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Computer Simulation, Guided Discovery, and Expository Methods of Teaching Ecological Management and Biology Students' Academic Achievement in Osisioma, Abia State

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Abstract

The study is an empirical examination of computer-simulation, guided-discovery, and expository methods of teaching ecological management and biology students' academic achievement and retention in Osisioma, Abia State. Three research questions and three null hypotheses guided the study. The design of the study was quasi-experimental with a non-randomized pretest, posttest control group factorial design. The population consisted of all 5,102 Senior Secondary School Two (SS 2) biology students. The sample size of 183 (88 males and 95 females) Senior Secondary Two (SS 2) students in three intact classes of three co-educational secondary schools in Osisioma Local Government Area, Abia State, was selected using a purposive sampling technique. The Biology Achievement Test (BAT) was used for data collection. The Biology Achievement Test (BAT) had fifty (50) multiple-choice items. The test measured students' pretest, posttest, and achievement in the concept. The reliability of

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BAT was determined using the test-retest method with a reliability index of 0.75. Mean and standard deviation were used to answer the research questions, while analysis of covariance (ANCOVA) was used to test the null hypotheses at a 0.05 level of significance. The result showed that there is a significant difference among the mean achievement scores of biology students taught ecological management using computer simulation, guided discovery, and expository methods, respectively. In addition, there exists no significant difference among the mean achievement scores of male and female biology students taught ecological management using computer simulation, guided discovery, and expository methods, respectively. More so, there exist significant interaction effects of instructional methods and gender on biology students' achievement scores on ecological management. It was concluded that computer-simulation and guided-discovery methods were more effective than expository methods in facilitating students' achievement in ecological management in biology. Based on the findings, it was recommended, among others, that biology teachers should make effective use of computer simulations and guided-discovery methods in teaching the concept of ecological management in biology.

Keywords: Computer Simulation, Guided Discovery, Expository, Academic Achievement, Ecological Management

Introduction

Biology is the science of life. It is a branch of natural science that deals with the study of living organisms, their structures, functions, evolution, distribution and inter-relationships. Biology occupies a unique position in the secondary school education curriculum because of its importance as science of life. It classifies and describes organisms, their functions, how species come into existence, and the interactions they

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have with each other and with the natural environment (Akunwa & Obidiwe, 2018). The four unifying principles forming the foundation of modern Biology are cell theory, evolution, genetics and homeostasis. Biology is a science subject which aims at equipping students with appropriate scientific attitude, competences and ability to apply scientific knowledge to every challenges of life. Biology as a science subject occupies a central position in the science curriculum (Federal Republic of Nigeria, FRN, 2021). This is because Biology as a life science subject concerned with the study of living organisms with regards to their structure, function, growth, evolution, distribution, identification and taxonomy. Okori and Jerry (2017) explained that the study of Biology enables man to understand the diversity of life forms, conservation and sustainable use of natural resources. The study of Biology equips students with useful concepts, principles, theories and safety that enable them face the challenges around them before and after graduation. It also equips students in the area of environmental science such as biodiversity, conservation, climate change, renewable energy, natural resource management and ecological management (Goji, 2018).

Ecological management refers to the process of balancing human activities with the need to conserve and restore ecosystems to maintain their long-term health and sustainability. It involves understanding and managing the intricate relationships between living organisms and their environment to ensure the preservation of biodiversity, natural processes, and overall ecosystem health (Bodin, 2017). Ecological management is the process of protecting the organisms and their interaction with the environment. It focuses on the management of biological components with their interaction with the physical environment and their effects on the planet. Ecological management constitutes four major categories, namely, association (biological associations), tolerance, adaptations, and pollution (Long et al. 2017). However, this study focuses on adaptations. Adaptation is a heritable trait that helps an organism survive and reproduce in its environment. It is the process by which a species becomes fitted to its environment as a result of natural selection's acting upon heritable variation over several generations (Houle & Rossoni, 2022). Adaptations are the processes by which species evolve or adjust features and behaviors to survive and reproduce in their

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environment. They are the result of evolutionary processes that enhance an organism's ability to survive and reproduce in specific environments. These adaptations can manifest as specialized structures, physiological changes, and behaviors that help species cope with their surroundings. Adaptations arise through mutations, which are inheritable changes in an organism's genetic material (Debevec et al. 2024). Mutation is a random change in an organism's DNA that, if beneficial, can be passed down to offspring and provide a survival advantage. This beneficial mutation becomes an adaptation, like a snow leopard's thick fur, which improves the animal's ability to survive and reproduce in its environment. These rare events are usually harmful, but occasionally, they give specific survival advantages to the mutated organism and its offspring (Gibson et al. 2017). When certain individuals in a population possess advantageous mutations, they are able to cope with their specific environmental conditions. As a result, they will contribute more offspring to future generations compared with those individuals in the population that lack the mutation. Over time, the number of individuals that have the advantageous mutation will increase in the population at the expense of those that do not have it. Individuals with an advantageous mutation are said to have a higher "fitness" than those without it because they tend to have comparatively higher survival and reproductive rates (Sotiridis et al. 2022). This is natural selection. However, adaptations may require the use of appropriate teaching methods such as guided discovery, instructional scaffolding, blended learning, and computer simulation methods to improve students' academic achievement in biology.

Computer simulation is the approach and methodology used to create, implement, and analyze computer-based models that mimic real-world processes, systems, or events. It is a tool that can be manipulated in order to effect changes in a model before invoking a particular change in the real world. It mimics real-life scenarios, making learning more relevant and meaningful. Computer simulations give learners an opportunity to observe and interact with the real-world experience. It is designed to help students learn about the nature and behavior of computers and electronic circuits. Computer simulations give students an opportunity to take initiative when learning about a given topic and create a teaching atmosphere where students are

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active. It is a package that reproduces or simulates a nonconcrete model of given content for students' quick grasp of complex concepts and application of knowledge gained (Isiyaku et al. 2015). It depicts using a computer to imitate the operations of a real-world process or facility according to appropriately developed assumptions taking the form of logical, statistical, or mathematical relationships, which are developed and shaped into a model (McHaney, 2019). However, Alhadlaq (2023) stated that computer simulation enhances guided-discovery learning by providing an interactive, risk-free, and data-driven platform for exploration and concept development.

Guided discovery is an instructional approach whereby the teacher facilitates learning by providing hints, prompts, or structured activities that lead students to discover concepts or solutions on their own. Instead of directly giving answers, the teacher guides students through exploration, questioning, and problem-solving. Guided discovery guides learners to take active roles in their learning process by answering a series of questions or solving problems designed by the teacher in order to introduce a particular concept (Yaunist, 2018). Guided discovery involves students' progressively developing key scientific ideas through learning how to investigate and diagnose situations, formulating problems, critiquing experiments, and distinguishing alternatives. It also helps students in planning investigations, researching assumptions, searching for information, constructing models, and debating with peers using evidence and representations as well as forming coherent arguments (Bamiro, 2016). It is an approach of teaching in which students are guided to find out information by themselves; in this way, students build their knowledge and understanding of the subject matter (Dajal & Mohammed, 2019). Bibi et al. (2022) added that good teaching often blends different methods, starting with expository for a foundation and then shifting to guided discovery for deeper engagement.

The expository method is a teacher-centered instructional strategy where the teacher presents information, concepts, principles, or ideas directly to students in a clear, structured, and organized way. The goal is to transmit knowledge efficiently from the teacher to the learner. It is a direct teaching strategy where the teacher takes the lead in delivering content. Expository strategy ensures efficient knowledge

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transfer, especially for foundational or complex topics (Prayekti, 2018). It is a didactic teaching approach in which the teacher presents information to students while the students merely listen. The expository method is a pressure-learning approach that the teacher uses to deliver a preplanned lesson to the students with or without the use of instructional materials. It is occasionally called deductive teaching because the teacher often begins with a definition of the concepts or principles, illustrates them, and unfolds their implications. However, Eze and Osuyi (2018) opined that the expository teaching method is the most commonly used method for teaching biology because it helps a teacher to take a large number of students at a time and cover a lot of ground but may not promote excellence and hard work.

Gender is the social and cultural roles, behaviors, expectations, and identities associated with being male or female. It is a wide range of biological, behavioral, physical, and mental characteristics regarding and differentiating the female and male populations (Okeke, 2020). Hence, gender is an aspect concerning the responsibilities, roles, opportunities, constraints, and needs of males and females in all aspects of social context (Omotosho, 2019). It is the different socio-cultural stereotyped roles and responsibilities expected of boys and girls. Ullah and Ullah (2019) opined that there is an acknowledged problem of female underperformance when compared with male counterparts, apparently, under equivalent conditions; this problem of female underachievement appeared to be more pronounced in science and mathematics. Turner et al. (2019) declared that it is not accurate to attribute any perceived difficulties or underachievement solely to female students, but even if there are any in sciences, there may be several factors contributing to it, such as societal expectations, stereotypes, and biases. Lane et al. (2022) stated that it is crucial to recognize that individuals vary widely and any challenges in mathematics and science subjects are not inherently tied to gender but rather influenced by a range of factors, including personal cognitive ability, teaching methods, and societal expectations.

Some research works have shown contradicting evidence in students' academic achievement in sciences due to gender. For instance, Oladejo et al. (2021) as well as Ani et al. (2022) asserted that gender has no significant difference in students'

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achievement. Mwhia (2020) and Oladejo *et al.* (2021) observed a significant difference between male and female students' achievement in sciences. In addition, Emerhiona *et al.* (2018) affirmed a significant interaction effect of teaching methods and gender on biology students' achievement. Oladejo (2018) stated that there are no significant interaction effects of teaching methods and gender on students' academic performance. However, Jack (2023) and Etukakpan *et al.* (2025) opined that there is a significant difference in the achievement scores of biology students taught using computer simulation and expository methods in favor of computer simulation. More so, Ubom *et al.* (2024) and Mgbomo *et al.* (2024) state that there existed a significant difference between the mean academic achievement scores of students taught science using the guided-discovery method and those taught using the expository method in favor of students taught using the guided-discovery method. These conflicting results and the inconsistency existing in literature on gender and academic achievement pose a need to check if gender would affect the academic achievement of students taught the concept of ecological management based on the three methods such as a computer simulation, guided discovery, and expository methods.

Statement of the Problem

One of the problems facing the Nigerian educational sector today is the persistent poor achievement of students in external examinations, especially in the sciences. Biology is no exception, particularly ecological management. The WAEC chief examiners' report of 2022 and other research reports have shown that a high percentage of secondary school students continue to perform poorly in biology during external examinations. The poor achievement of students in biology may be associated with poor teaching methods adopted by teachers during classroom instructions. Researchers in biology education have continually sought better teaching methods that would provide a bridge between concepts that seem impracticable, abstract, and complex as well as require students to memorize numerous facts and terminologies such as ecological management. Poor teaching methods adopted by teachers do not only lead to poor understanding of the concepts but are also capable of hindering students' ability

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to understand and apply information. Some teaching methods identified by studies to teach such concepts are computer simulation, guided discovery, blended learning, and activity-based methods when compared to the expository method. It is on this basis that the study sought to examine the effects of computer simulation, guided discovery, and expository methods of teaching ecological management and biology students' academic achievement in Osioma, Abia State.

Purpose of the Study

The main purpose of the study was to investigate computer-simulation, guided-discovery, and expository methods of teaching ecological management and biology students' academic achievement in Osioma, Abia State. The specific objectives of the study were to:

- i. Determine the difference among the academic achievement mean scores of biology students taught ecological management using computer simulation, guided discovery, and expository methods, respectively.
- ii. Examine the differences in academic achievement mean scores between male and female biology students when taught ecological management using computer simulation, guided discovery, and expository methods, respectively.
- iii. Determine the interaction effects of instructional methods (computer simulation, guided discovery, and expository) and gender on biology students' achievement mean scores when taught ecological management.

Research Questions

- i. What are the differences in the mean academic achievement scores of biology students taught ecological management using computer simulation, guided discovery, and expository methods?
- ii. What are the differences in the mean academic achievement scores of male and female biology students taught ecological management using computer simulation, guided discovery, and expository methods?

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- iii. What are the interaction effects of instructional methods (computer simulation, guided discovery, and expository methods) and gender on the mean academic achievement scores of biology students in ecological management?

Research Hypotheses

- i. There is no significant difference in the mean achievement scores of biology students taught ecological management using computer simulation, guided discovery, and expository methods.
- ii. There is no significant difference in the mean achievement scores of male and female biology students taught ecological management using computer simulation, guided discovery, and expository methods.
- iii. There is no significant interaction effect of instructional method (computer simulation, guided discovery, and expository) and gender on biology students' achievement scores in ecological management.

Methodology

The design of the study was a quasi-experimental research design. Specifically, the nonrandomized pretest-posttest control group factorial design. A quasi-experimental design is considered appropriate for the study because intact classes were used to avoid disruption of normal class lessons. The study was conducted in three co-educational public secondary schools in Osisioma Local Government Area in Abia State. The population consists of all 5,102 Senior Secondary School Two (SS 2) students offering biology in all the 14 public secondary schools in the Osisioma Local Government Area of Abia State. The sample size of the study was 183 senior secondary two students, made of 88 males and 95 females in three coeducational secondary schools. The sample was drawn from three co-educational secondary schools using the purposive sampling technique from the 14 public secondary schools available in the area. The selected schools met the criteria, which are schools that have qualified biology

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teachers, functional biology laboratories, and schools that have registered candidates for WASCE and NECO for the past 18 years. The instrument for the study was the Biology Achievement Test (BAT). BAT was designed to measure the students' achievement on the concept of adaptations. It consists of fifty (50) multiple-choice items with four (4) options. A-D-D with only one correct answer and three distracters drawn from the concept of adaptations.

The instrument was face-validated by experts in biology education at Abia State University, Uturu, who read through the items and suggested corrections where necessary. Based on the comments and suggestions, the researcher was appropriately guided in the development of the valid instruments. The instruments were adjusted accordingly. To ensure content validity, a test blueprint was used as a guide in the selection of the items. The reliability of the Biology Achievement Test (BAT) was determined using the test-retest method. A trial test was administered to twenty (20) Senior Secondary Two (SS 2) Biology students selected from the target population. Who did not participate in the main study? The second test was administered two weeks after the first test. The results showed a reliability index of 0.75. This is an indication that the instrument was reliable and capable of measuring the intended items in this study.

Experimental Procedure

The biology teachers in the sampled schools were used as research assistants with students in intact classes. Each of the classes was assigned to experimental group one, experimental group two, and a control group, respectively. To qualify as research assistants, the three biology teachers were trained for one week. Well-prepared lesson packages were used by the research assistants in teaching the concept of adaptations in their respective groups for four weeks.

Experimental group 1 using computer simulation: the research assistant displayed to students the downloaded video from the Bioman Biology site on adaptations and guided students through it. The students interacted with scenarios showing various types of adaptation. Identify the type of relationship shown; match

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the organisms with their type of interaction, and record results in their notebooks. In experimental group 2 using guided discovery, the research assistant displayed pictures showing a cow with an egret on its back, a tapeworm in the human intestine, and a remora fish attached to a shark. Ask; what do you observe in these pictures? In addition, encourage students to share what they think is happening to the organisms. The teacher (research assistant) allowed students to investigate adaptations through structured activities by modeling associations.

In the control group, adaptations were taught using the expository method. The research assistant also broke down the concept of adaptation into weeks and then used lesson notes on adaptation to teach the students.

The data obtained from the achievement test were analyzed using mean, standard deviation, and analysis of covariance (ANCOVA). Mean and standard deviation were used to answer research questions, while ANCOVA was used to test the null hypotheses at a 0.05 level of significance.

Results and Discussions

Research Question 1: What is the difference among the achievement mean scores of biology students taught ecological management using computer simulation, guided discovery, and expository methods, respectively?

Table 1: Mean, Standard Deviation, and Mean Gain Scores of Students' Pretest and Posttest Scores Taught Ecological Management Using Computer Simulation, Guided Discovery, and Expository Methods

Instructional Methods	N	Prettest Scores		Posttest Scores		Mean Gain
		\bar{X}	SD	\bar{X}	SD	
Computer Simulation	69	4.94	1.47	29.41	4.07	24.47
Guided Discovery	58	5.09	1.56	30.07	5.04	24.98

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Expository	56	4.95	1.59	22.00	4.09	17.05
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Results in Table 1 show that the pretest mean achievement scores of biology students taught ecological management using computer simulation, guided discovery, and expository methods are 4.94, 5.09, and 4.95, respectively, while their posttest mean achievement scores are 29.41, 30.07, and 22.00, respectively. The mean gain scores of students taught biology using computer simulation, guided discovery, and expository methods are 24.47, 24.98, and 17.05, respectively. This result indicates that biology students taught using the guided discovery method had the highest mean gain score, followed by those taught using the computer simulation method, while those taught using the expository method had the least mean gain score.

Research Question 2: What is the difference among the mean achievement scores of male and female biology students taught ecological management using computer simulation, guided discovery, and expository methods, respectively?

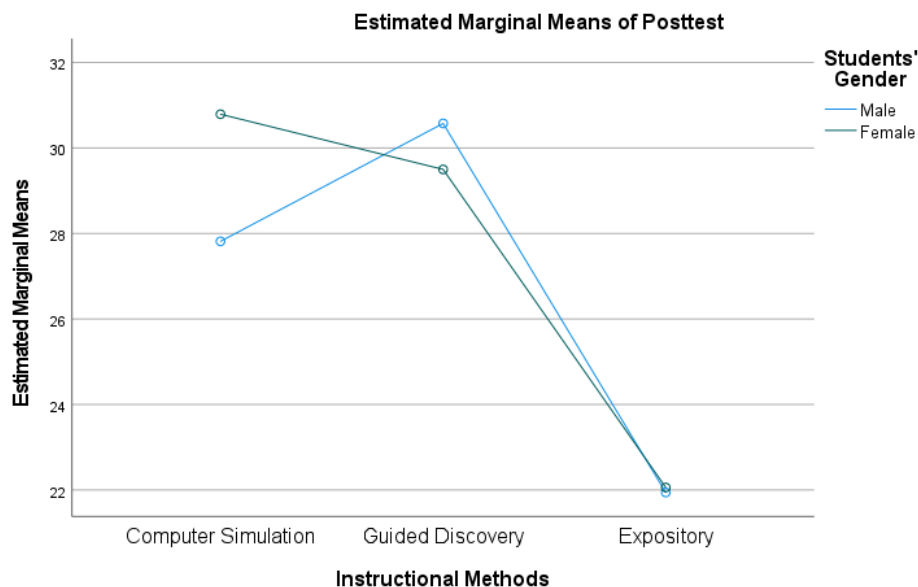
Table 2: Mean, Standard Deviation, and Mean Gain Scores of Male and Female Students' Pretest and Posttest Taught Ecological Management Using Computer Simulation, Guided Discovery, and Expository Methods

Instructional Methods	Gender	N	Pretest		Posttest		Mean Gain
			Mean	SD	Mean	SD	
Computer Simulation	Male	32	5.44	1.34	27.88	3.51	22.44
	Female	37	4.51	1.47	30.73	4.11	26.22
Guided Discovery	Male	30	5.43	1.46	30.63	5.42	25.20
	Female	28	4.71	1.61	29.46	4.63	24.75
Expository	Male	26	4.54	1.27	21.88	3.53	17.34
	Female	30	5.30	1.77	22.10	4.58	16.80

Results in Table 2 show the mean gain of male and female students taught ecological management using computer simulation is 22.44 and 26.22, respectively; the mean gain of male and female students taught ecological management using guided

discovery is 25.20 and 24.75, respectively, while the mean gain of male and female students taught ecological management using expository is 17.34 and 16.80, respectively. This result indicates that female students' mean gain score taught ecological management using computer simulation is higher than that of their male counterparts; male students' mean gain score taught ecological management using guided discovery is higher than that of their female counterparts, while male students' mean gain score taught ecological management using expository is higher than that of their female counterparts.

Research Question 3: What are the interaction effects of instructional methods (computer simulation, guided discovery, and expository) and gender on biology students' achievement scores on ecological management?



Covariates appearing in the model are evaluated at the following values: Pretest = 4.99

Fig 1: Interaction 1: Interaction effect plot for teaching methods and gender on biology students' achievement on ecological management.



Fig. 1 shows the interaction effects of instructional methods and gender on biology students' achievement scores on ecological management. The plot shows that the mean plots of male students taught ecological management using computer simulation, mean guided discovery, computer simulation, guided discovery, and expository methods are 27.82, 30.58, 30.58, 21.94, and 30.58, respectively, while those of their female counterparts are 30.79, 29.50, 21.94, 22.06, and 29.50, respectively. This result indicates that interaction exists at 22.06 and exists between male students and female students who are taught using computer simulation and guided discovery. This is because the mean of female students taught computer simulation is higher than that of male students, and the mean of male students taught using guided discovery is higher than that of female students. students, interaction effects on students. exist between male and female students taught using guided discovery and expository methods. This is because the mean of male students taught using guided discovery is higher than that of female students, and the mean of male students taught using expository is still lower than that of female students.

Testing of Hypotheses

Hypothesis 1: There is no significant difference among the mean achievement scores of biology students, students taught ecological management using computer simulation, biology computer simulation, guided discovery, computer simulation, and expository methods, and guided discovery, respectively.

Table 3: Analysis of Covariance (ANCOVA) of Students' Posttest Scores Classified by Instructional Methods with Pretest as Covariate

Source of Variation			Sum of Squares	Df	Mean Square	F	Sig. at P<.05
Posttest	Covariates	Pretest	4.08	1	4.08	0.209	0.65
	Main Effects	Instructional Methods	2320.14	2	1160.07	59.37	0.00
	Residual		3497.40	179	19.54		
	Total		5821.62	182	31.99		

In Table 3, the calculated probability value (P-value) of 0.00 of the main effects (methods) is less than the significance level (0.05). Therefore, the null hypothesis is rejected. This implies that at $P < 0.05$, there is a significant difference among the mean achievement scores of biology students taught ecological management using computer simulation, guided discovery, and expository methods, respectively. In order to determine the direction of significance, the Least Square Difference (LSD) post hoc pairwise comparison test was done, and the results are summarized in Table 4.

Table 4: LSD Post Hoc Pairwise Comparison Test of Students' Posttest Scores Classified by Instructional Methods with Pretest Scores as Covariate

(I) Methods	(J) Methods	Mean Difference (I-J)	Std. Error	Sign at $P < .05$
Computer Simulation	Guided Discovery	-0.66	0.788	0.41
	Expository	7.41*	0.795	0.00
Guided Discovery	Computer Simulation	0.66	0.788	0.41
	Expository	8.06*	0.829	0.00
Expository	Computer Simulation	-7.41*	0.795	0.00
	Guided Discovery	-8.06*	0.829	0.00

Table 4 shows a mean achievement difference of 0.66 between biology students taught ecological management using computer simulation and guided discovery methods; 7.41 between biology students taught ecological management using computer simulation and expository methods; and 8.06 between biology students taught ecological management using guided discovery and expository methods. The levels of significance displayed indicated that biology students taught ecological management using the computer-simulation instructional method achieved significantly better than those taught ecological management using the expository

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method; biology students taught ecological management using the guided discovery instructional method achieved significantly better than those taught ecological management using the expository method. There existed a non-significant difference between biology students taught ecological management using computer simulation and guided discovery instructional methods.

Hypothesis 2: There is no significant difference among the mean achievement scores of male and female biology students taught ecological management using computer simulation, guided discovery, and expository methods, respectively.

Table 5: Analysis of Covariance (ANCOVA) of Students' Posttest Scores Classified by Gender with Pretest as Covariate

Source of Variation			Sum of Squares	df	Mean Square	F	Sig. at P<.05
Posttest	Covariates	Pretest	4.08	1	4.08	0.22	0.64
	Main Effects	Instructional Methods	2320.14	2	1160.07	61.29	0.00
		Students' Gender	28.49	1	28.49	1.51	0.22
	2-Way Interactions	Instructional Methods * Students' Gender	137.43	2	68.72	3.63	0.03
	Residual		3331.48	176	18.93		
	Total		5821.62	182	31.99		

In Table 5, the calculated probability value (P-value) of 0.22 for the main effects of students' gender is greater than the significance level (0.05). Therefore, the null hypothesis is retained. This implies that at $P < 0.05$, there exists no significant difference among the mean achievement scores of male and female biology students

taught ecological management using computer simulation, guided discovery, and expository methods, respectively.

Hypothesis 3: There are no significant interaction effects of instructional methods (computer-simulation, guided-discovery, and expository) and gender on biology students' achievement scores on ecological management.

In Table 5, the calculated probability value (P-value) of the interaction effects of instructional methods and students' gender on achievement is less than the significance level (0.05). Therefore, the null hypothesis is rejected. This implies that at $P < 0.05$, there exist significant interaction effects of instructional methods (computer-simulation, guided-discovery, and expository) and gender on biology students' achievement scores on ecological management.

Discussion of Findings

Findings of the study showed there is a significant difference among the mean achievement scores of biology students taught ecological management using computer simulation, guided discovery, and expository methods, respectively, in favor of computer simulation and guided discovery methods. Biology students taught ecological management using a computer-simulation instructional method achieved significantly better than those taught ecological management using an expository method. The findings are also a result of computer simulation enhancing students' learning through the transformation of complex or abstract ideas into visual, interactive experiences that make it easier for students to grasp concepts and encourage active participation and exploration, leading to increased engagement and motivation. The finding is in line with that of Jack (2023) and Etukakpan et al. (2025), who investigated the effects of computer simulation on students' achievement and found that there is a significant difference in the achievement scores of biology students taught using computer simulation and expository methods in favor of computer simulation. In addition, the findings on instructional methods and students' achievement indicated that biology students taught ecological management using the guided-discovery instructional method also achieved significantly better than those taught ecological

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management using the expository method. The findings could be the guided discovery stimulating inquisitiveness and promoting students' enthusiasm to discover the answer to problems, thereby making students engage in hands-on activities. The findings are in line with those of Ubom et al. (2024) and Mgbomo et al. (2024), who investigated the effects of the guided-discovery method on senior secondary school students' academic achievement in science and found that there existed a significant difference between the mean academic achievement scores of students taught science using the guided-discovery method and those taught using the expository method in favor of students taught using the guided-discovery method.

The findings from the results on the difference in the mean achievement scores of male and female students taught the concept of ecological management indicated a significant difference. There existed no significant difference between the mean achievement scores of male and female biology students taught ecological management using computer-simulation-guided discovery and expository methods, respectively. This result indicates that female students' mean gain score from learning ecological management using computer simulation is higher than that of their male counterparts; male students' mean gain score from learning ecological management using guided discovery is higher than that of their female counterparts, while male students' mean gain score from learning ecological management using expository methods is higher than that of their female counterparts. Therefore, there is no significant difference in the mean achievement scores of male and female biology students taught ecological management using computer-simulation-guided discovery and expository methods, respectively. This might be due to the fact that the three teaching resources are student-friendly. This study is in line with the findings of Oladejo et al. (2021) as well as Ani et al. (2022), who found that gender has no significant difference in students' achievement. However, this study is contrary to the studies of Mwhia (2020) and Oladejo et al. (2021), who found a significant difference between male and female students' achievement in sciences.

The findings from the interaction effects of instructional methods and gender on students' achievement indicated significant interaction effects of instructional

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methods and gender on biology students' achievement scores in ecological management. This result indicates that interaction exists between male students and female students taught using computer simulation and guided discovery. This means that female students who were taught using computer simulation scored higher on average than male students taught with the same method, while male students taught using the guided discovery method scored higher on average than female students taught with that method. Interaction effects do exist between male and female students taught using guided discovery and expository methods. This is because the mean of male students taught using guided discovery is higher than that of female students, and the mean of male students taught using exposition is still lower than that of female students. There exist significant interaction effects of instructional methods (computer simulation, guided discovery, and expository) and gender on biology students' achievement scores on ecological management. This implies that computer simulation, guided discovery, and expository teaching methods do not work the same way for males and females; one gender benefits significantly more from a particular method than the other in the concept of ecological management. The finding of the study is in line with that of Emerhiona *et al.* (2018), who found significant interaction effects of teaching methods and gender on biology students' achievement. However, this finding is contrary to the study of Oladejo (2018), who found that there are no significant interaction effects of teaching methods and gender on students' academic performance.

Conclusion

Based on the findings of the study, it is hereby concluded that the three instructional methods investigated, computer simulation and guided discovery, were more effective than the expository method in facilitating students' achievement in the concept of ecological management in biology. Additionally, students' gender did not have a significant impact on their performance. However, there was a significant interaction effect between instructional methods and gender on the achievement of biology students.

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Recommendations

- i. Teachers should make use of computer simulation and guided-discovery methods in learning the concept of ecological management to improve students' academic achievement in biology.
- ii. Students should be exposed to computer simulation and guided-discovery methods in learning the concept of ecological management in order to increase students' academic achievement in biology.
- iii. Biology teachers should deploy computer-simulation and guided-discovery methods in teaching the concept of ecological management to increase students' academic achievement in biology.

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