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Effect of Cognitive Conflict Strategy and Gender on Senior Secondary School Students' Scientific Reasoning Skills in Conservation Biology

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Abstract

The study investigated the effect of cognitive conflict strategy and gender on scientific reasoning skills in conservation Biology among senior secondary school students in Biu Education Zone, Borno State. The study employed a pre-test post-test non- equivalent control group design. Two intact SSII Biology classes from two public co-education senior secondary schools were used. 22 male and 33 female students received treatment for six weeks while the control group consists of 25 male and 27 female students. A two-tier instrument titled Scientific Reasoning Skills Test (SRST) was administered as pre-test, reshuffled and administered as post-test. The reliability coefficient of the SRST was 0.85 determined using Kuder Richardson (Kr20). The hypotheses were tested at 0.05 level of significance using t-test. The study found that cognitive conflict strategy significantly enhanced students' scientific reasoning skills in conservation Biology than lecture method. It also found no significant difference in the scientific reasoning skills of male and female students taught using cognitive conflict strategy. The study recommended the use of cognitive conflict strategy to enhance students' scientific reasoning skills.

Keywords: Conservation, Cognitive Conflict, Gender, and Scientific Reasoning Skills.

Introduction

The knowledge of Biology as a science subject is an essential component of everyday life. Ibrahim (2015) assert that Biology is an important subject in the secondary school curriculum that is necessary for sustainable national development. It comprises different areas such as Botany, Zoology, Conservation, and Genetics among others. David-Egbenusi and Omoifo (2019) posited that poor foundation of Biology knowledge at secondary school level is detrimental to future scientific and technological development. It is therefore, necessary to use teaching strategies that could enhance students' scientific reasoning skills in conservation of natural resources in Biology, to ensure thinking about the future generation while using natural resources. Coracero *et al.* (2021) note that conservation as the management of natural resource which enhances biodiversity and reduction of unpleasant degradation. Similarly, Michael (2023) posits that conservation is the judicious use of natural resources to ensure their

availability and to guarantee their quality while maintaining the original nature of the environment. To effectively conserve natural resources, scientific reasoning skills are required to systematically profile or categorise resources in order to manage them properly.

According to Zimmerman (2012), scientific reasoning represent the ability to systematically explore a problem, formulate and test hypothesis, control and manipulate variables, explain, and evaluate experimental outcome. There are two major components of scientific reasoning which include deductive and inductive reasoning. Mehraj (2016) referred to deductive reasoning as a way of inferring that is dependent on facts and logicality while Mangal (2007) referred to inductive reasoning as articulation of generalisation based on crystal evidence. It has to do with exploration, generating hypotheses, and controlling variables. These skills could enhance conceptual knowledge development to enhance students' scientific reasoning skills in conservation Biology. It is therefore, important for Biology teachers to understand how scientific reasoning abilities develop through strategies. Nnorom (2013) portrayed that students who had high reasoning ability achieve better in Biology than students who had low reasoning ability. Therefore, facilitating conceptual knowledge construction is likely to enhance senior secondary school students' scientific reasoning skills.

One method that could enhance scientific reasoning skills is cognitive conflict strategy due to its ability to engender conceptual knowledge development. According to Abubakar (2021), cognitive conflict enhances students' scientific conception. It is a learning strategy that involves presenting students with situations that challenge their existing ideas and beliefs, compelling them to confront and resolve inconsistencies in their understanding or schema. To Mariana (2013), the essential objective of teaching Biology to gain concrete knowledge of the living world cannot be achieved theoretically by only lecturing students but by resorting to an instructive procedure focused on students making effort to construct their own knowledge. Makhrus and Hidayatullah (2021) found that cognitive conflict strategy enhances students' scientific reasoning skills in teaching of waves in Senior Secondary School Physics in Mataram, Indonesia. This finding corroborates Ngicho *et al.* (2020) who found that students taught using cognitive conflict strategy had a higher level of scientific reasoning skills than students taught using lecture method in Embu, Kenya. This indicates that cognitive conflict strategy could enhance Biology students' scientific reasoning skills and understanding in conservation of Natural resources.

Apart from teaching method, gender is another factor that could influence learning outcome. To Njoku (2012) gender refers to all the characteristics of male and female, which a particular society has assigned to each sex. This is majorly as a result of culture with women at the disadvantaged in terms of educational opportunities and other rights and privileges. This implies that gender determines the role which one plays in relation to general societal, cultural, political and economic system of any given society. Additionally, National Science Foundation (2019) suggests that cultural factors and socialisation may contribute to gender differences in scientific reasoning skills, with girls receiving less encouragement and support in science-related activities and careers compared to boys. This has shown that some societies expect male students to perform better than female students in some skills including scientific reasoning.

Heo and Toomey (2020) assert that gender is one of the multiple variables that influence teaching and learning process. It is therefore,

essential to investigate gender effect on students' scientific reasoning skills. According to Njoku and Usman (2013) females perform lower than males in Mathematics and science subjects including Biology because science subjects are considered male domain and females are not encouraged to compete with their male peers. This position was also corroborated by Njoku (2013) that females are not encouraged to do and perform well in science subjects. This may result in girls having less interest and exposure to activities that could engender scientific reasoning skills, leading to lower achievement in Conservation Biology. In agreement, Adam *et al*. (2022) found that male students significantly achieved higher than female students in Biology in a College of Education in Borno State.

Dike *et al*. (2018) examined the academic performance of Biology, Chemistry, and Physics students in relation to their gender effect among Nigeria Certificate in Education (NCE) students of Federal College of Education Zaria, Kaduna State and found that there was no gender disparity in the students' performance in all the subjects and overall science. This refutes the assumption that inherent abilities of thinking and reasoning that are found in males are deficient in females, it also indicates that male and female students perform equally when given equal opportunities using the appropriate strategy. This is also in agreement with Chakkrapan *et al.* (2014) who found that male and female students performed equally in scientific reasoning in Thailand. Literature has indicated that studies were conducted on the effect of cognitive conflict strategy, and gender on students' scientific reasoning skills. However, not much investigation seems to have been conducted in the area of cognitive conflict effect and gender on scientific reasoning skills of students in Biu Education Zone, Borno State. Hence, this study determined the effect of cognitive conflict strategy and gender on students' scientific reasoning skills in conservation Biology in Senior Secondary Schools in Biu Education Zone, Borno State.

Statement of the Problem

Scientific reasoning skills are essential for understanding Conservation in the teaching and learning process in Biology, to enhance students' achievement. However, low performance of Senior Secondary School Students in Biology in Nigeria has been reported over the years. This position has been a source of concern to stakeholders, and it was attributed to numerous factors including rote learning, inability of students to explain Biology concepts scientifically, traditional method of teaching, and gender disparity. According to WAEC Chief Examiners' Report from 2019 to 2020, students' performance in Biology was low and the report in 2021 indicated that studentsm had weaknesses in conservation of natural resources which include inability to state the effect of poor economy on conservation, inability to state the effect of poaching on conservation, and inability to state the roles played by government in conservation of natural resources led to poor performance in Biology. It is against this background that this study sought to determine the effect of cognitive conflict strategy and gender on students' scientific reasoning skills in conservation Biology in Biu Education Zone, Borno State.

Research Questions

The following research questions were raised to guide the study:

1. What is the difference in scientific reasoning skills of students taught conservation of natural resources with cognitive conflict strategy and those taught with lecture method.
2. What is the difference in scientific reasoning skills of male and female

students taught conservation of natural resources using cognitive conflict strategy?

Hypotheses

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

H01: There is no significant difference in scientific reasoning skills of students taught conservation of natural resources with cognitive conflict strategy and those taught with lecture method.

H02: There is no significant difference in the scientific reasoning skills of male and female students taught conservation of natural resources using cognitive conflict.

Methodology

This study employed a quasi-experimental research design, using pre-test post-test non-equivalent control group design. Two intact SSII Biology classes selected from two public co-education senior secondary schools served as control and experimental group. The experimental group consists of 22 male and 33 female making a total of 55 students taught concepts in conservation of natural resources in Biology using cognitive conflict strategy, which served as the treatment for six weeks. The control group which consists of 25 male and 27 female students made a total of 52 students that were taught the same concepts in conservation of natural resources in Biology as the experimental group using lecture method.

A two-tier instrument referred to as Scientific Reasoning Skills Test (SRST) tailored towards deductive and inductive reasoning skills was used. To score one point, each answer to the question and the reason for the choice of the answer must be correct. The SRST had a reliability coefficient of 0.85 determined using Kuder Richardson (Kr20), and was administered as pre-test, reshuffled and administered as post-test. The hypotheses were tested at 0.05 level of significance using t-test.

Results

H01: There is no significant difference in scientific reasoning skills of students taught conservation of natural resources with cognitive conflict strategy and those taught with lecture method.

Table 1

t-test of independent sample of Control and Experimental Group in Scientific Reasoning Skills.

Group	N	Mean	SD	df	t	Sig	Decision
Control	52	2.12	.11	105	6.62	.000	$H0_1$ rejected
Experimental	55	3.93	.68				

Table 1 show that the *p - value* of .000 is less than the alpha level of 0.05. The null hypothesis which states that the students' scientific reasoning skills will not differ based on instructional strategy is therefore, rejected. Hence, there is a significant difference in the scientific reasoning skills of students exposed to cognitive conflict strategy and those who received instruction by lecture method, in favour of cognitive conflict strategy group.

$H0_2$: There is no significant difference in the scientific reasoning skills of male and female students taught conservation of natural resources using cognitive conflict.

Table 2

t-test of Scientific Reasoning Skills of Students in the Experimental Group based on Gender

Gender	N	Mean	SD	df	t	Sig	Decision
Male	22	4.41	2.18	53	1.59	.124	Not Significant
Female	33	3.61	1.17				

Table 2 shows that the alpha level of 0.05 is less than the *p - value* of .124. Therefore, the null hypothesis which states that there is no

significant difference in the scientific reasoning skills of male and female students taught conservation of natural resources using cognitive conflict was retained. Hence, there was no significant difference in the scientific reasoning skills of male and female students exposed to cognitive conflict strategy.

Discussion of Findings

The findings revealed that there was a statistically significant difference in the scientific reasoning skills of students taught conservation of natural resources using lecture method and those taught conservation of natural resources using cognitive conflict strategy, in favour of cognitive conflict strategy group in Biu Education Zone Borno State. This finding could be attributed to the effectiveness of cognitive conflict strategy in teaching conservation of natural resources in Biology.

This finding is in agreement with Makhrus and Hidayatullah (2021) who found that cognitive conflict strategy enhances students' scientific reasoning skills, in teaching of waves in Senior Secondary School Physics in Mataram, Indonesia. The finding also corroborates Ngicho *et al*. (2020) who found that students taught using cognitive conflict strategy had a higher level of scientific reasoning skills than students taught using lecture method in Embu, Kenya. This finding demonstrates the efficacy of cognitive conflict strategy.

Another finding indicated that there was no significant difference in the scientific reasoning skills of male and female students taught conservation of natural resources using cognitive conflict strategy. This revealed that cognitive conflict strategy equally enhanced the scientific reasoning skills of both male and female students taught conservation of natural resources using cognitive conflict strategy in Biu Education Zone, Borno State. This finding corroborates Chakkrapan *et al.* (2014) who found that male and female students in Thailand performed equally in scientific reasoning ability. It also corroborates Nnorom (2013), who found no significant difference in the scientific reasoning of both male and female students in Anambra State. This finding however, disagreed with Luo *et al.* (2021), who found a significant difference in the scientific reasoning skills of male and female students, in favour of male students in China. This difference could be as a result of culture, sample difference, subject and location of the schools.

Conclusion

Based on the findings of this study, it was concluded that the use of cognitive conflict strategy enhanced students' scientific reasoning skills in conservation of natural resources in Biology than lecture method. It also concluded that cognitive conflict strategy enhanced both male and female students' scientific reasoning skills in conservation of natural resources in Biology in Biu Education Zone, Borno State.

Recommendations

The following recommendations were made based on the findings of the study;

1. Biology teachers should be encouraged to use cognitive conflict strategy because it enhances scientific reasoning skills in conservation of natural resources in Biology.
2. Biology teachers should use cognitive conflict strategy in teaching because it enhances both male and female students' scientific reasoning skills in conservation of natural resources in Biology.
3. Ministry of Education at federal and state levels should organise workshops and seminars for teachers on cognitive conflict strategy.

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