

Comparative Effect of Three Innovative Instructional Strategies on Academic Achievement of Students in Biology

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Abstract

The study determined the comparative effect of three innovative instructional strategies on achievement of students in biology. Two research questions and two null hypotheses guided the work. The study was conducted in Obollo Afor education zone of Enugu State. Four single sex schools out of seven, drawn through purposive random sampling techniques were used for the study. Two of the schools were for females while the other two were for males. The instrument for data collection was Biology Achievement Test (BAT). Three intact classes which were assigned to co-operative, competitive and individualist groups were used for the study. The sample consisted of three hundred and sixty (360) SSII Biology students. Means and standard deviations were used to answer the research questions while ANCOVA was used to test the null hypotheses at the 0.5 level of significance. The study revealed that the three innovative instructional strategies, co-operative, competitive and individualistic, enhanced achievement of students in biology. It also showed that the average scores for boys were consistently higher than that of girls in the three groups. Recommendations were made based on the findings of the study.

Key words: Innovative, Instructional, Strategies, Achievement, Students, Biology.

Introduction

The 21st knowledge economy promises a global competition in all spheres of life and human endeavors and only individuals or nations that are prepared for these competitions would thrive successfully. One of the ways nations can survive the compelling competition requires the use of appropriate instructional strategies in teaching and learning. The fast-growing trends of science and technology in Nigeria demands that innovative strategies be designed and implemented for effective teaching and learning of science subjects in schools. Ideally, the need for science and technology as potent tools for sustainable development cannot be over emphasized. Biology as school science subject is essential for science and technological advancement, for instance, in areas of manufacturing, processing, food production, medicine and pharmaceuticals. Also, credit pass in biology is required for qualification for candidates wishing to study medicine, agriculture, medicine, pharmacy, and other allied courses.

Of more concern, however, is that despite the importance of biology in all spheres of life and in the development of science and technology, research has shown that in Nigeria the academic achievement of students in the subject is low (Ekon, 2011, Okeke 2007, Obiekwe, 2008, Moris, 2006, Okoro, 20011, Nwagbo and Okoro (2012), Okoro, 2018) and the consistency is revealed by the senior school certificate Examination (SSCE) results from 2009- 2013.

Table 1: Percentage distribution of students’ performance (in grades) in Senior Secondary Certificate Examinations (SSCE) in biology in Nigeria from 2009 – 2013.

Year	A	B	C	ABC	D	E	F
2009	3.6	22.7	32.8	59.1	25.8	9.9	5.0
2010	3.1	26.5	33.0	62.6	23.3	8.7	4.5
2011	2.2	20.6	36.5	59.3	27.6	9.1	3.7
2012	1.3	17.9	39.2	58.4	28.2	9.4	3.5
2013	2.1	21.6	34.8	58.5	28.1	9.2	3.6

Source: Statistics Section, West African Examination Council (WAEC) National Office, Onipanu, Lagos, Nigeria.

Table 1 shows that the number of credit passes and above (ABC) in biology has consistently fallen below 59% for the period of five years reviewed. Although grade D and E are considered to be passes, these grades are not considered high achievement for candidates to gain admission into tertiary institutions.

Academic achievement is high when an individual excels and performs exceptionally well in his or her academic activities. But when a child performs poorly in his or her academic activities by scoring low marks (Ugwuanyi, 2015), academic achievement is said to be low. Some of the major reasons for low academic achievements of students in biology that have constantly appeared in the literature include large class size, school timetabling, voluminous curriculum contents, students' learning styles and use of ineffective teaching strategies by biology teachers (Okeke, 2007, Nwagbo and Okoro, 2012, Okoro 2018).

Academic achievement of students in biology may as well vary based on individual ability or gender. Gender according to Uguadu, (2011), is a broad analytical concept which draws out men's roles and responsibility in relation to those of women. Nworgu as cited by Okoro (2011) reported a significant difference in academic achievement in biology in favour of female while Brick House, Lowery and Schultz as cited in Akalonu (2002) reported that male students have higher academic achievement in biology than their female counter parts. The study contended that the more masculine the branch of science is (eg. Physics, biology, chemistry) the less likely it is that girls will do well. However, Ojikezie in Ugwu and Nzewi (2015) found out that there is no significant difference in achievement of male and female students in biology. Okoro (2011) opined that significant differences are not found in academic achievement in biology in respect to gender and argued that gender is not significant factor but the way the students were taught, the materials and teaching strategies employed by teachers.

Albeit, the declining level of students' achievement in the subject could be attributed to these factors, among others, further research is still needed in order to salvage the teaching and learning of biology in Nigerian schools. Granted that solutions so far proffered in the past research studies have not adequately solved the problems or too insufficient to rely upon, innovative instructional strategies need to be employed. Instructional strategies include those methods or carefully selected classroom instructions that could be employed by the teacher to teach a particular topic in a subject area. Oyelekan, Igbokwe and Olorundare (2017) described innovative strategy as a design that is full of new or purposively alternative instructional approach that could stimulate students' interest and enhance their achievement.

Recent Empirical studies have indicated that some of these innovative instructional strategies have significant roles to play in terms of students' achievement. Oyelekan, Igbokwe, Emoyoke and Olorundare (2017) compared teachers' utilization of innovative for teaching senior school science in Ilorin and found out that innovative instructional strategies enhanced academic achievement of students. Similarly, Okoro (2011) investigating effect of interaction patterns on achievement and interest in biology reported that innovative instructional strategy appears to be very effective instructional approach in teaching and learning biology.

Several innovative instructional strategies have been designed and used by many educators in teaching and learning process. Some research studies identified innovative instructional strategies as co-operative, competitive and individualistic approaches (Nwagbo and Okoro, 2012), concept mapping, co-operative learning, and learning cycle (Ajaja, 2013), group-based learning, active learning assessment- based and organizational or classroom engagement (Christine, 2018). While this isn't by any means an exhaustive list, the innovative instructional strategies of interest to the researcher in the present study include competitive based instructional strategy; group based and individualistic based instructional strategies

Competitive learning refers to learning situation in which individual students' performance is not related to any participant or any member of the class. It is a social situation in which the goals of separate individual are negatively correlated Johnson (in Okoro, 2011). Competitive learning exists when one student goal is achieved but all other students fail to reach that goal (Johnson & Johnson cited in Oloyede, Adebowale & Ojo (2012). In competitive learning, an individual between individual or between groups are usually involved. Members of each subgroup strive to outperform the other group for a reward. In this arrangement, the teacher verbally encourages individual's effort; makes sure that students sit apart from each other. Nwagbo and Okoro (2012) admitted that competitive learning enhances academic achievements of students. Introducing competitive instructional strategy into the classroom brings shift in students' attitude. It gives the students an air of importance and motivates them to perform better especially when rewards are attached to it (Okereke & Ujuegbulam, 2014).

Major limitation of this practice is that it tends to promote anxiety level of students. In class that is highly competitive the high achievers tend to be proud and the low achievers withdrawn leading to state of no

motivation. Moreover, the attitude of survival of the fittest could lead to antisocial behaviour. However, moderate competition among children seems generally to increase their efforts. Situations where each student is asked to compete against himself and increase his own score may be useful and generally harmless. This suggests that teachers should constantly present to students challenges which bring about activity and stimulate learning. When challenged he is, therefore, likely to strive harder or to adopt activities that could increase his output of work.

Group based instructional strategy on the other hand involves group of students working together, seeking help and clarification from fellow members rather than from the teacher. The members are of diverse ability, radical, dull, introverts, bullies, yet they work together to maximize their own and each other's learning. Here, the individual's rewards are based on the quality of the group outcome (Okoro, 2011). It promotes the communication of pre-social behaviour (Borich, 2004), actively engages students in the learning process that seeks to improve the critical thinking, reasoning and problem-solving skills of the learner (Bramlett, Megnim, Webb, Trooper and Fall as cited in Ajaja (2013). For instance, when children are given opportunities to play together, when they are encouraged to discuss their problems, and when techniques are used to foster oral communication, unity in the class group will be heightened. In this strategy, one would expect a number of characteristics which indicate high cohesiveness, co-ordination of effort, diversity of amount of contribution and attentiveness to follow members.

Unfortunately, Group based instructional strategies also has its short comings. Brtsch (2017) outlined three disadvantages of using co-operative learning such as group dynamic dilemma, uneven workloads and classroom management challenges. That notwithstanding, group based instructional strategy is said to bring about a significant difference in academic achievement among students when compared with others of competitive and individualistic learning approaches (Oloyede, Adebowale & Ojo,2012). Eyayu and Muchie (2018) opined that Group based instructional strategy strictly intended to promote knowledge construction through higher-order thinking.

In individualistic innovative approach, there is no correlation among the goal attainment of the participants. Whether an individual accomplishes his or her goals has no effect on whether other participants achieve their goals (Johnson & Johnson as cited in Nwagbo & Okoro, 2012). In this situation as the word individualistic suggests, individuals are rewarded on the basis of quality of his or her work independent of the work of other members of the class. This implies that the students in this category work independently at their own pace, avoiding interaction with the other participants, he/she seeks help and clarifications if need be from the teacher. However, individualistic instructional strategy, to some extent enhances students' academic achievements. According to Okoro, (2011), this strategy encourages independent study and gives the greatest assurance of maximum participation in the learning process.

Statement of the problem

The reviewed studies in respect to the three innovative learning strategies have shown varied impact on academic achievements of students in different subject areas. The researcher, however, argued that the inability of teachers to engage students in innovative, learner-centered instructional strategies in biology classrooms in Nigeria may account for students' poor academic achievement in biology. Evidence has shown gross underachievement of students in biology over time which has generated great concern among educationists, psychologists and the general public. Some reasons for poor performance in biology as suggested by past studies include the ineffective teaching methods used by teachers. Many more of similar factors are responsible for these ugly trends which have not been adequately addressed. In view of the above, the researcher intends to investigate the comparative effects of competitive based; group based and individualistic based instructional strategies on students' academic achievement in biology. Given the goals of this study the following research questions were posed to guide the study.

1. What is the comparative effect of the three innovative strategies on the mean achievement scores of students in biology?
2. What is the comparative effect of the three innovative instructional strategies on the mean achievement scores of male and female students in biology?

Research method

The design of this study is quasi-experimental. Specifically, it is pre-test, post-test, non-equivalent control group design. The study involved the use of intact classes to ensure that regular class period was not altered. A pre-test

was employed to determine initial group equivalence and control for selection bias. This design has been adopted in recent studies by Adene et al (2021), Ejimonye et al. (2020a, b), Njoku et al. (2020), Offordile et al. (2021), Adonu et al. (2021). The target population of the study consisted of all the senior secondary class two (SS2) biology students in the public secondary school located in Obollo Afor education Zone of Enugu State in the 2019/2020 academic session. There are forty-eight (48) public senior secondary schools in Obollo Afor Education zone in Enugu State.

The sample consisted of three hundred and sixty (360) SSII students from four schools out of 48 public secondary schools in Obollo Afor Education zone of Enugu State. Purposive and random sampling techniques were used for this study. Four (4) single sex schools (2 male and 2 female) were purposively sampled because these schools had up to three streams of SSII.

Two null hypotheses guided the study: H_{01} : There is no significant comparative effect of the three innovative strategies on the mean achievement scores of students in biology, H_{02} : There is no significant comparative effect of the three innovative strategies on the mean achievement scores of students in biology

Biology Achievement (BAT) was used as instrument for the study. The instrument consisted of a 24 multiple choice objective tests developed by the researcher using past WAEC question papers and biology textbooks. The measuring instrument was based on the following five (5) biology contents: Photosynthesis, mineral requirements of plants, food substances and test for food substances. From the list of topics and expected behavior outcome, the researcher built a table of specification from which the items for BAT were generated.

Experimental procedures

The regular biology teachers were trained using the training manuals developed by the researcher; one manual each for group instructional strategy, competitive learning strategy and individualistic learning strategy. The training manuals specifically defined the steps and stages involved in using each method and the specific activities in each stage. The researcher engaged the regular teachers on practice and generation of ideas on how to apply each method in the teaching of the selected contents. The training came to a close when the researcher was convinced that the biology teachers trained can accurately apply the strategies in teaching the selected concepts.

A week before the commencement of treatment, all the participating Biology teachers were given extracts which contained the five (5) Biology contents in the five-week instructional unit. The extracts were taken from Modern Biology for Senior Secondary Schools by Ramalingan (2008) and Biology; Principle and Exploration by Johnson and Raven (1998). Lesson plans were written on each of the concepts (one week for each concept) in the five (5) week instructional unit using the three methods teaching formats. The lesson plans were given to the specific teachers assigned to each class. This was done to ensure that all the instructional presentations followed the recommended formats for the designated classes. The lesson plans specified both the teachers' and students' activities during instruction.

. Three instructional approaches were employed, namely, group based instructional strategy, competitive instructional and individualistic instructional strategies. The three approaches were identical in terms of content coverage, time and mode of evaluation. The only difference was the instructional activities.

In co-operative class, the teacher gave the students tasks to perform (after dividing them into four or five groups). The students were allowed to share ideas and findings as members of the group. The teacher went round defining and explaining some concepts. In the end, the groups were rewarded based on the group performance. In competitive class, instructional activity was the same except that students did not share skills or ideas or communicated during the course of instruction. In individualistic class, students were not divided into groups as in co-operative and competitive classes. Students were made to work alone as a member of the class without co-operating or competing with one another. Students were rewarded according to individual performance and not as a group.

The group based, competitive and individualistic innovative instructional strategies were compared in terms of effects on achievement of students in biology. Each variable served as control to the other. The teachers administered pre-test and post-test before and after instructions respectively. Test items for the posttest were reshuffled and printed on the coloured paper to give it a different look.

Results

The results are presented according to the research questions and the hypotheses.

Research Question One; what is the comparative effect of three innovative strategies on the mean achievement scores of students in biology?

Data for answering research question 1 is presented in Table 3.

Table 2: Mean Effects of the Three Innovative Instructional Strategies on Students’ Achievement in Biology

Experimental Group				Pretest	Post-test	Achievement gain
Group based instructional strategy			Mean	10.7500	16.0500	5.3000
			SD	2.92555	3.08929	
Competitive based instructional strategy			Mean	10.0500	12.1917	
			SD	2.5333	2.26146	
Individualistic based instructional strategy			Mean	9.9750	11.7500	2.1417
			SD	2.68661	2.47424	
						1.7750

The results in Table 2 show that group, competitive and individualistic innovative instructional strategies with gain scores of 5.300, 2.14 and 1.77 respectively enhanced learning, judging from the pre-test results.

The results also indicate that group instructional strategies with mean achievement gain score of 5.3 enhanced learning more than the competitive instructional strategies with achievement gain score 2.1417. The individualistic instructional strategy was the least in enhancing learning with mean achievement gain score of 1.7750.

Research Question Two: what is the comparative effect of three innovative instructional strategies on the mean achievement scores of male and female students in biology?

Table 3: Achievement Scores of Male and Female Students in Biology due to the Group, Competitive and Individualistic based Instructional Strategies.

Experimental	Gender	n	Pretest mean	Post-test mean	Standard Deviation
Group based instructional strategy	Males	60	12.2131	17.3833	5.17
	Females	60	10.6417	14.7167	4.08
Competitive based instructional strategy	Males	60	10.7648	13.2667	2.50
	Females	60	8.0461	11.1167	3.07
Individualistic based instructional strategy	Males	60	9.4229	12.8500	3.43
	Females	50	10.1332	10.6500	4.52

The results as presented in Table 3 show that in each of the three approaches, male students performed higher than their female counterparts. In addition, both male and female students in group based instructional strategy score higher than those in competitive and individualistic groups.

Ho₁: There is no significant comparative effect of the three innovative strategies on the mean achievement scores of students in biology.

Table 4: Analysis of Covariance (ANCOVA) of Students’ overall Achievement Score due to the three Instructional Strategies and Gender (used to answer H_{o1} and H_{o2})

Source	Sum of Squares	DF	Mean Squares	F-Value	p
Corrected Models	2543.2229	6	424.870	117..550	.000
Intercept	1014.592	1	1014.592	281.467	.000

Pretest	703.141	1	703.141	195.065	.000
Experimental	1053.149	2	526.575	146.065	.000
Gender	55.867	1	55.867	15.498	
Expt. Gender	9.699	2	4.850	1.345	
Error	127789.000	353	3.60		
Total	67789.00	360			
Corrected total	3815.66	359			

The results in Table 4 indicate that there is a significant difference in the mean achievement scores of students subjected to the three instructional strategies. This is indicated by the calculated F value of 146.065 which is at 0.05 level of significance. Thus, the null hypothesis of no significant difference is not accepted.

The second hypothesis states that “there is no significant difference in the mean achievement scores of male and female students in biology due to instructional strategies” Results in table 5 also confirmed that there is a significant difference in the mean achievement scores of male and female students due to instructional strategies. This is indicated by the calculated F value at 15.498 which is significant at 0.05 levels of significance. Therefore, gender is a significant factor in students’ achievement in biology due to instructional strategies. The null hypothesis of no significant difference in the mean achievement scores of male and female in biology due to instructional strategies is rejected. However, to determine the source or direction of a significant effect a multiple comparison analysis was conducted using Scheffe test.

Discussion of the Findings

Results in Tables 2 and 3 show that students in the co-operative groups had significantly higher gain scores than students in competitive and individualistic groups. Students in competitive group had slightly higher gain achievement score than those in individualistic group. Although it was shown that the three instructional strategies enhanced achievements in biology, the results tend to favour group instructional strategy more than the other groups. This agrees with the findings of Ahaneku as cited in Okoro (2011) which stated that co-operative learning is considerably more effective than competitive groups. The higher achievement gain score may have been because each student sees himself or herself as being partner in the problem-solving process. This boosts morale thereby promoting effort in the learning process.

The result also indicates that gender is a significant factor in students’ achievement in biology due to instructional strategies. The result also shows that the scores of the male students in the three instructional strategies are consistently higher than that of their female counterparts. This finding agrees to a large extent with research work by Stabery cited in Nwagbo and Okoro (2011) on achievement of male and female students in biology due to instructional strategies. Possible explanations of gender differences in achievement of male and female students in relation to innovative instructional strategies could be as a result of unequal social environment in which the male and female students are asked to operate. Evidence has shown that girls are not allowed to be adventurous like boys, so girls do not have confidence in solving problems like boys. This situation is likely to affect the problem-solving skills such as manipulative skills, creative thinking, self-confidence and logical reasoning ability.

Conclusion

All in all, results of the present study suggest that the use of innovative instructional strategies can make differences in students’ academic achievement in biology. Result of the findings revealed that (1) the three innovative instructional strategies enhanced academic achievements of students in biology (2) students who were exposed to group instructional strategy had better achievement than those students in competitive and individualistic groups. (3) the mean achievement scores for boys were consistently higher than that of girls in the three groups.

It could be correct then to posit that the use of innovative instructional strategies, though more challenging and activity packed strategy, makes learning in biology classroom fun and exciting. In order to foster academic achievements in biology, it is recommended that Ministries of Education (Federal and State) in conjunction with education Institutions in the country should organize seminars and workshops to keep biology teachers abreast with the application of innovative instructional strategies. Teachers should endeavour to make teaching more learner-centered by encouraging co-operation and teamwork among learners. This will promote achievement in science subjects, including biology.

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