Effects of Project and Inquiry Strategies on Students Achievement in Selected Abstract Concepts in Biology in Kwara State, Nigeria

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Abstract

This study determined the effects of Project and Inquiry teaching Strategies on students' achievement in Biology. The study adopted the pretest-posttest control group, quasi-experimental design. 120 SS II Biology students from six co-educational schools in two Local Government Areas (LGAs) of Kwara state were randomly selected. Participants were randomly assigned to treatment groups. The instruments used were: Biology Student Achievement Test (r=0.88) and Teachers Instructional guides on Project and Inquiry strategies. Two hypotheses were tested at 0.05 level of significance. Data were subjected to analysis of covariance Treatment had significant main effect on students' achievement in Biology ($F_{(2, 107)}$ =12.061; $p<0.05$, partial η^2 = 0.10) . Students' in Project strategy (PS) treatment group 1 has the highest adjusted mean achievement scores ($\bar{x}$ = 23.21) than those in the Inquiry Strategy (IS) treatment group11 ($\bar{x}$ = 17.81) and the students in Conventional Strategy (CS) control group group has the least adjusted mean achievement scores ($\bar{x}$ = 17.20). Based on the finding Project and Inquiry strategies should be adopted for the improvement of students' achievement in abstract concepts in biology.

Keywords: Project and Inquiry strategies, Achievement in Biology, Gender and Abstract Concepts.

Introduction

Biology is the science that deals with the study of varieties of living organisms including plants, animals and micro-organisms. The importance of biology in our daily lives lies in the fact that biology attempts to find out the unifying principles that exists among diverse organisms having morphological and functional inequalities.

Biology covers the study of all the living things and their interactions into the biosphere. This is a very important task because we are able to known the behavior or functioning of each population when it faces other individuals from other populations or the specific sectors of the biosphere that are affected and/or benefited by that behavior or functioning of the populations into a community. Adewumi and Ogundiwin (2021) reported that biology plays a crucial role in everyone lives and touches almost every aspect of our existence. The importance of Biology is showed virtually in all field of education such as agriculture, medicine, pharmacy. Ajagun (2001), Chukwuemeka, 2011, and Lawal, (2011) asserted that biology is a very important science subject that offer a basic requirement for further learning of a number of science related professional courses like medicine, agriculture, pharmacy, nursing etc.

Biology helps in the production of high yielding of varieties of crop plants and their diseases resistant varieties. Biology help in minimizing human suffering and curing of hereditary abnormalities like hemophila, and down's syndrome. Bibian and Sam (2007) reported that "the principles of genetics are applied in the field of medicine, agriculture and science. Chukwuemeka (2011) stressed the importance of biology that "a sound theoretical and practical knowledge of biology is very necessary for the management of our natural resources, provision of good health facilities for the masses, adequate food supply and favourable life environment.

Also, the contributions of the biologist are critical and dynamic in industries, technologies, crime detection, controlling of environmental pollution, diseases control, population control, and factual sciences (i.e. physics and chemistry).

In spite of the fact that biology curriculum has very good and reliable objectives, it appears that the subject is giving problems to the students. This fact has led to low or poor performance of the subject in West Africa Senior School Certificate Examination (WASSCE) and other examinations. Ndioho, (2007) reported that history of students poor performance on a large scale is not new in Nigeria. The entire nation is painfully aware that a growing number of students that experience schools failure are science students (Sandoval, 2003). Most candidate who attempted questions on genetic crossing could not illustrate it (Chief examiners report, 2012, 2013 and 2018). Okoli (2006) reports support the coverage to indicate that students achieve poorly in secondary school sciences. Okoli (2006) established the fact when he reported that "available statistics from the West African Examination Council (WAEC) on Senior Secondary School Students performance in biology reveals that it recorded a very poor performance at SSCE Examinations".

The pattern of students achievement in Senior School Certificate Biology Examination conducted by WAEC for the past ten years revealed that within the period of ten years there were only two consecutive years that students pass percentage in biology rise above 40% (44%-48%) 20013, and 2016. There is no year that students performance rises above 50%. Uloma (2003) analysis of 1998-2003. Science result of Ebonyi State Secondary Schools reveals that candidates performance was worst with 49.1% passes. Ihejirika (2010) reported from his analysis of ten (10) Senior Secondary School Certificate Examinations biology result for the (2005-2009) that the "highest pass rate was 47% recorded from a school. The table above also showed that students achievement in eight years (2004, 2005, 2007, 2008, 2009, 2010, 2011 and 2012) were below 40%. Ukaegbu (2006) reported that only 34%, 32% and 35% of the entire candidate who participated

in the West Africa school certificate examination in 2001, 2002 and 2003 respectively obtained five credits and above. Ihejirika (2010) states that a school scores 37% while the other nine schools score percentage fall between 1.3% -18.6%.

Researche has revealed that effective teaching methodologies can bring about positive attitude of students towards a subject. Adeyemo (2001) asserted that students' academic performance can be influenced through the teachers' resourcefulness, interest in the subject area, attitude to work, creativity and interaction with the students. Various instructional techniques are employed to pass knowledge to students in the schooling process. It includes demonstration, problem based learning, lecture, discussion, practical, pictorial, mastering and excursion methods. The most enjoyable aspect of teaching and learning can occur when a variety of teaching methods are used. Agboola and Oloyede (2007) reported that experimental learning increases retention motivates students to learn and encourages group co-operation.

Olatayo and Agboola (2010) suggested the use of project strategy. The ordinary meaning of project is plan or scheme. Project strategy is a systematic teaching strategy that engages students in learning knowledge and skills through an extended inquiry process structured around complex, authentic questions and carefully designed products and task Olatoye and Adekoya (2010). The project strategy of teaching involves assigning a particular work to students to do and complete out of his/her/ their spare time and report back to the teachers as at when demanded. There are two type of project methods they are group and individual project method.

This research work is embarking on group project strategy and individual project method. Group project strategy is based on simplicity, yet sound principle. We learn physical or mental skills by actually performing those skills under supervision. An individual learn to write by writing, to weld by welding, and to fly an aircraft by actually performing flight maneuvers. Students also learn mental skills, such as speed reading by project method. Skill requiring the use of tools, machines and equipment are particularly well suited to this particular instructional (project) method. The group project strategy provides an excellent opportunity for the complete act of thinking by the students. Project strategy is a teaching strategy in which students acquire knowledge through the planning and execution of practical projects which may exist at individual and group levels respectively. It is an intentional process of diagnosing problems, critiquing experiments, distinguishing alternatives, planning investigation, researching conjecturies, searching for information, coherent arguments Linn, Davis and Bell (2004). Anderson (2002), Hages, (2002), expressed their view on both inquiry and project strategies stated that "inquiry is often conflated or used interchangeably with other terms that describe similar learning and teaching approaches such as hands-on, problem based, project based, students centred, inductive and dialogic approaches. In group project strategy students have occasion to define the problem, plan his work, find appropriate resources, carryout his plan and draw conclusion. Project strategy seems to have the components to motivate teachers and students to develop a cooperative work mainly aiming at the students to perceive and understand all the necessary stages required to arrive at logical conclusion Biajone (2006).

Inquiry strategy is another active strategy that can improve students' achievement in science class. Inquiry strategy is a student centered and teacher guided instructional approach that engage students in investigating real world questions that they choose within a broad thematic framework. Inquiry is a style or strategy of teaching where the learner with minimum guidance from the teacher seeks to discover and create answers to a recognized problem through procedure of making a diligent search. According to Sola and Ojo (2007), inquiry strategy is a way people learn when they are left alone. Katja (2011) and Abd-el-khalick et al, (2004) reported that nowadays the acronym inquiry based learning (IBL) is treated as a key to solving problems which exist in science and math's education as well as in other subjects on a global level. Inquiry is often widely used in other term such as inquiry based teaching and inquiry based strategy without clarifying connections and distinctions Katja, (2011). Eric (2012) reported that teaching science through inquiry is the cornerstone of good teaching because it stimulate excitement among students when learning science. Inquiry is a term used in science teaching that refers to a way of questioning, seeking knowledge or information or finding out about phenomenon. It involves investigation, searching, defining a problem, formulating hypothesis, gathering and interpreting data and arriving to a conclusion. Inquiry strategy opposed traditional methods where the teacher takes a dominant didactic role delivery science interaction to students through lectures, demonstration, expository and text reading. To overcome traditional method of teaching teacher needs to shift to learner centred method of teaching by given assignment which challen+ge the learner imagination in as many as possible.

Gender refers to the amount of masculinity and feminity found in human beings. The normal man has preponderance masculinity and normal female has preponderance feminity Bichi (2002). Most studies show that on average girls do better in school than boys, girls get higher grounds and complete high school at a high rate compare to boys Jacob (2002). standardized achievement tests also show that female are better at spelling and perform better on tests of literacy writing and general knowledge (National Center for Education Statistic (2003) and Umoniyang (2002) showed that achievement in secondary school science subjects could be influenced by gender, cognitive style and attitude. It has been reported that there are sex differences in specific ability performance of students. It was reported above that girls are better in spelling, writing and other knowledge in contrast to this Lucy

and Nkoyo (2000) and Okeke (2001) showed that women were not only under-represented but their levels of achievement in the fields of sciences and technology where low compared to the males. In recent years many research have been carried out on gender related issues. Such studies suggested that by the age of eleven many young star demonstrated a stereotyped behavior and attitudes Agboola and Oloyede (2007).

Statement of the Problem

The prevailing poor outcomes of students in biology every year in Senior School Certificate Examination suggests that the instructional strategies employed by teachers were inappropriate. These strategies did not help students learn and develop the ability to think critically and show a high degree of independence that is required for students to identify resources and communicate effectively. Thus, this study determined the effect of project and inquiry strategies of teaching on the understanding of certain abstract concepts in Biology and consequently improve the achievement in Biology. The moderating effect of gender was also examined.

Hypotheses

To guide the study, two null hypotheses were formulated and tested at 0.05 level of significance.

$H0_1$: There is no significant main effect of treatment on students' achievement in Biology

$H0_2$: There is no significant main effect of gender on students' achievement in Biology

Methodology

This study adopted the pretest-posttest control group quasi-experimental design. The multi-stage stratified sampling procedure was adopted. There were three senatorial district in Kwara State. A simple random sampling procedure using the table of random numbers was adopted for the selection of senatorial districts, local government, town, and schools. A judgmental procedure was used for selecting six (6) schools from two local government areas The six schools were randomly assigned to treatment and the control groups. Intact classes of the representative schools were used for the research.

Research Instruments

Five instruments were used in the study. They include;

1. Biology Students Achievement Test (BSAT)
2. Teachers Guide on Project Strategy(TGPS)
3. Teachers Guide on Inquiry Strategy(TGIS)
4. Teachers Guide on conventional Strategy(TGLS)

Research Procedure

The researcher administered the instruments to pre-test the students and their scores were recorded. The researcher exposed the experimental group I and 2 to abstract concepts (evolution and molecular Biology) using group project and inquiry strategies for eight weeks. The control group was subjected to conventional strategy for eight weeks.

Method of Data Analysis

Analysis of data collected in relation to this study was done using descriptive statistics (mean, standard deviation) including Bar charts to explain the mean distribution of various groups. The data was also analyzed using inferential statistics of Analysis of Covariance (ANCOVA) of the posttest scores, with the pretest scores as covariates. Multiple Classification Analysis (MCA) was used to determine estimated marginal means of different groups. Scheffe post hoc test was used where significant mean effects were obtained. Line graph were used to explain the significant interaction effects.

Results

$H0_1$: There is no significant main effect of treatment on students' achievement.

Table 3. Represents the summary of ANCOVA results on subjects' post test achievement scores.

Table 2: 3 x 2 x 2 ANCOVA of post-test achievement scores of students by treatment, mental ability and Gender

Source	Sum of Squares	DF	Mean Square	F	Sig.	Eta squared
Corrected Model	1749.922	12	145.827	8.727	.000	.495
PREACH	31.183	1	31.183	1.866	.175	.017
Main Effect: Treatment Group	403.061	2	201.530	12.061	.000*	.184
Mental Ability	75.354	1	75.354	4.510	.036*	.040
Gender	26.390	1	26.390	1.579	.212	.015
Error	1787.945	107	16.710			
Total	47468.000	120				
Corrected Total	3537.867	119				

* Significant at P< 0.05

Table 2 shows that there was a significant main effect on treatment on the Academic Achievement of the Students in biology ($F_{2, 107}$) = 12.061 P<.05,η^2 = 0.184). The effect size of 18.49% was fair. Therefore null hypothesis is rejected. This means that there was a significant difference in the mean achievement scores of subjects exposed to treatment on the basis of these findings, hypothesis 1a was rejected. To find out the magnitude of the mean scores of the group's performance the table 3 is presented as follows:

Table 3. Estimated Marginal Means of Posttests Achievement Scores by Treatment and Control Group.

Treatment	**N**	Mean	Standard Deviation
Project strategy	34	23.21	3.01
Inquiry strategy	46	17.81	.5.01
Conventional	40	17.20	.5.80

Table 3 revealed that students in Project Strategy Treatment Group has the highest adjusted mean achievement scores ($\bar{x}$ = 23. 21) followed by the Inquiry Strategy Treatment Group ($\bar{x}$ = 17.81) while students in the Conventional Strategy Group has the least adjusted mean achievement scores ($\bar{x}$ = 17.20). Further, the source of the significant difference obtained in Table 4 was traced using Scheffe post-hoc test.

Table 4. Scheffe Post-hoc Tests Analysis of Post-tests Achievement Score According to Treatment Group.

Treatment	N	Mean	Project strategy	Inquiry strategy	Conventional strategy
Project strategy	34	23.21		*	*
Inquiry strategy	46	17.81	*		*
Conventional strategy	40	17.26	*	*	

Pairs of groups significantly different at P <0.05

The result form post-hoc analysis in Table 4 revealed that group 1 (project strategy) was significantly different from Inquiry and conventional strategies in their achievement scores. Inquiry strategy was significantly, different from project and conventional strategies in achievement scores. These reveals that the direction of increasing effect of instructional strategies (treatment) on abstract concept achievement was conventional strategy not performing better than Inquiry strategy, Inquiry strategy not performing better than project strategy.

H02: There is no significant difference in male and female students' achievement.in Biology

Table 2 revealed that gender had no significant main effect on the academic achievement of the students' ($F_{(1,107)}$) = 1.579 P< 0.05. partial eta square (η^2) =0.015. The effect size of 1.5% was fair. Therefore, hypothesis 3a was not rejected.

Table 5: Estimated Marginal Means of Post Test Achievement Scores by Gender

Gender	N	Mean	Std deviation
Male	50	21.9406	4.1325
Female	70	17.1286	5.4185

Table 5 male students' had higher mean = 21.9400 while the female students had a lower mean = 17.1286. But the difference was not significant.

Discussion of findings

Main Effect of Treatment on Students' Achievements in Biology

There was significant differences in the effect of treatment on achievement on students exposed to project strategy and Inquiry strategy as shown in Table 2. The findings show that both strategies (project and Inquiry strategies) enhanced students' achievement over and above the conventional strategy. This result suggests that the project strategy effectively disseminated the achievement of learners exposed to it than those exposed to Inquiry strategy and conventional strategies. These may be attribute to the systematic and organized nature of the project and Inquiry strategies developed and implemented in the course of the research study in which the learners where allowed to engage in various learning activity that enabled them to find out and develop their own knowledge of the abstract concepts individually or in groups and use their thinking skills for planning, execution, evaluation, reporting and recording. They also formulated hypothesis, gather materials, record and analysis data and draw conclusion on the lessons all by themselves with minimal teacher interference. Inquiry strategy when compared with conventional strategy by Akinwumi (2009) analysis showed that Inquiry strategy was more effective. The findings further showed that Inquiry strategy contributed significantly to a better understanding of biological abstract concepts by students than their counterparts treated with conventional strategy. This study is in

support of Nwagbo (2001) and Suleeiman (2011) who found that the guided Inquiry strategy of teaching biology enhanced achievement better than the conventional strategy.

The poor performance of the conventional strategy in the post test achievement mean score when compare with the other treatment groups meant scores may not be unconnected with the fact that the group was exposed to the strategy which is teacher-centered conventional strategy to only allow students to listen passively, with little or no interaction with the teacher's mean while low achievement in conventional strategy repeats itself in this study as it was in the findings of Okolo (2006) Akinwumi (2009), martins and Oyebanji (2000), Olatoye and Adekoya (2010), Suleiman (2011) and Ogundiwin (2013). This is because conventional strategy often compels learners to the passive recipient position of fact subjected down to (him/her) by the teachers.

Gender and Students' Achievements

The study showed that gender has no significant main effect on students' achievement. That is, gender had no influence on achievement. Some researchers reported that there is significant effect of gender on the achievement of students, however, the finding of this work disagree with research findings of Njoku 2002 Inyang and Hannah (2000), Ukwungwu (2002) and Okebukola (1992) that established significant differences of treatment and gender on students achievement. This finding is in mutual agreement with the findings of Ogundiwin (2013), Akinwumi (2009) Ajiboye (1996), Ige (1998) Olagunju (1998) and Bora (2003) who found that gender did not have a significant main effect on students achievement. The reason was that both male and female were given the same opportunity to participate actively in the classroom activities which were the function of the two strategies (project and Inquiry). The strategies disallow discrimination or gender marginalization.

Conclusion

The findings There was a significant difference in the effect of treatment on achievement. This finding suggests that both strategies (project and Inquiry strategies) promoted students achievement. Meanwhile practicing teacher will be more competent and effective in delivering their services when trained with project and Inquiry strategies for teaching and learning abstract concepts in biology, the students achievement will highly improved. Also, these strategies encouraged students to take control of their learning in the classroom.

Recommendations

Based on the results and discussion, the following recommendations were advanced

(1) Project and Inquiry strategies should be adopted as viable strategies for studying abstract concepts in biology. This will enable students to be problem solvers, there by leading to improvement in the achievement of students in abstract concepts in biology.

(2) The teacher training curriculum at all levels of education should be upgraded to the education that is related to the real life situation by incorporating (activity innovative pedagogical strategy based instructional strategies such as project and Inquiry strategies.

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