

***EFFECTIVENESS OF GUIDED-INQUIRY AND FLIPPED-LEARNING METHODS ON
SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN ECOLOGY IN
ONITSHA EDUCATIONAL ZONE***

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Abstract

The study investigated on the effectiveness of Guided-inquiry and Flipped-learning methods on secondary school students' academic achievement in Onitsha Education Zone. Three purposes of studies, two research questions and three hypotheses tested at 0.05alpha level guided the study. A quasi-experimental design using was adopted, specifically the pretest-posttest non-randomized sample was used. Population of the study was 3787 SeniorSecondary students (SS1). A sample of 120 SS1 students from two schools was obtained using multi-stage sampling technique. The instrument used for data collection was Ecological Concepts Achievement Test (ECAT), validated by two lecturers from Departments of Science Education and one lecturer from Educational Foundations all from NnamdiAzikiwe University, Awka. Reliability was established using Kuder Richardson 21(KR21) for ECAT which yielded coefficient of 0.81. The experimental group 1 was taught Ecological concepts using guided-inquiry method while the experimental group 2 was taught using Flippedlearning method. This treatment lasted for four weeks. The students were given pretest and post-s test. The data collected were analysed using mean and standard deviation for research questions while analysis of covariance was used to test the null hypotheses. Results indicated that flipped –learning method significantly improves secondary students' achievement in Ecology compared to Guidedinquirymethod. Also there was a significant gender difference in academic achievement with the females outperforming the males. The findings revealed that there is no significant interaction effect of gender and teaching methods on students' academic achievement. It was recommended therefore that Flipped-learning method be adopted for teaching ecology since it uses the language of todays' students who are used to the web and social media for information and interaction.

Keywords: Academic achievement, Ecology, Guided-inquiry, Flipped-learning, Gender

Introduction

Ecology as a branch of biology is defined as the study of the relationship of organism or group of organisms and their environment or the science of the inter-relationship of organisms or organism and their environment (Egwu and Okigbo, 2019). Ecology creates the opportunity for students to explore the natural environment, ecosystem dynamics and ecological issues affecting the environment (Zumyil, 2019). An understanding of ecological principles will assist students in the rational use of the earth's resources to achieve the highest quality of living for mankind while reducing the likelihood of major environmental destruction. The utility of ecological concepts in day-to-day life and activities of human

has made. For this reason, the curriculum planners taught it wise in making ecology to have a sizeable content of the learning experiences in the secondary school biology curriculum.

Despite the relevance of ecology in day-to-day life activities of human, and sustainable environmental development, literature is replete with evidence that students experience difficulties in understanding ecological concepts in Biology (Babagana, Zainab and Ndagi, 2018). The Chief (WAEC) examiner's report in Egwu and Okigbo (2021) attributes the students' inability to answer questions on ecology as one of the reasons that result in unsatisfactory performance of students on Biology in public examinations such as the West African Examination Council (WAEC) and the National Examination Council (NECO). Onu, Anyaegbunam and Uzoigwe (2020) stated that academic achievement of students in Biology has been low and dwindling over the years in Nigeria especially in Senior Secondary Certificate Examination (SSCE). This agrees with the observations of Uzoma and Okoli (2015), Dorji and Dorji (2022) and Oyowvi (2019) who reported the poor academic achievements of students in Biology. The WAEC Chief examiners' report (2019) revealed that the percentage achievement score of students in the 2019 West African Senior Secondary Certificate Examination (WASSCE) was 55.6% while in 2018 it was 55.1% which is poorer than that of 2017 when students passed with average of 55.6%. This is just a little above the acceptable pass score of 50 required to get a 'C' grade in Biology. Several researchers like, Onu et al (2020), Oyovwi (2019), Nwafor and Oka (2018) and Obialor and Osuafor (2016) have attributed the poor performances to inadequate use of instructional materials and more especially inappropriate instructional methods that are not innovative among others. Teaching method is one major factor that contributed to the poor performance of students in ecology. This agrees with Zumyil (2019) who reported that conventional instructional method like lecture methods results to students' inability to apply abstract reasoning to understand concepts in ecology. Some activities applied in teaching ecology are characterized by a rigid teacher-centred pattern where students' active participation is not allowed. Teachers are often tempted to adopt the conventional method of teaching due to the overloaded nature of Biology curriculum or scheme of work.

The conventional method though allows for more content to be covered in little time does not sustain students' interest nor make better academic achievement and retention. (Onu et al, 2020). The conventional teaching method is classroom-based and consists of lecturing and direct instructions conducted by the teacher. The teacher-centred method emphasizes learning through the teachers' guidance at all times. (Uzoma and Okoli, 2015; Obialor and Osuafor, 2016)

Academic achievement is the measure of the extent of success recorded by learners in an academic setting. Beyoh and Akudolu (2016) stated that academic achievement refers to the students' progress in school as measured by their scores. It is also defined as the extent to which a student teacher or institution has achieved their short-term or long-term educational goals. (Nwuba and Osuafor, 2021) Kayanin Adedoyi (2019) pointed out that difficult concepts are better taught through learners' participations and use of effective instructional strategies that attend to the needs of the learners and make them active learners.

Active learning involves students' effort to actively construct their knowledge. It emphasizes higher order thinking and often involves group works. The guided inquiry and flipped-learning methods are among the teaching methods that promotes active learning in students.

Guided inquiry method is an approach of teaching in which students are guided by the teachers to find facts for themselves. It is student-oriented and activity- oriented (Ugwuadu, 2010). Guided inquiry is a type of inquiry that is efficacious for beginners in science such as Senior Secondary one (SS1) students who cannot be engaged in open inquiry because of lack of experience (Eziyi, Mumuni and Nwanekezi, 2016). Guided inquiry encourages students to ask questions, analyze, interpret evidence and choose the best solutions to the problems investigate the concept. The teacher may start the lesson by posing a question or a problem to the students and thereafter guide the students to arrive at the solution. By so doing, the students are actively involved in the lesson thereby reducing the tendency of presenting established facts to them (Ekomaye, 2019)

Mkpa and Nwachukwu (2019), among other researchers have all ascertained to the significant effectiveness of guided inquiry as a methods of instruction on many subject areas.

The flipped learning in the other hand is a pedagogical method in which the conventional notion of classroom-based learning is inverted. According to flipped learning Network (FLN, 2014) flipped learning is a pedagogical method in which teachers shift direct learninginstruction out of the large group learning space or classroom and move it into the individual learning space with the help of the several technologies. It is a form of blended learning that combines face-to-face learning in the classroom with group discussion and learning outside of the classroom with video lesson and online collaboration. (Adonuet al, 2021).Educators using flipped learning strategies according to (Bergman and Sams, 2012) declare that the best benefit is that, for the first time in their teaching career they have someone- on-one contact with the students during every class period

A significant body of research has supported the effectiveness of the flipped learning method in increasing student learning and achievement. This is in consonance withInengite and Zipamone, (2024) Aslan, (2022), Berhanu and sheferaw (2022), Shao and Liu (2021), Eppard and Rochidi (2017), Ahmed (2016), and Tully (2014). Much known works to the researcher has not been recorded in the relative effects of guided inquiry method and flipped learning method in secondary school students' academic achievement and interest on ecological concept. Nevertheless, research findings have shown contradictory reports on the influence of gender on students' academic achievements and interests in various subject areas. The researcher therefore would further investigate the interaction of gender on the effectiveness of guided-inquiry method and flipped-learning method on the academic achievement and interest of secondary school students in ecology.

Gender issues are currently the focus of discussion and research all over the world, Nigeria inclusive. The question of gender is a matter of great concern especially among scholars and policy formulators (Odukwe and Nwafor, 2022). Uzoma and Okoli (2019) reported that there is no significant difference in the mean achievement scores in terms of gender of male and female students in Biology. Some studies have observed significant sex difference in the academic achievement and interest in various subjects while some state that there are no significant differences in students' gender taught using both guided inquiry and flipped learning methods. With these inconclusive results on the gender stereotyping, the

researcher seeks to include gender as an intervening variables in this study to see if it has any influence on students' achievement when exposed to guided-inquiry and flipped-learning methods.

Purpose of the Study

The study determined the effectiveness of guided-inquiry and flipped learning methods on students' academic achievement on ecological concepts in Onitsha education zone.

Specifically, this study determined the:

1. difference in the mean academic achievement scores of students taught ecological concepts using guided inquiry method (GIM) and flipped learning method (FLM).
2. difference in the mean academic achievement of male and female students in ecological concepts when taught using GIM and FLM.
3. the interaction effect of gender and teaching methods on students' academic achievement.

Research Questions

The following research questions guided the study;

1. What is the difference in the mean academic achievement scores of students taught ecological concepts using guided inquiry method (GIM) and flipped learning method (FLM)?
2. What is the difference in the mean academic achievement scores of male and female students taught ecological concepts using GIM and FLM?

Hypotheses

The following null hypotheses guided the study and was tested at 0.05 level of significance;

1. There is no significant difference in the mean academic achievement scores of students taught ecological concepts using guided inquiry method (GIM) and flipped learning method (FLM).
2. There is no significant difference the mean academic achievement scores of male and female students taught ecological concepts using GIM and FLM.
3. There is no significant interaction of gender and teaching methods (GIM and FLM) on students' academic achievement in ecological concepts

Methods

The study adopted quasi-experimental research design of pre-test and post-test. A quasiexperimental research according to Nworgu (2015) is described as a type of experimental study that determines the effect of a treatment paradigm on a non-randomized sample. The population of the study comprised of 3787 (2427 males and 1361 females) SS 1 students drawn from co-education schools in Onitsha education zone. The sample of the study consisted of 120 (64 males and 56 females) SS 1 students drawn from two co-education schools out of eighteen (18) co-education schools in the three Local Government Areas in Onitsha Education Zone which was obtained using the multi-stage sampling procedure in three stages.

The two experimental group research assistants were briefed by the researcher before the treatment process on the effective implementations of the two methods.

The researcher explained to the research assistants of the experimental groups on separate meetings, the topics to cover and the methods to be used; the steps involved in each methods. The researcher illustrated to the research assistance how to apply each of the methods on separate meetings. The briefing period lasted for four days.

The ECAT and ECII will be administered as pre-test by the research assistants in the sampled schools before the commencement of treatment to the two experimental groups. The script were collected for scoring and recorded by the researcher and the scores remained undisclosed to the students.

The treatment lasted for four weeks after the first week of the training. From 2nd to 5th week, the research assistants taught ecological concepts as stated in the lesson plans to the two experimental groups.

At the end of the treatment, a post-test was administered to the students. The ECAT and ECII was reshuffled and used as post-test to the two experimental groups. The scripts was marked and recorded by the researcher

Instrumentation

The instruments used for data collection was Ecological Concept Achievement Test (ECAT). The reliability of ECAT was established after a pilottest and the reliability coefficient of the ECAT using Kuder-Richarson 21(K-R 21) formular yielded 0.81. The research questions were answered using descriptive statistics of mean and standard deviation while the hypotheses were tested at 0.05 level of significant using analysis of co-variance (ANCOVA) with pre-test serving as the covariate

Results

The result of the study was presented in line with the questions and the hypothesis as follows;

Research Question 1: What is the difference in the mean academic achievement scores of students taught ecological concepts using Guided Inquiry Method (GIM) and those taught using Flipped Learning Method (FLM)?

Table 1: Difference between the mean achievement scores of students taught ecological concepts using GIM and those taught using FLM.

Group	N	Pre-test		Post-test		Mean Gain
		<u>Mean</u> X	SD	<u>Mean</u> X	SD	
GIM	56	22..77	4.78	32.14	4.51	9.37
FLM	64	20.61	2.46	33.77	3.95	13.16 Mean
Difference		2.16	1.63		3.79	

Table 1: Shows that students taught ecological concepts using GIM had pre-test mean achievement score of 22.77 with a standard deviation of 4.78 and post-test mean achievement score of 32.14 with a standard deviation of 4.51. The mean gain achievement score was 9.37. The FLM group had pre-test mean achievement score of 20.61 with a standard deviation of 2.46 and post-test mean achievement score of 33.77 with a standard deviation of 3.95. The mean gain achievement score was 13.16. The difference in the mean gain achievement scores of the students was 3.79 in favour of FLM. This implies that FLM was more effective in improving students' academic achievement in ecological concepts than GIM.

Research Question 2: What is the difference in the mean academic achievement scores of male and female students taught ecological concepts using GIM and those taught using FLM?

Table 2: Difference in the mean academic achievement score of male and female students taught ecological concepts using GIM and FLM.

Group	Gender	N	Pre-test		Post-test		Mean Gain
			Mean X	SD	Mean X	SD	
GIM	Male	26	21.62	5.26	30.81	4.64	9.19
	Female	30	23.77	4.14	33.30	4.12	9.59
FLM	Male	37	20.62	2.44	31.89	3.19	11.27
	Female	27	20.59	2.52	36.33	2.20	15.74

Table 2 shows that for students taught ecological concepts using GIM, the males had pre-test mean achievement score of 21.62 with a standard deviation of 5.26 and post-test mean achievement score of 30.81 with a standard deviation of 4.64. The mean gain score for male group was 9.19. For the females, the pre-test mean achievement score was 23.77 with a standard deviation of 4.14 and posttest mean achievement score of 33.30 with a standard deviation of 4.12. The mean gain score for the female group was 9.53. The difference in the mean gain achievement scores of male and female students taught ecological concepts using GIM was 0.34 in favour of the female students.

More so, for the FLM group, the result shows that the males had a pre-test achievement mean score of 20.62 with a standard deviation of 2.45 and a post-test achievement score of 31.89 with a standard deviation of 3.91. The mean gain score was 11.27. For the female group, the pre-test mean achievement score was 20.59 with a standard deviation of 2.52 and a post-test mean achievement score of 36.33 with a standard deviation of 2.20. The mean gain achievement score was 15.74. The difference in the mean gain achievement scores of male and female students taught ecological concepts using FLM was 4.47 in favour of the female students. This result shows that the female students under the two teaching groups (GIM and FLM) achieved higher than their male counterparts.

This indicates that gender has some effect on students' academic achievement in Ecology.

Testing Null Hypothesis

Hypothesis 1: There is no significant difference in the mean achievement scores of students taught ecological concepts using Guided Inquiry Method (GIM) and those taught using Flipped Learning Method (FLM).

Table 3: Summary of the ANCOVA test of significant difference in the mean academic achievement scores of students taught ecological concepts using GIM and those taught using FLM.

Source Squares	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power ^b
Corrected Model	923.724 ^a	4	230.931	21.156	.000	.424	84.626	1.000
Intercept	1504.558	1	1504.558	137.838	.000	.545	137.838	1.000
PRETEST	450.638	1	450.638	41.285	.000	.264	41.285	1.000
Group	274.450	1	274.450	25.143	.000	.179	25.143	.999
Sex	242.242	1	242.242	22.193	.000	.162	22.193	.997
Group * Sex	69.953	1	69.953	6.409	.013	.053	6.409	.709
Error	1255.268	115	10.915					
Total	132925.000	120						
Corrected Total	2178.992	119						

a. R Squared = .424 (Adjusted R Squared = .404)

b. Computed using alpha = .05

Table 3 reveals that the $F(1,119) = 25.143$, $P = 0.000 < 0.05$ alpha level. Therefore, null hypothesis 1 was rejected. The inference drawn is that there is a significant difference in the mean academic achievement scores of students taught ecological concepts using GIM and those taught using FLM. This is in favour of the FLM group.

Hypothesis 2: There is no significant difference in the mean academic achievement scores of male and female students taught ecological concepts using GIM and those taught using FLM.

Table 3 shows that $F(1,119) = 22.193$, $p = 0.00 < 0.05$ alpha level. Therefore, hypothesis 2 was rejected. The inference drawn is that there is a significant difference in the mean academic achievement scores of male and female students taught ecological concepts using GIM and those taught using FLM. This is in favour of the female students.

Hypothesis 3: There is no significant interaction effect of gender and the teaching methods (GIM and FLM) on students' academic achievement in Ecology

Table 3 shows that $F(1,119) = 6.406, p = 0.013 < 0.05$ alpha level. Therefore, hypothesis 3 was rejected. The inference drawn is that there is significant interaction effect of gender and teaching method (GIM and FLM) on academic achievement of students in Ecology.

Figure 1: Profile plots of interaction effect of gender and teaching method (GIM and FLM) on students' academic achievement in Ecology.

The profile plots of the two teaching methods on male and female students' academic achievement score are not parallel to each other, there is almost an intersect. Hence there is an interaction effect of gender and teaching methods on students' academic achievement in Ecology. By implication the effect of the two methods of teaching on the mean academic achievement scores of the students in Ecology depends on their gender. Thus treatment affected the mean academic achievement scores of male and female students in Ecology.

DISCUSSION

The findings of this study revealed that there is a significant difference in the mean achievement scores of students taught ecological concepts using Guided Inquiry Method (GIM) and Flipped Learning Method (FLM) in favour of FLM. The students in FLM achieved higher than their counterparts in GIM. FLM provided the students with the pre-notion concepts generation of the being taught in the class. This provided the needed active participation of students which is based on Social constructivism theory. The finding validates the findings of Inengite and Zipomone (2024); Dorji and Dorji (2022) and Ugwuoke, Edeh and Ezemma (2018) who reported that flipped learning has significant influence on students' academic achievement.

The findings of this study also revealed that there is a statistical difference in the mean academic achievement of male and female students taught ecological concepts using GIM and FLM. The result showed that females outperformed their male counterparts. The finding is in line with Beyoh and Akudolu (2016) and Femi-Adeoye (2021) who reported a significant difference in the academic achievement of male and female students. The finding contradicts Inengite and Zipamone who posits that there was no significant difference in the academic achievement of students in terms of gender. There is an interaction effect of gender and teaching methods on students' academic achievement.

Conclusion

Based on the findings of this study, the researcher concluded that Flipped-learning method (FLM) is a more effective teaching method that can be used to improve the academic achievement of students in ecological concepts than GIM. It could be adopted as an alternative teaching method in the teaching of ecological concepts. Also Flipped-learning method has influence on both male and female academic achievement in ecological concepts. This means that FLM is a teaching method that can be used to effectively teach ecological concepts to both male and female and thus promote their autonomy in the concepts.

Recommendations

Based on the findings of this study, the following recommendations were made: Teachers should be trained on how to use FLM to improve students' academic achievement through workshops, seminars and conferences. Students should be provided with the technological gadgets that can be used in the teaching and learning processes which will invariably promote their interest and enhance their academic achievement. Students should be given equal opportunity in classrooms regardless of their gender in order to reduce the issue of gender stereotyping..

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