



Constructivist Teaching Approach and Academic Achievement in Biology among Senior Secondary School Students

*¹Aja, L., ²Chukwuemeka, C., & ³Elom, I. J.

^{1,2,3}Department of Science Education, Ebonyi State University, Abakaliki, Nigeria

¹Department of Science Education, Kampala International University, Western Campus, Uganda

*Corresponding author email: lucykul2011@yahoo.com

Abstract

The study looked at how a constructivist-based teaching approach affected the biology academic achievement of secondary school students. This study has three research questions and three null hypotheses. The study employed a quasi-experimental research design. 853 senior secondary two students from Ebonyi local government area in Ebonyi state make up the research population. Two of thirteen coeducational secondary schools were selected using simple random sampling techniques, and 284 students were chosen for the study. The Biology Achievement Test (BAT), which has been validated by experts in measurement and evaluation as well as biology, was used to gather the data. The reliability coefficient of the instrument was 0.76 when the Kuder-Richardson formula 20 was used to evaluate its reliability. The treatment group and the control group are the two study groups. The research questions were addressed and the hypotheses were evaluated using the mean, standard deviation, and analysis of covariance. The study's findings suggest that a constructivist-based teaching strategy for instruction is a better way to encourage biology achievement. The results also demonstrate that female students outperform male students when taught using a constructivist-based teaching approach. The results also demonstrate that gender and method do not interact. According to the study, educators and biology teachers should include a constructivist-based teaching strategy in their pedagogical practices instead of relying exclusively on a conventional teaching strategy.

Keywords: Constructivist, Student Achievement, Gender, Biology, Teaching Approach

Introduction

The field of science creates and arranges knowledge through universe-related theories and verifiable explanations. It is a collection of knowledge about the physical world and its phenomena, consisting of systematic experiments and objective observations. It involves an investigation of universal truths or the structure of fundamental laws. According to Igwe (2002), science is knowledge derived from studying how general laws of nature operate, particularly knowledge acquired, examined, validated, and authorized via the scientific process. It is widely known that science is vital to a child's education. The importance of science to society cannot be overstated; it is evident that science is used to categorize nations according to their level of development (Olarinloye, 2017). The goals of science education are to develop students' natural curiosity and improve their capacity for scientific thought. Students will understand the nature of science, as well as the scientific expertise and analytical abilities required to evaluate, via inquiry, the impacts of scientific and technological progress. According to Duyilemi (2005), emphasis must be placed on encouraging student participation in the teaching and learning process. According to Duffy and Cunningham (1996), learning is an active construction process as opposed to a passive acquisition process.

Developing scientifically literate people who are concerned with high competence for logical thoughts and acts is the main objective of science education. The goals of science education in Africa are to support and equip students for environmental observation and investigation, the explanation of basic natural phenomena, the formation of scientific attitudes, critical reflection and objectivity, and, finally, the application of scientific knowledge and skills to solve problems in daily life and the aforementioned goals all promote scientific literacy. The scientific method used to achieve these objectives includes; defining/stating the problem, formulating the hypothesis, designing an experiment, observing, and collecting data.

A constructivist-based teaching approach is a pedagogical strategy that permits students to interact with their surroundings and contribute to the creation of knowledge. To reflect established concepts, a teaching technique should alter or modify the learner's past knowledge. Asking thought-provoking questions to students can help them do this by altering their conceptual framework (Meyer & Land, 2013). According to constructivism, knowledge can only be constructed by students via experiences; information cannot be directly influenced. Constructivism aims to incorporate these experiences into education. The interactive learning process builds on the prior knowledge of the student. The majority of student work is done in groups; inquiry-based, problem-based, and reciprocal teaching and learning are a few examples.

According to constructivism, knowledge can only be constructed by students via experiences; information cannot be directly influenced. Constructivism aims to incorporate these experiences into education. The interactive learning process builds on the prior knowledge of the student. With its roots in the work of Piaget (1970), Vygotsky (1978), and Papert (1980), constructivism has a long history in education. According to the constructivist theory of learning (Von 1995; Fosnot 1996; Duffy and Cunningham 1996), students acquire knowledge by actively creating it.

Constructivism is an approach to learning that is predicated on the constructivist learning philosophies put out by Piaget (Harel & Papert 1991). Constructivism is a style of instruction that emphasizes students actively creating their knowledge. Using their immediate surroundings as a guide, pupils analyze messages as part of this learning technique. Constructivism, according to Schunk (2000), is a theory that holds that knowledge and comprehension are constructed by learners primarily as a result of their experiences in a learning environment. It also holds that learning occurs in context. Studies on constructivism place more focus on how students form their ideas and encourage critical thinking, which results in active learning that inspires students. Zemelman et al. (1993) suggest that constructivism theory be a part of the curriculum and advocate that learners should be a part of the knowledge-creation process. A constructivist educator should give students the chance to use and create new concepts in novel settings. It gives students the chance to complete assignments in a setting that is both relevant and practical for them. The constructive teaching method is a learning theory based on scientific observation, research, and explanations of how students learn. All this implies that, in the course of classes and group projects, students are free to consult their textbooks and other educational materials. When teaching biology, the instructor lets students build their concepts, which are recognized to assist them explore and change the environment. Researchers in biology education faced the challenge of exploring and certifying the actual effects of a constructivism-based teaching approach on student achievement in biology. Academic achievement and gender inequalities have emerged as a key concern for scholars, the comparison of male counterparts and female underachievement. Given the captivating attributes of a constructivism-based teaching approach to learning, researchers in the fields of science have advocated for the application of constructivist teaching strategy to learning, and researchers in the fields of science have advocated for the application of constructivist strategy in science classrooms (Nwafor & Aja, 2017). According to Samuel (2016), the constructivism-based teaching approach gives students the chance to create their knowledge rather than relying on what they have learned already, which improves learning. Nwagbo (2001) pointed out that teachers shy away from constructivism-based teaching strategy which is student-oriented, known to be effective and rely on strategies that are easy for example the chalk-talk method of teaching, but most times it is inadequate and inappropriate. The poor performance of students in biology therefore argues for reevaluating the biology classroom's approach to instruction. Thus, the constructivist-based teaching approach and students' academic achievement in biology were taken into consideration in this study.

Statement of the problem

In senior secondary schools in Nigeria, biology is one of the fundamental science subjects provided (Federal Republic Nigeria, 2004). Biology is an extremely essential science subject and a prerequisite for advanced study in science-related professional courses like biology education, applied biology, microbiology, biochemistry, and biotechnology, as well as medicine, agriculture, and pharmacy. These days, biology is present in every aspect of human effort and is crucial to the growth of education. Nigeria's federal government has prioritized enhancing science instruction and learning in biology classes because it cares about education (FRN, 2004).

To enhance scientific teaching and learning, the Association of Nigeria, which is engaged in the subject, along with the pertinent agencies, has organized conferences, workshops, seminars, and other events. The achievement of students in biology has not improved despite all of these efforts (Okoye, 2013). The world is becoming more scientific, and science plays a major role in ensuring that lives work properly (Ogunleye, 2022). Arokoyu &

Chukwu, (2017) asserts that the decline in biology achievement can be unquestionably linked to the poor instructional methods used by secondary school teachers. The West African Examination Council examiner report of 2013-2018 in (Chukwu & Arokoyu, 2019) , shows that , there is reason for concern regarding the efficacy of the common teaching approach taken by biology teachers while instructing their students in biology given the students' consistently low performance on the Secondary School Certificate Examination. Biology education in many Nigerian secondary schools has traditionally followed a pattern in which instructors mostly employ lecture-based teaching methods with little demonstrations (Iduma, 2020).

Students are exposed to very few practical exercises through the instructional technique and, a lack of group discussion. The lack of modern technology gadgets, the extensive biology curriculum, the lack of funds, the low motivation of teachers, and the instructional methods used by the teachers. To give students meaningful learning experiences, science educators nowadays have placed a strong emphasis on the employment of cutting-edge teaching techniques like inquiry, problem-based learning, discovery, laboratory methods, and demonstration. In light of this, the researcher suggested several solutions to this issue, one of which is implementing a constructivism-based teaching approach in biology classes.

Objectives of the Study

The following are the objectives of the study;

1. The mean academic achievement scores of students taught biology using a constructivist-based teaching approach and those taught using the conventional approach.
2. Variations in the mean academic achievement scores of male and female students taught biology using a constructivist-based approach.
3. The impact of method and gender on student academic achievement in biology

Research Questions

To direct this investigation, the following research questions were developed.

1. What is the mean academic achievement score of students taught biology using the constructivist-based teaching approach and those taught using the conventional approach?
2. What are the mean academic achievement scores of male and female students taught biology using a constructivist-based teaching approach?
3. What is the interaction effect of methods and gender on students' academic achievement in biology?

Hypotheses

This study was guided by the following null hypothesis, which was tested at an alpha level of 0.05:

H₀₁: The mean achievement scores of students taught biology using the constructivist-based teaching approach and those taught using the conventional approach did not differ statistically significantly.

H₀₂: Using a constructivist-based teaching approach, there is no statistically significant difference in the mean achievement scores of male and female biology students.

H₀₃: The interaction effect between gender and methods is not statistically significant.

Methodology

A quasi-experimental research design was adopted for this study, the goal is to make clear the relationship between biology students' academic achievement in senior secondary schools and the implications of a constructivist-based teaching approach. Two groups were created from the sampled population, (the experimental group, and the control group). Constructivist-based teaching approach (CBTA) was the approach employed by the researchers to teach biology to the experimental group, and the conventional teaching approach (CTA) was employed to teach biology to the control group. For this particular study, the researcher employed a pretest-posttest nonequivalent control group design. The study was conducted in Ebonyi State's Local Government Area and it is located in the state's northern region. Thirteen public secondary schools within this local government area are authorized by the Secondary Education Board (SEB, 2022). The researchers chose this topic because they are curious about how the constructivism-based teaching approach affects secondary school biology students' academic achievement. Eight hundred and fifty-three SS II biology students from the 2021-2022 school year in Ebonyi Local Government Area, Ebonyi State, comprise the research's population (Secondary Education Board SEB, 2022). The researchers selected SSII because the study's subjects are covered in the Ministry of Education's SSII curriculum.

Out of the thirteen coeducational secondary schools in Ebonyi Local Government Area, Ebonyi State, two were chosen using simple random sampling techniques. By flipping a coin, one of the coeducational schools was placed

in the treatment group and the other in the control group. Using an achievement test based on the scheme of work, the biology achievement test (BAT) was able to attain content validity. The Biology Achievement Test (BAT), created by the researchers, was the tool utilized to gather data for this study. The instrument for data collection consists of 20 multiple-choice questions that are based on the topics that were covered throughout the experiment. Two secondary schools in Ebonyi Local Government area of Ebonyi State used the instrument's test-retest method. The K-R-20 technique was used to examine the reliability of the 20-item BAT. The instrument's test-retest method yielded a reliability index of 0.76 using Pearson's Product Moment Correlation Procedure to obtain data from 30 students after the instruments were administered multiple times and evaluated for reliability.

Results

Research Question 1: What is the mean academic achievement score of students taught biology using the constructivist-based teaching approach and those taught using the conventional approach?

Table 1: Mean Academic Achievement Score of Students Taught Biology Using the Constructivist-Based Teaching Approach and Those Taught Using the Conventional Approach

Methods of Instruction	N	Adjusted Mean	S.D
Constructivist-based approach (Treatment Group)	138	66.19	14.27
Conventional approach (Control Group)	146	47.60	11.09

According to the data analysis summary shown in Table 1, the treatment group, (constructivist-based teaching approach) has an adjusted mean of (66.19) whereas the control group, (conventional teaching approach) has an adjusted mean of (47.60). The constructivist-based teaching approach outperforms the conventional teaching approach. Therefore, in terms of promoting academic achievement in biology, the constructivist-based teaching approach is more suitable than the conventional teaching approach.

Research Question 2: What are the mean academic achievement scores of male and female students taught biology using a constructivist-based teaching approach?

Table 2: Mean Academic Achievement Scores of Male and Female Students Taught Biology Using a Constructivist-Based Teaching Approach

Gender of Students	N	Adjusted Mean	S.D
Male	56	55.28	15.04
Female	82	57.97	16.38

The data analysis summary displayed in Table 2 indicates that the average score for females of 57.97, in the group taught using the constructivist-based teaching approach was greater than the mean score of males, which was 55.28. With the use of the constructivism-based teaching approach, the female outperforms the male. This shows that female students perform better academically when taught using constructivism-based teaching than male students.

Research Question 3: How do gender and instructional approaches combine to affect biology students' academic achievement?

Table 3: Interaction effect of methods and gender on student achievement in Biology.

Category of gender	Constructivist approach	Conventional approach
Male	66.52	47.88
Female	65.98	47.21

The results summary suggests that the constructivist-based strategy surpasses the conventional approach at both gender levels, suggesting that method and gender do not affect students' biology achievement. This suggests that the gender and method do not interact in any way.

Hypotheses

H₀₁: The mean achievement scores of students taught biology using the constructivist-based teaching approach and those taught using the conventional approach did not differ statistically significantly.

H₀₃: The interaction effect between gender and methods is not statistically significant.

To test hypotheses 1 and 3, the Biology Achievement Test (BAT) data for the treatment and control groups were analyzed using covariance. In Table 4, an overview of the analysis is displayed.

Table 4: ANCOVA Test of Significance for Method and Interactions between Method and Gender on Achievement in Biology

Source of variation	Sum of Square	Df	Mean Square	F	p-value
Corrected model	24807.6051	4	6201.901	38.024	0.000
Intercept	107855.280	1	107855.280	661.267	0.000
Pretest	256.947	1	256.947	1.575	0.210
Method	23349.514	1	23349.514	143.157	0.000
Gender	17.556	1	17.556	0.108	0.743
Method Gender	0.119	1	0.119	0.001	0.978
Total	9.81325.000	284			

Since the significance of F ($F=143.157$, $p=0.000$) is less than the alpha level (0.05) for hypothesis 1, the researchers reject the null hypothesis. The researchers concluded that there was a substantial difference in the mean achievement scores between biology students who were taught with the conventional approach and those who were taught using a constructivist-based teaching approach. According to Table 4's summary of the data analysis for hypothesis 3 ($F=0.001$, $p=0.978$), F's significance is 0.978 at an alpha level of 0.05. Because the alpha level of 0.05 is smaller than the F Probability of 0.978, the researchers conclude that there is no significant interaction between method and gender on students' mean achievement in biology, supporting the null hypothesis.

H₀₂: Using a constructivist-based teaching approach, there is no statistically significant difference in the mean achievement scores of male and female biology students.

Table 5: ANCOVA Test of Significance of Difference for Method by Gender for Treatment Group Only

Source of variation	Sum of Square	Df	Mean Square	F	p-value
Corrected model	628.938	2	314.469	1.555	0.215
Intercept	47841.822	1	47841.822	236.591	0.000
Pretest	619.154	1	619.154	3.062	0.082
Gender	3.682	1	3.682	0.018	0.893
Total	632625.00	138			

The summary in Table 5 indicates that the F.value is 0.018 and the significance of F-IS is 0.893. Because the alpha level (0.05) is less than (0.893), the researchers conclude that there is no statistically significant difference between the mean achievement scores of male and female biology students, supporting the null hypothesis.

Discussion

From research question one, the constructivist-based teaching approach is more effective than the conventional teaching approach for supporting students' biology achievement, indicating that the approach is superior to the conventional approach. This investigation validates Nwafor and Aja's (2017) findings, who discovered that students taught with a constructivist-based strategy outperformed those trained with the conventional approach in terms of achievement. This study empirically demonstrated the usefulness of a constructivist-based teaching strategy on biology student achievement. From research question two, the group taught using the constructivist-based teaching approach, the mean score of the females is higher than the mean score of the males. There aren't many differences between the two genders. The results of Oludipe's (2012) study, which found no gender-specific differences in male and female students' academic achievement at the pretest,

posttest, and delayed posttest, respectively, are corroborated by the results of this study. The study of Atomatofa (2012) shows that the constructivist-based teaching environment helps to reduce gender differences. The findings of Sridevi (2013) are in support of the study, and the findings revealed that in improving achievement and attitude, the constructivist approach is effective for boys and girls in improving achievement and attitude towards science.

The answer to research question three suggests that there is no interaction between method and gender in terms of students' biology achievement, as the constructivism-based teaching approach outperforms the conventional approach at both gender levels. The results of this investigation are consistent with those of Ukozor's (2011) study, which discovered that the constructivist-based teaching approach had a noticeably greater impact on students' physics achievement and self-efficacy. This study also supports the findings of Nwafor and Aja, (2017), who found that the constructivist-based approach is superior to the conventional approach at the two levels of gender.

This suggests that there is no interaction between gender and method and how well basic science students perform.

Conclusion

According to the study, a constructivist-based teaching strategy significantly impacts biology students' academic achievement. The constructivist-based teaching approach is superior to the conventional teaching approach in terms of effectiveness. The findings showed that when it comes to enhancing students' comprehension of biology concepts, the constructivist-based teaching approach outperforms the conventional teaching approach. However, the study's conclusions indicated that a constructivist-based teaching approach can effectively assist girls' biology education. On students' biology achievement, however, there was no interaction between the teaching approach and gender, suggesting that both boys and girls gain equally from the constructivist-based teaching approach.

Recommendations

1. The study concluded that educators, learners, policymakers, and educational administrators should highly value using a constructivism-based teaching strategy to teach and learn biology in senior secondary schools.
2. Instructors ought to let students work together, solve problems independently, and build their knowledge on their own.
3. The instruction ought to be student-focused and grounded in their prior knowledge.
4. The study finally recommended that the results of the findings will have implications for educators, especially those teaching biology, as they imply that incorporating a constructivism-based teaching strategy into their pedagogical practices may improve student outcomes, especially for female students.

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