scores on Ecological concepts between male and female student taught with Cartoon-incorporated instructional strategy and those in the control group.

H0₄ There is no significant effect of interaction of method and sex on achievement.

METHODOLOGY

The research design adopted for this study is the quasi-experimental pre-test, post-test non-equivalent control group design. The study consists of experimental and control groups of intact classes. An intact class was used in order not to disrupt classroom teaching. The population of the study is made up of all public senior secondary school two (SS 2) Biology students in Delta State, which is made up of eighteen thousand, eight hundred and seventy-four (18,874) Biology students both male and female from 474 public senior secondary school in the three senatorial districts in Delta State. Four (4) schools were randomly selected from the three (3) senatorial District in Delta state. The sample size comprises of two hundred and thirty-five (235) SSII Biology students in four public co-educational secondary school in Delta State. The samples were selected using simple random technique. (Balloting with Replacement after excluding single sex schools). The main reason is to ensure that all co-educational school in Delta State has equal chances of being selected for this study. The four schools were randomly assigned into experimental and control groups. Two classes were used as the experimental group and two classes as the control group. The experimental group was taught using the Cartoon Incorporated instructional Strategy while the control group was taught with the traditional lecture method which was the conventional method used in the school. The experimental and the control group was taught using research assistants who were trained for the purpose of the research.

Group	Pre-test	Treatment	Post-test
Cartoon-incorporated instructional Strategy (Experimental Group)	O ₁	X ₁	O ₂
Lecture method (Control Group)	O ₃	X ₂	O ₄

Where,

O₁ = Pre-test of Cartoon-incorporated instructional Strategy for Experimental Group

O₂ = Post-test of Cartoon-incorporated instructional Strategy for Experimental Group

O₃ = Pretest of the Lecture method for Control Group

O₄ = Post-test of the Lecture method for Control Group

X₁ = Treatment using Cartoon-incorporated instructional Strategy for Experimental Group

X₂ = Treatment using Lecture method for Control Group

The independent variable for this study is the instructional method (Cartoon-incorporated instructional Strategy and the lecture method). While the dependent variable for this study is Achievement. The four groups were pre-tested to determine their equivalence. The experimental groups were exposed to the treatment which is Cartoon-incorporated instructional Strategy by the research assistants in the school while the control group was exposed to the lecture method by the research assistants in the school for a period of six (6) 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.

The Biology Achievement Test (BAT) instrument was used for data collection to assess student's Achievement of Ecological Concepts in Biology. 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 50 multiple choice objectives questions in Ecology drawn from Biology Scheme of work and SSCE past questions on Nutrients cycles in Nature and Decomposition in nature having four options (A, B, C, and D). Content validity of the instrument was carried out using a table of specification to ensure content coverage and true representation of each content area of the unit under study. The instrument was also face validated by three experts in the field, which is made up of one experienced Biology teacher drawn from a Public Secondary School in Uvwie Local Government Area of Delta State, one Science Educator from Delta State University and an expert in Measurement and Evaluation from Delta State University Abraka. In other to ascertain the reliability of the instrument, the Biology Achievement test (BAT) instrument was administered to 50 students offering Biology in a secondary School in Edo State, which are not part of the sampled school for the study. The Kuder-Richardson formula 21 (KR- 21) was used to obtain the reliability coefficient. A reliability value of 0.8 was obtained. The completed instrument from each group was collected, marked and stored separately.

For the purpose of the study, data collected were analyzed using descriptive statistics and inferential statistics. Research question one to four was answered using descriptive statistics. Hypothesis 1-3 was tested using inferential statistics t-test at 0.05 level of significance. Hypotheses 4 were tested using Analysis of Covariance (ANCOVA). All hypotheses were tested at 0.05 level of significance.

The treatment procedure was carried out in two phases. The first phase is the assignment of students into the experimental group and the control group, also the first phase research assistants were trained using the training format of Ajaja and Erawoke (2010) on the use of cartoon incorporated instructional strategy.

The second phase is the administration and treatment using the respective instructional packages. The treatment lasted for a period of six (6) weeks. Before the treatment the research instrument was given to both the experimental and control groups as a pre-test. Following that, appropriate instruction began utilizing the planned lesson. The experimental group was taught Ecology using cartoon incorporated instructional strategy and the control groups was taught using the lecture method. Both groups were taught using research assistant from the various schools. After a period of six weeks a posttest was given to both the experimental and control groups using the same instrument of the pretest. The completed instrument from each group was collected, marked and stored separately.

FINDINGS

A total of 235 students were used for this study which is made up of 111 students of both sexes for the experimental group and 124 students of both sexes for the control group. The results obtained from the pretest and posttest of the students were used to answer the research questions and hypotheses. Research question 1 to 5 were answered using mean and standard deviation while hypothesis 1 to 4 were analyzed using inferential statistics t-test and hypothesis was analyzed using Analysis of Covariance (ANCOVA). The pre-test and the post-test scores were analyzed to determine if there is any significant difference between each group. The results are presented in tables and charts as indicated.

Research Questions 1

What is the effect of Cartoon-incorporated instructional strategy and Lecture method on Biology students' achievement of Ecological concepts?

To determine the effect of Cartoon-incorporated instructional strategy and Lecture method on Biology students' achievement of Ecological concepts, the mean score before and after the instructional strategy were compared and the effect size calculated using eta squared. The result is presented on Table 1

Table 1. Effect of Cartoon-incorporated instructional strategy, and Lecture method on Biology students' achievement of Ecological concepts

Group	N	Test	Mean	Standard Deviation	Mean Difference
Cartoon Group	110	Pretest	12.08	4.25	28.38
		Posttest	40.46	7.27	
Lecture Group	124	Pretest	11.73	3.80	8.80
		Posttest	20.53	5.04	

Table 1 shows that the students taught ecological concepts using cartoon-incorporated instructional strategy had a mean achievement score of 12.08 before the intervention. After the intervention, their mean achievement scored increased to 40.46. The mean difference between the pretest score and the posttest scores of the students is 28.38 in favour of the posttest score. With a higher mean posttest score, cartoon-incorporated instructional strategy had a positive effect on students' achievement scores. For the students taught using the lecture method, their mean achievement score improved from 11.73 in the pretest to 20.53 in the posttest achievement. The mean difference in the scores for students taught using the lecture method is 8.80. Comparing the mean difference of the two instructional strategies, the cartoon-incorporated instructional strategy was more effective than the lecture method in teaching ecology.

Research Questions 2

What is the difference in mean achievement scores between students taught with cartoon-incorporated instructional strategy and those in the control group?

Table 2. Mean achievement scores of between students taught with cartoon-incorporated instructional strategy and those in the control group.

Group	N	Test	Mean	SD	Mean Gain
Cartoon (C)	110	Pretest	12.08	4.25	28.38
		Posttest	40.41	7.27	
Lecture (L)	124	Pretest	11.73	3.80	8.80
		Posttest	20.53	5.04	

Table 9 shows the differences in the mean achievement scores of respondents in the various groups of study. The result shows that for the group taught using the lecture method, there was an improvement in their mean achievement scores from 11.73 during the pretest to 20.53 when the posttest was administered also for the cartoon-incorporated instructional strategy group, their mean achievement scores had the highest improvement from 12.08 during the pretesting to 40.41 after the treatment.

Although there was difference between the pretest and posttest achievement scores of the students, comparing the differences based on group, Table 2 shows that the differences in Mean gain between students taught using the cartoon-incorporated instructional strategy and lecture method is 19.58. Comparing the mean differences, the result shows that students taught using cartoon-incorporated instructional strategy had the highest mean gain (28.38), followed by those in the control group (8.80).

Research Questions 3

What is the difference in mean attitude scores between male and female students taught with cartoon-incorporated instructional strategy and those in the control group?

Table 3. Mean attitude scores between male and female students taught with cartoon-incorporated instructional strategy and those in the control group.

Method	Sex	N	Mean	SD	Mean Difference
Cartoon	Male	51	50.49	4.34	0.09
	Female	60	50.83	4.435	
Lecture	Male	64	48.91	3.26	0.39
	Female	60	49.30	3.86	

Table 3 shows the mean attitude scores of male and female student taught with the various instructional strategy. For those taught using the Cartoon-incorporated instructional strategy, Male students had their attitude score as 50.49, while the female students had a mean attitude score of 50.83. The mean attitude difference for male and female students taught ecological concepts using cartoon- incorporated instructional strategy is 0.09. For students taught using the lecture method, the mean attitude score is 48.91 for male students and 49.30 for female students, with a mean difference of 0.39 in their attitude scores. The result shows that the mean attitude differences for the various groups of study was very small.

Research Questions 4

What is the effect of interaction of method and sex on achievement?

Table 4. Mean and Standard Deviation on Interaction between Teaching Method and Sex on Students' Achievement in Ecology

Methods	Cartoon			Lecture		
	N	Mean	SD	N	Mean	SD
Pretest						
Male	51	11.69	4.16	64	12.45	3.83
Female	59	12.42	4.34	60	10.95	3.64
Differences		0.73	-0.18		1.50	0.19
Posttest						
Male	51	40.88	7.63	64	19.98	4.81
Female	59	40.10	6.99	60	21.12	5.25
Differences		0.78	0.64		1.14	-0.44

Table 4 shows the effect of interaction of teaching method and sex on the achievement scores of the student that participated in the study. For the students taught using cartoon-incorporated instructional strategy, the mean difference in achievement between the male (40.88) and female (40.10) students is 0.78. For the lecture group, while the male students had a mean achievement score of 19.98 the female students' mean achievement score is 21.11 after the treatment. The mean difference between male and female students in the lecture group is 1.14. The result in Table 4 shows that in the different group (lecture and cartoon) the mean differences between male and female students' achievement scores is very small, indicating that the interaction of teaching method and sex does not have any effect on the achievement score of students.

Hypothesis 1

There is no significant effect of Cartoon-incorporated instructional strategy, and Lecture method on Biology students' achievement of Ecological concepts.

To test the null hypothesis one, a paired sample t-test was conducted to determine if there is a significant difference in the students' pretest and posttest achievement scores. Also, the eta squared was calculated to determine the effect (size) of the cartoon-incorporated instructional strategy on the students achievement score. The result of the analysis conducted is presented in Table.

Table 5. Paired Sample t-test on Effect of Cartoon-incorporated instructional strategy and Lecture method on Biology students' achievement of Ecological concepts

	N	test	Mean	Std. Deviation	T	df	P	Effect size
Cartoon Group	110	pretest	12.06	4.29	-40.742	107	0.000	0.938
		posttest	40.41	7.28				
Lecture Group	124	pretest	11.73	3.80	-18.37	123	0.000	0.733
		posttest	20.53	5.04				

Table 5 shows that there is a significant effect in the mean pretest (12.06) and posttest (40.41) achievement scores of students taught using the cartoon-incorporated instructional strategy [$t(107) = -40.742$; $p = 0.000$; eta squared = 0.938]. The null hypothesis is therefore rejected, and the alternative hypothesis not rejected. The effect size of 0.939 indicates that the magnitude of the difference in the pretest and posttest mean achievement scores of students taught using the cartoon-incorporated instructional strategy is 93.9%, implying a 93.9% effect on Cartoon-incorporated instructional strategy on students' achievement.

For students taught Ecology using the lecture method, there is also a significant effect in the mean pretest (11.73) and posttest (20.53) achievement scores [$t(123) = -18.37$; $p = 0.000$; eta squared = 0.733]. The null is therefore rejected, and the alternative hypothesis not rejected. The eta squared shows that the magnitude of the difference in the pretest and posttest scores of the students taught ecology using the lecture method is 73.3%. Comparing the cartoon and lecture groups, the result shows that based the magnitude of the difference observed in the two instructional strategies, cartoon-incorporated instructional strategy was more effective in improving students' achievement in ecology than lecture method.

Hypothesis 2

There is no significant difference in mean achievement scores between students taught with cartoon-incorporated instructional strategy and those in the control group.

Table 6. Independent Sample t-test on the difference in the mean achievement scores between students taught with cartoon-incorporated instructional strategy and those taught with the lecture method.

	Groups	N	\bar{x}	SD	t	df	Sig	Decision
Pretest	Cartoon	110	12.08	4.253	-0.677	232	0.599	Not Rejected $P > 0.05$
	Lecture	124	11.08	3.796				
Posttest	Cartoon	110	40.46	7.27	24.55	232	0.000	Rejected $P < 0.05$
	Lecture	124	20.53	5.04				

Table 6 shows that there is no significant difference in the pretest scores of students taught using cartoon-incorporated instructional strategy and lecture method [$t(232) = -0.677$; $sig = 0.599$]. Since no significant difference was found among the pretest achievement scores of students taught using cartoon-incorporated instructional strategy and the lecture method, the posttest achievement scores of the students were then compared and the shows that there is a significant difference in the mean achievement scores between students taught with cartoon-incorporated instructional strategy and those taught with the lecture method [$t(232) = 24.55$; $sig = 0.000$]. The null hypothesis three was therefore rejected. The result maintains that the posttest achievement scores of students taught ecology using the various teaching methods was statically different.

Hypothesis 3

There is no significant difference in the mean achievement scores on Ecological concepts between male and female students' taught with Cartoon-incorporated instructional strategy, and those in the control group.

Table 7. Independent Sample t-test of the difference in the mean achievement scores on Ecological concepts between male and female students' taught with Cartoon-incorporated instructional strategy and those in the control group.

Methods	Sex	N	\bar{x}	SD	t	df.	Sig.	Decision
Cartoon	Male	50	40.88	7.63	0.555	107	0.580	Not Rejected $P > 0.05$
	Female	59	40.10	6.99				
Lecture	Male	64	19.98	4.81	-1.253	122	0.213	Not Rejected $P > 0.05$
	Female	60	21.12	5.25				

Dependent Variable: Posttest Achievement Scores

Table 7 shows that there is no significant difference in the mean achievement scores on Ecological concepts between male and female students' taught with Cartoon-incorporated instructional strategy [$t(107) = 0.555$; $\rho = 0.580$]. There was also no significant difference in the mean achievement scores of male and female students taught using the lecture method [$t(122) = -1.252$; $\rho = 0.213$]. The null hypothesis five was therefore not rejected. The result maintains that the achievement scores of male and female students taught ecology using the various teaching methods was not statically different.

Hypothesis 4

There is no significant effect of interaction of method and sex on achievement.

Table 8. ANCOVA of the effect of interaction of method and sex on achievement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	23741.153	4	5935.288	171.456	0.000	0.751
Intercept	14197.147	1	14197.147	410.120	0.000	0.644
Pretest	878.376	1	878.376	25.374	0.000	0.101
Group	22344.682	1	22334.682	645.482	0.000	0.740
Sex	5.191	1	5.191	.150	0.699	0.001

group * sex	138.658	1	138.658	4.005	0.047	0.017
Error	7858.071	227	34.617			
Total	237410.000	232				
Corrected Total	31599.224	231				

Dependent Variable: *posttest Achievement Scores*

Table 8 shows that there is a significant interaction effect of method and sex on the mean achievement scores of students [$F(1, 227) = 4.005$; $\rho = 0.047$; partial eta squared = 0.017]. The null hypothesis seven was therefore rejected. The result implies that there was a statistical effect of interaction of method and sex on the achievement of student taught ecology. Since a significant difference was observed in the study, the graph was drawn to show the nature of interaction.

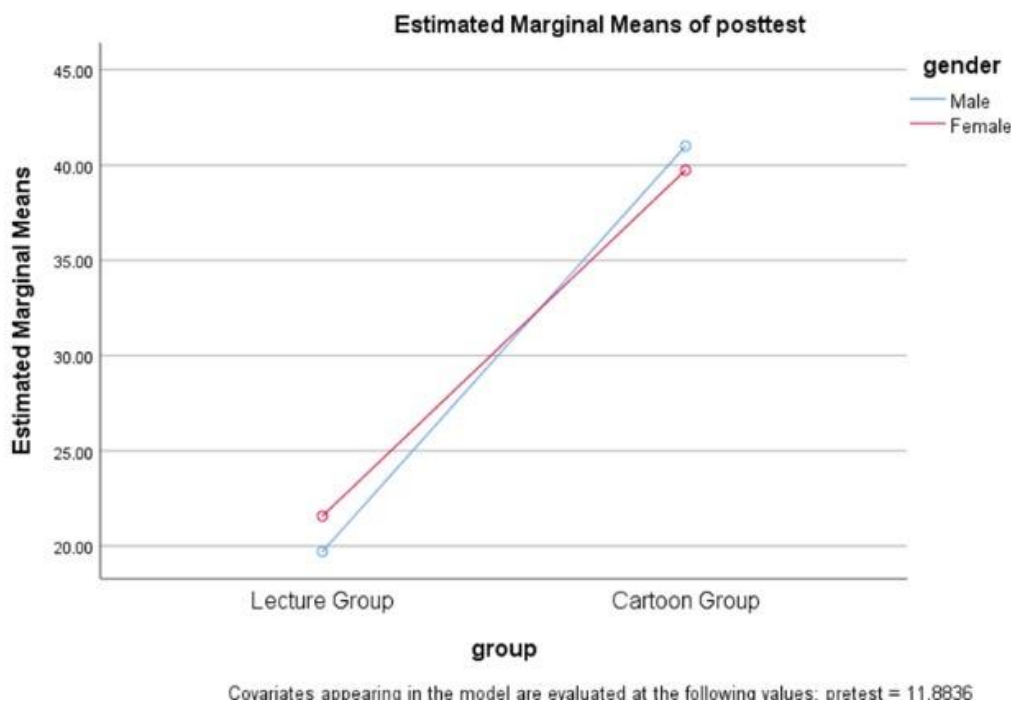


Figure 1: Interaction of Methods between Male and Female students Achievement Score

This shows that there is no significant difference in the mean achievement scores of male and female students taught ecology. Obviously, the interaction effect was due to the study intervention and not sex.

DISCUSSION OF FINDINGS

This study investigated the effects of cartoon-incorporated instructional strategy on students' achievement on ecology in delta state. Four (4) research questions were raised, and four (4) hypotheses were formulated to guide the study. Hypothesis one to three were tested using inferential statistics t-test while hypothesis four (4) was tested using Analysis of Covariance (ANCOVA) both at 0.05 level of significance. The result of this study reveals that student achievement were the same at pre-test, both for the control group and the experimental group. This may be as a result that 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, 2, 5, and 6 it shows that the students taught ecological concepts using cartoon-incorporated instructional strategy shows high achievement scores over those taught using the lecture method. This may be as a result of students' active participation in the teaching and learning process which stimulates the students to be actively involved in the teaching and learning process. The variation in the teaching method may have translated into influencing students' achievement scores. The low achievement scores as found among the students taught with lecture method may not be unconnected with the method of teaching involved, where the teachers verbally pass information, facts and ideas to the students and the students merely listened to the teachers' explanation. This implies that the passive involvement of students in the lecture method group may have accounted for the observed less performance of students in the control group. These findings conform to the findings of Eneh (2015), Abdullah & Ozturk (2015), Pekel (2021), and Asha (2020) also reported that cartoons as an instructional strategy was more effective than the lecture method in promoting students' achievement. However, the findings of this study are not in agreement with the report of Aslan et al. (2021), who reported that the differences between the cartoon instructional group and the lecture method group was not significant.

From Table 3 and 7 it is shown that there is no significant difference in the mean achievement scores on Ecological concepts between male and female students' taught Ecology using Cartoon-incorporated instructional strategy and the lecture method. This implies that the use of Cartoon-incorporated instructional strategy did not discriminate between male and female students. The explanation for this finding could be that both male and female students equally participated during the teaching and learning process. The equal participation of both sexes could have accounted for the insignificant difference in the mean achievement scores of male and female students taught Ecology. This finding is in agreement with the findings of Norfarah et al (2019) who reported that there exists no significant difference in the mean scores of male and female students taught with cartoon. Babayemi and Ahmed (2019) also reported that there was no significant two-way interaction effect of treatment and sex on achievement. This is in agreement with the findings in the present study. The findings in this study are also in agreement with Eneh (2015) who reported that the mean achievement scores of primary three students taught Environmental education exposed to cartoons were unaffected by sex.

Table 4 and 8 shows there is no significant interaction effect between teaching method and sex on students' achievement in Ecology. This implies that teaching strategies (Cartoon-incorporated instructional Strategy and lecture method) did not combine with sex to influence students' achievement in Biology. Again, the study revealed that there is no significant interaction effect between teaching method and sex on students' attitude towards Ecology. This indicates that the students' sex (moderator variable) does not influence the relationship between teaching strategy (independent variable) and academic achievement, and attitude towards Ecology (dependent variables). This finding disagrees with that of Okereke and Akinlade et al. (2019) who reported significant interaction effect of teaching strategy and gender on students' attitude towards photosynthesis in Biology. This finding further disagrees with the view of Murad (2009) who reported significant interaction effect of teaching strategy and gender on achievement.

CONCLUSION

The utilitarian nature of Ecology and Biology as a whole in human endeavors makes it highly essential. This study highlights the effects of cartoon-incorporated instructional strategy on students' achievement on ecology in senior secondary schools in delta state.

The findings from this study indicated that the cartoon-incorporated instructional strategy is more superior and effective to the lecture 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 cartoon-incorporated instructional

strategy, since students taught with this method performed better than students taught with the lecture method.

Secondly there was no significant difference in the achievement scores between male and female student taught Ecology with cartoon-incorporated instructional strategy and there is no significant interaction effect between sex and method of instruction on student's achievement in Ecology.

Thirdly since there was a significant effect between instructional strategy and student achievement, 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 biology ideas are teachable with the appropriate methodology.
2. According to the study, using cartoons into instructional strategies is a suitable way to help students learn about ecology and how it is used in the real world.
3. Students' perceived difficulties with concepts can be made very simple to understand through the use of active learning strategies in the classroom.
4. The national curriculum objectives, which are intended to encourage students' inquiring spirit and the formation of a lifelong knowledge necessary for national development, will be supported by the employment of cartoon-incorporated instructional strategies in biology teaching and learning.

RECOMMENDATIONS

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

1. Biology teachers should evaluate their approaches and implement the ones that result in better student performance.
2. To promote the adoption of active learning strategies, biology should be given more time in the timetable.
3. If the cartoon-incorporated teaching technique is used as the medium of instruction, biology teachers will be driven to teach ecology well, and students will be encouraged to learn better as they interact with the materials.
4. All secondary schools should have access to educational materials provided by the government.

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