



EFFECTS OF PROBLEM –SOLVING INSTRUCTIONAL APPROACH ON STUDENTS' ACHIEVEMENT IN BIOLOGY

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Abstract

This study was designed to investigate the effects of problem-solving instructional approach on students' achievement in biology. The study was carried out in two secondary schools in Afikpo North L.G.A. of Ebonyi State. One school was assigned to treatment group while the other school was assigned to control group. The treatment group was taught biology using problem-solving instructional approach while the control group was taught biology using the conventional approach. The findings revealed that the problem-solving instructional approach is more effective than the conventional approach in fostering students' achievement. It was also discovered that with the problem-solving instructional approach, males showed higher achievement in biology than females. However, the difference in the mean achievement of males and females taught biology using the approach isn't statistically significant. This means that there was no interaction between gender and instructional approach on students' achievement in biology.

Keywords: Effects, Problem-solving, Instruction, Approach, Achievement, Biology.

Introduction

Generally education plays a vital role in the development of individuals and the society at large. Science education has been recognized as the instrument for national development. In view of its importance, the Federal Government of Nigeria emphasized the teaching of science in all institutions as contained in the National Policy on Education (FRN, 2005). Biology education in particular is so important in nation building and sustainable development considering the roles it plays in various areas of the economy such as in Medicare/health, agriculture, industries, security, foreign exchange and research etc (Ibe and Ukpai 2013). Biology as a popular subject in secondary school addresses the needs of majority through its relevance and functionality in content, practice and application (Ukpai and Okoro 2010). In spite of the importance

and popularity of Biology among students, their performance at senior secondary level remains poor. This trend had been attributed to many factors including ineffective (or poor) teaching methods adopted by the teachers or poor classroom delivery (WAEC 2014-2018). Consequently, efforts are targeted towards classroom teaching methods that guarantee a shift from teacher-centered to learner-centered approach. This is why the current emphasis in science instruction are geared toward bridging the chasm between the initial background of the learners and the new field of knowledge which also ensures learners involvement in doing things themselves and thinking about the things they are doing. In line with that, the global concern for biology education in particular is the teaching /learning approach that ensures hand –on, minds-on activities that can promote critical thinking and



enhance creativity.

Problem-solving approach is step by step instruction where learners are allowed to construct their own knowledge while the teacher serves as the facilitator. Bichi (2002) and Adesoji(2008) described problem-solving approach as one of the activity-based approach that could develop certain skills in learners such as manipulative skills, logical reasoning ability, team spirit, self confidence and creative thinking. Eze (2001) and Danjuma (2005) observed that a systematic approach to problem solving encourages good learning habits, contributes to clarity in thinking, self-confidence, logical reasoning and promotes intellectual development. Problem-solving instructional approach is one of the activity-based approaches that gives students the opportunity to fully participate in the teaching and learning process. Specifically, this study employed Tree Diagrams as one of the examples of the problem-solving methods. Tree diagrams are a type of graphic organizer that shows how items are related to one another. The tree's trunk represents the main topic, and the branches represent relevant concepts, facts, factors, influences, traits, people or outcomes. Tree diagrams can be used to sort items or classify them.

Purpose of the study

The purpose of this study was to investigate empirically the effects of problem-solving on students' achievement in biology. The study specifically:

1. verified the effects of problem-solving instructional approach on students' achievement in biology.
2. assessed the achievement of male and female students in biology.
3. assessed the interaction effect of gender and instructional approach on students' achievement in biology.

Research Questions

The following research questions guided the study:

1. What is the effect of problem-solving instructional approach on students' achievement in biology?
2. What is the effect of problem-solving

instructional approach on the achievement of male and female students in biology?

3. What is the interaction effect of gender and instructional approach on students' achievement in biology?

Hypotheses

The following null hypotheses were formulated and tested at an alpha level of 0.05:

- HO₁: There is no significant difference in the mean achievement scores of students taught biology using problem-solving instructional approach and those taught biology using conventional approach.
- HO₂: There is no significant difference in the mean achievement scores of male and female students taught biology using problem-solving instructional approach.
- HO₃: There is no significant interaction between gender and instructional approach on students' achievement in biology.

Design and Procedures

The study adopted the quasi – experimental research design, specifically the researcher used a pre-test post-test non-equivalent control group design. This involved intact classes which allowed the initial equivalence for the subjects in the two groups to be achieved. The study was conducted in Afikpo North LGA of Ebonyi State, Nigeria. The population for the study comprised of all SS1 students in all the secondary schools within Afikpo North L.G.A.. The Sample for the study comprised of one hundred and twenty eight (128) SS1 students drawn from two secondary schools out of the twenty four (24) secondary schools in the Local Government. The two secondary (co-educational) schools were drawn through a simple random sampling. In each of the two schools, one intact class was drawn for the study through a simple random sampling. One school was



assigned to the treatment group while the other school was assigned to control group through a simple toss of coin. In all, 64 students were used for treatment group and 64 students were used for control group. This makes a total sample of 128 respondents. The instrument used for data collection was Biology Achievement Test (BST) which was designed to assess students' achievement in biology. The instrument was a 25 items multiple choice test which was developed by the researcher from the content that was covered in the study. The items were drawn using table of specification. The instrument covered concept of ecology, basic ecological concepts, the functioning ecosystem and energy transfer in nature. The instrument was subjected to both face and content validation. The instrument was face validated by two specialists in biology and in measurement and evaluation each from the department of science education in Ebonyi State University. A table of specification was used to subject the instrument to content validation as shown in appendix 1. The instrument also was subjected to test of reliability as it was administered to a trial group of 40 students who were not part of the study but were equivalent to the students in the study. The instrument was tested for internal consistency using K-R 21 approach. Result obtained showed reliability co- efficient of 0.76. Summary of the reliability assessment is shown in the appendix 2. Two instructional approaches were used for the study. The first approach was the problem-solving approach developed by the researcher. The second approach was the conventional approach. The two

approaches are identical in terms of content, basic instructional objectives and mode of evaluation. The only difference is in the instructional activities where problem-solving approach deviates from the conventional approach by employing principles, paradigms and theories during instructional process. The problem-solving approach was used for the treatment group while the conventional approach was used for the control group. The treatment and control groups were not selected from the same school, this is to ensure that the students in the treatment and control groups do not mix up in any way. This is to reduce the errors arising from interaction and exchange of ideas among research subjects from the two groups. Before the commencement of the study, subjects from both treatment and control groups were given the pre-test which is an alternate form of the biology achievement test. After the pre-test the regular biology teachers started the experiment in their respective schools adhering strictly to the lesson procedure developed during pre- experimental conference. The experiment was conducted during the normal school period and normal school timetable was followed. At the end of the experiment that lasted for four (4) weeks, the teachers administered post-tests to the subjects in the two groups. Data collected from the pre-test and post-test on achievement in biology were kept separately for the two groups and were used to answer the research questions and test hypotheses. Data were analyzed using mean, standard deviation and Analysis of Co- Variance (ANCOVA).



Results

Data obtained from the Biology achievement test administered to the subjects in both treatment and control groups were used to answer the research questions. Summary of the results obtained from the two groups is shown in table 1 below:

Table 1: Mean Biology achievement scores of students taught Biology with problem-solving and those taught with the conventional method.

Teach methods	Groups	N	Pre-test \bar{X}	Scores SD	Post-test \bar{X}	Scores SD	Means gain scores
Problem solving	Experimental	64	25.42	3.64	63.56	5.18	38.14
Conventional	Control	64	20.16	2.35	48.32	3.85	28.16

Summary of the result presented in Table 1 revealed that the mean gain scores of students for the experimental group is 38.14 and the mean gain scores for control group is 28.16. The two mean scores from the table tend to suggest that the students in the experimental group performed better academically than the students in the control group. This further suggested that problem-solving approach is superior to the conventional approach in fostering achievement in biology.

On the effect of the problem-solving instructional approach on achievement of male and female students in biology, the summary of result is shown in Table 2 below:

Table 2: Mean Achievement Scores of Male and Female Students Taught Biology Using the Problem-Solving Approach.

Teaching method	GENDER	N	\bar{X}	SD	Mean gain
Problem-solving	Male	28	13.46	1.85	0.44
	Female	36	13.02	1.94	



Summary in Table 2 revealed that the problem-solving approach yielded a higher achievement in biology among the males than for females. The mean achievement scores of male students is 13.46 with a standard deviation of 1.85 while the females had a mean achievement score of 13.02 with a standard deviation of 1.94. The problem-solving instructional approach is therefore more effective in fostering the achievement of males in biology.

On the interaction effect of gender and instructional approach on students' achievement in biology the adjusted mean for the two levels of gender who were taught biology with the problem-solving approach and conventional approaches was used to assess the interaction. Summary of the result is presented in Table 3 below:

Table 3: Interaction Between Gender and Instructional Approach on Students' Achievement in Biology.

Instructional Approach				
Gender	N	Problem-solving Approach (\bar{X})	N	Conventional Approach (\bar{X})
Male	28	0.36	30	0.18
Female	36	0.34	34	0.17

Summary of result presented in Table 3 revealed that there is no interaction between gender and teaching method on students' achievement in biology. This is so as seen from Table 3 that the performance of both males (0.36) and females (0.34) in the treatment group is higher than those of males (0.18) and females (0.17) in the conventional group. This indicates that the problem-solving approach is superior to the conventional approach at the two levels of gender (male and female).

The three hypotheses on the differences in achievements of students across methods and gender and the significance of interaction between method and gender were tested using analysis of covariance. Summary of the three hypotheses are presented in the tables below:

Table 4: Analysis of Co-Variance (ANCOVA) for Students Over-all Achievement Scores by Instructional Approaches.



Sources of variation	Sum of square	df	Mean square	F	Sig (p)	Decision
Problem solving	1843.52	2	921.76			
Conventional method	626.49	125	5.01	184.0	0.031	reject HO

From the hypothesis on differences across methods, the ANCOVA table shows that the F-cal (184.0) is greater than the critical value (0.031) at an alpha level of 0.05. The decision rule is to reject the null hypothesis if the calculated value is greater than the critical value at a given probability level. The null hypothesis is therefore rejected. The researcher concluded that there is significant difference in the mean achievement scores of students taught biology using problem-solving approach and those taught biology using the conventional approach.

Table 5: Analysis of Co-Variance (ANCOVA) for Over-all Achievement Scores by gender.

Sources of variation	Sum of squares	Df	Mean squares	F	Sig	Decision
Male	26.38	2	13.19			
Female	1956.85	125	15.65	0.84	0.98	retain HO

For analysis on difference across gender, Table 5 revealed that F-ratio (0.84) is less than the critical value (0.98) of F at df of 2 to 125 and at an alpha level of 0.05. Since the calculated value is less than the critical value at a given probability level, the null hypothesis is not rejected (upheld). The researcher therefore concludes that the difference between the mean achievement scores of male and female students taught Biology using the problem-solving approach is not significant.



Table 6: Two-way Analysis of Co-Variance (ANCOVA) of Interaction Between Gender and Instructional Approach.

Sources of variation	Sum of squares	Df	Mean square	F	Sig	decision
2 –way interactions:						
Gender	1983.23	2	15.87	0.09	0.26	Retain HO
Instructional Approach	1321.28	125	17.65			

For the test of significance of interaction, result in Table 6 revealed that for the two-way interaction the F-cal (0.09) is less than the critical value (0.26) at an alpha level of 0.05. This shows that the joint effects of gender and instructional approach on students’ mean achievement in biology is not significant. Based on the decision rule, the researcher upholds the null hypothesis and therefore concludes that there is no significant interaction between gender and instructional approach on students’ achievement in biology.

Discussions of Results

Result presented in Table 1 revealed that problem-solving approach enhances achievement in biology better than the conventional approach. With the conventional method the students had the mean gain scores of 28.16 while the problem-solving had the mean gain scores of 38.14. Summary of result in Table 4 shows that there is a significant difference in the mean achievement scores of students taught biology using problem-solving approach and those taught biology using conventional approach. This is in line with the works of Bichi (2014) and Adesoji (2008) who asserted that problem-solving gives room for student's full participation in the teaching and learning process thereby enhancing permanent learning and better achievement compared to conventional method which easily leads to boredom and forgetfulness in students. This finding is also in agreement with the works of Achimugu (1995), Babatunde (2008) and Ibiene (2009), which revealed that instructional method helps in imparting knowledge, skills, abilities and attitudes

expertly to facilitate students achievement.

From the results obtained and tested based on research question 2 and hypothesis 2, it is evident that the mean achievement of male and female students in biology is not significant. This means that the difference between the achievement of males and females in biology is not significant. This further shows that problem-solving produced the same effect on the mean achievement of the male and female students. The result of this study is contrary to the work of Olatoye and Atuwape (2004), which revealed that there is gender difference in the achievement of students in science subjects. Olatoye and Atuwape's study that provides gender disparity is against other studies which showed that problem-solving is not gender biased. This is due to the fact that problem-solving presents topics/concepts bit by bit, from known to unknown, shows meaningful relationships between concepts and promotes creative thinking in both male and female students. Problem-solving takes care of individual differences in the students and as well



reduces to the barest minimum the bore on the students when taught with conventional method. Hence, the findings of this study agreed with the findings of Onwioduokit and Akinyemi (2005), and Ibiene (2009), who observed that both males and females could do well in science if exposed to similar learning conditions.

The results obtained and tested based on research question 3 and hypothesis 3 revealed that there is no interaction between method and gender on students' achievement in biology. The result is supported by the work of Ukpai, Gabriel, Ebonyi and Ugama (2016) and Adeoye (2004), which yielded a similar result. Furthermore, the result is in line with the work of Ibiene (2009), who asserted that there was no significant difference when interaction effect of gender and instructional method was explored, showing that the males and females were affected positively by the method. However, the instructional approach (problem-solving) seemed to have provided an environment free from stress and dullness in which male and female students have achieved some level of equilibrium in biology. Problem-solving therefore, should be used for teaching both male and female students in biology.

Conclusion:

From the results obtained in the investigation into the effects of problem-solving instructional approach on students' achievement in biology, the researcher drew the following conclusions:

1. The problem-solving instructional approach is more effective than the conventional method in fostering achievement in biology

as the difference between the mean achievement for students in problem-solving group and conventional group is statistically very significant in favor of the problem-solving group.

2. Although with the problem-solving instructional approach, males show higher achievement than females. The difference in the mean achievements of males and females taught biology using problem-solving is not statistically significant.
3. There is no significant interaction between gender and instructional approach in students' achievement in biology for both males and females. The problem-solving approach is superior to conventional approach in fostering achievement in biology.

Recommendations

Based on the findings of the study, the researcher made the following recommendations:

1. Science teachers should be trained and encouraged on the use of problem-solving during classes in order to stimulate and sustain students' learning thereby enhancing achievement in biology.
2. The government in conjunction with curriculum developers and science teachers should procure science instructional materials based on the use of problem-solving in teaching science.
3. Textbook authors in biology should adopt the use of problem-solving in presenting materials in their books



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- COURTESY OF TETFUND (IBR) PROJECT 2020/2021.