EFFECT OF INDIVIDUALIZED AND GROUP PROBLEM-BASED LEARNING STRATEGIES ON SECONDARY SCHOOL STUDENTS' CRITICAL THINKING IN BIOLOGY IN ZAMFARA STATE, NIGERIA

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Abstract
This study compared the effect of individualized and group problem-based learning strategies on secondary school student's critical thinking in biology in Zamfara state, Nigeria. A quasi-experimental design was employed, with a target population of 5,940 and a sample of 255 students obtained from four public senior secondary schools. Data were collected using Sense Organs Critical Thinking Test (SOCTT), with a strong internal consistency as indicated by Cronbach's alpha value of 0.88. T-test and two way ANOVA were used to test hypotheses one and two respectively. Findings revealed that group problem-based learning strategy improved more on students' critical thinking in learning sense organs concept than the individualized problem-based learning strategy while there is no significant difference among male and female students critical thinking taught sense organs using the group problem-based learning strategy and individualized problem-based learning strategy. The study concluded that group problem based learning strategy in the teaching and learning of sense organs concepts is a better option to improve students' critical thinking in biology at the senior secondary school level. The study recommended that biology and other science subject teachers at secondary school level should adopt group problem-based learning strategy during instruction for students' long-term memory.
Keywords: Individualized, Group Problem-Based, Instructional Strategies, Critical Thinking, Biology

Introduction

Biology is one of the core science subject offered at secondary school in Nigeria, and is among the most important science subject that students registered during National Examination Council (NECO) and West African Senior Secondary School Examination Certificate (WASSSCE). Biology as a subject contained in the senior secondary school curriculum, provides students with knowledge to understand living organisms, their interaction with environment and scientific basis of life processes, (NERDC, 2012).Among the objective of biology is to help students develop practical skills, as well as enhancing their ability to analyze, solve problems and make a decision. Therefore, the knowledge of biology as a science subject like any other science subject in terms of its significance to the society, contributed a lot in the field of medicine, agriculture and biotechnology among others (Abbas & Idris, 2024). Moreover, biology consist of the following topics; cell biology, digestive system, evolution, nutrition, ecology, genetics, classification of living things, skeleton system, transport system, and sense organs among others.

Sense organs are among the concept of biology that requires critical thinking skills because it involves the interpretation of how structures function together to produce perception. Goldstein (2014) stated that to understand sensory processes it require students to analyze relationships between structure and function, interpret and evaluate how the brain transform stimuli into sensation. Similarly, Akinbobola and folabi (2021) stated that investigation on sensory adaptation promotes reasoning, inference and decision making skills, which are the main components of critical thinking. Therefore, teaching sense organs concept through problem based-learning strategy can effectively improve students' critical thinking skills. However, some of the teachers used conventional approach which emphasis the concept memorization. Aliyu and Umar (2023) stated that most biology teachers rely heavily talk-chalk method, which limit students' engagement and reasoning. Similarly, Eze (2022) stated that conventional method promotes memorization of concept rather than developing critical thinking in teaching sense organs.

Critical thinking is considered as the ability to analyze, evaluate, interpret information and make value judgments. Therefore, critical thinking plays a vital role in learning sense organs, because sense organs involve structures and physiological processes. The significance of critical thinking in learning sense organs includes; encourage scientific reasoning and inquiry. Learners who are encourages to reasons develop problem solving and order thinking skills (Adegoke, 2020). Critical thinking help students to analyze these processes, connect structure and function, explain the cause and effect rather than just memorizing organs part. Ennis (2018) stated that critical thinking allow the learner to analyze, synthesize and evaluate evidence before making a decision. Critical thinking allows knowledge application to real life situations. That is linking classroom knowledge to real life experience. Eze (2022) opined that critical thinking change the acquired knowledge into functions that guide behavior and decision making in health and environment, improve retention ability. This is because when students evaluate and reason through sensory function, they build deep cognitive connections that enhance retention. Aliyu and Umar (2023) lamented that when students were engaged in analytical discussion and problem based-learning, shows higher order thinking and retention than those taught conventional method. Therefore, based on the observation, interaction with the students in the study area shows that most of the teachers used conventional method in teaching and learning biology. Similarly, the research finding of Akilu and Sulaiman (2023) maintained that, there was a report of WAEC (2023) that shows students often find it difficult to solve practical problems. To address this challenge, educators considered problem based-learning strategy as an effective approach that improve students' critical thinking.

Individualized learning strategy is a teaching approach in which a learner works on activity independently, whereas the teachers only act as a guide. This strategy enables the learners to set a learning objective, monitor their progress and choose learning resources that support their understanding. Major (2021) put forward that, one of the strength of individualized learning strategy is that it promotes self-paced learning, in which the fast learners progress quickly while allowing the slow learners the time they need to understand the concept. Individualized learning strategy support learner autonomy, as the students take responsibility of their learning

decisions. This aligns with constructivist view of learning, which emphasizes active participation (Adeyemi, 2017). Therefore, Problem based-learning is a student-centered learning which exposed students to real-world problems. Problem based learning strategy is a learning approach in which the teacher serves as a vehicle that promotes students learning concepts as opposed to direct presentation of facts and concepts (Tortorella & Cauchick, 2018). Problem based-learning strategy can be implemented using different modes, thus, include individualized and group-based approaches. In individualized problem-based learning strategy, each student works independently to identify, research, and solve given problems at their own pace, promoting autonomy, self-regulation, and personal accountability (Cerezo et al., 2019). While group problem-based learning emphasizes collaboration, discussion, and shared responsibility among students working in team to address a problem (Barrows & Tamblyn, 2010). Similarly, group problem based-learning strategy encourages team work and share ideas which enhance better understanding and critical thinking reasoning.

Even though, both individualized and group problem-based learning strategies enhance active learning and develop critical thinking, but they differ in structure, learner interaction, and outcome result. Individualized problem-based learning promotes self-paced inquiry and internal reflection, while group problem-based learning enhances social negotiation, communication skills, and shared problem-solving. The question of which of these two strategies is more effective in developing students' critical thinking skills, this remains an important issue in science education research. Empirical studies have reported mixed results. Some researchers found that group-based problem solving enhances students' reasoning, creativity, and motivation through peer interaction (Johnson & Johnson, 2014; Akinbobola & Afolabi, 2021), while others observed that individualized problem learning leads to better conceptual understanding and independent thinking (Cerezo et al., 2019; Adeyemi, 2017). These inconsistencies necessitate the specific investigations, particularly within Gusau, Zamfara State, Nigeria. Therefore, this study compared the effect of individualized and group problem-based learning strategies on secondary school students' critical thinking on sense organs concept.

Statement of the Problem

Despite the recognized importance of critical thinking in learning biology, many secondary school students in Zamfara State, Nigeria still demonstrate low levels of reasoning and analytical skills. Preliminary observations and the finding of Akilu and Suleiman (2024) revealed that chief examiners' reports from WAEC (2023) and (2024) indicate that students often find it difficult to solve practical problems, interpret data, or draw logical conclusions. As well as the teacher-centered methods adopted by the teachers failed to stimulate students' curiosity and reasoning.

However, problem-based learning strategy was identified as an effective learning strategy for improving higher-order thinking. Also, based on the preliminary observation and empirical studies reviewed, shows insufficient evidence on the comparison of individualized and group problem based-learning strategy on secondary school students' critical thinking. These necessitate investigating which of these approaches better enhances critical thinking.

Objectives of the Study

Specifically the study intends to:

1. Examine the difference between the critical thinking of senior secondary school students taught sense organs using individualised problem-based learning strategy and group problem based learning strategy in Zamfara State, Nigeria
2. Ascertain the difference between male and female senior secondary school students' critical thinking using individualised problem-based learning strategy and group problem based learning strategy in Zamfara State, Nigeria.

Hypotheses

The Hypothesis were formulated and tested at 0.05 levels of significance:

1. **H_{01}:** There is no significant difference between the critical thinking of senior secondary school students taught sense organs using individualised problem-based learning strategy and group problem based learning strategy in Zamfara State, Nigeria
2. **H_{O2}:** There is no significant difference between male and female senior secondary school students' critical thinking taught individualised problem-based learning strategy and group problem based learning strategy in Zamfara State, Nigeria.

Methodology

The research design for this study is Quasi-experimental design using pre-test and post-test experimental control group. A quasi-experiment is an empirical interventional study used to estimate the casual impact of an intervention on target population without random assignment (Wager & Susan, 2018). It was considered to be appropriate because the general procedure in Quasi-experimental design is independent variable (individualized and group problem based learning strategy) manipulated to determined their effect on dependent variables (students' critical thinking and retention) (Muthomi & Mbugua, 2014).

The target population which consisted of SS (III) biology students enrolled in 181 public schools across the State. The data obtained from Ministry of Education, Science and Technology, Zamfara State (2024) revealed that, there are 181 public senior secondary schools in Zamfara State with the total population of the biology students of 39,197 respectively. The target population of biology students out of the 181 public schools is 5,940 and the average age of the population is 18 years old. Because from the literature reviewed showed most of the researches conducted in Zamfara were on SS I and SS II students. Similarly, intact class were used in selecting the sample of 255 students from the four (4) sample schools.

Instrument used in this study is Sense Organs Critical Thinking Test, which is developed by the researcher. The sense organs critical thinking test (SOCTT) comprised (30) multiple choice questions on sense organs, the instrument contains options letter A-D with only one correct answer, and the questions were developed from the content of sense organs concepts. However, the instrument was validated by the three experts, the two experts were from science education department (biology) and the other one is from measurement and evaluation department Sokoto state university. The instrument is reliable for measuring critical thinking in relation to sense organs, with a strong internal consistency as indicated by the Cronbach's alpha value of 0.88.

After the selection of the classes to be used from the four sample schools, pre-test was administered to each of the class. The experimental group was taught using group problem-based learning strategy while the control group was taught using individualized problem-based learning strategy in learning sense organs for the period of five weeks. Immediately after the treatment, post-test was administered to measure students' critical thinking. The post-test sense organs critical thinking test score were subjected to t-test and two-way analysis of variance (ANOVA).

The study used descriptive statistics to find the mean, standard deviation, and mean difference for each of the two research questions and provide them in the table. The t-test was used to test the null hypothesis one and two-way analysis of variance (ANOVA) to test the null hypothesis two at alpha=0.05 level of significance with the help of the statistical packages known as SPSS.

Results

H_{01}: There is no significant difference between the critical thinking of senior secondary school students taught sense organs using individualised problem-based learning strategy and group problem based learning strategy in Zamfara state, Nigeria

Table 1: Summary of t-test Analysis of the difference between Students' Critical Thinking exposed in IPBLS and GPBLS

Groups	N	$\bar{X}$	SD	Df	t-Cal	P-Value	Decision
GPBLS	130	20.36	1.880				
				253	13.329	.000	H_{01}Rejected
IPBLS	125	17.14	1.974				

Table 1 shows that the P-value of 0.000 is less than the ≤ 0.05 (p=0.000< 0.05) at degree of freedom of 253, (df= 253) indicating that null hypothesis one (Ho_1) is therefore rejected. It implies that there is a significant difference between students critical thinking taught sense organs using the group problem-based learning strategy and those taught the same with the individualized problem-based learning strategy among senior secondary schools in Zamfara State.

H_{O2}: There is no significant difference between male and female senior secondary school students' critical thinking taught individualised problem-based learning strategy and group problem based learning strategy in Zamfara state, Nigeria.

Table 2: Summary of two-way Analysis of Variance (NOVA) of the differences between Male and Female Students' Critical Thinking taught Sense Organs using GPBLS and IPBLS.

Strategy	Sex	N	$\bar{X}$	SD	Df	f-Cal	P-Value	Decision
	Female	80	20.31	1.887				
GPBLS					128	0.213	0.645	
	Male	50	20.44	1.886				

	Female	70	17.10	2.008				H_{O2} Accepted
IPBL					123	0.213	0.645	
	Male	55	17.20	1.947				

Table 2 shows that the P-value of 0.645 is greater than the ≤ 0.05 (p=0.645> 0.05) at degree of freedom of 251, (df= 251) indicating that null hypothesis two (Ho_2) is therefore accepted. It implies that there is no significant difference between male and female students critical thinking taught sense organs using the group problem-based learning strategy and individualized problem based learning strategy among senior secondary schools in Zamfara State.

Discussion of Findings

The first finding of the study indicates that group problem based learning strategy improved students' critical thinking in learning sense organs concept more than individualized problem based learning strategy. This finding is in agreement with the finding of Dennis (2025) who conducted a research on the effect of cooperative and individualized problem solving strategy on students' performance in challenging biology concepts. The result revealed that students who were taught using group learning strategy perform better than those taught using the individualized problem solving strategy. Similarly, the finding is also in line with the finding of Oyarole and Deola (2017) that revealed students taught biology using small group perform better. Furthermore, the finding is also in agreement with the finding of Okebukola (2016) that said there is significant difference in the mean performance scores of students who used group or cooperative learning strategy compared to the individualized problem based learning strategy. Also, this finding is in agreement with the finding of Arokoyu and Nduudee (2018) who conducted a study on effect of collaborative learning and individualized learning strategies on students' performance and retention in organic Chemistry. The results showed that the experimental group taught organic chemistry using, collaborative learning strategy performed better than the control group taught the same using individualized learning strategy. The results of the study as revealed is may be due to the fact that group problem based learning strategy encourages students to work on the same task, share ideas and communicate freely.

The second finding of the study indicates *t*hat Individualized problem based learning strategy and group problem based learning strategy improve the critical thinking of male and female students in learning sense organs concept. Therefore, the finding shows that there is no significance differences between male and female students' critical thinking taught sense organs using Individualized problem based learning strategy and group problem based learning strategy.

This finding is in agreement with the finding of Oyarole and Deola (2017) who conducted a research on impact of small learning strategy on students' performance and retention in ecology, in Gusau, Zamfara State. The finding revealed that both male and female students taught using small group strategy perform better without gender differences. Similarly, the finding is in line with the finding of Yahaya (2023) that revealed problem based-learning

strategy is gender friendly because it eliminates the gender related differences. Furthermore, the finding is in agreement with the finding of Arokoyu and Nduudee (2018) which revealed that there was no significance difference between male and female students performance in both collaborative and individualized learning strategies. Also, this finding is in line with the finding of Denis, et al, (2023) that shows there is no significant difference in the mean performance scores of male and female students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy In addition, this finding showed that performance is a function of orientation, not gender. Therefore, the results of the study as revealed may be due to the equal opportunity for the students to learn in respective of their gender differences.

Conclusion

Based on the results of the findings in this study, indicates that group problem based learning strategy improved students' critical thinking in learning sense organs concept more than individualized problem based learning strategy. Similarly, Individualized and group problem based learning strategy are gender friendly, because they improve the critical thinking of male and female students in learning sense organs concept, without significant differences. Therefore, it can be concluded that adopting group problem based learning strategy in the teaching and learning of sense organs concepts is a better option to improve students' critical thinking in biology.

Recommendations

Based on the findings of this study, the researcher recommends, among others, that:

1. Biology teachers and other science subjects at the senior secondary school level should adopt group problem-based learning strategy into their instructional practices.
2. Biology teachers should use group problem based learning strategy to enhance senior secondary school students' long-term memory of sense organs concepts.
3. Schools should provide structured opportunities for group problem based learning where students can share ideas, debate alternative solutions, and build collective knowledge.

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